VOICES AND VISIONS OF MAUNA KEA

MAUNA KEA SCIENCE RESERVE MASTER PLAN AND IMPLEMENTATION PROCESS SUMMARY

"Mauna Kea kuahiwi kū ha'o i ka malie"
(Mauna Kea is the astonishing mountain that stands in the calm.)
—Pukui 1983: No. 2147

"It will afford me unfeigned satisfaction if my kingdom can add its quota toward the successful accomplishment of the most important astrono-mical observation of the present century and assist, however humbly, the enlight-ened nations of the earth in these costly enterprises . . ."
—King David Kalakaua

"After all, the ancient Hawaiians were among the first great astronomers, using the stars to guide them among the islands in the vast Pacific, centuries before anyone else had developed such skill. Long before Europeans and mainlanders, Hawaiian astronomers were studying the heavens with awe and wonder, the same feelings that draw modern astronomers to study the heavens. At this very deep level, I feel we are brothers and sisters."
—Frederic Chaffee,
Director, W.M. Keck
Observatory

PREPARED BY THE UNIVERSITY OF HAWAI'I
MARCH 2000

EXHIBIT A-48

INTRODUCTION

DOCUMENT PURPOSES

1. To provide an educational tool for broad public dissemination to further an understanding of the master plan and its process, including steps and challenges for implementation of the plan.

2. To focus on the physical, management and implementation aspects of the Mauna Kea Science Reserve Master Plan.

3. To make a distinction between the master plan as a policy framework, and the implementation process that will occur after the master plan is adopted.

4. To incorporate and respect the voices and visions of various parties who have been involved in the planning process.

MASTER PLAN GOALS

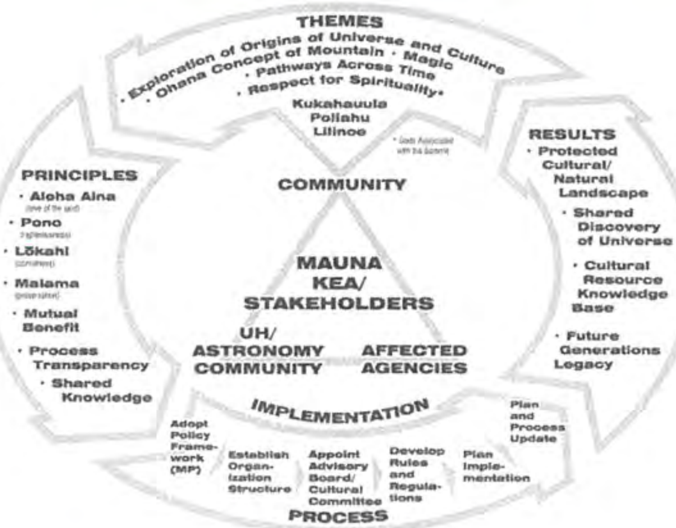
To update the 1983 Mauna Kea Science Reserve Complex Development Plan by:

1. Developing a vision for the sustainable use and enhancement of the Mauna Kea Science Reserve as a Hawaiian place with significant and unique cultural, natural, educational/research and recreational values, meanings and potentials, both locally and globally.

2. Integrating and balancing cultural, natural, educational/research and recreational values and uses in a physical and management plan which will remedy existing problems and provide a framework and structure for the responsible and sustainable stewardship of the Mauna Kea Science Reserve.

MASTER PLAN CONCEPT

The graphic below provides an integrated conceptual framework of the plan in terms of overriding themes, principles, implementation steps and expected results. This surrounds the central image of the mountain, its stakeholders and the relationship of Mauna Kea to cultural perspectives and the related themes of exploring the origins of the universe and origins of Native Hawaiian culture.



DEFINITIONS

Master Plan - A policy framework with a 20 year horizon that includes the plan methodology, existing conditions, cultural background and the physical and management plans. The Master Plan is an update and extension of the 1983 Mauna Kea Science Reserve Complex Development Plan.

Science Reserve – An 11,228 acre area on the Mauna Kea summit that is leased by the University of Hawai'i from the State of Hawai'i for use as a scientific complex. The Astronomy facilities are near the summit, while 95 percent of the Science Reserve serves as a protected buffer area.

Astronomy Precinct – A 525 acre area where astronomy development will be consolidated to maintain a close grouping of astronomy facilities while minimizing the potential impact to the natural and cultural resources of the summit region.

Implementation – A short term process of establishing the organization structure, consultation protocols, rules and regulations and actual phases of development and resource protection after adoption of the Master Plan.

"Astronomers don't seek to exploit the land. We respect the fragility of the mountain. The Mauna Kea Master Plan doesn't call for covering the slopes with telescopes. Concern for the consequences...The Mauna Kea Master Plan is a plan to share the mountain."
—Peter Kapack, student, Institute for Astronomy

"Stargazing from Mauna Kea and the success of Hokule'a are all tied together."
—Herring Kalua, Native Hawaiian

The Planning Process

Themes

The planning process for the Mauna Kea Science Reserve is driven by a related set of factors and principles including:

- Extensive consultations - A series of consultations with interested stakeholders and the community through a variety of means including the Advisory Committee, written testimony, presentations to the Board of Regents and the formation by Senator Inouye of a special group to address stakeholder concerns, with an emphasis on Native Hawaiian issues.
- Special scientific and cultural studies – An extensive series of studies, technical research, related management plans and related research to establish comprehensive baselines for the formation of policies regarding the management of Mauna Kea and related resources.
- Technical drafts - A series of five drafts of the Management Plan, widely circulated and posted on the Internet for public review and completion of a Final Environmental Impact Statement.
- Response to auditor report - The February 1998 State Auditor's report on management of the mountain identified key issues for the planning process. The Master Plan includes specific responses to the Auditor's report recommendations.
- Plan the beginning - The completion and adoption of a Master Plan signals only the beginning, and not the end of the process. Goals, objectives and policies outlined in the plan are a framework of action and not actions in and of themselves. Specific action steps are further outlined under the section entitled Pathways to Implementation.

Planning And Management Process

A ten step generalized process as outlined below, beginning with the Legislature's required audit report and ending in the evaluation amendment and update of the plan after its initial implementation steps. Implementation is discussed in greater detail on page 6.

Related Studies And Plans

The master plan process has triggered the most extensive assessment and consultation process in the history of Mauna Kea. These include, but are not limited to, the following:

- Cultural study and surveys, respecting Hawaiian natural and cultural resources
- Historic Preservation Plan, guiding management of historic and cultural properties
- Botanic and Geologic Resources Management Plans – Plans reflecting the concept that geologic, hydrologic and botanic resources are all part of the life cycle of the mountain
- Cultural Impact Assessment – Native Hawaiian cultural practices, features and beliefs
- Economic Impact Study - Economic impacts of observatories on the County and State
- Astronomy Research Development Plan and plan updates
- Mauna Kea Astronomy Education Center

Roles And Responsibilities

A variety of key players share responsibility for the planning and management of the Mauna Kea Science Reserve. The principal legal responsibility is vested with the University of Hawai'i through the Office of the President, with policy decisions approved by the Board of Regents. Other key parties include the following:

- University of Hawai'i Hilo Office of Mauna Kea Management
- Institute for Astronomy
- Mauna Kea Advisory Board
- Kahu/Kūpuna Advisory Committee
- Observatory Organizations
- State Department of Land and Natural Resources
- State Office of Historic Preservation

"Mauna Kea offers an unequaled opportunity for research. The University of Hawai'i must work actively to preserve this leadership."
—R.D. Joseph, IFA and Director, NASA Infrared Telescope Facility

"Had we had the opportunity to be part of the planning from the very beginning, you would not have the problems you have today. But we are happy to see outreach from the scientists to the community."
—Eleanor Ahuna

Plan Setting - Values and Voices

Overview and Themes

All planning is based on values and Mauna Kea is a unique setting that requires a balancing of needs and values of all who are involved, especially when it comes to the management of the summit. Values are best expressed through the voices of the various players who are stakeholders in Mauna Kea, and this section is representative of the various values and voices, as well as the changes that have been made in Master Plan through the process of consulting and listening to those whose beliefs and aspirations are focused on Mauna Kea. In understanding the values setting of Mauna Kea the following themes have resonated throughout the Mauna Kea Science Reserve Master Plan process:

- *Sharing "Place" – The Master Plan provides opportunities for sharing the unique setting of Mauna Kea including sharing science while minimizing intrusiveness on sacred and traditional values.*

- *Two Way Education – The plan and management of the mountain involves the values of research and education on technology, combined with the education of native Hawaiians and the broader community on cultural and traditional origins and beliefs.*

Values Dimensions

The Master Plan attempts to balance varied and sometimes competing values of process stakeholders. These are best represented by the following:

"The mountain is very sacred. The iwi (ancestral remains) found there must be returned. There are few Hawaiians here tonight. They know they will not have the chance to share their mana'o. We are astronomers ourselves. We understand. But you don't need more . . . there are enough there already. Some of us feel that you need to remove these structures, but I must accept them. I know that our children need the education. They are gone because there are no jobs here. Just maintain what you have now."

—Aunty Maile, Kupuna

"There is little recognition of the faces behind the science. This is the only industry that has withstood the tides of economic decay. Hilo is dying, and Mauna Kea is giving it back."

—Pat Cravello, Keck Observatory Employee

"The outriggers will allow us to look for other planets around other solar systems. The Master Plan provides a spirit that will result in responsible use of the Mauna Kea summit. We should not give in to polarization."

—Al Conrad, Keck Observatory

"All of my children have benefited from my employment. But this represents a crossroads of two important Hawaiian values: preserving the aina or protecting my ohana. Nothing can be found in the past that can compensate for failure in the present."

—Samuel Alameda Jr., Keck Observatory Employee

"The Mauna Kea Science Reserve directly pumps over $50 million into the Big Island economy annually and over 400 positions associated with that activity."

—University of Hawai'i Fact Sheet

Changes

The Mauna Kea Science Reserve Master Plan has undergone five different drafts during the past year. In response to issues, concerns and input, especially from the native Hawaiian community, a number of changes were made in the Master Plan and its proposed policies. These changes include the following:

1. Limiting astronomy activities to an area of no more than 150 acres over the next 20 years and creating a natural/cultural preservation area of 10,760 acres as a natural and cultural buffer around the 525 acre astronomy precinct which is ten acres less than the 1983 Master Plan.

2. Redefinition of astronomy precinct boundary preventing reuse of the Very Long Baseline Array site for a new facility.

3. Prohibiting any new facilities on currently undeveloped pu'u (cinder cones)

4. Local management structure incorporating strong participation of community, including establishment of the Advisory Board and Cultural Council (Kahu/Kūpuna) to maximize local consultation and preservation of environmental and cultural resources

5. Development limited to replacement of existing facilities, expansion of two facilities and four telescopes at new sites, over a 20 year period, all subject to new design guidelines.

"Changes in the Draft Management Plan over the past few months reflect concerns over natural and cultural issues. Thus, there has been a greatly increased understanding between the respective groups as a result of the process."
—Antony Schinckel, Director of Operations, Submillimeter Array

Education

(Adopted from the UH Hilo Proposal for the Mauna Kea Astronomy Center) The Plan setting goes beyond the legal boundaries of the Science Reserve to embrace educational initiatives that extend the values of discovering the origins of the universe and Hawaiian culture to the Hawaiian community and the world beyond. Thus, one of the critical elements of the Plan is to engender an educational outreach to native Hawaiians and to the world at large. Components include:

- Collaborative use of Mauna Kea telescopes to enhance instruction in K-12 schools, community colleges and universities locally and nationally.

- Summer astronomy workshops and courses for secondary school students, community colleges and universities using the Center's facilities and the Mauna Kea observatories.

- Professional development programs for teachers through year-round workshops, on-site and distance learning courses, curriculum development and research opportunities in collaboration with University of Hawai'i astronomy facility.

- Year-round Hawaiian and indigenous culture workshops.

- Academic programs in Hawaiian and other indigenous languages.

- Enhancement throughout the State of astronomy instruction by in-class programs presented by Center staff affiliated UH astronomy faculty and students.

"All islands have their sacred places. The highest places are the most sacred. Mauna Kea is our legendary place. The summit was too sacred for the workings of man. It was a burial site for only the most special personages of the past."
—Ed Stevens

Physical Plan

Overview And Objectives

This section summarizes the main features of the Mauna Kea Master Plan physical plan contained in Chapter IX of the Plan document. The principal objective of the physical plan is to promote the sustainable use, enhancement and development of the resources of The Mauna Kea Science Reserve including:

- Protect natural resources (e.g., Wekiu bug habitat, alpine ecosystems)
- Protect historic and Hawaiian cultural resources and practices (e.g., archaeological sites, cultural landforms)
- Protect and enhance education and research (e.g., astronomy, ecology, geology)
- Protect and enhance recreational opportunities (e.g., skiing, hiking)

MAJOR FEATURES

Figure 1, Aerial View of Summit – The concentration of the observatories and astronomy precinct, surrounded by the land forms of the natural/cultural preservation area

Figure 2, the setting of the Science Reserve, including access roads, the Mauna Kea Ice Age Natural Area Reserve and Hale Pōhaku, the mid elevation facility

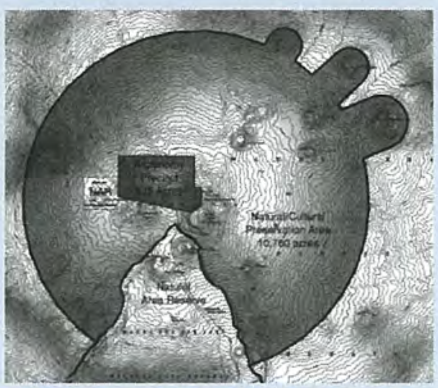


Figure 3, a detailed map of the Mauna Kea Science Reserve noting the acreages of the astronomy precinct and natural/cultural preservation area, as well as zones for the Natural Area Reserve

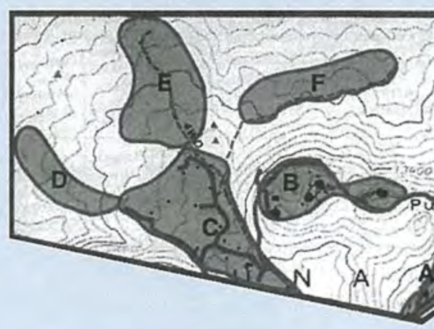


Figure 4, telescope siting areas (2000-2020). This figure notes the 6 siting areas. The Plan reduces areas A and B, reconfigures areas C and D and adds areas E and F. However, the Master Plan reduces the total area allocated for telescope siting from the 1983 Plan to 150 acres, 10 less than the previous plan.

Integrated Approach

The physical plan is an integration and balancing of four components. The natural resource component documents the extent of significant habitat areas and unique geology areas, and delineates preservation areas. The historic and Hawaiian cultural component identifies archeological sites and culturally significant land forms to be preserved. The education and research component identifies appropriate sites for the future expansion of astronomy facilities, with respect for natural and cultural resource preserve areas. Lastly, the recreational uses of the mountain are defined.

"Research in astronomy is necessarily passive. It is observational alone, possessing as such a humble quality. It demands access to the best sites and the best facilities. We should make, not every possible, but every reasonable effort to improve those facilities, for without continuing to strive, we are saying we've learned enough."
—Harald Ebeling, Assistant Astronomer, IFA

"I am sentimentally opposed to development. But reality is more complex. Technology resides within the mountains. I want the children to have a choice. Supporting astronomy and other scientific research cultivates choice. I expect the university to follow through on their obligations."
—Peggy Kamisato, Waimea Resident

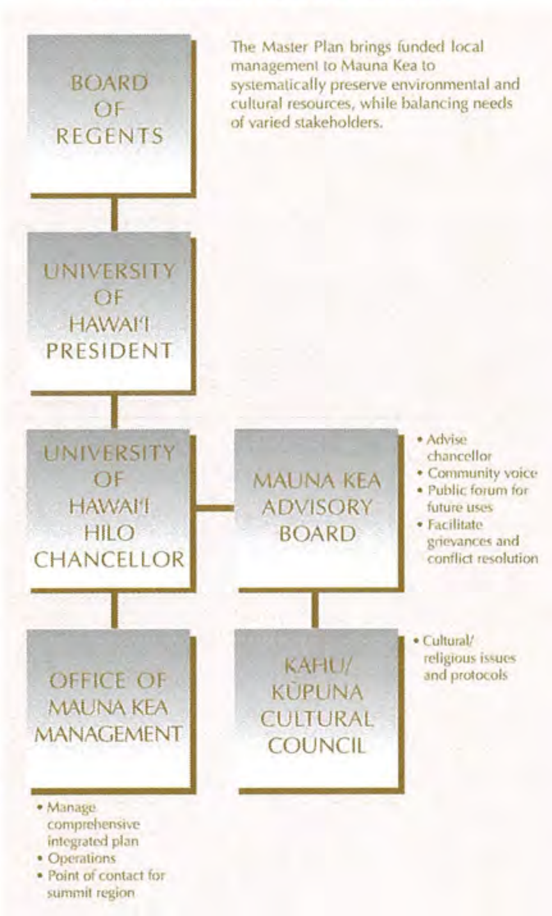
Management Plan

Overview And Objectives

This section summarizes Chapter X, Management Plan, of the Mauna Kea Science Reserve Master Plan. The Management Plan provides policies and strategies to integrate and balance the natural, cultural, educational/research and recreational values of Mauna Kea within a framework that provides responsible stewardship of the resources. This includes creating a structure to meet the following objectives:

- Promote community input
- Establish local management
- Establish a focal point for management responsibility
- Establish clear lines of decision making and accountability
- Establish economic and structural feasibility
- Provide a base for future expansion beyond astronomy that includes cultural, educational and community programs

Management Organization



Commitments

Management and implementation of a master plan requires firm commitments on the part of the lead authority, The University of Hawai'i. These commitments include the following:

1. University President committing funding, in the amount of at least $400,000 annually, to support the Mauna Kea Management Office
2. Board of Regents adoption of the concept of a Mauna Kea Management Authority
3. Significant commitment by the University to community and native Hawaiian involvement through the Master Plan Advisory Board, the Inouye Group and the Kahu/ Kūpuna Cultural Council
4. Commitment to unrestricted religious and cultural practices in the Mauna Kea Science Reserve
5. Commitment to a program of education and research and extends beyond the summit and brings the magic of discovery of the origins of the universe and discovery of the origins of Hawaiian culture to the youth

Themes

The following themes underlie the Management Plan for the Mauna Kea Science Reserve:

- Managed access – Policies and protocols to manage access while still providing unrestricted religious and cultural practices
- Balance of management and cultural perspectives – management goes beyond astronomy to include the cultural perspective and the integration of biological, geological and hydrological elements in a Native Hawaiian view of life cycles

"Protecting culture is important. Astronomy is important. The Draft Plan calls for a balance of uses, with greater attention to natural and cultural resources and limited, carefully controlled and restricted development. The Management Plan is a good starting point."
—Barbara Schaefer, Observing Support Coordinator, W.M. Keck Observatory

"Hawaiian and astronomical questions are similar. Where do we come from, where are we going? Good solutions bring convergence."
—Jim Kennedy, Operations Manager, Gemini Observatory Northern Operations Center

Pathways To Implementation

Overview And Objectives

The adoption of the Mauna Kea Science Reserve Master Plan by the Board of Regents is just the beginning of the voyage of discovery. This section touches on highlights of Chapter XI, Implementation Plan, of the Master Plan and identifies the major pathways to the future that translate the framework of policies of the Master Plan into realities of integrated management of the Science Reserve and related resources. It also respects the voices and viewpoints of the community and those native Hawaiians who did not necessarily agree with the total direction of the Master Plan by framing a set of challenges that should be addressed during the implementation of Master Plan policies.

Implementation Pathways

Implementation of the updated Mauna Kea Master Plan begins with the adoption of the plan by The University of Hawai'i Board of Regents. As noted in the section on the planning process, this is step 9 of the general process, but it actually triggers a whole new series of processes and pathways that flesh out and add substance to the broad policies of the Master Plan. These pathways and their action horizons are summarized as follows:

PATHWAY	FEATURES	HORIZON
Establish Office of Mauna Kea Management (UHMKM)	This includes finalizing the organizational structure, setting up funding, selecting and training staff.	Within six months
Mauna Kea Advisory Board	This includes appointing the Advisory Board, establishing administrative rules and organizing the Kahu Kupuna Cultural Council.	Within six months
Rules and Regulations	These are the rules that guide daily operations and management of the Science Reserve. These will involve public hearings and incorporate traditional protocols as required. Rules should also be adopted for both the MKM and the Advisory Board.	Draft rules within six months of hiring Director and final rules adopted within 18 months of formation of the UHMKM
Reorganize Hale Pōhaku Operations	This includes renovation of the Visitor Information Station, establishing registration protocol and education materials/programs and a control point kiosk.	Renovations and kiosk within one year and Visitor Information Station expansion within three years
Design and Project Review Guidelines	This is to assure that any development is done in a manner which integrates it into the summit environment and contributes to the mountain's overall character and environmental quality.	Appoint Design Review Committee within six months of adoption of Master Plan and implement policies
Programs Development	These are community, research and education programs that extend beyond the astronomy at the summit and bring the excitement of astronomy and discovery to the community, schools and youth.	Program prioritization within one year and program launch based on funding and resource capture
Facility Development	Summit, mid-elevation and off-mountain base facilities	Ongoing, subject to design and project review guidelines
UHMKM Management Operations	The day to day operations of UHMKM including building of management and technical capacity and implementation of rules and regulations as adopted.	Appointment of staff and coordination with adopted rules and regulations
Master Plan Evaluation, Amendment and Update	This includes a periodic assessment of operations and review with the President and Board of Regents, as well as implementation of amendment procedures and formal update of the Master Plan, as required.	Assessment after 18 months and plan amendments per adopted policies

Challenges

The intense planning process can be characterized as a voyage through varying rough and calm waters of debate, disagreement and enlightenment. It is critical to recognize and respect the realities of differing viewpoints and hold these as challenges for implementation, including:

1. Beyond the Summit – The challenges of the Master Plan and its implementation go beyond the summit, especially with respect to education programs and community outreach.
2. Intrusion – Spiritual and sacred places are considered threatened by elements of the plan; policies and protocols need to assure maximum respect and protection.
3. Trust and Healing – The planning process raised understanding but equally raised fears and suspicions among many native Hawaiians. This requires continued communication, education and relationship building.
4. Management Protocols – Special attention is needed to maintain a balance of interests in the rules, regulations and management protocols, especially the roles of players and decision making authorities.
5. Education Benefits – Capturing the imagination of the community and especially native Hawaiian youth through an aggressive astronomy and cultural education program.

"Planning does not include na'au...soul. There will be Hawaiians who feel that nothing has been done. All they can see is that the plan is to build up there, and the building has to do with science. The public has to see that the Master Plan is not the end . . . it's the beginning."
—Pualani Kanahele

"We face the problem of improving education for our youngsters. They suffer from a lack of excitement and learning. Mauna Kea astronomers generate new excitement and their study of the heavens ties in with ancient navigators. What is beyond that horizon?"
—Alan Okinaka, GTE Hawaiian Tel

Voices and Visions of Mauna Kea

MAUNA KEA SCIENCE RESERVE MASTER PLAN AND IMPLEMENTATION PROCESS SUMMARY

Message From The President, University of Hawai'i

This document represents the commitment by the University of Hawai'i to fulfill its legal responsibilities for the planning and management of the Mauna Kea Science Reserve. But the vision for this special and sacred place is not just ours. It truly comes from the voices and visions of many people. Likewise, the responsibility for implementation is a shared venture. As noted, adoption of the Master Plan by the Board of Regents is just the beginning, not the end. This voyage of discovery, learning and sharing is at the heart of an educational institution and we look to our many partners and the community to guide us in the next steps and challenges ahead.

Dr. Kenneth Mortimer, President

"This mountain is big enough to embrace us all."

—Christopher Mullis, Research Associate, IFA

DOCUMENT SCOPE

This document is organized into a series of highly graphic, easy to read panels that highlight various aspects of the planning process and its implementation. Sections include the following:

Master Plan Availability

The complete two-volume Master Plan is available at all Hawai'i Island libraries and is posted at www.hawaii.edu/maunakea. Comments are welcome and should be sent to the Office of the Senior Vice President for Research at UH Manoa, 2444 Dole Street, Bachman Hall, Suite 105, Honolulu, HI 96822

Canoe Logo

Traditional canoe symbol, patterned after Hokule'a, represents planning process as a voyage surrounded by stars, with the canoe carrying cultural beliefs and practices.

Credits

Document concept and text: The Johnson Strategy Group, Inc.
Master Plan materials and layout: Group 70 International, Inc.

TABLE OF CONTENTS

APPENDICES
(Separate volume)

A. Astronomy Research Development Plan (Institute for Astronomy, August 1999)

B. Mauna Kea Astronomy Education Center

C. Existing Astronomy Facilities

D. Mauna Kea Advisory Committee Roster

E. Glossary of Hawaiian Terms

F. Management Components of Mauna Kea Historic Preservation Plan (State of Hawaii, Department of Land and Natural Resources, Historic Preservation Division, March 2000)

G. Botanical Resources, Hale Pōhaku Mid-Elevation Facilities (Char, July 1999)
Botanical Resources, Mauna Kea Summit, Hawai'i (Char, July 1999)
Mauna Kea Science Reserve Management Recommendations – Botanical Resources (Char, January 2000)

H. Mauna Kea Science Reserve Geological Resources Management Plan (J. Lockwood, Geohazards Consultants International, Inc. January 2000)

I. 1999 Mauna Kea Science Reserve and Hale Pōhaku Complex Development Plan Update: Oral History and Consultation Study, and Archival Literature Research. Ahupua'a of – Ka'ohe (Hāmākua District) and Humu'ula (Hilo District), Island of Hawai'i (various TMK) (Maly, February 1999)

J. An Arthropod Assessment Within Selected Areas Of The Mauna Kea Science Reserve – Final Report (Howarth, Brenner, Preston, May 7, 1999)

K. Mauna Kea Science Reserve Archaeological Site Inventory (McCoy, February 1999)
Mauna Kea Science Reserve Site Descriptions – DRAFT (McCoy, 1999)

L. Mauna Kea Science Reserve Complex Development Plan Update – Roadway and Utilities Report (Sam O. Hirota, July 1999)

M. Economic Impact of Mauna Kea Observatories, Hawai'i County, State of Hawai'i (SMS Research and Marketing, Inc., July 1999)

N. Cultural Impact Assessment Study: Native Hawaiian Cultural Practices, Features, and Beliefs Associated with the University of Hawai'i Mauna Kea Science Reserve Master Plan Project Area (PHRI, Inc., August 1999)

O. Voices and Visions of Mauna Kea: Educational Circular (The Johnson Strategy Group, Inc. March 2000)

LIST OF FIGURES

LIST OF TABLES

MASTER PLAN ADOPTION

On June 16, 2000, the University of Hawai'i Board of Regents adopted the following document, the Mauna Kea Science Reserve Master Plan, as the policy framework for the responsible stewardship and use of University-managed lands on Mauna Kea through the year 2020. At the same time, the Regents called for the immediate establishment of the Office of Mauna Kea Management, the Mauna Kea Management Board, and the Kahu Kūpuna Council, as the first steps in the implementation process.

EXECUTIVE SUMMARY

The Mauna Kea Science Reserve is an 11,288 acre area of land leased by the University of Hawai'i from the State of Hawai'i for use as a scientific complex. Facility development in the Science Reserve has focussed predominantly on the summit area above 13,200 feet. Support facilities have been developed at Hale Pōhaku (elevation 9,200 feet) outside the Science Reserve. The Reserve was established in 1968 when the Board of Land and Natural Resources approved a 65 year lease (Lease No. S-4191). Two parcels in the summit region excluded from the Science Reserve belong to the Mauna Kea Ice Age Natural Area Reserve (NAR).

The University of Hawai'i adopted the Mauna Kea Science Reserve Complex Development Plan (CDP) in 1983 which has guided development up to the present time. The CDP projected development up to the year 2000 and has been largely implemented. The 1983 Plan and the State of Hawai'i's efforts to develop astronomy as an academic discipline and an industry have been largely successful. Today, Mauna Kea is known as the premier location for astronomy in the Northern hemisphere and has a significant positive economic impact on the State of Hawai'i and the Big Island. This report is an update of the 1983 Plan and extends the planning horizon to the year 2020.

The Plan also addresses issues and concerns that have arisen in 30 years of development on the mountain. It specifically addresses comments and recommendations included in the 1998 Legislative Auditor's report on the management of Mauna Kea. The Plan integrates future uses (education, research, culture and recreation) with a deeper awareness of the natural and cultural resources and significance of Mauna Kea. In particular, the Plan lays the groundwork for implementation of educational outreach to the native Hawaiian community at primary, secondary, and post-secondary levels. New ethnographic, archaeological and biological studies of the mountain have expanded knowledge and increased sensitivity to the special qualities that make Mauna Kea a unique place on the planet.

The Master Plan report is structured in three parts. The first section lays out the direction and methodology of the Plan. The second section identifies the major components of the Plan. This section presents existing conditions and the historical background of these components. It also includes a chapter on issues and opportunities. The third section integrates these components into physical and management plans which make up the Master Plan. The physical and management plans represent a major change in the allocation of use areas and management structure.

New Management Organization: To implement this Plan a new management structure with a single point of contact located on the Island of Hawai'i is recommended. This organization would be an operational unit within the administrative purview of the Office of the Chancellor at UH Hilo. The organization would have a director, administrative staff, rangers and maintenance personnel. Additionally, it would serve as the nerve center for volunteers and organizations affiliated with Mauna Kea. This single point of contact, given comprehensive management authority located in Hilo and on the mountain, would integrate management responsibilities to protect the sustainability of Mauna Kea's resources. It would coordinate interagency issues and be a conduit to the community. The continuous presence of rangers on the mountain at all times is expected to vastly improve stewardship of Mauna Kea. Being an operational unit of UH Hilo emphasizes the permanence of the organization and the University's commitment to its operations.

Community Involvement: The Plan recommends that the University appoint a Mauna Kea Management Board to provide the community with a direct voice into the management of the mountain. Additionally, a Kahu Kupūna Council is recommended to provide advice and direction on native Hawaiian cultural issues. Establishment of a professional Design Review Committee is also recommended. This Committee would review all project proposals to ensure that project plans conform to the design guidelines and intents of the Master Plan. Additionally, a docent program and other volunteer programs coordinated by the new management organization would provide nearly constant, intimate community involvement in the care of the mountain. Community input during the Master Plan process is addressed in Section XII.

Management Policy Guidelines: The Plan recommends management policy guidelines that may be further developed and adopted by the new management organization. Hours of operation and the possible development of a shuttle service are proposed for safety and resource protection. Recommendations are also made concerning the support facilities at Hale Pōhaku and the summit and concerning safety and security procedures. Public access would remain open but may be managed through registration as needed for safety or resource protection purposes. All existing uses such as snow playing, skiing and hunting will be permitted. Hunting usually occurs in the lower elevations. Parking areas would be increased incrementally at Hale Pōhaku, and near the summit "Poi Bowl" area as demand increases. There would be no restrictions on religious worship.

Physical Planning Guide: The Physical Planning Guide consists of four major components: natural resources, culture, education and research, and recreation. The existing 11,288-acre Science Reserve would be divided into two areas under the new Plan. The great majority of the Science Reserve (95%) will become a 10,760-acre Natural/Cultural Preservation Area, with no development activity. The remaining 525 acres (5%) are designated as an Astronomy Precinct, thereby greatly reducing the area previously available for astronomy development. The 525-acre area would be subject to architectural, environmental, and cultural controls. All currently undeveloped summit *pu'u* (hills or cinder cones) would remain undeveloped. Support facilities at Hale Pōhaku would be expanded incrementally as needed, and existing construction cabins will become available for public use. Management and expansion of the facilities at Hale Pōhaku would accommodate other educational and research programs as well as cultural and recreational uses that are compatible with ongoing operations. A common database containing information about all the major components is recommended to facilitate management efforts and integrate policies.

The Physical Planning Guide directs future development on the mountain in three ways. First, the Plan consists of plans, maps, geographic information system (GIS), and criteria, which promote the sustainable use, enhancement and development of the Mauna Kea Science Reserve. Second, design guidelines and project review procedures guide physical development through assessments of site location, size, mass, color and other physical attributes. Third, it identifies an Astronomy Precinct which contains astronomy development within and near existing developments and creates a natural/cultural preservation area for the remainder of the Science Reserve. The following highlights some of the important concepts associated with each component area:

<u>Natural Resources:</u> Natural resources are protected in the following way:

- Identification and GIS mapping of resources.
- The bulk of the Science Reserve (10,760 acres) is designated as a natural and cultural preservation area.
- Future facilities will be designed and sited to avoid and minimize impacts to sensitive habitat and rare or fragile geological features. Additionally, development approvals would contain conditions for the protection of natural resources.
- Registration procedures and signage plans would be geared to educate visitors about the value and fragility of these resources.
- Volunteer groups would be encouraged to adopt the mountain and support activities that sustain the mountain.

<u>Archaeology and Culture:</u> The cultural resources component includes the following:

- GIS mapping of known features.
- Designation of 10,760 acres as a Natural and Cultural Preservation Area. This designation highlights the cultural values of Mauna Kea.
- The importance of geo-physical forms such as Pu'u Poli'ahu, Pu'u Līlīnoe, other summit *pu'u* and Wai'au is recognized and protected in the Plan. All undeveloped *pu'u* are preserved.
- A view corridor to the west is preserved based on a common cultural practice with a potential for future interpretation.
- Modern cultural practitioners would have unrestricted access.
- The formation of a Kahu Kupūna Council to provide advice and facilitation in cultural matters is recommended.
- Photographic monitoring of historic sites is suggested.
- Registration procedures, signage and docent programs are recommended to educate the public on the value of cultural resources and the appropriate protocol for movement in sensitive areas.
- Special development protocols are recommended to avoid inadvertent impacts on cultural properties.
- Management practices would be coordinated with the State Historic Preservation Office.

Education and Research: The education and research component includes the following proposed actions and developments:

- Recycling of up to five of the existing observatory sites with renovations or newer Optical/Infrared facilities. Five potential recycle sites are identified.
- Expansion of the Keck facility to include 4 to 6 outrigger telescopes within the existing Keck site and no higher than 1/3 the height of the existing Keck telescopes.
- Expansion of the Submillimeter Array to include up to 24 new pads and 12 new antennas in addition to the 12 currently permitted antennas.
- One additional site for a new conventional Optical/IR instrument on the north plateau.
- Site for a Next Generation Large Telescope with a mirror 25 to 50 meters in diameter.
- Expanded educational outreach, with particular emphasis on native Hawaiians.
- A UH Hilo instructional telescope and site to replace the existing cinderblock building located between the UKIRT and UH 24-inch telescopes. The telescope is designated for use in teaching and training students. Besides basic undergraduate education, this facility would facilitate training for jobs in astronomy.
- The total economic impact of the mountain's existing observatories in the State is estimated at $142 million annually. This includes employment and expenditures directly related to telescope operations as well as the indirect impact of purchases made by astronomy-related firms and employees. Construction expenditures in the County of Hawai'i have totaled approximately $207 million to date.
- Other academic disciplines and programs are specifically encouraged to view the mountain as an outdoor classroom and laboratory. These efforts would be supported at Hale Pōhaku and the summit area.
- Joint use of existing facilities/new support facilities at Hale Pōhaku.
- Docent programs in broad areas of natural, cultural and educational areas within the management plan.
- Special educational and cultural events at Hale Pōhaku.

Recreation: Recreational opportunities are protected and supported as follows:

- A public recreational shelter and comfort station is included for visitors, spectators and recreationalists in the Astronomy Precinct summit snow area.
- Recreational activities that are currently allowed will continue to be permitted.

This document, the UH Mauna Kea Science Reserve Master Plan, provides the policy framework for the responsible stewardship and use of University-managed lands on Mauna Kea through the year 2020. It proposes several significant land use and management structural changes based on a new paradigm of the University's leased lands as a natural and Hawaiian cultural reserve in addition to being a Science Reserve. This framework represents a vision which will require conscientious implementation and development over the years to realize, yet one which promises the achievement of stated goals and objectives of the Master Plan. As these goals and objectives are realized, it is hoped that Mauna Kea will increase in its meaning and value to many individuals and groups in the community who see it as a unique treasure worthy of our respect and care.

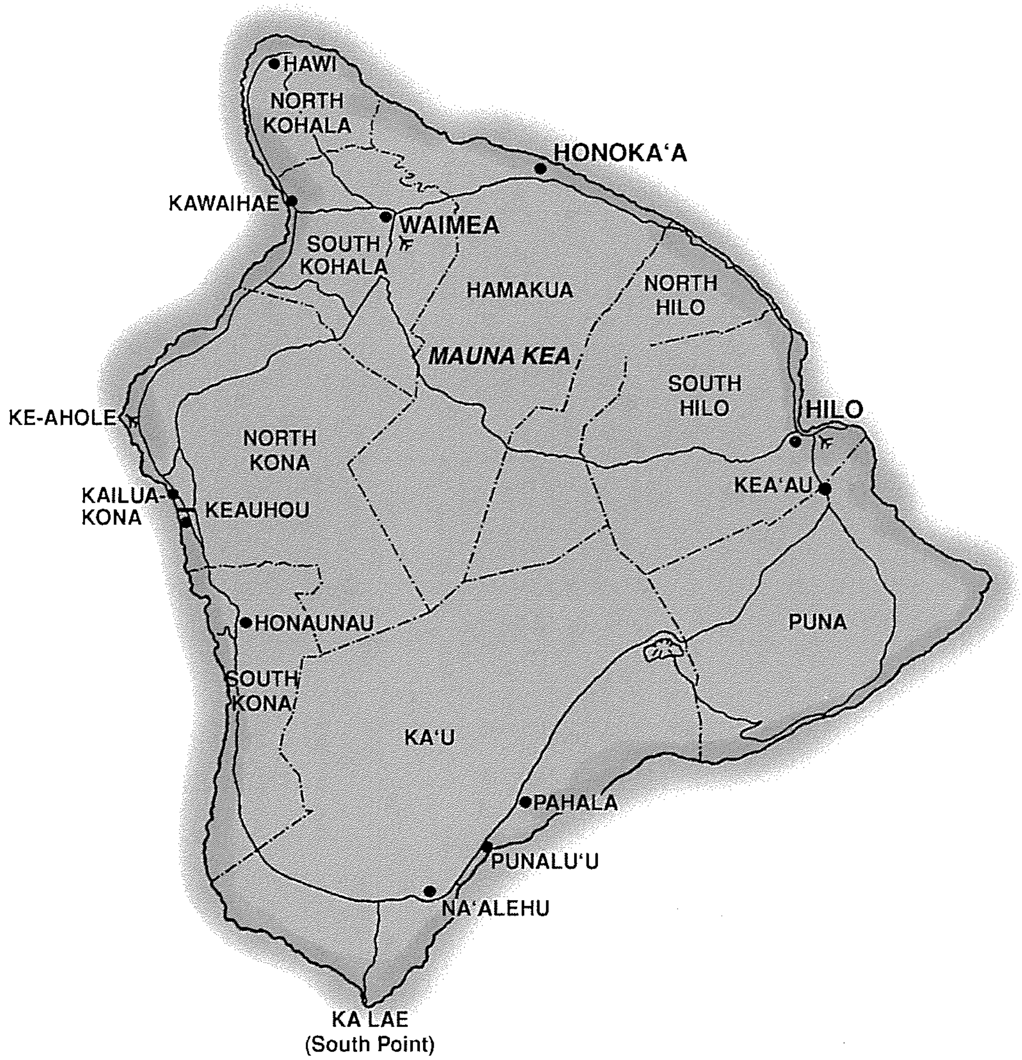
INTRODUCTION

The ancient saying "*Mauna Kea kuahiwi ku ha'o i ka mālie*" (Mauna Kea is the astonishing mountain that stands in the calm) (Pukui 1983: No. 2147), expresses the universal feeling experienced by all who come in contact with this special place. Standing tall over the Island of Hawai'i, Mauna Kea is home to vast physical, natural and cultural resources (Figure I-1). From early adze makers to modern day astronomers, Mauna Kea has long been a special place for work, worship, and reflection. For native Hawaiians, both ancient and modern, the feelings for Mauna Kea go beyond wonder and astonishment, to the recognition of the mountain as a sacred domain. These profound feelings of reverence are expressed in the saying: "*O Mauna Kea ko kākou kuahiwi la'a*" (Mauna Kea, our sacred mountain). As with other ethnic cultures throughout the world, early Polynesians believed their highest points of land were the most sacred; and Mauna Kea having the highest mountain top in all of Pacific Polynesia, was considered the most sacred place of all. Standing tall over the island if Hawai'i, Mauna Kea was host to early Hawai'ian traditions which included religious practices, study of the heavens, and tool making in the Keanakāko'i adze quarry.

For many years hikers, hunters, scientists, worshippers, and skiers have come to the highest mountain in the Pacific Basin. In the past three decades the Mauna Kea Science Reserve has evolved into the world's premier astronomy complex. Mauna Kea's observatories are known worldwide for their advanced technologies, excellent viewing environment, and the discoveries that have been made with these facilities. The development of this complex has not come without its costs. The roadway that was installed for the testing and construction of the first telescopes has opened the mountain to all. Physical development, foot and vehicular traffic, and the byproducts of man's use of the mountain have all left temporary and permanent impacts on the mountain. More positively, the access has provided a wealth of information and enjoyment for those who have taken interest in this great mountain.

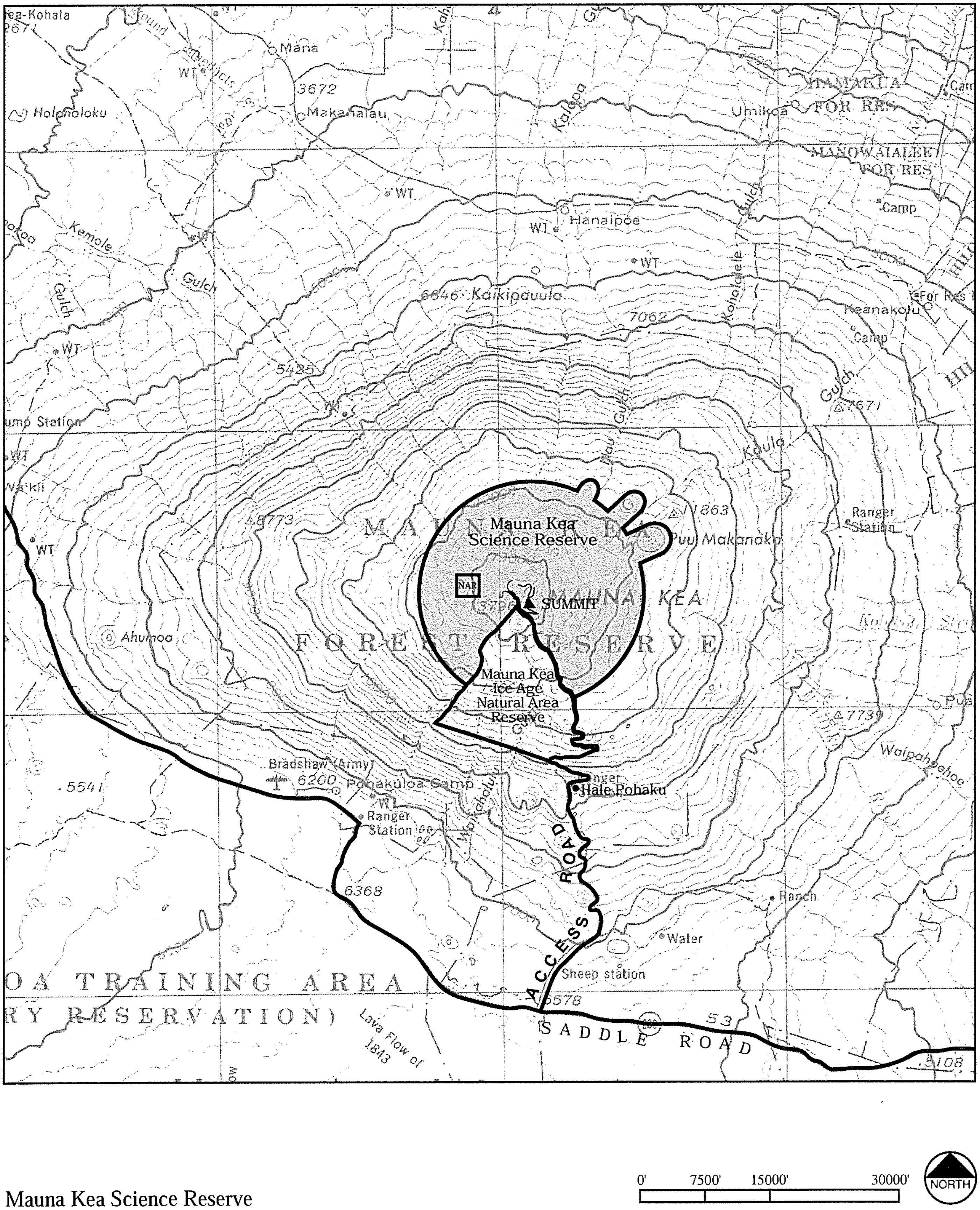
The Science Reserve is a 11,288 acre area of land that is leased by the University of Hawai'i from the State of Hawai'i for use as a scientific complex (Figure I-2). The astronomy complex is centered near the middle of the summit plateau while the remainder of the Science Reserve serves as a buffer area. The Science Reserve is a circular area (2.5 miles in radius) centered on the Mauna Kea summit -- approximately those lands above the 12,000 foot elevation -- except for those areas that are part of the Mauna Kea Ice Age Natural Area Reserve.

Tomorrow, when we are gone, man will continue to look to his ancestors for wisdom and guidance, seek knowledge and joy in his physical world, and look to the stars and elsewhere to answer universal questions. Given the changes that Mauna Kea has experienced over time, we must ask ourselves what the mountain will be like in the future. Will this cultural treasure be well cared for and preserved? Will it be more accessible to hikers, cultural practitioners, scientists, students, and skiers? Will its natural



Island of Hawaiÿi

No Scale



Mauna Kea Science Reserve

resources be in better condition than they are today? Will native Hawaiians again play leading roles in discoveries and way finding for humanity? The answers will rest in the hands of those who accept the responsibility of stewardship entrusted to them.

The Mauna Kea Science Reserve Master Plan is an update and extension of the 1983 Mauna Kea Science Reserve Complex Development Plan. The 1983 Plan provided a physical plan for astronomy development to the year 2000 and presented a management plan and implementation strategy for managing and monitoring the various uses of the mountain. The purpose of this Plan update is to develop physical and management plans to guide the use of and facility development within the Mauna Kea Science Reserve, Summit Access Road, and Hale Pōhaku, for the next twenty years.

The 1983 Plan has largely been implemented in terms of the astronomy facilities that have been built or are under construction and the improvements that have been made to the infrastructure and mid-elevation facilities. This planning effort extends the physical planning for the mountain another 20 years and more fully integrates non-astronomy resources and uses. The management plan offers an organizational solution and policy guidance to address some of the use conflicts, maintenance, and access issues that exist today. The Master Plan assumes that the Mauna Kea Science Reserve will continue, and even grow, in importance to scientists, educators, naturalists, and recreational users in the years to come.

The Master Plan report is structured in three parts. The first section includes the introduction, goals and objectives, and methodology, which establish the direction and process for the Plan. The second section details the components that make up the physical environment and human use of Mauna Kea. The relationships among these components – the natural environment, culture, education and research, and recreation – are analyzed and integrated into future plans in the third section of the Master Plan. The physical and management plans which make up the Master Plan propose facilities, supporting infrastructure, preservation areas, and a management structure and policies to guide the future of uses within the Science Reserve.

This approach to the Master Plan is based on the principles of integrated cultural and natural resources management planning. This Plan appreciates and respects the inter-relationships of all facets of the natural systems and cultural context of the site and provides a framework for sustainable development on the mountain. The Plan values preservation and interpretation of indigenous natural and cultural resources and the uniqueness of these resources on Mauna Kea. The proposed Plan, in its simplest sense, attempts to balance economic and scientific prosperity, social equity, cultural values, and environmental integrity.

GOALS AND OBJECTIVES

The following goals and objectives were established to guide the preparation of the Master Plan.

Update the 1983 Mauna Kea Science Reserve Complex Development Plan by:

1) Developing a vision for the sustainable use and enhancement of the Mauna Kea Science Reserve as a Hawaiian place with significant and unique cultural, natural, educational/ research and recreational values, meanings and potentials, both locally and globally.

2) Integrate and balance cultural, natural, education/research and recreational values and uses in a physical and management plan which will remedy existing problems and provide a framework and structure for the responsible and sustainable stewardship of the Mauna Kea Science Reserve.

These goals have been carried throughout the master planning process from the integration of data to the formulation of physical plans and a proposed management structure. The goals of sustainability and integration should continue to guide the future decision making for Mauna Kea through and beyond the implementation of this plan.

A. Cultural Objectives

1) Promote a greater knowledge base and understanding of cultural resources, Hawaiian cultural practices, and significance of archaeological sites, place names, and geophysical elements (such as cinder cones, glacial deposits, etc.), through the planning process.

2) Preserve and manage cultural resources in a sustainable manner so that future generations may share in the understanding and knowledge of the mountain's archaeological and cultural sites.

3) Protect the opportunities for individuals and groups to engage in cultural practices.

4) Define areas, criteria and support facilities for cultural resources and practices, as applicable, to allow for sustainable, integrated planning and management.

5) Preserve the cultural landscape to enhance meaning, relationships, and resources for modern appreciation, research, and practice.

The cultural objectives recognize that Mauna Kea, the highest point in Pacific Polynesia, is a revered resource and the site of Hawaiian cultural practice today. This plan encourages preservation of cultural resources and at the same time supports use and further understanding of the mountain's resources by practitioners and others.

B. Natural Resources Objectives

1) Promote a greater knowledge base focused on the most critical natural resources to include flora, fauna, and natural landforms, through the planning process.

2) Protect and preserve, through planning and management, unique geological features and biological communities, recognizing the symbiotic relationship between the two in the Science Reserve.

3) Use natural resource areas for recreation in a manner that both protects the resources and promotes the safety of individuals.

4) Allow for current and future use of natural resources for educational programs and Hawaiian cultural practices for the community, schools and universities, and visitors.

5) Protect the mountain's natural landscape to preserve its cultural and scenic values.

6) Define specific areas and criteria for natural resource use as applicable, to allow for sustainable, integrated planning and management.

As in the case of cultural resources, the Master Plan encourages greater understanding, appropriate use, and preservation of the mountain's natural resources. The Master Plan objectives call for the integration of natural resources with cultural resources and use, education and research, and recreation components.

C. Education/Research Objectives

1) Expand knowledge of the Science Reserve as an educational resource for the benefit of the community, including native Hawaiians, students, researchers, and visitors, through the planning process.

2) Protect natural and cultural resources and insure managed access to the Science Reserve for education and research use.

3) Protect and enhance astronomy research at Mauna Kea as the premier observatory site in the Northern Hemisphere.

4) Define areas, criteria and support facilities for education and research as applicable, to allow for sustainable, integrated planning and management.

The education and research objectives recognize the importance of astronomy activity at Mauna Kea and encourage appropriate use of the mountain for further education and research use in other fields to include science and cultural fields.

D. Recreational Objectives

1) Expand understanding of recreational uses and potentials of the Science Reserve.

2) Retain and enhance recreational opportunities within the Science Reserve, while protecting natural resources, cultural resources, and cultural practices.

3) Define areas, criteria and support facilities for recreational uses, sightseeing and commercial tours, as applicable, to allow for sustainable, integrated planning and management.

The above objectives encourage mixed use of Mauna Kea in an organized setting and with the primary importance given to the preservation of the resources of the mountain. Recreational activities are guided in a direction that promotes safety and practices that respect the mountain's natural and cultural values.

E. Physical Plan Objectives

1) Create physical plans, maps, and criteria which promote the sustainable use, enhancement and development of resources of the Science Reserve in order to:

   - Protect historic/cultural resources and practices: e.g. archaeology sites, Hawaiian cultural practices
   - Protect natural resources: e.g. Wēkiu habitat, alpine ecosystem
   - Protect and enhance education and research: e.g. astronomy, ecology, geology
   - Protect and enhance recreational opportunities: e.g. hiking, skiing

2) Analyze and depict physical implications of uses over time; address and mitigate visual and environmental impacts.

3) Guide future physical development, not only locationally, but with respect to character, size, mass, color and other physical attributes.

4) Define infrastructure and elements to support goals regarding natural resources, culture, education/research, and recreation.

These objectives are further detailed in the Physical Planning Guide (Section IX).

F. Management Plan Objectives

1) Create a funded structure for sustainable, focused management of resources and operations of the Mauna Kea Science Reserve in order to:

    - Protect historic/cultural resources: e.g. archaeology sites, Hawaiian cultural practices
    - Protect natural resources: e.g. Wēkiu habitat, alpine ecosystem
    - Protect and enhance education and research: e.g. astronomy, ecology, geology, Hawaiian culture and archaeology
    - Protect and enhance recreational opportunities: e.g. hiking, snow play, skiing
    - Promote public safety

2) Create a funded structure which meets the following objectives:

    - Promotes community input.
    - Establishes local management.
    - Establishes a focal point for management responsibility.
    - Establishes clear lines of decision making and accountability.
    - Is economically and structurally feasible.
    - Provides a base for future expansion of the scope of activities in the Science Reserve.

These objectives are further detailed in the physical and management plan sections (Sections IX and X).

METHODOLOGY

During the preparation of the 1983 plan, studies were undertaken which were the first of their kind on Mauna Kea and which provided valuable scientific, archaeological, and ethnographic information. Follow-up work and additional studies have been accomplished in the preparation of this Master Plan as follows:

Dr. Francis Howarth of the Bishop Museum and colleague Greg Brenner have conducted field work and analysis updating arthropod studies done in the 1980s. During the earlier work, Howarth and his team identified numerous arthropods including the Wēkiu bug, which exists only on Mauna Kea and which had not been discovered previously. Recently, Howarth and Brenner tested the bug's population distribution, assessed seasonal trends, and expanded on their understanding of the bug. Their surveys also included other endemic and introduced species.

Archaeologist Patrick McCoy has worked on Mauna Kea for over two decades studying sites in the Mauna Kea Science Reserve and in the Mauna Kea Ice Age Natural Area Reserve. A total of 93 archaeological sites have been identified in surveys encompassing some 3000 acres of land in the Science Reserve (McCoy, 1999). McCoy and Holly McEldowney, both with the State Historic Preservation Division, have prepared an historic preservation management plan for Mauna Kea. The plan identifies and assesses the archaeological sites that have been found in the Science Reserve and suggest guidelines for the future management of the sites and the broader summit plateau.

Cultural specialist Kepā Maly has conducted oral history interviews and archival research to "document some of the traditions and practices associated with Mauna Kea, and to identify some of the significant features of the landscape, including natural and man-made cultural resources on Mauna Kea so that they can be protected, preserved, and appropriately managed in the future" (Maly, 1999).

In addition to Maly's work for this Plan, he conducted earlier archival research of the Humu'ula and Ka'ohe *ahupua'a* for the Native Lands Institute (Maly, 1998). Other cultural specialists have also conducted ethnographic research that is valuable to this effort. Edward and Pualani Kanahele (1997), and Charles Langlas (1997) conducted studies in association with the Saddle Road Improvement project. Their work provides important information and adds to the greater understanding of Mauna Kea as a cultural place.

The ongoing studies of the natural and cultural resources of Mauna Kea provide sound information that can be used for physical planning and management policy decision-making. In preparing this plan, recent and historical data were compiled in a Geographic Information System (GIS). Information on slope, Wēkiu bug habitat, flora, archaeological sites, cultural landscape features, roads, and astronomy facilities were layered together and analyzed in relationship to one another. These components are described in Sections IV through VII and analyzed in Section IX. By looking at the information in an integrated way, areas that must be protected and areas that can be used for educational and recreational uses and facilities, including new astronomy facilities, are identified. The physical and management plans included in this Master Plan recommend the continued integration of knowledge, resources, uses and management practices.

In addition to expert research, this planning process incorporates broad community input. In the Spring of 1998, University of Hawai'i president Kenneth Mortimer invited twenty-four individuals to serve on the Mauna Kea Advisory Committee to "help the University of Hawai'i as it plans for future facilities development on the mountain and strives to improve its management of the Science Reserve and the Visitors' Station at Hale Pōhaku." (Mortimer, May 8, 1998) Committee members represented various organizations including the University of Hawai'i at Hilo, the UH Institute for Astronomy, environmental groups, the business community, native Hawaiian organizations, state agencies, county government, and the broader Hawai'i community. In his invitation to the individual committee members the President stated that "The purpose of the Mauna Kea Advisory Committee in its broadest terms is to provide needed input to the University of Hawai'i and the people of the State of Hawai'i regarding the conditions under which future development should occur on Mauna Kea" (Mortimer, May 8, 1998).

This Committee met regularly from June, 1998 to August, 1999 to discuss existing conditions, management issues, and the future uses and management of Mauna Kea. The Committee invited various experts to their meetings and conducted an initial round of public meetings to gather the opinions and suggestions of the broader Hawai'i Island community. Public meetings were held in the communities of Waimea, Kona, and Hilo on August 31, September 1, and September 3, 1998, respectively. Approximately 50 individuals attended the Waimea meeting, 15 attended the Kona meeting, and 100 attended the meeting in Hilo (all numbers are estimates). A variety of views were expressed during these meetings. Some individuals expressed the need for better management of the mountain's resources. Some felt that no more astronomy facilities should be developed on the Mauna Kea summit plateau. Others expressed an appreciation for the scientific and economic benefits provided by the astronomy industry and a desire for astronomy to continue and expand.

During Advisory Committee meetings, several members presented specific proposals, representing their views or the views of organizations they represent. Committee members reviewed and discussed proposals before providing recommendations.

The Committee conducted a second series of public meetings during which specific physical and management proposals were presented to the community. As in the first series of public meetings, these were held in Waimea, Kona, and Hilo on May 24, 25, and 27, 1999, respectively. During these meetings a slide presentation was given by Group 70 International, Inc. The presentation reviewed the natural, cultural, recreational and educational resources of the mountain and introduced the master plan, with proposed facilities and management structure. Community members were asked to share their reactions and proposals for the mountain. Based on their own deliberations and the feedback received from the community, the Mauna Kea Advisory Committee formulated and forwarded their recommendations to the University President. In addition to the information shared in Committee meetings and public meetings, Group 70 also met with other community members, groups, and experts to discuss possible recommendations for the physical and management plans. Among those contacted were representatives of the astronomy community nationwide, the National Park Service, the Department of Land and Natural Resources, the UH Administration, the Department of Hawaiian Home Lands, and representatives of various Hawai'i Island organizations such as the ILWU, Chambers of Commerce, and local school administrations. This report, while a product of Group 70 International which is responsible for any errors, therefore incorporates the recommendations of the Mauna Kea Advisory Committee, and the input of many other stakeholders.

An Environmental Impact Statement (EIS) has been prepared for this Master Plan in accordance with Hawai'i Revised Statutes, Chapter 343. During the public review process, the comments received from the public and from governmental agencies were assessed and responses incorporated into the revised Master Plan report. The Final EIS was accepted by the Governor on February 2, 2000. The University of Hawai'i Board of Regents adopted the Mauna Kea Science Reserve Master Plan in June 2000.

PLANNING COMPONENTS
BACKGROUND SECTIONS

Natural Environment
Culture
Education and Research
Recreation
Issues and Opportunities

In Hawai'i and elsewhere, those who know of Mauna Kea have a personal sense of the mountain and its resources. While each has their own experience and perception, there is a wealth of historical and scientific knowledge available for sharing and for use in planning for the future of the mountain.

The following sections explore the use and resource components that combine to create the unique history, landscape and activities of Mauna Kea. The natural environment – the *pu'u*, glacial remains, atmospheric qualities, and views - and cultural resources – landscape and archaeological sites - of Mauna Kea shape much of today's use of the mountain. Because of the unique natural and cultural qualities of the mountain, its slopes and summit plateau are used by a variety of individuals and organizations for cultural practice, education, research, and recreation.

Natural environment, culture, education and research, and recreation components are presented in the following sections. Previous studies are reviewed and on-going research is discussed. Current uses are explored as are the potentials for new uses in the future. The use and management of these components, and their relationships with each other create both issues that must be addressed and opportunities that may be explored. These issues and opportunities are also discussed.

Taken as a whole, these sections provide the basis for the development of the physical and management plans that follow. Many of the Master Plan's recommendations are based on the research and issues explored here.

NATURAL ENVIRONMENT

Geologic History

The Hawaiian Archipelago, extending 2,200 miles across the Pacific Ocean, was built almost entirely by volcanic activity. The oldest of the volcanoes are in the northwest and the youngest extend to the southeast. Each island is the top of an enormous volcano that grew from the seafloor to above sealevel, modified by stream and wave erosion and by minor amounts of organic reef growth.

Mauna Kea formed as a shield volcano that was later modified by neatly formed cinder cones and associated blocky lava flows. It is a dormant postshield stage volcano that last erupted about 4,500 years ago; and hence cannot yet be labeled as extinct. The oldest exposed lava flows on Mauna Kea are approximately 250,000 years old. The mountain's latest volcanic activity was characterized by explosive eruptions that produced widespread ash deposits. (Clague in Atlas of Hawaii , 1998).

The dome of Mauna Kea measures 30 miles across and is studded with cinder cones in a pattern indicating that the volcano was built over rifts extending eastward, southward, and westward. The volcanic rocks of Mauna Kea are divided into two series. The older Hamakua series is made up chiefly of primitive olivine basalts and forms the bulk of the mountain. The overlying Laupahoehoe volcanic series predominantly consists of andesine andesites ("hawaiites") and forms a thin veneer over the upper part of the mountain. The Laupahoehoe series is the thickest at the Mauna Kea summit where it has filled in the summit caldera. This volcanic series is characterized by both short and long *a'a* flows and bulky cinder cones. (Stearns, 1966).

During the last glaciation of the Pleistocene epoch, an ice cap covered approximately 27 square miles of the summit area of Mauna Kea (Porter, 1979). The tops of several of the mountain's cinder cones stood above the ice cap, which had an average thickness of 200 feet and a maximum thickness of 350 feet in places. Within the limits of this glacier, which reached down to the 11,000 and even the 10,500-foot elevation, many areas were scraped bare of ash and cinder. (Macdonald and Abbott, 1970).

The scouring action of the glacier is documented today by the common occurrence of glacially polished rock outcrops in the summit area and by glacial till deposits and classic terminal moraines such as those of Pohakuloa Gulch. In other parts of the summit plateau, oversteepened sides of *pu'u* and large areas of glacial till indicate the extent of the glacier. Areas of buried ground ice in the craters of two of the summit cinder cones show that permafrost exists near the summit where the mean annual temperature is below freezing . Cycles of freezing and thawing continue today, creating ever-changing patterns of rock fragments. These fragments of various coarseness are constantly moving, sorted into stripes and polygons . Mauna Kea, seemingly quiet and still, is never at rest.

During this period, volcanic eruptions continued to take place beneath the ice cap, forming several subglacial lava flows. Margins of these lava flows cooled quickly against ice meltwater, creating uniquely hard, dense rock in many places. Thousands of years later, this fine-grained, dense rock was sought after by Hawaiians who used it to craft adzes.

The landscape that exists today was formed by volcanic and glacial activity and is a unique environment for insects, spiders, lichens, ferns, and mosses. Rocky outcrops, loose cinder, and smooth lava flows make up habitats that combine with the snowfall and wind patterns of the summit area to support various forms of plant and animal life.

Among the many natural features found on Mauna Kea, the small alpine lake, Wai'au, is unique and revered. Wai'au is a nearly circular pond, 300 feet in diameter, situated on the summit platform of Mauna Kea at an altitude of approximately 13,020 feet. It is the highest lake within the boundaries of the Pacific Ocean basin and one of the highest lakes in the United States. The southern rim of the depression containing the lake is the rim of a subglacially-formed cinder cone, Pu'u Wai'au. The water of the lake, a maximum of 10 feet deep, is derived entirely from precipitation and runoff from the edges of the basin. (Stearns and Macdonald, 1946)

Mauna Kea's Flora and Fauna

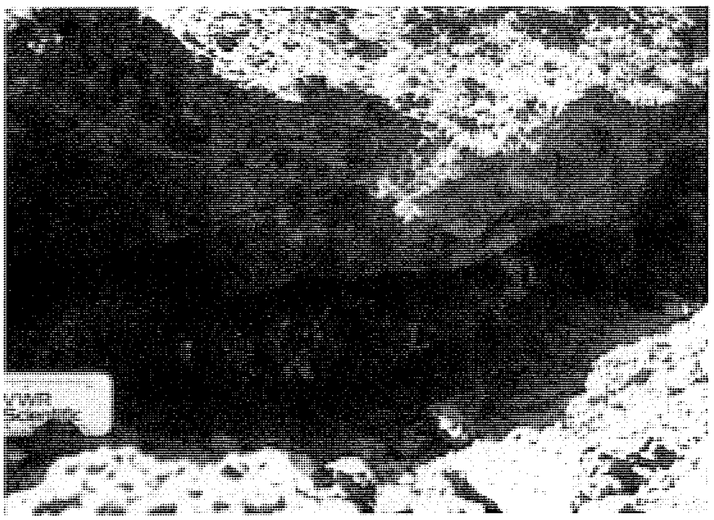
Over time, seeds and insects came to the islands carried by the wind from far away places. Some survived and some perished but eventually a diversity of plant and animal life evolved.

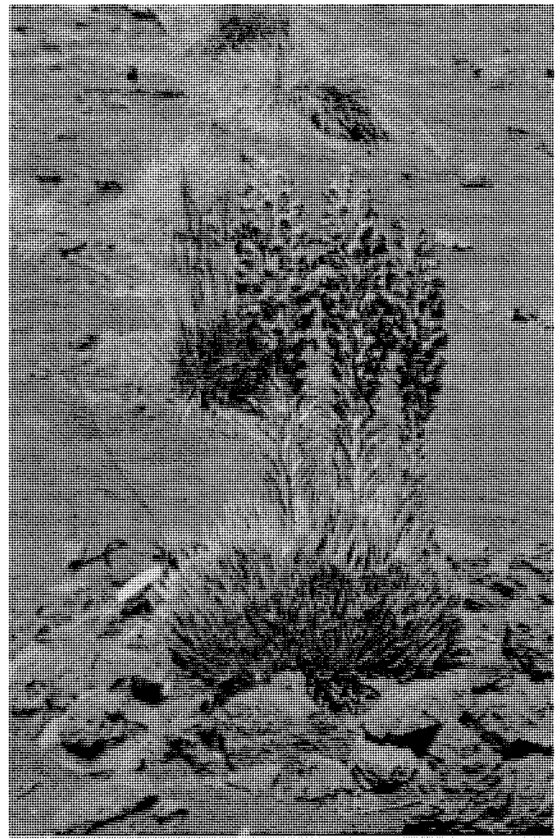
Hawai'i's plants evolved in the absence of indigenous browsing mammals and therefore bear no thorns or toxins (National Geographic, February 1999). Flightless birds adapted to an environment free of predators and were easy prey when man eventually came.

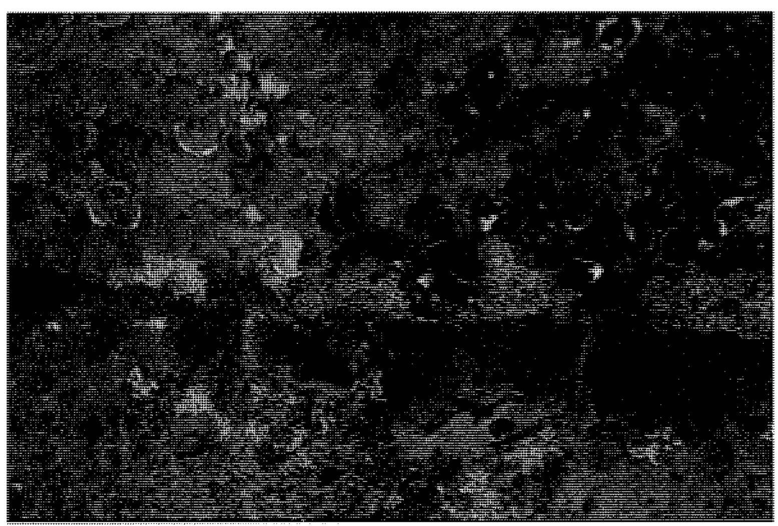
By the time the first humans arrived, the islands were lush with plants, birds, and insects. Cycles of intermittent volcanic activity have played a role in shaping how and where the species survive. The slopes of Mauna Kea host a wide range of ecosystems extending from the alpine summit region to the fertile lowlands.

Most of the Mauna Kea Science Reserve falls within the alpine ecosystem. While not obvious at first glance, the Mauna Kea summit region contains a variety of flora and fauna. Above 11,500 feet, small plants, mostly lichens, mosses, and ferns, grow in protected cracks and crevices (Figure IV-1 and Section IX).

In 1982, Dr. Clifford Smith studied approximately 25 different lichen communities on Mauna Kea. Approximately half of the species are endemic to Hawai'i, with two occurring only on Mauna Kea. High concentrations of lichens occur in areas with andesite rock outcroppings, generally on the north and west-facing sides where the lichens are able to intercept moisture from the tradewinds yet are not exposed to the full


Ferns in Crevice (Photo: Dr. Frank Howarth)


Mauna Kea Silversword (Photo: Institute for Astronomy)


Lichens & Moss (Photo: Dr. Frank Howarth)

Summit Flora Examples

sun. Fissures and small caves generally support lichen communities. In contrast, areas with cinder substrate do not provide good habitat for lichens. Winona Char (1999) indicates that lichen are found throughout the summit region.

Suitable moss habitat are widely distributed over the summit area. In his 1982 study, Dr. William Hoe collected approximately 12 species of mosses in the summit area. Less than a quarter of these species are endemic to Hawai'i. Mosses are most abundant on north-northeast facing sides of rock mounds, as well as south-southwest facing sides of these mounds. Some species are restricted to habitats that are at least partially protected by rock overhangs, while others are confined to deeply-shaded pockets and crevices where liquid water is available.

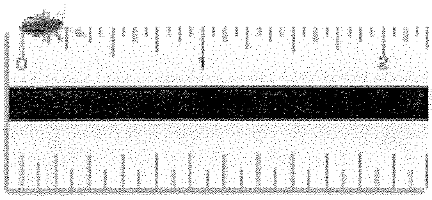
Also in 1982 Dr. Peter O'Conner studied vascular plants in the summit area of Mauna Kea and collected six different species. The *Cystopteris douglasii* is an endemic species found only in a few high altitude locations in the state. Vascular plants are found in areas of stable substrate. Most ferns are found within or at the base of andesitic rock outcrops where protection from sun and wind permits the accumulation of small amounts of soil and moisture. The Mauna Kea Silversword, a sub-species unique to this mountain, was once found in the summit area. It is suspected that feral ungulates destroyed much of this and other vegetation types.

The harsh climate of the Mauna Kea summit proves to be a difficult environment for the survival of many species. The summit region is an aeolian ecosystem where strong winds distribute dust, cinder, and food sources such as insects. The major component of the fauna on the Mauna Kea summit are arthropods such as spiders, moths, mites, springtails, centipedes, booklice, barklice, and true bugs. Feral pigs will occasionally travel to the higher elevations.

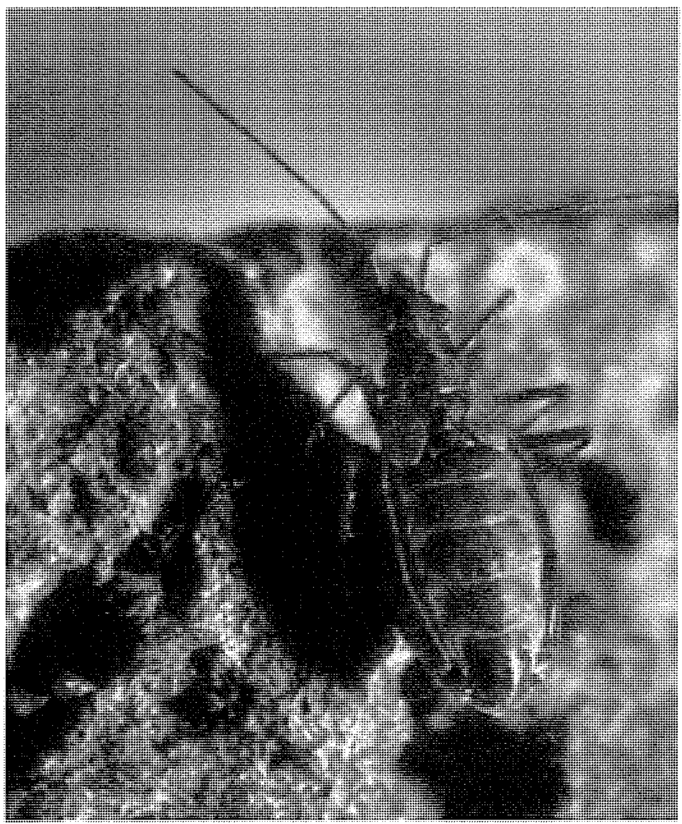
The one true bug found on the summit is the Wēkiu bug *(Nysius wēkiuicola)*. The bug has been found only in the summit area of Mauna Kea above about 12,800 foot elevation, however, recent fieldwork has identified suitable habitat down to approximately 11,800 feet (Howarth, 1999) (Figure IV-2 and Section IX). A relative of this bug is found on Mauna Loa.

The Wēkiu is found under large boulders and in among loose cinders. Researchers speculate that undisturbed cinder cones allow the bug to migrate vertically within the substrate to escape cold and drought and to seek moisture. Larger pore spaces in the cinder allow movement and provide resting and hiding spaces. The Wēkiu is a long-legged, black carnivore which does not fly. The Wēkiu survives on the water and insects carried by the wind and deposited to the substrate in melting snow.

The Wēkiu has been the subject of extensive study by the team of Francis Howarth, Gregory Brenner, and David Preston. From August 1997, to September, 1998 a total of 179 person days have been spent on the mountain in sampling and reconnaissance work. The summit's areas with the most suitable habitat for the Wēkiu are shown in Figure IX-9 and discussed more in that section. In addition to broad areas of suitable substrate, the



Average Size of Wēkiu Bug



Wēkiu Bug (Photo: William P. Mull)

Agrotis, moth (Photo: Stephen L. Montgomery)

Lycosa, wolf spider (Photo: Wiliam P. Mull)

Summit Fauna Examples

climatic conditions above approximately 13,000 feet make habitation possible in small isolated areas where the surface geology has specific characteristics (Howarth, 1999). While there is suitable geologic conditions below 13,000 feet, climatic differences appear to be the reason for the low populations at these elevations.

Recent field studies and analysis indicate a decline in the Wēkiu population on Mauna Kea. The reasons for the decline in population are unclear at this time and may include climatic factors, man-made disturbances, alien predators or seasonal trends. A puzzling question for researchers is the lack of bugs on the undeveloped Pu'u Mahoe in contrast to the presence of Wēkiu on the more developed Pu'u Hau Oki, home of the Subaru Telescope (Howarth, 1999). The research and analysis of the Wēkiu bug, including management recommendations, are thoroughly discussed in the Environmental Impact Statement prepared for this Master Plan.

Other species, the Lycosid wolf spiders and noctuid moths have been found to be widespread at low to moderate population densities within the Science Reserve. Both species are good at dispersing and appear to take advantage of temporarily available resources to survive.

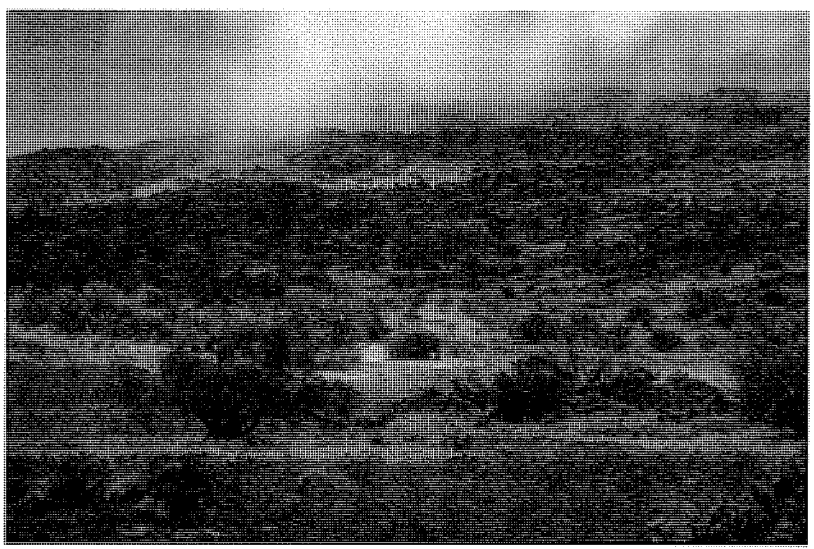
Further down the mountain, from approximately 11,000 foot elevation to the treeline, is alpine shrub land. *Pūkiawe* and *'ōhelo* grow in this band on the mountain below the Science Reserve. Below the Science Reserve and in the area related to the mid-elevation facilities at Hale Pōhaku the mountain's vegetation shifts to a sparsely wooded environment. The band from approximately 7,000 feet to 9,500 feet elevation is an open woodland of *māmane* (*Sophora chrysophylla*) and *naio* (*Myoporum sandwicense*). Both the *māmane* and *naio* are endemic species. Two species of mint and several native shrubs and vines occur in the area. Grasses and weeds also grow under the *māmane* tree, and sparse ground cover is found in this forest region. On the southwest side of the mountain and extending up the mountain, the *māmane* is mixed with *naio*. On the north side of the mountain, it is mixed with *koa* at lower elevations (Langlas, 1999). Mid-elevation flora and fauna are shown in Figure IV-3.

Nēnē, *'ua'u*, and *palila* were found in the *māmane* forest. These birds were prized for their meat and feathers. By 1990, the *'ua'u*, a pelagic seabird that breeds on many of the Hawaiian Islands between the months of May and October, were practically gone from the Saddle area between Mauna Kea and Mauna Loa, having been destroyed by mongoose. The *palila* (*Loxioides bailleui*) is a small bird of the Hawaiian honey-creeper subfamily that has been listed as an endangered species since 1966. Today the *'ua'u* as well as the *palila* is designated as an endangered species.

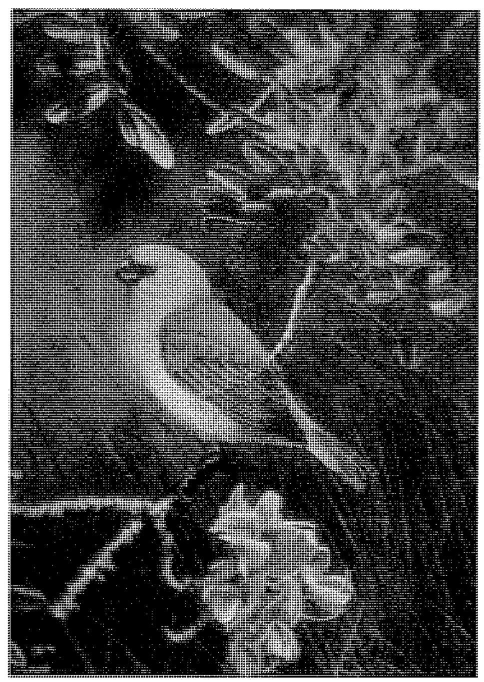
The seed of the *māmane* is the major food source of a number of bird species. The *palila*, a bird found nowhere else in the world, feeds on the green *māmane* seeds and the fruit of the *naio*. The *māmane* trees also provide shelter and nesting sites for the bird. The clumps of *māmane* are also important because they act as fog interceptors to provide themselves, and other species associated with them, with the small amounts of moisture

Naio (Photo: Winona Char)

Māmane (Photo: Winona Char)



Māmane Forest (Photo: Winona Char)



Palila and Māmane (Photo: Audibon Society "Birds of Hawai'i")

Mid-Elevation Flora and Fauna Examples

they need for survival. Pualani Kanahele and Edward Kanahele (1997) discuss the importance of the *māmane* forest as a food source for the *palila*. The Kanahele's explain that in the Hawaiian hierarchy system, the important entity is the source of food and not the animal that depends on this food. Noting this, the Kanahele's explain that it is most important to preserve the *māmane* forest as a cultural resource.

Introduced Mammals and the Destruction of Vegetation

In the late 1700s and early 1800s cattle were introduced and soon ran wild in the saddle between Mauna Loa and Mauna Kea. In addition to wild cattle, sheep and goats thrived on the mountain. As early as the 1820s, feral ungulates began destroying the summit area's silversword population and any other plants not protected in rocky crevices. In the 1820s and 1830s, Western, and later Hawaiian, hunters stalked wild cattle roaming the mid-elevation area slopes which were covered in *pili* grass and *māmane* trees. However, this activity was not enough to keep the population in check. Feral sheep and goats destroyed large portions of the *māmane* ecosystem by eating the leaves, stems, seedlings, and sprouts of the plants. The ungulate grazing has caused a gradual shift in the balance of trees from *māmane* to *naio*. By 1850, the cattle had visibly destroyed portions of the upper *'ōhi'a-koa* forest by eating the underbrush and stripping the trees. (Cordy, 1994) In a relatively short period of time, the landscape and use of the upper slopes of Mauna Kea changed dramatically.

By the late 1920's much of the vegetation had been destroyed and a government-sponsored eradication program began. Through hunting, fencing, and stock drives, feral cattle were eliminated from Mauna Kea and the feral sheep population, estimated at 40,000 in the mid 1930s was reduced to nearly 200 by 1950 (Giffin in Juvik and Juvik, 1984). With the decrease in wild animals, the forests of Mauna Kea began to regenerate themselves. Juvik and Juvik report that forest management policies shifted once again in the period following World War II. The number of game hunters increased and they were able to convince the government that sport hunting should be supported. In areas favored by hunters, the forest continued to regenerate. However, in less accessible areas the game returned and further damaged the fragile forest.

By destroying vegetation the rampant ungulates destroyed critical habitat for the *palila*. Efforts to protect the endangered *palila* bird resulted in a 1979 Federal court order mandating the removal of feral sheep and goats from the critical habitat area. A 1987 federal court order dictated the complete and permanent removal of all mouflon and hybrid sheep from the mountain. Though not popular with hunters, sheep and goat eradication programs have kept the numbers of feral ungulates in check and have assisted the revegetation of certain areas of the mountain. Over 30,000 acres of the *māmane-naio* forest have been designated as the critical habitat of the *palila*. *Māmane* revegetation programs have been undertaken to replenish the *palila* habitat. Revegetation efforts near the Hale Pōhaku facilities have favorable chances of success as the human activity tends to keep destructive animals out of the area.

CULTURE

The First Arrivals: Native Hawaiian Uses

In Hawaiian culture, natural and cultural resources are one and the same. Native traditions describe the formation of the Hawaiian Islands and the presence of life on and around them. All forms of the natural environment, from the skies and mountain peaks, to the valleys and plains, and to the shoreline and ocean depth are the embodiments of Hawaiian gods and deities. One Hawaiian genealogical account records that Wākea (the expanse of the sky) and Papa-hāna-moku (Papa – Earth mother who gave birth to the islands) and various gods and creative forces of nature gave birth to the islands. Hawai'i, the largest of the islands, was the first-born of these island children. The account continues that the same god-beings were also the parents of the first man (Hāloa), and from this ancestor, all Hawaiian people are descended. In some genealogical chants, Mauna Kea is referred to as "Ka Mauna a Kea" (Wākea's Mountain), and it is likened to the first-born of the Island of Hawai'i. (Maly, 1999)

"Cultural attachment is demonstrated in the intimate relationship (developed over generations of experiences) that a people of a particular culture share with their landscape – for example, the geographic features, natural phenomena and resources, and traditional sites, etc., that make up their surroundings. This attachment to environment bears direct relationship to the beliefs, practices, cultural evolution, and identity of a people. In Hawai'i, cultural attachment is manifest in the very core of Hawaiian spirituality and attachment to landscape. The creative forces of nature which gave birth to the islands (e.g., Hawai'i), mountains (e.g. Mauna Kea) and all forms of nature, also gave birth to *nā kānaka* (the people), thus in Hawaiian tradition, island and humankind share the same genealogy." (Maly, 1999, p. 27)

According to Kanahele and Kanahele (1997), the first Hawaiians landed on the island's shores between 25 BCE and 125 CE. Many more Polynesians voyaged to Hawai'i and settled over the next thousand years. During this settlement period, the early Hawaiians developed stable water and food sources and adapted to their new environment. (Kanahele and Kanahele, 1997) Hawaiians first settled near the shore where there was ready access to the ocean's plentiful resources. The forests provided plants and animals for food, tools, and shelter. Flightless birds, knowing no predators before, became easy prey for Hawaiian hunters. The mountain tops, the highest points of the land, were considered sacred. Mauna Kea is among the most sacred of these high points.

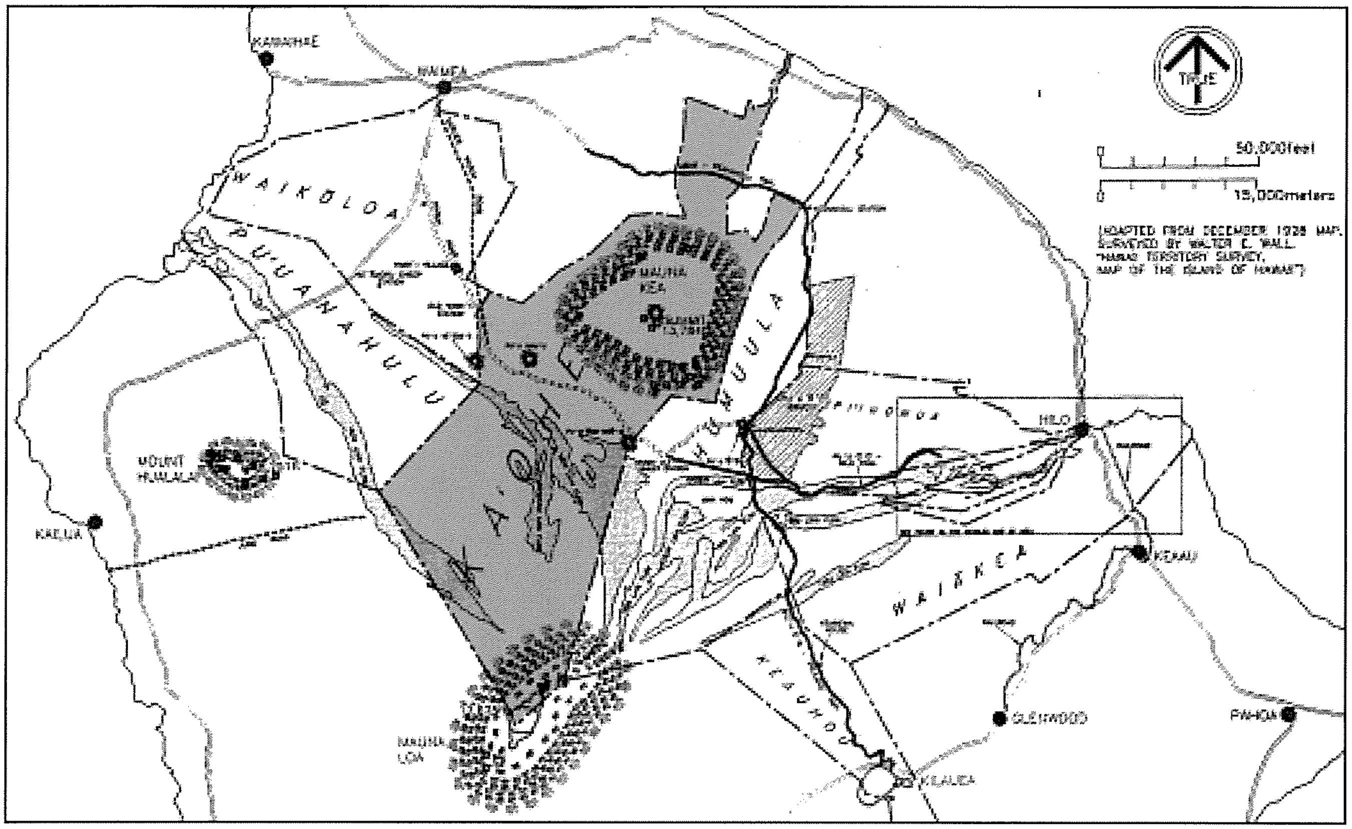
As early as AD 1100, adze makers came in reverence to the Mauna Kea adze quarry, Keanakāko'i (most of which is located in the Mauna Kea Ice Age Natural Area Reserve), to craft tools from the unique dense basalt found here. As part of the ritual associated with quarrying, craftsman erected shrines to their gods. Adze makers came to the mountain for short periods of time to work on the basalt that formed from molten lava which erupted under the glacial ice cap. They chipped out chunks of basalt and then worked the stone to form refined tools in shelters and workshops they had built. Different areas were designated for chipping, rough-finishing, and fine-finishing. *Māmane* wood was preferred for adze handles. In addition to the quarrying of adze basalt, craftsmen also collected volcanic glass and dunnite/gabbro for cutting tools and octopus fishing gear sinkers (McCoy, various and Maly, 1999). Further down the mountain, near a spring, the adze makers erected shelters from which they would gather water, wood, and food to sustain them as they worked in the quarry. (PHRI, 1997) Remnants of shelters, shrines, adze manufacturing, food and offerings remain today to tell of these early craftsmen. The adze makers are thought to have come from neighboring areas and the adzes they crafted were widely used. Keanakāko'i was an active place for hundreds of years, with intensive use after AD 1400 and eventual decline prior to Western contact.

Following the long period of initial settlement, an era of high culture ensued. The Hawaiian society advanced in all areas from the 1200s until the late 1700s. During this time political powers exerted their might and the structure of communities was refined. (Kanahele and Kanahele, 1997)

In the beginning of the 1600s, during the time of Umi, the Hawaiian Islands were divided into political regions. The larger islands (*mokupuni*) were divided into districts (*moku*). The *moku* were divided into *ahupua'a* and large *ahupua'a* were divided into *'ili*. *Ahupua'a* were often entire valleys spanning from the top of the mountain ridge to the ocean. The *konohiki* managed the day-to-day operations of the *ahupua'a* with the aid of *luna* who were experts in various fields such as planting and fishing. Each *ahupua'a* contained nearly all of the resources Hawaiians required for survival from fresh water, plants, and a variety of animals, and was managed so that these resources could be sustained over time. (The Ahupua'a, 1994)

The *ahupua'a* of Ka'ohe spans the summit of Mauna Kea and includes the Mauna Kea Science Reserve (Figure V-1). The lower slopes of Mauna Kea reach into the *ahupua'a* of Humu'ula and Ka'ohe. Hawaiians hunted and gathered in Mauna Kea's *māmane* forests which were rich with vegetation and native birds including the *'ua'u* (dark-rumped petrel), *nēnē*, and *palila*. So prized were the plump young *'ua'u* that they could be eaten only by the *ali'i*. Hawaiians came to the *koa* and *'ōhi'a* forest on the mountain's lower slopes to gather wood for canoe-making and to collect bird feathers. Above the *koa* forests was the open *māmane* forest where they may have hunted *'ua'u* and *nēnē*.

All aspects of Hawaiian life were steeped in ritual. For the Hawaiian people, spiritual beliefs, cultural practices and all facets of daily life were intricately bound to the natural landscape of the islands. The lake, Wai'au, was believed to contain pure water associated with the god Kāne and was used in healing and worship practices. Archaeologist Pat McCoy suggests that shrines located at the edge of the summit plateau may mark the transition to a spiritual zone associated with the summit of Mauna Kea (McCoy and McEldowney, 1982). The shrines may be associated with the snow line and thus



Source : PHRI, 1997, Archaeological Inventory Survey and Historic Traditional Cultural Assessment for the Hawai'i Defense Access Road A-AD-6(1) and Saddle Road (SR 200) project

Ahupua'a of Ka'ohe

represent shrines to Poli'ahu and/or other deities. Hawaiians also buried the bones of their dead on the slopes of Mauna Kea.

Archaeology and Ethnographic Research

What we know today of Mauna Kea's ancient use and meaning we have learned from the physical clues left behind on the mountain. Ethnographic research explores more recent human activity and the traditions that have been handed down within families over time.

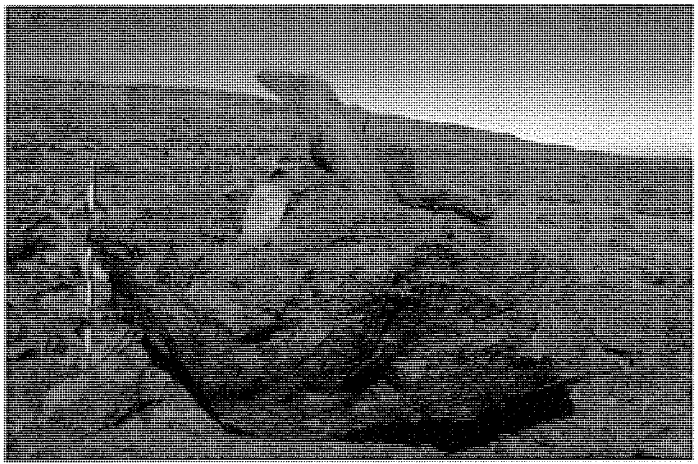
For the past two decades archaeologists have conducted extensive field work on the slopes of Mauna Kea, with access made much easier with the construction of a road to summit area. Approximately 3,000 acres, or 27 percent, of the Science Reserve has been surveyed to date (McCoy, 1999). Much of this archaeological work has been undertaken by Dr. Patrick McCoy, currently with the State Historic Preservation Division. McCoy and colleague Dr. Holly McEldowney have prepared an Historic Preservation Management Plan for Mauna Kea. As part of this plan, McCoy has inventoried and summarized the archaeological sites that provide a wealth of knowledge of past use of the mountain (McCoy, 1999) (Figures V-2 and V-3).

In addition to the archaeological field work, several individuals have recently conducted ethnographic studies concerning Mauna Kea. Their research is summarized here.

Dr. Charles Langlas of the University of Hawai'i-Hilo worked with Paul H. Rosendahl, Ph.D., Inc. to prepare an Archaeological Inventory Survey and Historic and Traditional Cultural Assessment for the Hawai'i Defense Access Road A-AD-6(1) and Saddle Road (SR 200) Project (1997). Pualani and Edward Kanahele prepared a Social Impact Assessment of Indigenous Hawaiian Cultural Values for this same project (1997).

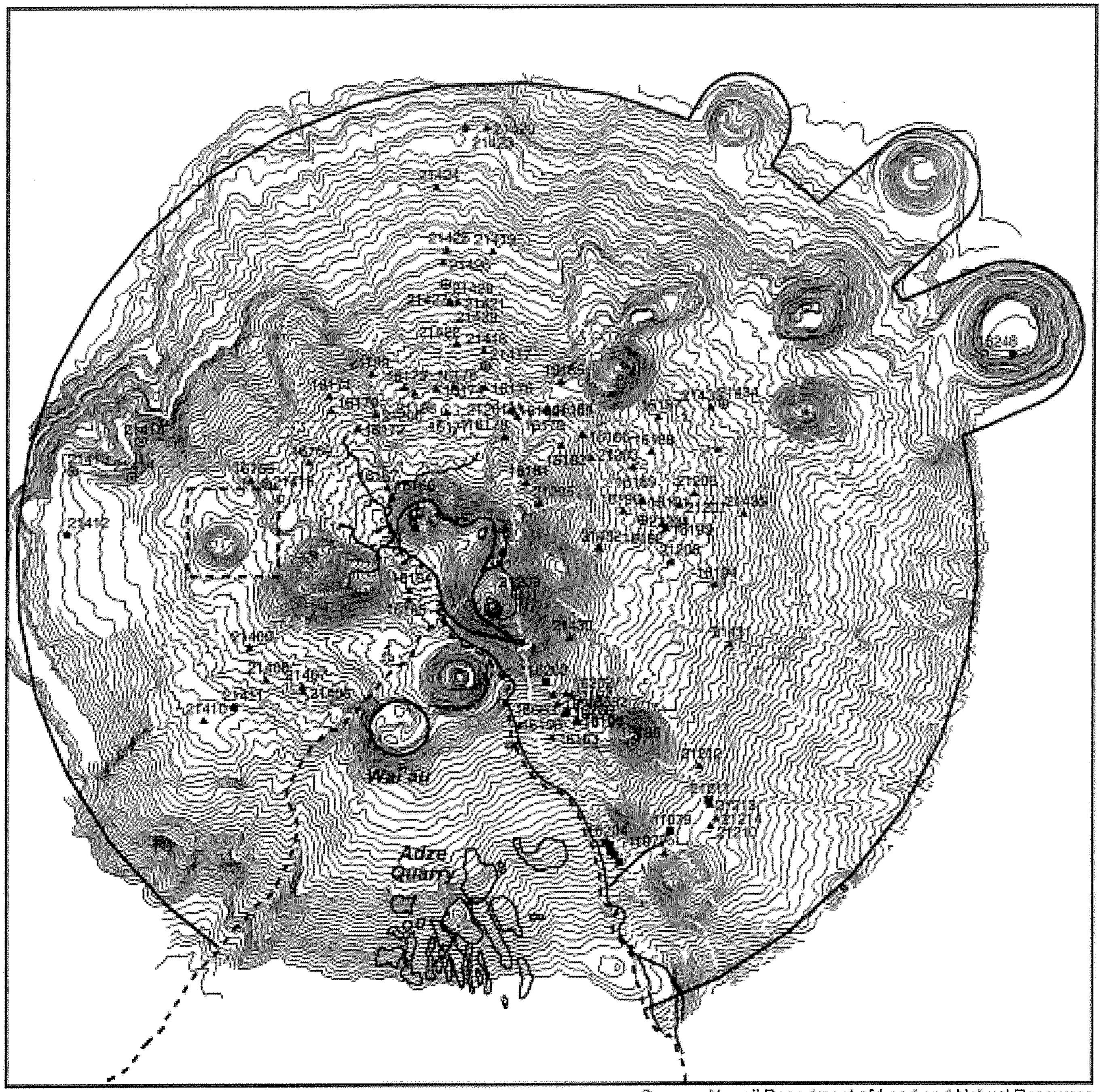
In association with the preparation of this Master Plan, cultural specialist Kepā Maly conducted an oral history interview and archival research effort in the later part of 1998 to compile the thoughts and memories that those living today have of Mauna Kea (Maly, 1999). Maly interviewed 22 individuals and structured his research into broad groupings that are helpful in organizing the often generalized feelings that individuals have toward Mauna Kea.

McCoy summarizes the most recent archaeological work within the Mauna Kea Science Reserve. Based on field work undertaken between 1975 and 1997, a total of 93 archaeological sites have been identified in surveys covering approximately 3,000 acres within the larger Science Reserve, including the immediate summit ridge areas. These sites tell us much about the history of man's association with Mauna Kea. Of the 93 sites, 76 are shrines, four are adze manufacturing workshops, and three are markers. One burial has been positively identified and four other possible burial sites exist. The function of five of the 93 sites is unknown. (McCoy 1999)



Archaeological Site Examples

Photos: Pat McCoy



Source: Hawaii Department of Land and Natural Resources
Historic Preservation Division, February 1999

▲ Shrines
● Marker
⊕ Unknown
■ Workshop

25' Contour Intervals

Natural Area Reserve

0' 2000' 4000' 8000' NORTH

Archaeology Sites Map - Science Reserve

Shrines

The term 'shrine' is used by McCoy to describe all of the religious structures that exist in the summit region of Mauna Kea. The most common of the archaeological features on Mauna Kea, shrines are characterized by the presence of one or more upright stones. The shrines at Mauna Kea range from single uprights to more sophisticated complexes with pavements and prepared courts.

The majority of shrines on Mauna Kea are located conspicuously on ridgetops or at breaks in the slope. It is not surprising that shrines were placed in prominent locations with commanding views of the landscape. Shrines have not been found on the tops of cinder cones.

McCoy suggests that each upright on a shrine may have stood for a separate god. The majority of uprights were made of angular slabs found in the glaciated area of Mauna Kea. These select stones were unmodified by their human gatherers and provided a place for the gods to inhabit when they were needed. Based on ethnographic information McCoy suggests that the pointed uprights might represent male gods and the flat-topped uprights, female gods.

Stone uprights were typically set in a crack in the bedrock and braced with a few stones. In other shrines, most notably those in the north and east slopes, uprights were set on the top of a boulder. In shrines dispersed throughout the summit area, stone uprights were set into low rubble heaps or piles of stones. In only a few cases, cairns were built to support the stone upright. Platforms were also built to support one or more uprights.

McCoy suggests that the shrines on Mauna Kea were erected for one of two, and possibly more, functions. Though they are not distinguished from each other by physical characteristics, the shrines can be classified as occupational or non-occupational in function. The eight occupational shrines are identified by the remains of specialized workshops and adze manufacturing byproducts.

The non-occupational shrines range in complexity from simple features with a small number of uprights to more complex structures with courts and larger numbers of uprights. Most of the shrines found on Mauna Kea have just 1 to 3 uprights, however, some have as many as 24 or 25 stone uprights. McCoy speculates that the simple shrines were built and used by small family groups and the larger, more complex structures were built and maintained by a priesthood. McCoy reasons that the larger number of uprights indicate a larger number of gods than most Hawaiians would probably have known. In addition, many of these more complex sites are isolated from the main areas of worship.

McCoy has interpreted the shrine complex in the summit region as evidence of an historically undocumented pattern of pilgrimage to worship the snow goddess, Poliʻahu, and other mountain gods and goddesses.

Adze Quarrying and Manufacturing

The main adze quarry, Keanakāko‘i, is located within the Mauna Kea Ice Age Natural Area Reserve. The majority of the workshops and shrines associated with adze manufacturing are located near the main quarry. Four additional adze manufacturing workshops have been found in the Science Reserve across the Summit Access Road from the adze quarry. However, these workshops are of a different kind than those found in the adze quarry. Manufacturing byproducts such as flakes, cores, adze rejects, and hammerstones have been found at these workshops, however, no stone-tool quality raw material is found. Thus it is likely that adzes were flaked elsewhere and transported to these localities at a later stage of the manufacturing process. Each workshop has one or more shrines upon which adze byproducts were offered to the tutelary gods of adze making. McCoy has identified one of these workshops as the location of initiation rites for apprentice adze makers. (McCoy 1999)

Several of those interviewed by Maly have heard of or visited the adze quarry areas on Mauna Kea.

> Coco Hind recalls, "I went up once [to Mauna Kea], a long time ago, we went up to Lake Waiau. I remember feeling kind of weak when we got up there, and it was the thin air. I wasn't that old. We went up to Humu‘ula and then we took horses. We rode horses up to Wai‘au. I was with my father, my mother didn't go. My mother was afraid of horses, she wouldn't go near a horse."... "... we went up and dad showed us this...there were other people with us too, my uncle Allan and his son, and others. He showed us this place where there were *‘ōpihi* shells all over and it was where daddy said that they used to rough cut the adzes and then bring them down and finish them up, down below..." (Florence La‘i-ke-aloha-o- Kamālu "Coco" Vrendenburg-Hind, p. A-118 in Maly, 1999)

Trails and Access

In pre-contact times, it is suspected that travel to Mauna Kea was guided by individual knowledge of the landscape rather than by any distinct trails. It is possible that ridges were followed or that sources of water were known and visited along the way. Individuals going up the mountain likely visited the shrines erected by their family members to their gods. No evidence of pre-contact trails has been documented. (McEldowney, 1999)

Maly reports that by the later nineteenth and early twentieth centuries, trails were created and often traveled on horseback. The trails of Mauna Kea linked communities and cultural and natural resources together. To reach the summit, people left the near-shore and plains lands and traveled the mountain slopes to the summit. The trails ascend the slopes of Mauna Kea from nearly all of the major, and many of the smaller *ahupua‘a* which lie upon Mauna Kea's slopes. Traditions pertaining to journeys on the mountain trails, and knowledge of Mauna Kea are still retained as important family history today. Mauna Kea's trails, as told of in the oral and written histories, are depicted on the annotated interview map (Figure V-4). Significantly, many of these trails converge at Wai'au, in the Natural Area Reserve.

Interviewees told Maly of their elders travelling to Mauna Kea to worship in the summit region, gather water from Wai'au for healing practices, procure stone for adze making, and take individuals' ash remains to the summit area or to Wai'au for their return to the Earth. Teddy Bell describes one of the mountain trails to Wai'au.

> "And then we also went from Waiki'i" . . ."You go so far from Pu'u Lā'au . . . There used to be one pine tree forest. And from that reserve, there's a clump of pine trees. That's where they've got a lot of cones. From that pine trees, you look at Mauna Kea, the two sides, it's almost like a *pali* but wide. And then you right up through that hollow there, and you come up to Lake Waiau. Almost to the end of the *pali* on Mauna Kea." (Theodore "Teddy" Bell, Sr., p. A-128 in Maly, 1999) (This trail is indicated in Figure V-4 as <u>K</u> Waiki'i-Waiau trail.)

During the historic period, people have traveled the mountain for Territorial Forestry operations, ranching, hunting, and recreational activities. Lloyd Case describes game trails on the mountain.

> "You know one of the most amazing things, and I don't know if some of the old timers told you this. But a lot of these Hawaiian trails, a lot of them were used by the sheep, they became game trails after a while. The sheep would use some of these trails. Some of these trails we walked 'em, on the Kemole side, Pu'u Mali side. But a lot of them, they are still there, but you have to have a good trained eye to find 'em." (p. A-348 in Maly, 1999)

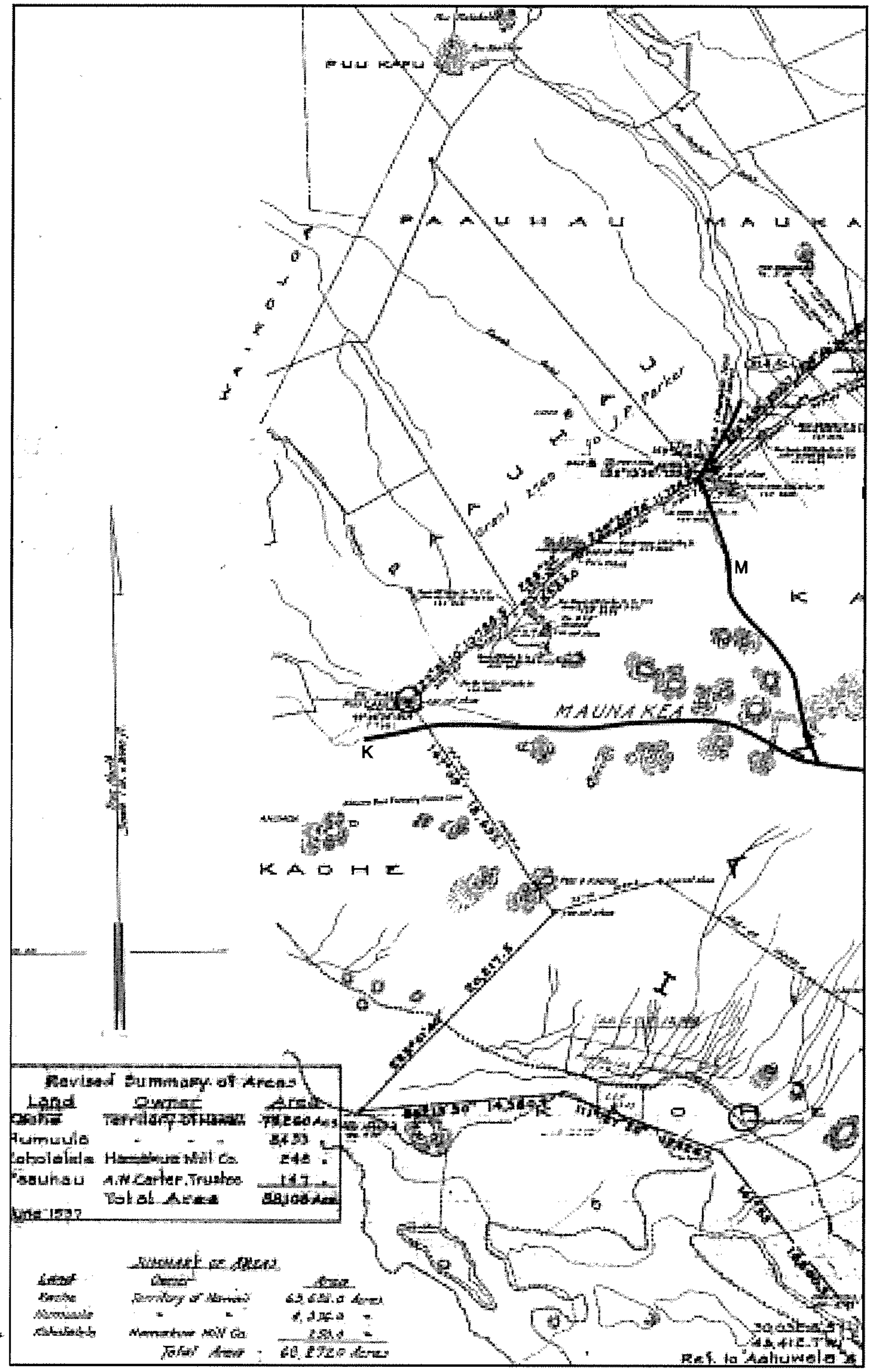
<u>Burials</u>

As was mentioned earlier, no shrines have been identified on top of cinder cones in the Mauna Kea Science Reserve. McCoy believes that these high and remote places were reserved for burying the dead. Although there are references to human burials on Mauna Kea in oral histories, only one burial site has been positively identified in the mountain summit area.

"To date the only positively identified human remains found in the Science Reserve are located at Site 16248 on the summit of Pu'u Makanaka (Fig. 1). Jerome Kilmartin, a surveyor with the United States Geological Survey, noted the presence of human remains on this prominent cinder cone in 1925." (McCoy 1999)

Four other sites within the Science Reserve have been identified as possible burials by McCoy.

Figure 1. HTS Plat 613; March 1928 (State Survey Division) Annotated as Interview Map Showing Approximate Locations of Selected Sites Referenced During Oral History Interviews
Kumu Pono Associates Report No. HiMK-21 (020199)



Key to Sites Identified on Map
(Source – Mauna Kea Oral History Interviews):

A – Mauna Kea. "Ka Mauna a Wākea" (the Mountain of Wākea), "Ka piko kaulana o ka 'āina" (The famous summit of the island); a sacred landscape[1].

B – Pu'u Kūkahau'ula. The summit peak, a sacred landscape. Site of an altar, repository of piko, and site where ashes of deceased are released.

C – Pu'u Poli'ahu. A sacred landscape.

D – Pu'u Līlinoe. A sacred landscape.

E – Waiau. A sacred landscape, source of water used for ceremonial and healing rituals, and repository of piko.

F – Site of an old altar or cairn on which a bottle was placed, and in which papers with the names of early visitors to Mauna Kea were placed.

G – Memorial plaque commemorating the life of Eben Low (placed in January 1954 – later removed by unknown individuals).

H – Mauna Kea-Humu'ula Trail.

I – Mauna Kea-'Umikoa Trail.

J – Keanakāko'i (Kaluakāko'i). A specific adze quarry site, and area extending several miles with associated quarries, caves and platform features.

K – Waikī'i-Waiau Trail (shown at approximate route).

L – Pu'upōhaku. A sacred Landscape.

M – [illegible]-Waiau Trail (shown at approximate route).

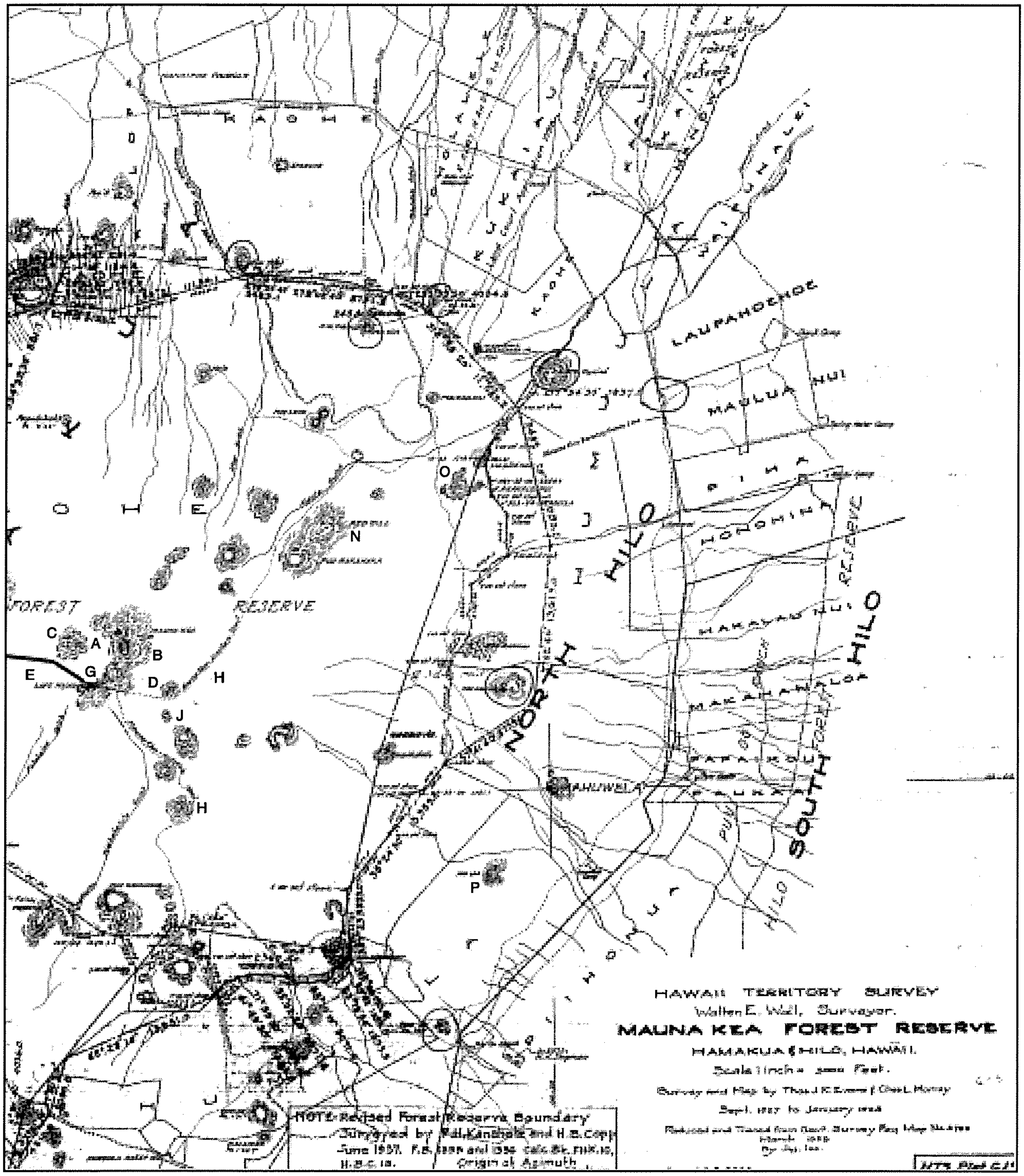
N – Pu'u Mākanaka and Koupō. A sacred landscape.

O – Pu'u Keonehehe'e. A sacred landscape.

P – Pu'u Lāu. A sacred landscape.

Other pu'u and natural features circled on map.

[1] Sacred landscape indicates that a location is associated with one or more attributes, for example: (1) a Hawaiian god or goddess; (2) prayer and/or ritual observances; (3) traditional practices; and/or (4) interment of remains.


HAWAII TERRITORY SURVEY
Walter E. Wall, Surveyor.
MAUNA KEA FOREST RESERVE
HAMAKUA & HILO, HAWAII.
NOTE: Revised Forest Reserve Boundary
Surveyed by Pal. Kanehele and H. E. Copp
June 1937.
Origin of Azimuth
LAUPAHOEHOE
MAULUA NUI
NORTH HILO
SOUTH HILO
FOREST RESERVE
A
B
C
D
E
G
H
J
N
O
P

> "There are four other sites in the surveyed areas of the Science Reserve that have been identified as possible burials (Sites 16195, 21413, 21414, and 21416). In each case there are compelling reasons to believe that the site is indeed a burial, but because human remains were not seen at the time the site was recorded it has been called a possible burial."

Of these four possible burial sites one consists of two adjacent cairns located on the eastern rim of Pu‘u Līlīnoe. The other three are located on the southern and eastern rim of a large unnamed cinder cone on the northwestern edge of the Science Reserve. (McCoy 1999)

McCoy notes that archaeological sites have been found in all areas that have been surveyed to date but the distribution and density of the various types of sites follows certain patterns. The one burial and four possible burials have been found only on the tops of cinder cones and never with shrines.

While none of the individuals interviewed by Maly reported knowing of specific locations of burials in the immediate area of the Mauna Kea summit, many spoke of *ilina* (burial sites) in cinder cones, and other natural features in the region extending from about the 12,000 down to the 7,000 foot elevation. In modern times several family members or close friends of interviewees have had their cremated remains taken to the summit of Mauna Kea for release.

<u>Summit Area</u>
A significant pattern is the virtual absence of archaeological sites at the very top of the mountain. McCoy states that the "top of the mountain was clearly a sacred precinct that must, moreover, have been under a *kapu* and accessible to only the highest chiefs or priests."

Most of the shrines in the Science Reserve are found on the northern and eastern slopes just above and below the 13,000 foot elevation. This pattern suggest that most of those who journeyed to the summit area came from the Hāmākua and Hilo sides of the mountain. Discussing the scarcity of sites on the western and southwestern slopes, McCoy makes the following observations:

> "While the small number of shrines on this side of the mountain suggest the possibility of people coming from the Kona and South Kohala districts, the number would appear to have never been high. The implications are quite interesting. It suggests that while the mountain may have been viewed from a distance by people from everywhere on the island as a sacred mountain, in practice those who made the journey and worshipped there did not represent an even cross-section of the island populace. The implication is that access to the summit region was under the political control of the east Hawaii chiefdoms, a conclusion that is consistent with all of the other data." (McCoy 1999)

All of those interviewed by Maly attributed spirituality and healing qualities to being on Mauna Kea; and several recorded that they still go to Mauna Kea for prayer and restoration. One described Mauna Kea as a sanctuary in ancient times. The area above the forest line was so sacred that once in the upper region, your enemies could not pursue you. (Maly 1999)

In addition to the sites identified within the Science Reserve, a wealth of physical evidence can be found in the Mauna Kea Ice Age Natural Area Reserve, outside of the Science Reserve. Within the Natural Area Reserve, the main adze quarry and numerous sites at Wai'au tell of the activity in this geologically and culturally unique area. Many of these sites have been inventoried but have yet to be fully analyzed and related to the other sites found on the mountain.

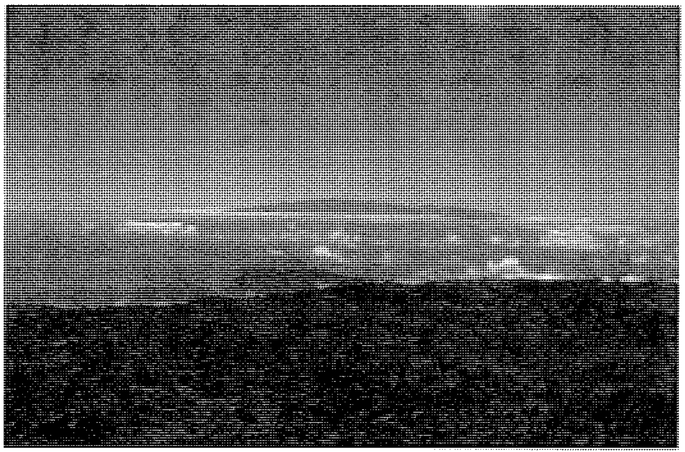
Cultural Landscape

The summit of Mauna Kea has been referred to as *wao akua* (region of the gods). The most common understanding of *wao akua* is that it was a remote desolate location where spirits, benevolent or malevolent, lived and people did not live. Usually these places were deep interior regions, inhospitable places such as high mountains, deserts and deep jungles. These areas were not necessarily *kapu* but were places generally avoided out of fear or respect. Different people and family had different protocols when they traveled through these remote regions. (George Atta personal communication with Holly McEldowney and Pat McCoy, June 2, 1999)

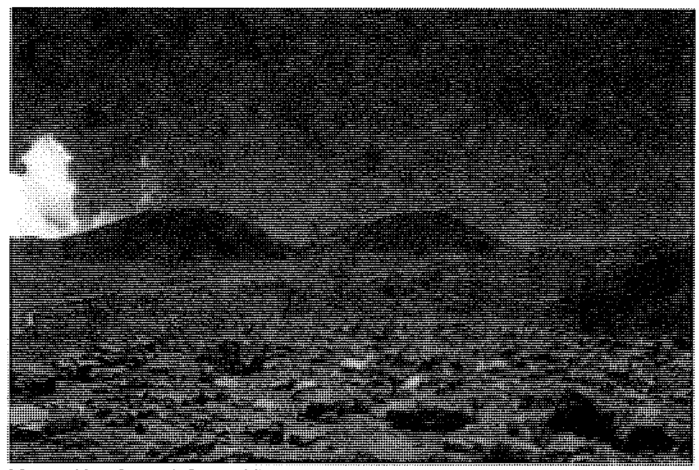
"Perhaps as a result of its prominence, isolation, and extreme environmental conditions, Mauna Kea's place in the culture and history of the Hawaiian people is significant. This 'cultural significance' extends beyond a physical siting, sites or particular features which have been previously identified in archaeological site studies. Mauna Kea is a prominent feature on the cultural landscape of Hawai'i which has been and continues to be, viewed from afar, and to which spiritual and cultural significance is attributed." (Maly, 1999, p. 3)

The ancient saying "Mauna Kea kuahiwi ku ha'o i ka mālie" (Mauna Kea is the astonishing mountain that stands in the calm) (Pukui 1983: No. 2147), expresses the feeling that Mauna Kea is a source of awe and inspiration for the Hawaiian people. The mountain is a respected elder, a spiritual connection to one's gods. Thus, the landscape can be interpreted as a significant facet of a Hawaiian's identify. Mauna Kea is the focal point of numerous traditional and historical Hawaiian practices and narratives recorded by both native Hawaiians and foreign visitors. Views of the mountain landscape are presented in Figure V-5.

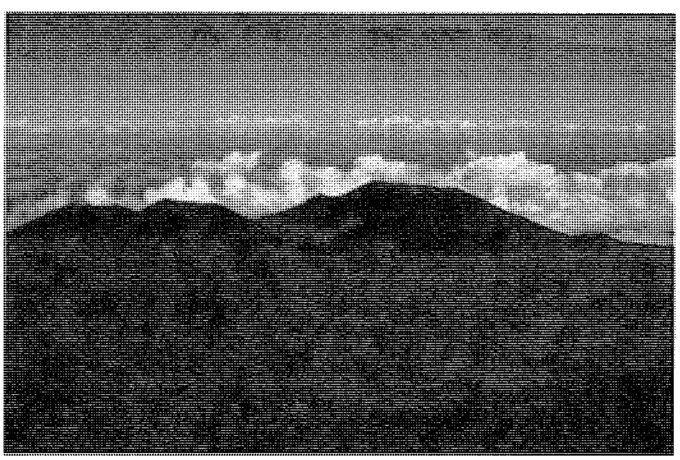
"A number of place names recorded for this mountain landscape are associated with Hawaiian gods. Other place names are descriptive of natural features and resources, or document events that occurred on the mountain." (Maly, 1999) "Native families also



View from SMA Road, Haleakalā in background (Photo: Group 70)



Mauna Kea Summit Road, View to Summit Area (Photo: Group 70)



Summit Plateau Cinder Cones (Photo: Pat McCoy) retain names such as Maunakea, Poliʻahu, Lilinoe, and Waiʻau, which in some cases are directly tied to the mountain landscape." (Maly, 1999)

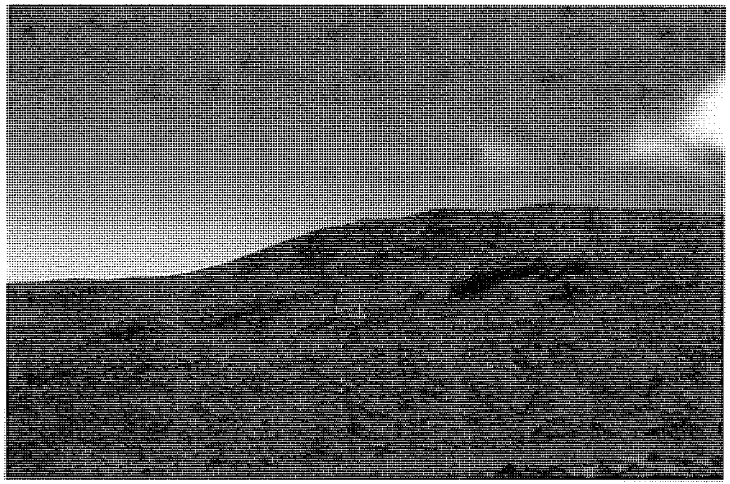
The Kanaheles (1997) tell of Mauna Kea as the *piko* or origin point for the island of Hawaiʻi, and specifically the northern half of the island. Mauna Kea is, therefore, a place of great *mana*. Kanahele has also said that the three *puʻu*, Poliʻahu, Līlīnoe, and Waiʻau are named for three sister goddesses who are female forms of water. Poliʻahu is embodied in the snow, Līlīnoe in mist, and Waiʻau in the lake. These *puʻu* are where the goddesses manifest themselves. Of these three landforms two, Poliʻahu and Līlīnoe, are located in the Science Reserve. Waiʻau is located in the Natural Area Reserve (Figure V-6).

Many of those interviewed by Kepā Maly expressed the significance Mauna Kea holds for them as Hawaiians and as individuals.

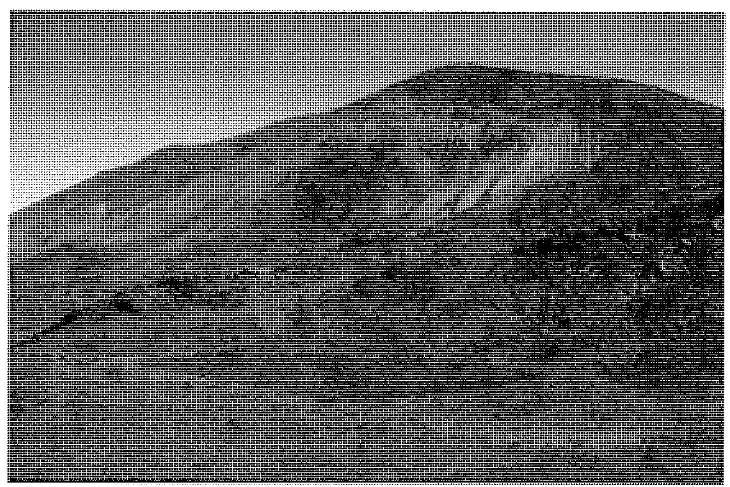
John Speilman and Pualani Kanahele describe Mauna Kea in the context of the entire Island of Hawaiʻi and in Hawaiian ancestral history.

> "And I think too, what is important to understand and for people to realize is that it is all connected. Although we are talking about Mauna Kea, Mauna Kea and Paniau are connected. When you go fishing from Paniau, you look up to Mauna Kea and you check out the weather. You look to the mountain and see what the weather patterns are doing. The Kohala mountains. So the fishermen use the mountains as visual aids to help them in their fishing. And perhaps, I don't this as much, but from the mountain side down, but I would imagine that the farmers and the people that lived higher, would look down to the ocean to see if the weather was changing, the cloud patterns on the ocean. It's all connected. It is not separate. But Mauna Kea, I think, is the focal point of this island. It is the *piko*, the breath . . ." (John K. Spielman, p. A-282 in Maly, 1999)

> "Mauna Kea was always *kupuna* [an elder, ancestor] to us. Mauna Kea and Mauna Loa, the tips, they were always *kūpuna* [elders, ancestors]. and there was no wanting to go on top. You know, just to know that they were there was just satisfying to us. And so it was kind of a hallowed place that you know is there, and you don't need to go there. You don't need to bother it. But it is there, and it exists. And it was always reassuring because it was the foundation for our island." (Pualani Kanakaʻole Kanahele, p. A-366 in Maly, 1999)


Adze Quarry (Photo: Group 70)


Adze Quarry (Photo: Group 70)


Wai'au (Photo: Pat McCoy)

Natural Area Reserve (Adze Quarry, Wai'au)

Alexander Lancaster and Tita Spielman relay the significance of Mauna Kea to each of their families.

> "Yes, my grandmother Alice. Her Hawaiian name is Kamahalo – she was named after her grandmother, my great, great, great grandmother. She said " When you go up there, you going feel the spirit." And you do feel the spirit." (Alexander Kanani'alika Lancaster, p. A-234 in Maly, 1999)

> Regarding her family's relationship to Mauna Kea, Spielman explains, "Well, it was through my mother, because of course, she grew up in Kohala and spent a lot of time there. And at Pu'u Wa'awa'a and Kiholo, and always loved Mauna Kea. She used to say 'That's my mountain.' And so we got to know it and love it as we do." ("Tita" Elizabeth Kauikeōlani Ruddle-Spielman, p. A-265 in Maly, 1999)

Teddy Bell and Lloyd Case relay their own personal feelings about Mauna Kea.

> "On the slopes of Mauna Kea, there is a ridge there called Pu'u Nānā. Pu'u Nānā, if it's a clear day, you can see all of this Waimea. So that's where I want my ashes to be scattered." Theodore "Teddy" Bell Sr., p. A-139 in Maly, 1999)

> "Because the one thing I loved about it was just going up there and sitting down under the tree and looking out at space. Looking at everything. That is the most rewarding thing that I ever can say happens to me. When I go up there, it just heals me. That is a place for healing . I come back a different person." (Lloyd Case, p. A-353 in Maly, 1999)

A gentleman interviewed by Langlas was taught by his great-grandparents that there were two sites of ritual importance on Mauna Kea, the summit peak and the lake and surrounding *pu'u* Wai'au. According to this individual, the summit peak was a place to go and pray to the gods for *mana*, to cleanse the person and give him health.

Wai'au is a place of tradition and a source of inspiration. Located outside the Science Reserve in the Natural Area Reserve, Wai'au is a focal point for many visitors to the mountain. Many of the individuals interviewed by Kepā Maly discussed their own visits or visits by family members to Wai'au.

> "It [Mauna Kea] brings back memories, you know. But way back, people never used to go up there. They never did go to Mauna Kea except on horse back, and that was very few. And right at Lake Waiau, had a bottle there. Whoever went up, would write their name and the date, and put it in the bottle." . . ." Yeah. So, I don't know what happened to that bottle. My first trip to Mauna Kea was in 1934. And there were a few peoples

names in that bottle already." (Theodore "Teddy" Bell Sr., p. A-123 in Maly, 1999)

Kepā Maly, "And you mentioned that Waiau was a favorite place [of your grandfather Eben Low]." Tita Spielman, "A very favorite place. Yes, and that's why his plaque was put there. Because that was one of his favorite places. Although, his ashes were scattered at the top, the plaque was put at Waiau." ("Tita" Elizabeth Kauikeōlani Ruddle-Spielman p. A-270 in Maly, 1999)

In addition to feelings of *aloha* expressed for the place, numerous oral traditions of the importance of Wai'au have been handed down through families.

Kepā Maly, "So he [your father] would go *mauka* to Waiau and gather water there?" Anita Lancaster, "And he would bring it, and he had my mom and I drink that water. And if we had it for a week, it never went into the refrigerator, it stayed on the counter, but it was always cold. And that was the sweetest water. It was so pure. I thought nothing of it because I was so young. But as I grew older, I would always remember it because my dad always had this gallon hanging, you know when he didn't go hunt, the gallon was always hanging in the house. In fact, the last time I saw it was just before he died, and then I don't know what happened to the gallon..." (Anita Leilani (Kamaka'ala) Landcaster, p. 245 in Maly, 1999)

"The water they used...the *lā'au lapa'au*, the healers went to this particular place, and another place in the Kohala mountains, there is another spring up there which Papa Auwae uses." . . . "So, I've heard of the old ones getting water from Waiau to use for healing. (Lloyd Case, p. A-353 in Maly, 1999)

"And so here, within the Mauna a Wākea, sits this *'apu wai* [water container] which is Waiau. What they are calling Lake Waiau. And as it hasn't had a chance to come down to the rest of us, then it is sacred water, like the water that is in the piko of *lau kalo* [taro leaf], and the water that is found in the *'ohe* [bamboo – interpreted as the meaning of the *ahupua'a* name Ka'ohe, within which the summit of Mauna Kea and Waiau are situated]. And the water that is found also in the *niu* [coconut]. So you have all of these different, sacred waters, but to me, that water, Waiau, is the most sacred because it isn't the water that has been spilled, it is still up there in the realm of Wākea.". . . "The most sacred of all the waters." (Pualani Kanaka'ole Kanahele p. A-368 in Maly, 1999)

In ca. 1881, Dowager Queen Emma ascended Mauna Kea on a journey of spiritual and physical well-being. At the time, Queen Emma was in competition with David Kalākaua for the position of ruling chief for the Kingdom of Hawai'i. Each of the two embarked on journeys to prove their connection to the senior line and connect back to a *wahi pana* (a sacred physical place). Emma went to the top of Mauna Kea to bathe in the waters of Wai'au, and cleanse herself in the *piko* of the island. (Kanahele and Kanahele, 1997)

For some, Wai'au has a special family tie. "...Hawaiian members of the Lindsey family have a tradition of taking the *piko* of their children to Wai'au and the summit of Mauna Kea.". "Other interviewees who had not heard of the practice of taking *piko* to Mauna Kea all felt that it was likely to have occurred, and they shared similar stories from their own families of the custom at various localities." (Maly, 1999)

Kanahele explains the importance of this tradition of taking the *piko* to a particular place.

> "I don't personally know any families [who took the *piko* to Waiau]. I know that people took *piko* there, I just don't know who." . . . Well, the *piko* is that part of the child that connected the child back to the past. Connected the child back to the mama. And the mama's *piko* is connected to her mama, and so on. So it takes it back, not only to the *wā kahiko* [ancient times], but all the way to *Kumu Lipo*." . . . "So, it's not only the *piko*, but it is the extension of the whole family that is taken and put up in a particular place, that again connects to the whole family line. And it not only gives *mana* or life to the *piko* and that child, but life again to the whole family." (Pualani Kanaka'ole Kanahele p. A-368 in Maly, 1999)

The Physical Planning Guide (Section IX) incorporates the information gained from interviews, ethnographic, research, and archaeology studies to determine areas recommended for preservation. The Management Plan (Section X) uses this same information in making recommendations for the establishment and operation of a local management authority.

The First European Contact to the Islands

As evidenced by the archaeological evidence and though oral histories, Hawaiian adze-making and worship at Mauna Kea continued through the 1700s.

In 1778, the first foreigner arrived in Hawai'i. In the decades that followed, life in Hawai'i changed dramatically with the introduction of new technologies, religion, diseases, animals, and industry. The population of Hawaiians was decimated by the effects of diseases that had never been seen before in the islands. Port towns such as Kailua, Kealakekua and Hilo developed into commercial centers accommodating Western ships. Adze quarrying on Mauna Kea ceased to exist as stone adzes were soon replaced by metal tools after European contact.

In the late 1700s and through the 1800s several Europeans led expeditions to Mauna Kea. The names Goodrich, Baldwin and Alexander are well-known to students of the mountain. Their maps and documents are the earliest written descriptions of Mauna Kea. Early in the 20th Century, the Board of Agriculture and Forestry designated the Mauna Kea Forest Reserve.

In 1793 the first cattle were brought to Hawai'i and offered by Captain George Vancouver to King Kamehameha. By the early 1800s more cattle had arrived and escaped to forested areas where, in the absence of natural predators, their populations multiplied (Juvik and Juvik, 1984). In addition to wild cattle, sheep and goats thrived on the mountain. In 1809, John Palmer Parker settled in Hawai'i and became friends with King Kamehameha I. The king placed Parker in charge of the wild cattle. With a land grant from King Kamehameha III in 1845, Parker established a ranch, Parker Ranch, which has been in continuous operation until the present. Other ranches also operated in the mid-1800s, however, much of the cattle and sheep continued to run free on the mountain's slopes destroying the native vegetation. By this time, hunting had become a vital lifestyle for many island residents. Hunters continued to pursue the animals for their hides and meat which were consumed locally and bartered for goods from visiting ships.

After the decline in adze making on Mauna Kea, there was limited human activity on the mountain. On the lower portions of the mountain animals grazed and hunters pursued them. On the higher slopes a few Western explorers conducted expeditions up to the summit region. The next major phase of activity began in the early 1960s with the exploration of Mauna Kea as a potential site for astronomy observations.

The travel journals of the first Westerners to explore the mountain's summit region highlight some of the first information on the physical evidence of past activity. McCoy (1999) shares some of these earliest observations. The first documented trip to the summit of Mauna Kea was that of Reverend Joseph Goodrich in 1823. Later writings of this trip record some of the observations and thoughts about the summit region:

> "Rev. Joseph Goodrich, who, on this occasion, was unfortunately laid up with mountain sickness, had on 26th August, 1823, reached the summit of Mauna Kea. This is the first recorded instance of the ascent of this mountain, although Mr. Goodrich mentions that on reaching the top of one of the terminal cones that encircle the main plateau of Mauna Kea, he discovered a heap of stones, probably erected by some former visitor. Who this former visitor was is unknown, but he was probably one of the white men that in the early years of the nineteenth century got a living by shooting wild bullocks that roved on the side of Mauna Kea. It is very unlikely that any native had reached the top of the terminal cones on the summit, owing to being unprovided with warm clothing to resist the great cold and also to the fact that the natives had a superstitious dread of the mountain spirits or gods." (Macrae 1922)

An account of Alexander's journey in 1892 mentions the presence of a cairn at the top of a cinder cone:

> "Messrs. Muir and Alexander ascended the second highest peak on the northwest, overlooking Waimea, 13,645 height to continue their survey. In the cairn on the summit a tin can was found, which contains brief records of the visits of five different parties from 1870 to the present time, to which we added our own." (Alexander 1892)

Reflecting this notion, Ellis (1979) looked back to the travels of Goodrich and Blatchely, who ascended the peak about six months after Goodrich, and provided this description of Hawaiians' view of Mauna Kea.

> "The snow on the summit of the mountain, in all probability, induced the natives to call it Mouna-Kea (mountain white), or, as we should say, white mountain. They have numerous fabulous tales relative to its being the abode of the gods, and none ever approach the summit – as, they say, some who have gone there have been turned to stone. We do not know that any have been frozen to death; but neither Mr. Goodrich, nor Dr. Blatchely and his companion, could persuade the natives, whom they engaged as guides up the side of the mountain, to go near its summit." (Ellis 1979)

The early exploration of the summit region and the subsequent development of the astronomy industry on the mountain is detailed further in the Education and Research section of this report.

Cultural Practice Today

In their ethnographic work Maly, Langlas, and Kanahele and Kanahele describe some of the practices that individuals and families conduct on Mauna Kea today. Several of the individuals interviewed by Maly stated that "they still go to Mauna Kea for prayer and restoration". All interviewees attributed spirituality and healing qualities to being on Mauna Kea. (Maly, 1999)

Dr. Langlas interviewed a woman of the Poli'ahu line, meaning that Poli'ahu is one of her family's *'aumakua.* This family has designated an individual as their *kahu* for worship of Poli'ahu. This individual has constructed a shrine on Mauna Kea to worship Poli'ahu and has incorporated a stone given to her by the family. She considers the whole mountain to be sacred and feels that it is appropriate to worship anyplace on the mountain if one is spiritually guided there. Thus, worship should not be limited to traditional sites. The shrine placed by this *kahu* is not located in a traditional site but rather in a place that she was guided to.

Maly's interviewees also report of the practice of taking ash remains to the summit of Mauna Kea for release. Two of the individuals interviewed by Maly have instructed that upon their deaths, their ashes are to be taken to specific places on the slopes of Mauna Kea.

While the ethnographic research provides few accounts of actual cultural practices on the mountain, other individuals and groups may visit the mountain for worship on special occasions or on a regular basis. Many more carry with them an esteem and respect for Mauna Kea.

"In both its genealogical associations and its physical presence on the island landscape, Mauna Kea is a source of awe and inspiration for the Hawaiian people. In Hawaiian practice elders are revered – they are the connection to one's past – and they are looked to for spiritual guidance. Because of its place in the Hawaiian genealogies, Mauna Kea, the landscape itself is a sacred ancestor." (Maly, 1999, p. D-25) This is the spirit with which many view the mountain today.

EDUCATION AND RESEARCH

Searching for a New Industry

As ranching operations dominated the inland areas, the port towns of Kawaihae, Kailua, and Hilo continued to grow.

In May of 1960, a powerful tidal wave washed through the town of Hilo, destroying property and severely damaging the economy. In looking for a new industry to help save the island's economy, the Hawai'i Island Chamber of Commerce, with the support of Governor John Burns, approached universities in the United States and Japan with the idea of developing Mauna Kea and Mauna Loa as astronomy locales.

What started as a search for a new industry has resulted in new knowledge, expertise, and learning opportunities in a variety of fields.

Evolution of Astronomy on Mauna Kea

Dr. Gerard Kuiper, of the University of Arizona, was already working with NASA and the Department of Defense to test sites on Haleakalā and was eager to explore possibilities on Hawai'i Island. While Haleakalā was considered a good site, and telescopes were subsequently developed there, Kuiper preferred to find a site further above the cloud layer. Having flown over Mauna Kea, Kuiper became interested in its potential and developed a plan for site testing. Mauna Loa was less favored because of the possibility of volcanic activity (Parker, 1994).

To support this testing, Dr. Kuiper persuaded then Governor John Burns to provide funds to establish a jeep trail to the summit area. In 1964, a NASA-funded 12.5 -inch telescope was installed on Pu'u Poli'ahu and Kuiper's team began "seeing" studies. Kuiper concluded that "The mountaintop is probably the best site in the world – I repeat – in the world - from which to study the moon, the planets, and stars." With this exclamation, a new industry was born in Hawai'i.

Many now understand what Dr. Kuiper first saw. Mauna Kea is one of the finest locations in the world for ground-based astronomical observations. Because of its location high on an island in the Pacific, the sky above the mountain is generally cloud-free. This gives Mauna Kea one of the highest proportion of clear nights in the world, an important factor given the number of researchers requesting observing time. The stability of the atmosphere at Mauna Kea, free from disturbance caused by neighboring land forms, allows more detailed observations than available elsewhere. Finally, the summit's height above the tropical inversion cloud layer provides summit skies that are pure, dry and free from atmospheric pollutants.

During 1965, Dr. John Jefferies' team from the University of Hawai'i and Gerard Kuiper's team from the University of Arizona conducted extensive tests of the skies at Mauna Kea. The two universities, along with Harvard University, applied to NASA for funding of a new telescope on Mauna Kea. In 1965, NASA accepted the University of Hawai'i's proposal and agreed to fund the design and construction of the telescope. Construction of the UH 88-inch (also known as the UH 2.2-meter) telescope began in the Fall of 1967. Images of some of the early work on the mountain are presented in Figure VI-1.

The University of Hawai'i Institute for Astronomy was founded in 1967 and is responsible for carrying out research in astrophysics and planetary science and for the development and management of the Mauna Kea Science Reserve. University of Hawai'i scientists have access to a guaranteed fraction of viewing time on all of Mauna Kea's telescopes.

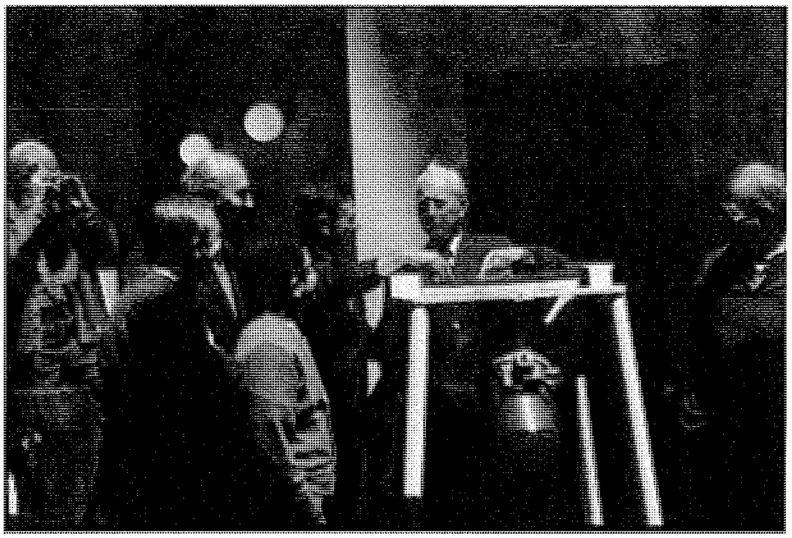
In 1968, the State Board of Land and Natural Resources recognized the importance of Mauna Kea for astronomy observations and leased an area of land to the University of Hawai'i for a 65 year period. (In 1998, the lease area known as the Mauna Kea Science Reserve was modified to exclude the Natural Area Reserve parcels [designated in 1981] leaving a total area of 11,288 acres under the agreement.) The Science Reserve includes the lands from approximately 12,000 foot elevation to the summit. The Natural Area Reserve contains two parcels. The largest is a pie shaped area of land extending from the Summit Access Road to Pōhakuloa Gulch and containing the main adze quarry and Wai'au. The second Natural Area Reserve parcel on Mauna Kea contains Pu'u Pōhaku, a cinder cone that contains evidence of the ice age in permafrost.

Working astronomy on Mauna Kea advanced at the close of the decade with the construction of two 0.6-meter telescopes, provided to UH by the U.S. Air Force and by NASA in 1968 and 1969.

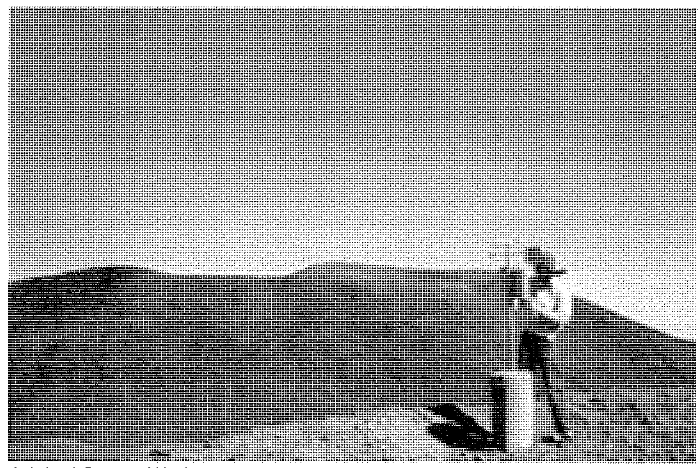
The 1970s brought a flurry of interest in Mauna Kea from the international astronomy community and the first comprehensive planning steps for the mountain. Development of four telescopes marked a decade of new beginnings on the mountain. Infrastructure planning for the mountain was also active during this time, as Hawai'i took its place among the world's top astronomy centers.

On the summit, the UH 2.2 meter Telescope, the Canada-France-Hawai'i Telescope, NASA's Infrared Telescope Facility, and the United Kingdom Infrared Telescope were constructed to support optical and infrared astronomy.

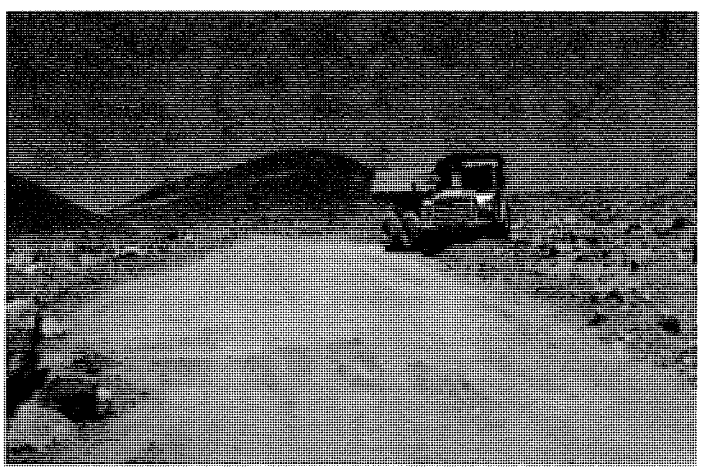
In 1975, the jeep trail to the summit was realigned to eliminate some of the steep grades and sharp turns in the original alignment. Power was supplied to each telescope facility by on-site generators. In 1977 the first management plan for the mountain was adopted. This and subsequent plans are discussed in the Issues chapter of this plan.



Governor Burns at Mauna Kea Observatory Dedication (1970)



Original Survey Work



Road Work (1988)

Evolution of Facility Development

Photos: Institute for Astronomy

To support the development of these facilities, five temporary buildings were erected at the mid-elevation level. Here construction workers slept, ate, and acclimated to the altitude and weather.

Ever since the testing and construction of the first telescopes on Mauna Kea began during the late 1960s, temporary buildings and the original stone cabins at Hale Pōhaku have been used as a construction camp and astronomy support facility. The high elevation of the summit of Mauna Kea creates conditions that are difficult and potentially dangerous for those working at and visiting the mountain. Traveling directly from sea level to almost 14,000 feet can cause short-term high altitude effects such as light-headedness, shortness of breath, headaches, nausea, and dehydration. In extreme cases, life-threatening conditions can occur. The mid-level facilities, located at approximately 9,200 feet, provide a place to rest and acclimate for those who are visiting or working on the summit.

The Mid-Level Facility was completed and dedicated in 1983. Astronomers working at the summit facilities for a few days were able to stay in the dorms at Hale Pōhaku to maintain their acclimatization to the altitude. Dining and lounge areas provide rest and relaxation for the scientists and telescope operators. Offices, a library, and small labs support the scientific activity which draws the astronomers to Mauna Kea.

Along with construction of the Mid-Level Facility, a Visitor Information Station (VIS) was constructed below the main lodging facilities and stone cabins. The 950-square foot facility serves as an interpretive center and as the control point for visitors to the mountain. It also provides a transition point where visitors can acclimate to Mauna Kea's altitude. The VIS was developed approximately 650 feet below the main food and lodging facilities' nearest dorm. The entire area is designed to separate the visitor and construction activities from astronomy support activities. Astronomers and support staff work at night and must use the daytime hours to sleep and analyze the data that's been collected during the night. Visitors are accommodated in other facilities to allow the scientists to rest.

Below the VIS, a Construction Camp area has been developed. With the construction of the main food and lodging facility to support active astronomy observations, construction support was moved further down the mountain. Two temporary buildings were relocated from the main lodging area down to the Construction Camp area to support the construction of the W. M. Keck Observatory. One building is a dorm housing 24-29 people. The other was used as a common building and includes a kitchen, dining room, and recreation area. Four 4-bedroom cabins, built to support the Subaru Telescope construction crews, accommodate a total of 32 individuals. If the 1970s represented the beginning of this new industry, the 1980s was a period of maturation with the adoption of the first comprehensive physical and management plan for the Science Reserve and Hale Pōhaku in 1983, and the development of mid-elevation facilities.

The 1990s, then, have been a decade in which astronomy at Mauna Kea has leapt forward with the development of some of the finest telescopes in the world. This decade has been unsurpassed for astronomers as new discoveries and new facilities have been realized. The decade has also brought new international partners to the mountain such as Japan (Subaru), Taiwan (Submillimeter Array), and Chile, Australia, Argentina, and Brazil (Gemini). Five telescope facilities began operations this decade so far, and one more will do so in the year 2001.

The Very Long Baseline Array (VLBA) consists of ten identical radio telescopes, each 25 meters in diameter, spread across the United States from Hawai'i to the U.S. Virgin Islands. The Hawai'i component of the VLBA is located at approximately the 12,000 foot elevation within the Mauna Kea Science Reserve.

Envisioned in the 1983 Complex Development Plan as the University of California 10-meter Telescope, the W. M. Keck Observatory (Keck I) was completed in 1992. Subsequently, a second 10-meter telescope, Keck II, was constructed, and shortly thereafter, NASA joined the Keck team.

The most recent facilities to come on-line include Gemini North, an 8-meter optical/infrared telescope and Subaru, an 8.3-meter optical/infrared telescope (Figure VI-2). In addition to the telescopes already described, the 1983 Complex Development Plan projected the development of a single-dish millimeter-wave or radio telescope in the 1990s. This facility was expected to be 10 to 25-meters in size and located in millimeter valley with the James Clerk Maxwell Telescope and the Caltech Submillimeter Observatory. Astronomy technology has advanced since the Research Development Plan and Complex Development Plan were published in the early 1980s. As a consequence, a submillimeter interferometer was proposed for Mauna Kea to achieve the scientific objective of a millimeter-wave telescope. The Smithsonian's Submillimeter Array, a complex of 24 antenna pads and up to 12 movable antennas, will begin operations in 2001. Existing and proposed astronomical facilities are discussed in Section IX.

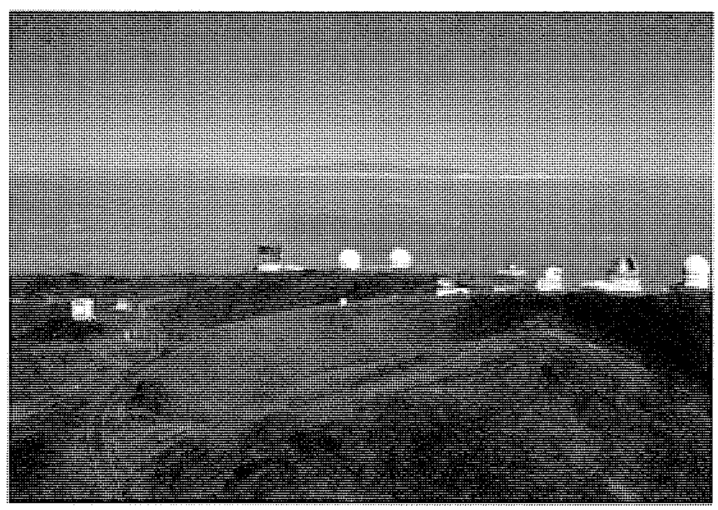
New Astronomical Discoveries at Mauna Kea

Astronomers come to Mauna Kea in search of scientific answers to some of humanity's most fundamental questions: How and when did the stars, planets, and galaxies form? What threats do we face from the Sun and other celestial bodies? What will be the ultimate fate of the Universe?

Improvements at existing facilities and the operations of new facilities will help to answer these questions. Scientists are now working on the interferometry technology to link the two Keck telescopes and provide the resolving power of a telescope with a mirror 85 meters in diameter. Pointing both telescopes at stars that are several hundred trillion miles away, and then combining the observations using sophisticated technology, the Keck interferometer will provide measurements and images that will be a quantum leap beyond those made by single telescopes.


CFHT, Gemini Northern, UH 2.2-m and UKIRT Telescopes (Photo: Group 70)


Subaru Telescope (Photo: Group 70)


Mauna Kea Observatory with Haleakalā in Background (Photo: Richard Wainscoat)

The Keck Interferometer will search for planets beyond our solar system. Because even nearby stars are far away, and because planets are much smaller and fainter than stars, powerful telescopes are needed. In the last few years, astronomers have observed definitive signs of planets in other solar systems, however, no direct images have been produced. Rather, scientists have observed the effects of the gravitational pull between a star and neighboring planet. The NASA's Origins program seeks to capture direct images of Earth-like planets, if they exist, and study their planetary atmospheres in an effort to determine whether life exists on other worlds. Combining the images through interferometry will vastly improve the ability to distinguish the faint motion of two distant objects, such as a star and a planet, that are actually very close to each other in space.

Support Facilities

<u>Hale Pōhaku Today</u>

Today Hale Pōhaku continues to serve as the main base for astronomers and technicians. Sleeping accommodations are provided in 72 units, designed with blackout shades and other accommodations tailored to daytime sleepers. Astronomers, technicians and support staff gather in the common building which includes a kitchen, dining area, lounges, offices and a library. A maintenance area serves as a headquarters for Mauna Kea Support Services (MKSS) repair and maintenance activities. MKSS staff at Hale Pōhaku include 12 persons supporting food and lodging and 5 persons in the utility area. The latter perform road maintenance, snow removal and facility maintenance at Hale Pōhaku.

Over time, the use of the mid-level facilities has changed. At one time they were often filled to capacity with visiting astronomers and construction crews. Technological advances have made remote viewing a practical alternative to working at the summit and astronomers do not necessarily need to be at the summit to analyze data collected at some of the observatories. The W. M. Keck Observatory, for example, has designed its Waimea headquarters with control rooms linked with data and video lines to the observatory on Mauna Kea. Astronomers using the Keck facilities can stay in the Keck dorms in Waimea and perform their work without traveling to the mountain. The VLBA is operated remotely from the VLBA headquarters in New Mexico. It can be expected that, over time, more and more astronomers will be able to obtain their data without going to the summit of Mauna Kea and perhaps even without coming to Hawai'i. As a result, the lodging facilities at Hale Pōhaku may experience less demand from the astronomy community.

Currently, the facilities at Hale Pōhaku average 3,400 reservations a year (Koehler, 1999). On average, 34 of the 72 rooms are occupied. During special astronomical events, such as an eclipse or comet collisions with Jupiter, the facilities are often full. Demand also increases when significant milestones are achieved in telescope development. For example, most of the lodging units were occupied with first light preparations for Gemini and Subaru telescopes in early 1999.

Base Support Facilities

The development of the astronomy facilities on Hawai'i extended from the top of Mauna Kea to the island's coast. While telescopes are constructed on top of the mountain, and common facilities provided in the mid-elevation area, base facilities have been developed in Hilo and Waimea. Built in population centers, base facilities for each observatory are located near the workforce, in comfortable climates, and near business, schools, and housing. Typically, these base facilities contain offices, laboratories, and computer facilities to support the observations on the mountain. While most base facilities are located in Hilo, the W.M. Keck Observatory and Canada-France-Hawai'i Telescope have chosen to located their headquarters in Waimea. Mauna Kea Support Services (MKSS), the organization responsible for the food and lodging accommodations and road maintenance on Mauna Kea, also has a base facility in Hilo.

Infrastructure

The sophisticated astronomy complex atop Mauna Kea is supported by an infrastructure system designed to meet state of the art communication needs, address personal safety concerns, and impact the natural environment as little as possible while accomplishing these goals.

Over time, the roadways and other infrastructure systems have been improved to provide safer and more efficient service to the astronomy facilities. As mentioned above, the original jeep road to the summit built in 1964 was improved for safety purposes in 1975. The gravel road that served the summit for the next decade was better, however, it still was dusty, which interferes with observations, and can be unsafe for vehicles.

In 1985, funded by State funds and the Keck Observatory's infrastructure contribution, the State Department of Transportation began the design process for a 20-foot wide roadway beginning at Hale Pōhaku and looping around summit facilities. To date, two of the six phases of construction have been completed, including pavement of the roadway from the 11,800 elevation to the summit facilities. When funding is available, future phases will include the paving of the road from Hale Pōhaku to 11,800 feet, construction of additional parking areas, and two runaway truck ramps.

Water for Hale Pōhaku and the summit is regularly trucked from Hilo. Two-40,000 gallon water tanks are located at Hale Pōhaku. Currently, 25,000 gallons per week are trucked to the Mid-Level Facility. An additional 15,000 gallons per week are trucked to the summit to supply the various observatories. These quantities have remained fairly constant throughout the development of the telescope facilities. However, during heavy construction periods additional water is consumed by the construction crews.

All sewer disposal and treatment is handled by individual cesspools and septic tank/leaching field systems that serve each facility. All existing facilities have been approved by the State Department of Health. There is no plan to construct a sewer system to collect and treat wastewater from each facility.

During the early years of telescope development, power was provided to individual facilities by on-site generators. The first phase of bringing power lines to the summit began in 1985 with the construction of a 69KV overhead system from the Humu'ula Radio Site to a substation located just below the mid-level facilities. There, the voltage is reduced to 12.47KV, and the power distributed via underground distribution system to the summit. The initial construction of the distribution system was completed in 1988. In 1995, the electrical system was upgraded to complete the loop at the summit and provide service to the Submillimeter Array.

Development of the communications system required many phases of construction to complete. The first phase began during the construction of the underground power distribution system in 1985. The addition of summit communications system continued into the 1990's, with the installation of fiber optic lines.

A project to add fiber optic lines to the existing 69KV overhead power system began in 1995. The lines were added to the existing system of poles from the Humu'ula Radio Site to the substation near Hale Pōhaku. In 1996, the construction began on the final phase of the fiber optics communication system, which completed the linking of all the telescope facilities and the mid-elevation support facilities.

Other Research and Education

The first research activities on Mauna Kea are documented in the journals of some of the early explorers of the mountain. The first confirmed ascent of Mauna Kea by a foreigner was made in 1823 by Joseph Goodrich. Botanist David Douglas scaled the mountain summit in 1831. Like Goodrich, Douglas made observations of the summit cinder cones and desolate landscape. In 1892 W.D. Alexander led a surveying party to Mauna Kea. They spent time on the summit of Līlīnoe and made observations of stone cairns and unique land forms. On one of the summit cones, they found a tin can that contained records of five different parties that had visited between 1870 and 1892 (in McCoy, 1999). In 1937, Gregory and Wentworth wrote of the evidence of Mauna Kea's glaciation, describing the character of the bedrock that has been shattered and shaped by the glacial ice.

Explorers, educators, and scientists have long appreciated the unique natural and cultural features of Mauna Kea. The development of a road to the summit provided vehicular access to the region's rich resources that had not been available before. Some of the first formal archaeology surveys took place in the Natural Area Reserve and Science Reserve in the mid 1970s.

Much of the detailed archaeological and scientific research was conducted as part of the comprehensive planning process for the Science Reserve in the early 1980s. Botanical studies and arthropod studies were conducted of the summit area. During this time the first discovery of the Wēkiu bug was made. Archaeological surveys of the summit identified shrines and workshops that tell the story of the mountain's earliest use by man. Biological and archaeological surveys of the Hale Pōhaku area were also undertaken in the early 1980s.

With the development of the astronomy complex has come a wealth of educational outreach programs. Thousands of high school and elementary students each year receive an introduction to astronomy's wonders through field trips to the mid-elevation facilities and through contact with the scientists and educators from the various observatories. University professors take their students to the mountain to study astronomy, geology and climatic processes, and Hawaiian culture and language.

Up to the present time, education and research activities have focused largely on astronomy. Other research activities have resulted largely from astronomy planning efforts. However, there is great potential for much broader educational and research use on Mauna Kea independent of astronomy activities. There is a sentiment among educators that non-astronomy education should be encouraged and promoted. So, in addition to programs to train Hawai'i's young people in the science and technology of astronomy, there is a need for K-12 and remote learning programs statewide, together with learning centers at University of Hawai'i at Hilo and Hawai'i Community College to provide balance between science and culture through education.

In a proposal (14 January 1998) for the creation of a management structure, Dr. James Juvik, Ph.D., lists some of the research projects undertaken by University of Hawai'i-Hilo faculty as examples of the many areas of study that can be supported and enhanced through use of Mauna Kea as a laboratory and classroom. Among the many possibilities is study of Hawaiian culture and archaeology, high altitude atmospheric research, earth processes and quaternary studies, montane terrestrial ecology, and human biology and response to high altitude.

Currently the University of Hawai'i at Hilo is working with NASA and the Bishop Museum to develop the Mauna Kea Astronomy Education Center. This facility will be constructed in University Park and will serve as a science and education resource for astronomers, students of all ages, and the general public. Plans for the Center will include a planetarium and theater, displays of astronomy, natural history, cultural history, classrooms and laboratories, distance learning facilities, and visitor amenities. The purposes of the Education Center are multi-faceted. The complete proposal for the Center can be found in Appendix B; and an excerpt is presented below.

(*Excerpt from the UH-Hilo Proposal for the Mauna Kea Astronomy Education Center*)

> "Education, with an emphasis on outreach to indigenous community members, is a central feature of the Master Plan. Much of the philosophical framework for this finds expression in the proposed Mauna Kea Astronomy Education Center at the University of Hawai'i at Hilo. The Center will serve to facilitate formal astronomy education and the integration of science into indigenous cultures at all

levels. It also will serve as the principal center in the world demonstrating how the latest science can be integrated with indigenous cultures of great antiquity to maintain unique cultural identity and knowledge while participating at the scientific forefront of the international global society. The Center will help to train the next generation of space scientists and to raise the overall level of science literacy in our nation. Students, teachers and college instructors, and community college/ baccalaureate students locally, nationally, and worldwide. Programs to support formal astronomy education will include:

- School class visitation programs, for visiting school groups from Hawai'i and throughout the world, utilizing all the Center observatory visitor facilities and some of the academic support facilities.
- Professional development experiences for teachers and college instructors in the forms of year-round workshops, on-site and distance learning courses and programs, curriculum development, and research opportunities in collaboration with University of Hawai'i astronomy faculty.
- Enhancement of classroom astronomy instruction throughout the State of Hawai'i by in-class programs presented by Center staff and affiliated University of Hawai'i astronomy pre-service education students.
- Collaborative use of Mauna Kea telescopes to enhance astronomy instruction in cooperating community colleges, universities, and K-12 schools, locally, nationally and world-wide.
- Summer astronomy workshops and courses for astronomy students from secondary schools, community colleges, and universities using the Center's facilities and the Mauna Kea observatories.
- Electronic dissemination of scientific data from Mauna Kea telescopes and live images, to schools and universities world-wide.
- Development of a national Astronomy Scholars Program in conjunction with the University of Hawai'i at Hilo.
- Year-round Hawaiian and indigenous culture workshops.
- Development of curriculum materials on Hawaiian and indigenous cultures.
- Academic programs in Hawaiian and other indigenous languages and cultures at the community college, baccalaureate and graduate levels."

RECREATION

Enjoying Mauna Kea's Unique Natural Resources

Before the first road to the summit was built in 1964, only hardy recreationalists hiked Mauna Kea's slopes. During this time, hunters were active on the mountain's lower slopes. Stone cabins built by the Civilian Conservation Corps (CCC) in the 1930s served as the base camp for hunters, hikers, and explorers. The name of the mid-elevation area, Hale Pōhaku, derives from these cabins.

Ever since the first road was developed to the summit, people have come to Mauna Kea to hike, play in the snow and sightsee. Hunting is also an important activity which may be viewed as recreation but for many is an integral part of their lifestyle, subsistence and culture. Hunting continues to occur at the lower elevations of the mountain outside the Science Reserve.

Residents and visitors alike come to Mauna Kea simply to experience this place that is unlike any other in Hawai'i. Many are drawn to the mountain to witness the world class telescopes, feel the chill of the air, and appreciate the desolate beauty and natural land forms of Mauna Kea. What they must also keep in mind is that the extreme weather conditions on the mountain make all recreational activities potentially dangerous.

Hiking

Hikers visit Mauna Kea for an experience that is unmatched in the Hawaiian Islands. The clear skies, cool air, and awe-inspiring landscape draw experienced and novice hikers alike. The factors that make Mauna Kea such a uniquely appealing place to hike are also cause for health and safety concerns. Hikers must be prepared for the affects of high altitude on their bodies and the possibility of a sudden and severe change in weather.

Hiking is most popular in the Ice Age Natural Area Reserve and along existing roads. Individuals typically drive up the mountain for a distance before parking and hiking. The Humu'ula-Mauna Kea trail runs from the old sheep station at Humu'ula to Wai'au. A few individuals brave the low temperatures and swim in Wai'au.

Snow Play

Big Island residents and visitors look forward to those winter periods when snow falls at the higher elevations of Mauna Kea. Families and individuals visit the mountain to ski, snowboard, and play in the snow. Often, people load their pickup trucks with snow to take down to Hilo and other towns so that others can enjoy the snow.

The Summit Access Road is kept clear of snow by Mauna Kea Support Services staff. Private vehicles typically park along the roadways and visitors play nearby. The most popular ski and snowplay areas are those easily accessed by roadways. The ski run known as Poi Bowl is the most popular because it is accessible by roads at both the top and bottom of the run. Skiers typically establish an informal shuttle system where the skier is dropped off at the top of the run and then met at the bottom. If the snowfall is heavy enough, the area to the east of the summit, known as King Kamehameha run, is used for longer ski runs although the bottom of the run is not accessible by vehicle and the skier must hike back to a roadway. At times it is possible to ski from the summit to the edge of the Science Reserve. Once or twice a year, depending on the snow conditions, a skiing or snowboarding competition is held on the mountain. Popular ski areas are shown in Figure IX-25.

The weather patterns for any particular year will determine how much and where snow falls. Snow typically falls first and melts last from the northern slope of Pu'u Hau Kea (also known as Goodrich). At times it is the only place on the mountain with snow. When snowfall is light, people tend to hike between snowy areas.

Sightseeing and Stargazing

Sightseeing is another favorite activity for residents and visitors alike. Before proceeding up the mountain visitors are asked to spend time at the Visitor Information Station (VIS) to view the exhibits and acclimate to the altitude. A number of visitors use private vehicles to explore the summit on their own. Visitors will drive up to the summit possibly stopping along the way to walk around a bit and take photographs. At the summit, the public can visit the Keck Visitor Gallery to view exhibits and see the inside of one of the Keck domes. Other visitors will join MKSS-led tours twice a week. In 1998, an estimated 38 visitor vehicles traveled to the summit of Mauna Kea daily (Koehler, 1999). Another 100 to 150 vehicles visited the VIS only each week. Approximately 100 students visit the VIS each month during the school year and even more visit in the summer months.

While many residents and visitors drive to the summit area themselves, others join commercial tours. DLNR issues a limited number of Commercial Activity Permits to tour operators who pay annual and per customer fees. Commercial tours register at Hale Pōhaku each time they ascend the mountain. In 1999, eleven Commercial Activity Permits were active (Unoki, 1999). Of these, ten allowed tours to the summit and one provided commercial access to Hale Pōhaku only. Tour operators take visitors for six to eight hour trips which can include an observatory tour, lunch, hikes to Wai'au, and narratives on the area vegetation and natural history. In the Fall of 1998, an estimated 30 tours per week went to the summit (Koehler, 1998).

Taking sightseeing to a higher level, the MKSS offers stargazing programs at the Visitor Information Station seven evenings a week. These stargazing programs drew an average of 80 participants per evening (320/week) in 1998 (Koehler, 1998).

The same factors that make Mauna Kea a premier spot for major astronomy research also provide excellent conditions for amateur astronomy. Many of the evening visitors to the mountain, especially the VIS area, are amateur astronomers.

Hunting

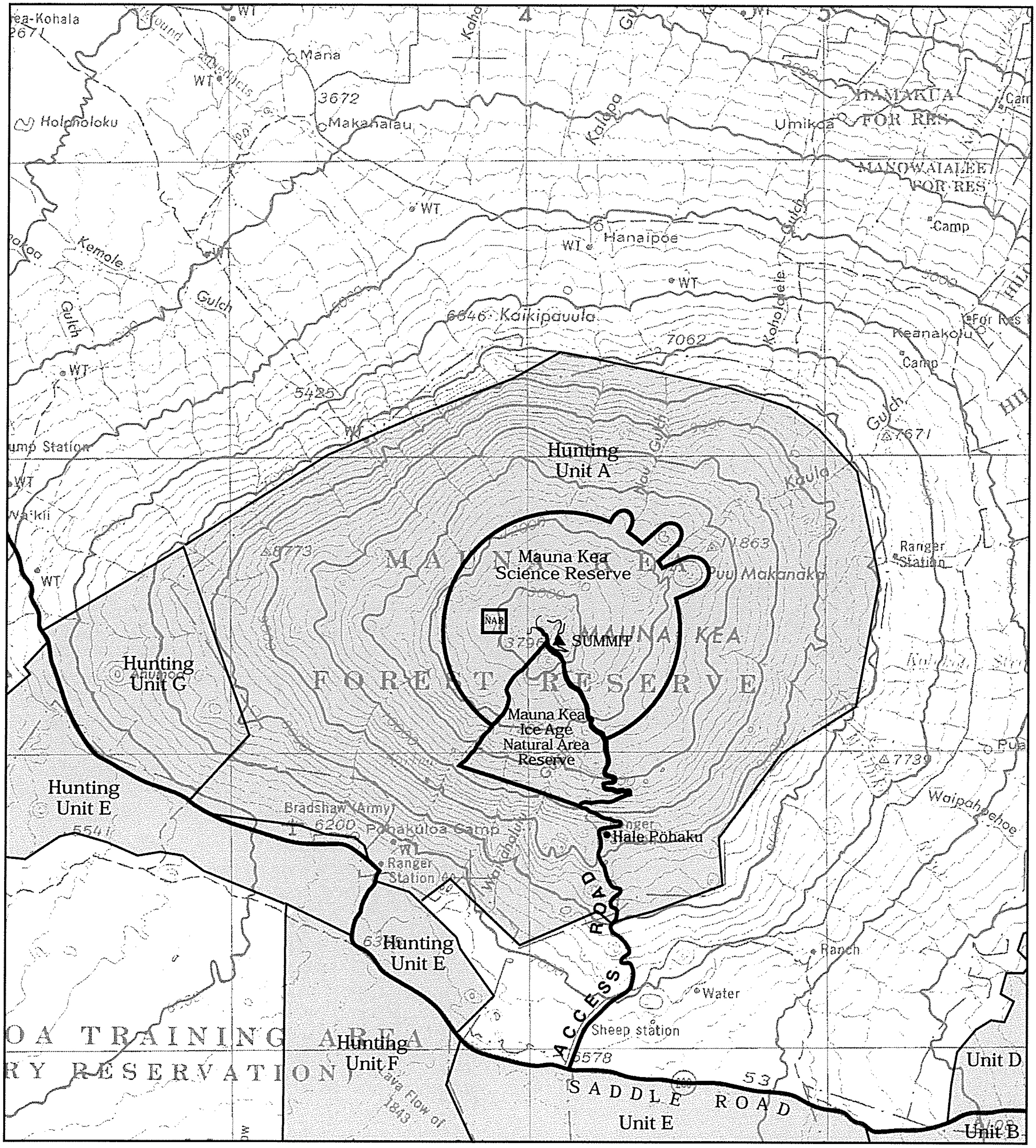
Long a tradition on the island, hunting continues on Mauna Kea in a managed structure. Hunting on Mauna Kea occurs largely outside of the Science Reserve on the mountain's lower slopes. Today, pigs, sheep, goats, and a variety of gamebirds are hunted by rifle or archery in three dozen hunting units concentrated in the central portion of the Island of Hawai'i (Figure VII-1).

Lloyd Case, interviewed in Kepā Maly's oral history study for Mauna Kea, describes hunting with his family on Mauna Kea.

> "I started going hunting with my brothers, from five years old, I went out several times. Then later on, from eight years old to ten, I started going more and more with my brothers. But Mauna Kea was one of our particular areas that we liked to hunt. One of our favorite places because it had a variety of game. You could go there and get your *pua'a* (pig), you could get your *hipa* (sheep), there were goats in those days too. But our family, we grew up on sheep, so Mauna Kea was a place that I always went to gather sheep." (p. A-345 in Maly, 1999)

> "What we used to do is, we'd sleep right there, and in the morning, the sheep would come down for eat. So what we would do is go right above and wait for them to come back up." . . . "They come down to eat. So what we'd do is walk up a little bit and intercept them on their way back up. And it's all down hill then, so we'd pack 'em right down to the road yeah." (p. A-345 in Maly, 1999)

Gamebirds including turkey, pheasants, quails, chukars, and francolins are also present on Mauna Kea's slopes. There are over 3,000 licensed hunters living on the island. The Mauna Kea Forest Reserve (elevations over 7,000 feet) is a hunting unit where pigs, goats, sheep and birds can be hunted with archery and firearms. Sport hunting is a popular activity which contributes to the island's economy. While sheep, goats, pigs and some game bird species sometimes enter the Science Reserve area, most of the birds and mammals are hunted on the mountain's lower slopes.



Source: Saddle Road (SR 200) Mamalahoa Highway (SR 190) to Milepost 6
DEIS, Techinical Appendices, Volume V, 1997

DLNR Hunting Units

0' 7500' 15000' 30000' NORTH

ISSUES AND OPPORTUNITIES

Management and use issues are not new to Mauna Kea. Soon after the introduction of the first cattle, goats and sheep, these animals roamed the slopes of the mountain, contributing to the decline of vegetation in the *palila* habitat. Wildfire has also been a source of habitat destruction. Hunting was and is an important way of life for many Hawai'i Island residents; however, even the hunters could not keep pace with the rapidly growing animal population. In destroying portions of the *māmane-naio* forest, the animals impacted the only habitat of the *palila* bird. Territorial and State government agencies have attempted to control the population of ungulates through formal hunting efforts. However, the long-standing issue of balancing habitat protection and hunting traditions exists to this day.

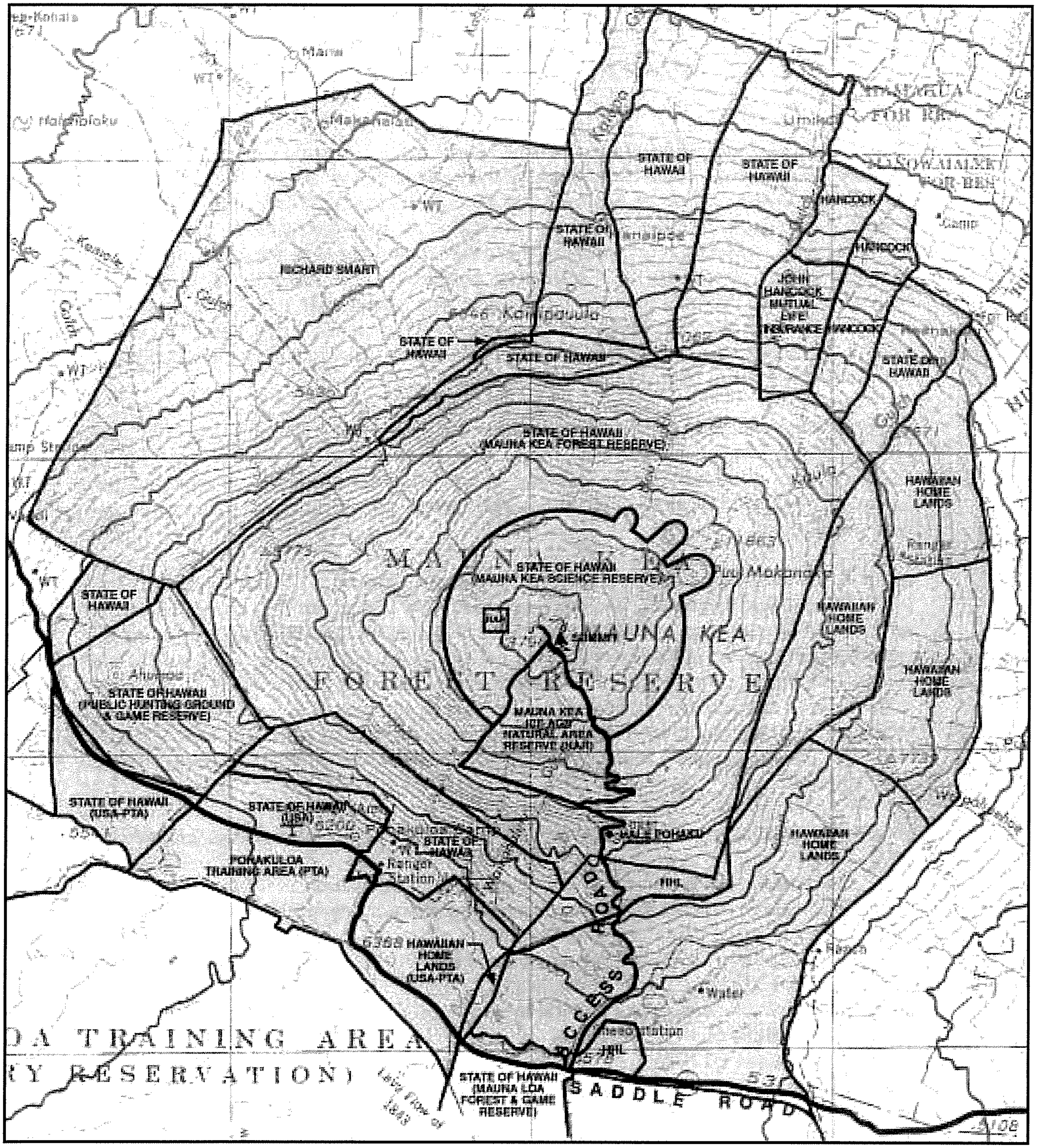
With the development of the astronomy facilities and supporting infrastructure on Mauna Kea in the late 1960s, access to the summit area increased and the number and types of mountain users multiplied. As a response to user conflicts and concerns regarding the natural and cultural resources of the mountain, several management and planning efforts were undertaken.

In 1968, the Board of Land and Natural Resources approved a 65 year lease (General Lease No. S-4191; January 1, 1968 to December 31, 2033) to the University of Hawai'i for a 13,321-acre circular area (2.5 miles in radius) centered on the Mauna Kea summit (approximately all the lands above 12,000 feet elevation) and referred to this land as the Mauna Kea Science Reserve (Land ownership is presented in Figure VIII-1). As stated in the Lease: "The land hereby leased shall be used by the Lessee as a scientific complex, including without limitation thereof an observatory, and as a scientific reserve being more specifically a buffer zone to prevent the intrusion of activities inimical to said scientific complex."

Most of the broad responsibilities of the University of Hawai'i stem from this Lease:

1. Maintenance of the premises in a clean and orderly fashion.
2. The right to develop improvements upon review and approval by the BLNR.
3. General liability resulting from negligence of UH.
4. Compliance with DLNR regulations and all other federal, state and county laws affecting land or improvements.
5. UH must not damage any cultural or historic site of value.
6. No planting of trees, shrubs or other vegetation except those approved by the Chairman of BLNR.

In addition to the general retention of regulatory authority, the BLNR specifically identified and retained all water rights, rights to access through the Science Reserve, hunting/recreation rights, rights to use any part of the Science Reserve or permit another party to use parts of the Science Reserve with the mutual consent of the University.



Source: City and County of Honolulu,
Real Property Assessment Division
Tax Maps Branch, 12/31/98

0' 7500' 15000' 30000'

NORTH

Land Ownership Map

1970s Planning

As astronomy development expanded in the early 1970s, concerns about further telescope developments were raised by hunters and conservationists. It was generally recognized that an overall Mauna Kea plan was necessary in order to control development on the mountain and to resolve the conflicting interests of the various users. Recognizing the increased scientific and recreational activity on Mauna Kea and expressing concern for native Hawaiian ecosystems, Acting Governor George Ariyoshi directed the Board of Land and Natural Resources to develop a master plan for all of Mauna Kea. DLNR initiated the planning study in 1975 and The Mauna Kea Plan was approved by the BLNR and published in 1977. The plan provides a policy framework for the management of the mountain from the Saddle Road area at 6,000 feet to the summit (DLNR, 1977).

The plan identified areas of responsibility for DLNR, the University of Hawai'i and the State Department of Transportation. According to the plan, the University is responsible for management and upkeep of Hale Pōhaku area astronomy facilities and management and upkeep of Mauna Kea Science Reserve.

All other management functions were retained by DLNR except for control of the Summit Access Road which was designated for the State Department of Transportation.

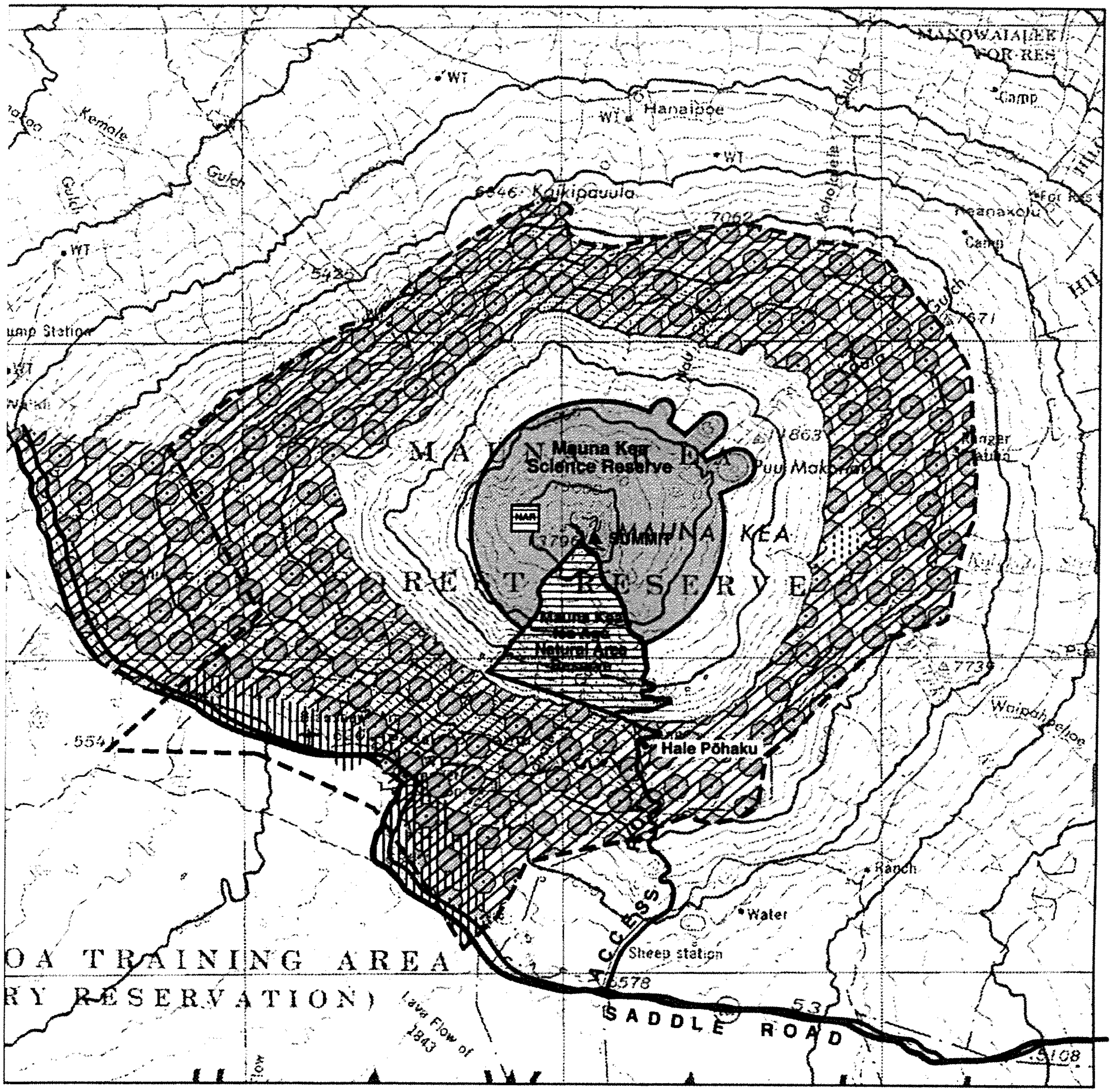
The 1977 Plan established five management areas and described acceptable use and management controls for each area (Figure VIII-2).

1. *Māmane-naio* Forest Ecosystem Management Area
2. Science Reserve Management Area
3. Special Natural Area and Historic/Archaeological Management Area
4. Silversword Management Area
5. Military Management Area

1980s Planning

During the initial years of increased astronomy support activity at Hale Pōhaku, other mountain users expressed concern about that area's development. Hunters worried about the potential loss in the size of the hunting range. Environmentalists expressed concern that the *palila* habitat would be damaged by new construction. Recreational users asked that park facilities be included for public use.

Recognizing the concerns raised by various interest groups, and a need to replace temporary structures with permanent astronomy support facilities, the Hale Pōhaku Complex Development Plan was prepared by Group 70 in 1980. The report recommended specific siting, organization, and general characteristics of the permanent facilities proposed for Hale Pōhaku in support of the six telescopes developed on the summit at that time. The CDP also provided design guidelines which call for minimized



Source: The Mauna Kea Plan
Hawai'i Department of Land
and Natural Resources, 1977

Māmane - Naio and Associated Ecosystem	Military Area		
Natural Area Reserve	Palila Critical Habitat		
Silversword Area	Forest Reserve Boundary		Science Reserve

0' 7500' 15000' 30000' NORTH

1977 Mauna Kea Plan Management Areas

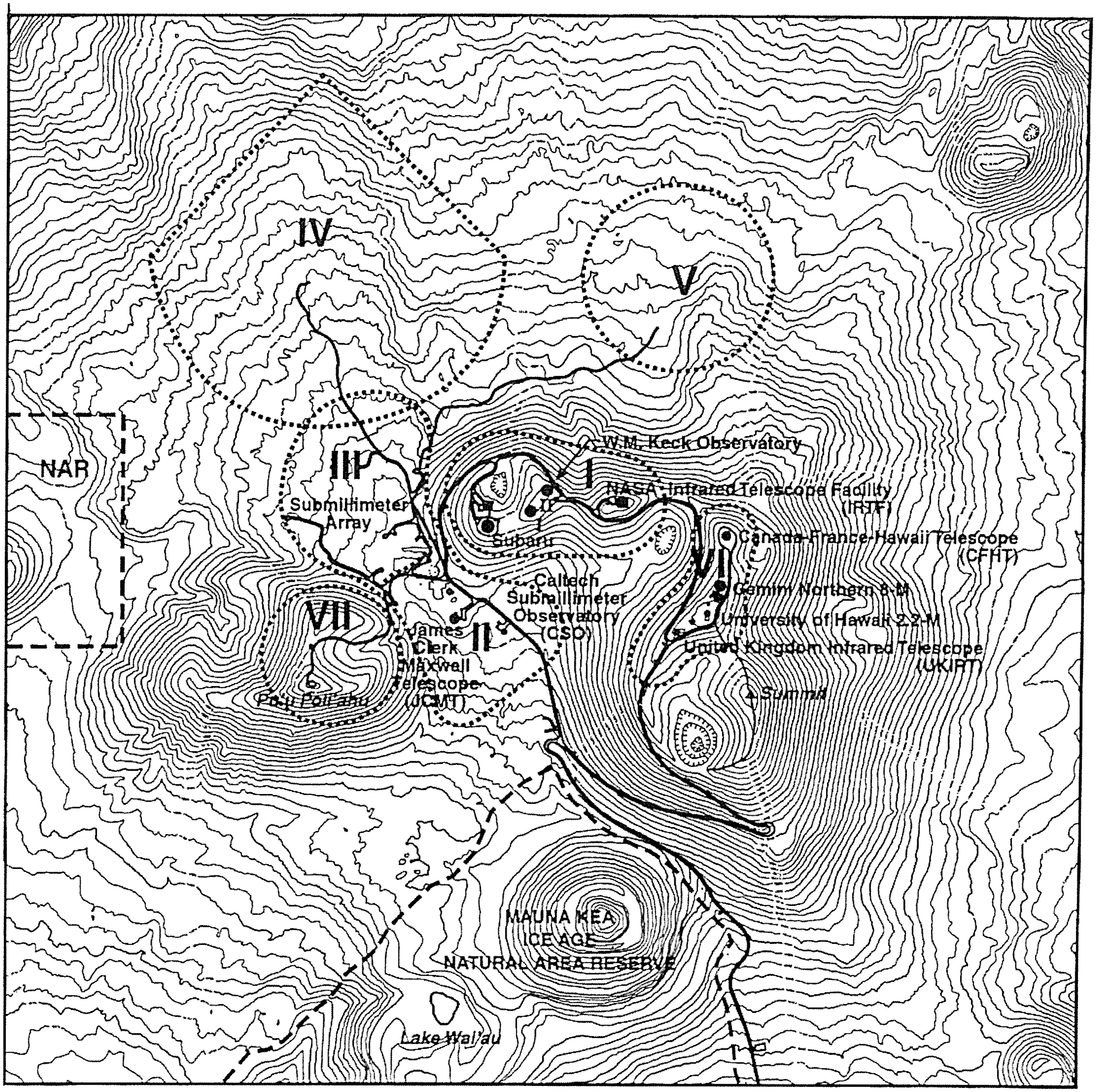
disturbance of the *māmane-naio* ecosystem and integration of facilities into the landscape. These guidelines were followed in the development of the main food and lodging complex. These facilities are built on pier type foundations following the natural terrain. Building colors blend into the landscape and surfaces are designed to be only minimally reflective. The entire complex was designed to incorporate the area's vegetation with minimum disturbance of the *māmane-naio* ecosystem.

In an administrative action that occurred during this time, Executive Order No.3101 dated November 16, 1981 identified two Natural Area Reserve parcels to be set aside from the Science Reserve and placed under the management of the DLNR. Parcel 1 was a 1,889.7-acre pie-shaped parcel encompassing much of the adze quarry and Wai'au and the other was a 143.5-acre rectangular parcel surrounding Pu'u Pōhaku. The formal withdrawal of the parcels from the general lease occurred on March 23, 1998. These actions removed the University from responsibility for management of these areas.

While the Hale Pōhaku facilities were being constructed, the University of Hawai'i was also looking towards the future of ground-based astronomy at Mauna Kea. The University of Hawai'i Research Development Plan (RDP) was adopted by the UH Board of Regents in 1982. The RDP provided the programmatic basis for the continued development of the Science Reserve and Hale Pōhaku with the goal of developing a pre-eminent state, national, and international resource for astronomical observations. The Research Development Plan called for future development of telescopes, infrastructure improvements and expansion of the mid-elevation facilities at Hale Pōhaku to support proposed telescope development.

The Mauna Kea Science Reserve Complex Development Plan (CDP) (1983) was prepared by Group 70 to provide the physical planning framework and management guidelines necessary to implement the UH Research Development Plan. The CDP serves as a guide for development which preserves the scientific, physical and environmental integrity of the mountain. It also provides proposals for managing the mountain's resources and visitor use. During this planning effort, the summit's biological and archaeological features were scientifically documented for the first time. Extensive flora and fauna studies, in addition to further archaeological work, were undertaken. As a result of the analysis of this information, a mixed use plan was developed for the summit and mid-elevation areas.

In the plan, areas of the summit plateau above 13,000 were analyzed using scientific, natural resource, and cultural resource criteria. Areas selected for potential facility development met scientific wind turbulence and obscuration requirements, were in areas where the ground was suited for construction, and where the impacts to recreational uses, visibility, biological resources, and archaeological sites would be minimized. The seven areas (Figure VIII-3) initially analyzed were refined to four planning areas to accommodate development of appropriate proposals through the end of the 1990's. The plan specifically identified proposed new telescopes which became the facilities now known as CSO, JCMT, and Keck I. It also envisioned proposals for additional



Source: 1983 Mauna Kea Science Reserve Complex Development Plan

25' Contour Intervals

Natural Area Reserve

Telescope Siting Areas

0' 750' 1500' 3000' NORTH

Analysis Areas for Telescope Siting (1983) optical/infrared and millimeter telescopes. In addition to defining four siting areas and supporting infrastructure requirements, the plan called for parking, trash, and toilet facilities at the summit to support recreational users of the mountain. This plan also called for the expansion of the Hale Pōhaku facilities to accommodate the new astronomy facilities proposed for the summit. The plan called for these facilities to be consistent with the mid-level facilities that had just opened. One new dormitory was subsequently developed.

Much of the 1983 plan has been implemented. The astronomy facilities that were projected have been realized. Policies were laid out for non-astronomy research and educational use for the mountain. Guidelines were established for such activities as commercial use and off-road vehicles.

The plan encouraged the University to hold open nights at the Visitor Information Station to share astronomy with the public. Today, the MKSS sponsors star-gazing programs seven nights a week. With respect to infrastructure, the plan called for the paving of the entire road from Hale Pōhaku to the summit. To date, the upper half (approximately 4 miles) of the road has been paved with further work awaiting funding.

While much of the 1983 plan was carried out, a number of the plan's recommendations have not been implemented. For example, the plan recommended that rangers be hired to patrol the mountain and, in fact, the Institute for Astronomy established these job positions at one time. However, the unfilled position were eliminated during budget cuts that affected all University programs.

With respect to recreational uses, the plan called for visitor parking and trash facilities in the summit area, and established enforcement guidelines aimed at encouraging visitors to use the designated parking areas. Other facilities proposed in the plan included a multipurpose research laboratory in the summit area and a permanently installed telescope for visitor use in the Hale Pōhaku area. These facilities have not been developed.

In an effort to remedy the difficulties caused by multiple jurisdictions, the plan called for the establishment of a management committee that would be advisory to the Department of Land and Natural Resources and the University of Hawai'i. This committee has never been formed.

1990s Planning

In 1995, a joint revised management plan was adopted by the University of Hawai'i and the DLNR. This plan clarifies and redefines the rights and responsibilities of the two organizations in the Science Reserve. The UH retained the following rights and responsibilities:

1. Mauna Kea Science Reserve Access:

- The right to control, maintain and manage access in the Science Reserve; including the Access Road and associated parking areas.
- The right to limit vehicle type or impose driving requirements.
- The right to restrict hours of access.
- The right to close the road for maintenance, hazards, snow removal or road repairs.
- The right to ask others to assist in crowd control (similar to deputizing).
- The right to require liability waivers.
- The right to comment on commercial permit applications.
- The right to control visitor activities around astronomy facilities.
- The right to limit commercial vehicles in the Science Reserve.

2. Activities at Hale Pōhaku Visitor Information Station:

- The right to limit 14 passenger commercial vehicles.
- The authority to enforce rules and institute crowd control policies at the Visitor Information Station.
- Authority to set the hours of operation at the Visitor Station.
- The right to issue special permits for the use of the Visitor Station.

3. Commercial Activities at UH Facilities:

- The right to operate concessions.
- The right to contract for shuttle service to the summit.

Approval of this management plan came with several conditions. The following identifies major or special responsibilities of the University:

1. Historic Preservation Plan to be completed and implemented by UH IfA.
2. This management plan replaces the plan identified in CDUA HA-1573.
3. Include cultural uses that do not involve physical impacts.
4. MKSS (Mauna Kea Support Services) staff be educated and instructed to report violations of the Mauna Kea Plan.
5. Additional specifications on protection of historic sites intentionally or otherwise.
6. Reporting back to the BLNR after the completion of archaeological and biological studies to review possible needs for change.
7. Additional signage for various purposes.
8. 7 day a week Visitor Station hours and DOCARE for Mauna Kea (not exclusive), subject to funding.

Under the current conditions, DLNR retains the following responsibilities:

1. Authority to determine permitted public and commercial uses of the UH management areas (Science Reserve, Access Road, Hale Pōhaku).
2. Authority over recreational uses and commercial tours within the Science Reserve.
3. Authority over research and education, natural resources, historical and cultural resources, recreation, and commercial use on State land, including the Natural Area Reserve.
4. Statutory responsibility for treatment of historic sites.
5. The responsibility to make sure commercial permits have consistent fees, set terms and are subject to review and renewal by DLNR. These permits may be superceded by Land Division permits in the future.

These existing management responsibilities, based on the latest plans and statutory requirements are depicted in Table VIII-1.

Auditor's Report

In 1997, the State Legislature, through Senate Concurrent Resolution No. 109, requested that the State Auditor conduct an audit of the management of the mountain. The Auditor's report was issued in February 1998 as Report No. 98-6. Both the University of Hawai'i and the Department of Land and Natural Resources were criticized in the report which concluded that new technology impacted development of the Science Reserve and management of the summit area did not adequately protect cultural and natural resources. The audit concluded with the following recommendations to address issues raised in the report:

Management

- Develop rules and regulations for summit area and Hale Pōhaku
- Hire ranger/guides at Hale Pōhaku who will be there on a daily basis
- Require registration of visitors for education and safety reasons
- Develop milestones, specific timeframes & other controls to ensure implementation
- Develop a forum for continuous community input
- New method for measuring impact
- Measure impacts individually and cumulatively
- State specific carrying capacity
- Require management plans that have time frames
- Ensure internal deadlines prior to release of land or leases.
- Make sure all responsibilities are assigned; either UH or DLNR

Historic/Cultural Resources

- Address cultural and historic issues
- Complete the Historic Preservation Plan

Table VIII-1 MAUNA KEA RESPONSIBILITY MATRIX
EXISTING AUTHORITY

Responsibility	Science Reserve (Includes Summit Road)	Hale Pōhaku	State Land (Includes NAR)
Research/Education			
Astronomy	UH	UH	DLNR
Other Disciplines	UH	UH	DLNR
Public Education	---	UH	---
Natural Resources			
Ice age/Periglacial	DLNR/UH	---	DLNR
Wekiu Habitat	DLNR/UH	---	DLNR
Palila Habitat	---	DLNR/UH	DLNR
Endangered Species	---	DLNR/UH	DLNR
Feral Ungulates	DLNR	DLNR/UH	DLNR
Alien Species	DLNR/UH	DLNR/UH	DLNR
Ecosystem Restoration	DLNR/UH	DLNR/UH	DLNR
Historical and Cultural Resources			
Historic Sites	DLNR/UH	DLNR/UH	DLNR
Burials	DLNR-BC/UH	DLNR-BC/UH	DLNR-BC
Cultural Practices	DLNR/UH	DLNR/UH	DLNR
Recreation			
Skiing and Snow Play	DLNR	---	---
Hiking	DLNR	DLNR/UH	DLNR
Camping	---	DLNR/UH	DLNR
Sightseeing/FIT Tourism	---	DLNR/UH	DLNR
Hunting	DLNR	DLNR	DLNR
Other Recreation	DLNR/UH	DLNR/UH	DLNR
Commercial Uses			
Tours	DLNR	DLNR	DLNR
Concessions	DLNR/UH	DLNR/UH	DLNR
Movies/Commercials	DLNR	DLNR	DLNR
Cabin/room accommodations	---	UH	---
Access			
Summit Road	UH	UH	UH
Trails	DLNR/UH	DLNR/UH	DLNR
Safety and Security			
Road Conditions (above HP)	---	UH*	UH
Dangerous Weather	---	UH*	---
Altitude Education	---	UH*	---
Medical Emergencies	UH/CTY	UH/CTY	CTY
Fire	UH/CTY	UH/CTY	CTY
Crime	CTY	CTY	CTY
Maintenance			
Road (above HP)	---	---	IfA
Utilities	UH/Utilities	UH/Utilities	UH/Utilities
Trash Removal	UH	UH	DLNR
Removal of Old equipment	UH	UH	
Graffiti	UH	UH	DLNR
Community Participation			
Public Restrooms	Keck*	UH	---
Programs	---	UH	---
Notification	UH	UH	---

--- = None or not applicable
UH = University of Hawai'i at Manoa (Includes IfA)
BC = Burial Council
* = Done but not required
DLNR has rights to authorize other uses of the Science Reserve as long as it does not interfere with lease conditions

Maintenance
- Periodic inspection and documentation of trash control
- Remove remnants of old equipment

Physical Planning Guidance
- Identify areas suitable for astronomical development
- Identify critical habitats for plants, invertebrates and other endangered species
- Identify no build zones
- Include facilities besides telescopes.

Statutory Recommendations/Lease Agreements
- Incorporate EIS mitigation measures as CDUA conditions
- Relate permit conditions to leases
- Adopt rules for Chapter 6E, Historic Preservation Program.

Planning Today

This Mauna Kea Science Reserve Master Plan will serve to address current concerns and guide the planning for the Mauna Kea Science Reserve for the next 20 years. While the projections of the 1982 Research Development Plan and 1983 Complex Development Plan have largely been implemented by 1999 as scheduled (the planning period was to the year 2000), the goals of balanced use and protection of resources have not been fully achieved. Issues and opportunities for the future use and management of the mountain beyond 2000 are explored below. Recommendations concerning these issues are detailed in the Physical (Section IX) and Management (Section X) plans that follow.

Management Authority

The joint responsibilities and layers of historical leases, plans, permits and written or verbal commitments have created a complex and often confusing pattern of management responsibility.

ISSUES

Unclear Responsibility: The legal and constitutional mandates to various agencies are articulated in the general lease, Hawai'i Revised Statutes and various plans and permits that have been adopted. Over the years, changes in plans, permits and personnel have resulted in a complex web of responsibility. Table VIII-1 summarizes the major areas of responsibility at the current time. A quick glance at this matrix shows the complexity of the arrangements. DLNR has had no permanent personnel on the mountain while UH has a number of people. UH IfA also has control and responsibility for the Summit Access Road. Therefore, some assume that UH has had *de facto* control and responsibility over the whole summit region even when it has no statutory authority to manage all the resources and activities in the Science Reserve. Management of the whole summit area requires management of both the Science Reserve and the Natural Area Reserve. There has been no authority that has been fully responsible for the whole summit area. As a result, some concerns were not addressed or were only addressed after much delay. This lack of functional clarity has created a situation which sometimes frustrates the general public because it is unclear to them who can address their concerns.

Lack of Confidence in Current Organizations: At the present time DLNR and the University are the key agencies with authority and management responsibilities for the mountain. Both entities will continue to be key stakeholders in all future scenarios. The problem is the lack of confidence held by some members of the general public in the ability or will of these agencies to protect the natural and cultural resources of the mountain. While some of this lack of confidence is, arguably, a matter of perception rather than fact, there are some real shortcomings. DLNR's current structure and priorities are not likely to provide improved management or significant resources to address these shortcomings. IfA, by mission and expertise, is not focussed to provide overall property management services. Another management structure with the specific charge to manage the Science Reserve is perceived by many to be an appropriate alternative to IfA/DLNR management.

Local Control: A commonly held perception on Hawai'i Island is that a major source of problems is the lack of local control. Decision makers for both IfA and the DLNR are headquartered in Honolulu. The representatives of IfA who interact most with the Hawai'i Island public are mostly with Mauna Kea Support Services (MKSS), the organization which provides support services for the observatories. As service providers, MKSS does not have the authority to speak for the University. In late 1998, the IfA began construction of a Hawai'i Island headquarters building in University Park at UH Hilo.

The DLNR has offices for the Division of Forestry and Wildlife, State Historic Preservation Division, and the Land Division in Hilo but these offices often do not have the authority or resources to respond to the concerns that are raised regarding Mauna Kea. The lack of decision-making on Hawai'i Island makes it difficult for people to have their concerns addressed in a timely manner. Mauna Kea often does not receive the priority or attention it deserves because it must compete with other state-wide issues and priorities.

Staff Presence on the Mountain: There are currently no designated rangers stationed in the summit area to educate visitors about the resources and safety requirements of the mountain. However, MKSS does have astronomy support personnel on the mountain who are able to provide some of this guidance. In addition, a number of IfA and MKSS staff are concentrated at Hale Pōhaku during the day. Three ranger positions were once included in the Institute for Astronomy budget but were cut during University-wide budget reductions in the early 1990s. These positions could have been used to address many of the management concerns that subsequently arose. Today, if an IfA or MKSS staff member witnesses a vehicle driving off-road or any dangerous activity, he or she will talk to the individual about safety and the rules on the mountain and provide assistance as needed. Litter pick-up also occurs on an ad hoc basis.

Unfunded Mandate: A persistent concern is the lack of adequate funding for management of the mountain. The 1983 plan recommended a policy advisory committee and baseline studies of natural and cultural resources. These activities were either not conducted or late in receiving funding. General lease S-4191 sets conditions for trash clean-up and removal of old facilities. The Auditor's report identified many problems that require changes but did not identify sources of financing to implement the changes. In any case, management responsibilities must be funded. Potential sources for funding are contributions from astronomy facilities, appropriations within the University of Hawaiʻi or the Department of Land and Natural Resources and fees from commercial activities.

Unbalanced Priorities: Some feel that management of the summit area has been excessively dominated by astronomy. While official UH policy does not restrict other uses, critics have felt that academic programs outside of IfA have not been supported. The perceived dominance of astronomy research has evolved into a criticism that cultural and natural resource values and programs, and astronomy education programs, have been neglected and that in some cases resources have been damaged.

Unmanaged Access: Currently, access is loosely regulated and hardly managed. It has been stated repeatedly that the creation of the Summit Access Road for astronomy opened the summit to general use and potential environmental degradation. If the road had not been built, the reasoning goes, the impacts would not have occurred or would have been minimal because the numbers of users would have been much lower. Additionally, the rise in popularity of off-road vehicles has increased the potential impacts and conflicts of uses arising from unrestricted access. Concerns related to access, particularly off-road vehicle use, include destruction of archaeological sites, impacts to sensitive environmental areas, increase dust, conflicts of use and increased hazards to visitors.

Maintenance: The University and the astronomy community has been criticized for creating trash on the mountain and not cleaning it up in a timely manner. In the past, construction debris has been scattered in the summit area by high winds. Recently, the University has conducted clean up days to remove this debris. Litter is also left on the mountain by non-astronomy users.

Financial Issues: The Science Reserve is comprised of ceded lands. Some claim that the Office of Hawaiian Affairs deserves 20% of all revenues. It is also noted that education is also an equal beneficiary of ceded land revenues under State law. Other charges include the criticism that astronomy facilities are being undercharged and that the resource (the mountain) is being unfairly exploited without benefits to the broader community.

OPPORTUNITIES

With the Auditor's report and current planning process, management problems and concerns have been comprehensively articulated. With the preparation of this Master Plan, the University, DLNR, and the community now have the opportunity to redefine management responsibilities and priorities for the Science Reserve. The resulting recommendations are presented in the physical planning guide (Section IX) and management plan (Section X).

Access

ISSUES

<u>Safety</u>: Unmanaged access increases concerns about safety. Hazards in the Science Reserve include accidents in wilderness places, brake failures and loss of vehicle control on the steep Summit Road, quick changes in weather that could lead to hypothermia and disorientation, pulmonary edema and various physiological problems that could arise from high altitude and reduced oxygen environments. Brake failures and vehicular malfunctions are a common occurrence in the summit area. These conditions raise potential safety and liability concerns. Over the past few years there have been about six accidents each year where a vehicle must be towed down the mountain (Koehler, 1998). In several cases, vehicles have run off the road and overturned. People have also been injured while snowboarding and skiing.

<u>Increased Access and Traffic</u>: The Mauna Kea Access Road and Summit Access Road are increasingly busy roads used by observatory crews, construction workers, cultural practitioners, recreational users, and Mauna Kea Support Services staff.

Because of the steep grade and sharp turns on the Summit Road, only four-wheel-drive (4WD) vehicles are recommended above Hale Pōhaku. The MKSS-led summit tours require that participants drive 4WD vehicles. In the Fall of 1998, an average of 560 vehicles per week drove to the summit area (Koehler, 1998). The following user breakdown is estimated for the period.

Construction Projects (Gemini/Subaru/SMA)	150 per week
Observatory Day Crews	150 per week
Observatory Evening Crews	85 per week
Commercial Tours	30 per week
MKSS Vehicles	20 per week
Tourists and Local Traffic	125 per week

Another 100 to 150 vehicles per week visited the Visitor Information Station only during the day and for evening stargazing programs. During the 1999 periods of snowfall, it was estimated that over 200 vehicles drove beyond Hale Pōhaku during the busiest days (Koehler, 1998). Snow removal and road conditions during inclement weather are presented in Figure VIII-4. While it is recommended that only four-wheeled-drive vehicles go above Hale Pōhaku, there are no staff assigned to prevent two-wheel drive vehicles from using the summit road.

Beyond permitted vehicular access, individuals occasionally take their vehicles off of the paved roads. In seeking their own thrills, these people risk damage to archaeological sites, arthropod and flora habitats, and to the serenity of the natural landscape. Prominent signage advises visitors that off-road driving is prohibited. Although there are no permanent barriers preventing vehicles from leaving the summit access road, access points are blocked with rocks where instances of off-road driving occur.

Improvements to the Saddle Road and further publicity about Mauna Kea's resources and astronomy complex are likely to increase the number of individuals who visit the mountain. On the other hand, the development of the Mauna Kea Education Center in Hilo's University Park may serve to decrease traffic to the summit of Mauna Kea by providing displays and programs that explore the mountain's astronomical, natural and cultural resources.

OPPORTUNITIES

With the understanding that Mauna Kea will continue to be a popular destination for large numbers of people, the opportunity to manage access for the health and safety of people and the environment is clear. Education can be provided by personnel stationed on the mountain and at the Visitor Information Station. Furthermore, education can take place at the Mauna Kea Education Center proposed for Hilo and in those observatory base facilities which have visitor galleries.

Snow & Snow Removal

Photos: Institute for Astronomy

Figure VIII-4

Natural Resources

ISSUES

Astronomy Facility Development: Concern has been expressed about the impact of the development of astronomy facilities and supporting infrastructure on the mountain's natural resources, to include specific habitats and the overall landscape.

Arthropod Habitat: In the summit area, research done by Dr. Francis Howarth in 1982, 1997, and 1998 has shown a dramatic decline in the population of the Wēkiu bug. The cause of the difference has not been determined and could be due to any of several factors including sampling methods, changing weather patterns, habitat disturbances, presence of harmful alien species, and long-term population cycles. The latest arthropod research, theories, and management recommendations are addressed in the Environmental Impact Statement, prepared for this Master Plan.

In all but one case, arthropod activity on Pu'u Hau'Oki was greater than or equal to that found on Kūkahau'ula. Kūkahau'ula is supposedly less disturbed, although substrate disturbance was evident, apparently caused by the greatly increased foot traffic along the ridge and within the crater since the 1982 study. Trap capture rates for Wēkiu bugs were significantly higher in disturbed areas than in undisturbed areas. These results raise the possibility that observatory construction and other human activities have not impacted the Wēkiu bug distributions at the summit, outside of the immediate vicinity of the paved and covered areas.

In an effort to preserve the habitat and encourage growth in the Wēkiu's population, Howarth and team recommend caution during activities such as hiking and trash collection efforts. They also recommend monitoring and additional field work to track population and assess reasons for the population decline (Howarth, 1999).

Increased Access: There is concern that recreational users may have a negative impact on natural resources on the mountain. Off-road vehicles and unmanaged hiking can crush loose cinder and create dust, damaging arthropod and flora habitat in the summit area.

OPPORTUNITIES

The extensive flora and fauna information gathered in the early 1980s and subsequent studies of arthropods provide a foundation of knowledge about the natural resources of the mountain. Future research and monitoring will increase knowledge about the mountain's resources and aid in the protection of these resources.

In addition, understanding of potential damage caused by vehicles, hikers, and skiers should encourage management policies that educate and provide guidance to mountain users.

Culture

The Auditor's report emphasized the neglect of cultural resources and cultural practices. There has been one verified case of damage to an archaeological site by astronomy-related development (destruction of a lithic scatter near Hale Pōhaku). However, changes in historic preservation policies and the growth of the Hawaiian cultural renaissance have brought new sensitivity toward cultural values and issues. As a result, issues of current cultural practices and the significance of the mountain have emerged. Ethnographic studies have become a standard part of cultural interpretation in the last 10 to 15 years and the values that emerge from such studies have contributed new knowledge and sensitivity to our attitudes toward the land and its culture. Cultural landscapes, geophysical forms and associated cultural attachments, have also emerged as a resource of value. These perspectives require a re-evaluation of the archaeological, geophysical and ethnographic dimensions of the mountain.

ISSUES

Cultural Resources: Cultural associations with Mauna Kea and specific archaeology sites are important cultural resources. Important archaeological and cultural features of the mountain are located in both the Natural Area Reserve (NAR) and the Science Reserve, with Wai'au and most of the adze quarry located in the NAR. Concern has been expressed regarding the access made available by the summit road and the potential for uninformed individuals to inflict damage on resources in both the Science Reserve and the NAR. There is concern that astronomy facility development and other uses of the mountain may harm these features. Some have expressed the sentiment that the presence of telescopes upsets the views of the natural and cultural landscape of the summit plateau. Off-road driving, uninformed hikers and impacts of snow play have all been highlighted as concerns to specific archaeological sites and broader respect for the mountain.

Another potential issue is the modification of archaeology sites for modern cultural practice. As an example, concern has been expressed that an individual or family may add stones or modify an existing shrine in their own practice of worship. It is not clear how much of a concern this would actually be as a number of Hawaiians have stated that other Hawaiians will not alter an *ahu* that is not associated with their own family.

Cultural Practice: There is a perception among some that modern practice of traditional Hawaiian culture is not welcome on Mauna Kea. There are no existing or proposed restrictions placed on this activity. Isolated interference with the cultural practice of one individual, which was caused by ignorance of the significance of a site, has led to concern in the larger Hawaiian community that undue interference could be a problem.

OPPORTUNITIES

Numerous archaeological and ethnographic studies have been conducted for Mauna Kea. During this master planning process several studies were conducted or initiated to include the State Historic Preservation Division's Mauna Kea Historic Preservation Management Plan, Kepā Maly's oral history and archival research study, and PHRI's archaeological study.

This wealth of written and recorded information provides a base from which others, including mountain staff, can be educated about Mauna Kea's cultural resources. Education and management strategies will play an important role in the preservation of these resources over time.

Education and Research

ISSUES

Development of Astronomy Facilities

Ever since the first telescopes were proposed for Mauna Kea, there have been mixed sentiments in the community concerning development on the mountain summit. Some members of the community ask that development upon Mauna Kea continue no further. Others see Mauna Kea as one of the real success stories of economic development in Hawai'i.

Economic Impact of Astronomy

SMS Research analyzed the economic impact of astronomy conducted on Mauna Kea for the Master Plan. In addition to established facilities, new facilities Subaru, Gemini Northern, and the Submillimeter Array are considered as operating facilities in the economic analysis. Construction costs for all facilities built or to be built prior to the year 2000 total approximately $826 million. Approximately one fourth of this sum is spent in Hawai'i County.

From the construction of new facilities, to the employment of a trained technician, to the purchases made by a visiting scientist, the astronomy industry contributes widely to the Big Island economy.

Approximately 400 full-time positions will be supported by Hawai'i's astronomy industry in the year 2000. These include astronomers, engineers and engineering technicians, software programmers, equipment technicians, and administrative personnel.

SMS Research (1999) estimates the direct impacts of Mauna Kea astronomy in the State to include:

Operating Budget	$51.9 million/year
Workforce	397
Visiting Researchers	3,755 trips/year
Visitor Spending	$0.7 million/year

Total economic impact of astronomy, assuming operation of Subaru, Gemini, and the SMA, is estimated at $130.9 million annually for the County and $141.7 million annually for the State. Direct impacts include employment and expenditures directly associated with the operation of the astronomy industry and represent $61.1 million for the County and $63.0 million for the State annually. Indirect impacts occur when astronomy-related firms purchase goods and services from other firms. Induced impacts are due to spending by the astronomy workforce in the local community.

Over the next two decades, two trends may have large economic effects. First, with continuing support of science education and internships, and continuing need for staff, the observatories will encourage development of a local pool of skilled technical personnel. Second, tourism on the island may draw more extensively on astronomy as a resource. This activity does not necessarily have to occur on Mauna Kea as it can be encouraged in the new Mauna Kea Education Center being proposed in Hilo.

Future Astronomy Facilities

It is the hope of the University of Hawai'i and many in the State that Mauna Kea continues as the leading astronomy complex in the Northern Hemisphere or even the world and remains a driver of the Hawai'i Island economy. It is envisioned that because of the sensitive environment and cultural landscape that only world class telescopes should be located on Mauna Kea. Mauna Kea is not the place for just any instrument. It is a premier location and environment that should host only those facilities that are unique.

The world astronomy community is looking forward to the next decade with a focus toward space telescope development and complementary ground-based telescopes. Recent developments in astronomy technology have led to greater ability to identify previously unknown objects. The world astronomy community now projects the need for additional state-of-the-art 10-meter instruments (such as the Keck I and II), as well as specialized instruments to address defined research objectives. The following categories of telescope facilities are foreseen for the future:

Conventional Optical/Infrared Telescopes: These telescopes would have mirror sizes of 2 to 12 meter diameter. The smaller 2 to 6 m telescopes could be modern versions of the UH 2.2m, CFHT and IRTF. Larger telescopes with 6 to 12 m mirrors would be similar to Keck, Subaru and Gemini.

Next Generation Large Telescope. Planning for a large optical/IR telescope (aperture 25-50 m) is advancing. This instrument is significantly bigger than any existing telescope and would have much greater light collection potential than a space telescope which would be much smaller. One major goal is to study a spectra of galaxies as they were forming approximately 10 billion years ago. This telescope would also provide the capability to study planets around nearby stars.

Submillimeter Interferometer. The creation of additional and larger submillimeter interferometer arrays is also being contemplated by the world astronomy community. There will be a need to expand the viewing capabilities in the submillimeter band to support growing research efforts in this area of astronomy (radio interferometry).

Optical/IR Interferometer. An optical interferometer could contain a number of telescopes at separations up to several hundred meters. Prime objectives of this type of telescope are the detection of planets around nearby stars and the study of star formation.

Large Array/Millimeter Array. The world astronomy community is planning to develop a large array for millimeter astronomy during the next decade. This facility is not likely to be located at Mauna Kea due its large area requirement (6-10 km) and the large number of antenna (about 50). A consortium of U.S. and European astronomy organizations is currently planning to develop this large millimeter array in Chile.

<u>Non-Astronomy Science and Education</u>: Currently there is the perception that educational opportunities are limited to programs related to the Institute for Astronomy or individual telescope facilities. A process for proposing other educational programs or activities is not widely communicated or understood.

OPPORTUNITIES

The environmental and technical qualities of the Mauna Kea Science Reserve make it the superior site in the Northern Hemisphere for most types of ground-based astronomy. First, the natural conditions are ideal for astronomical observations. Second, there is now the critical mass of world class telescope facilities for Mauna Kea to continue to be at the forefront of ground-based astronomy. Third, the astronomy and astronomy support technologies that have been developed on Hawai'i Island can be the catalyst for other research and education programs.

Mauna Kea's unique natural and cultural resources provide a wealth of opportunities for research and education that is coordinated and conducted in a manner that is most appropriate for the resource. Supporting facilities could include the construction camp cabins below the Visitor Information Station.

Recreation

Issues related to recreational use include safety concerns and possible inadvertent damage to archaeological sites. Off-road driving is also a major concern because of the cultural and natural resources which may be damaged.

ISSUES

<u>Snow Season Activity</u>. While hikers and other recreationalists are active throughout the year, the greatest number of recreational users come to the mountain during snow season. With so many people on the mountain enjoying the snow, cars must park on the side of the road. The large number of people skiing, hiking, snowboarding and sledding in the snow at such a high elevation, can be hazardous to individuals and to cultural resources such as *ahu*.

A portable toilet and the facilities at the Keck Observatory are the only public restrooms available above Hale Pohaku, and often these do not meet demand or are inconvenient to access. As a result, individuals often relieve themselves on the side of the road or wherever is convenient, resulting in unsanitary conditions.

<u>Safety</u>. The high altitude environment hosts natural resources that provide recreational opportunities that are unavailable anywhere else in Hawai'i. Skiing and various forms of snow play attract large numbers of people when conditions are right. Recently, there have been requests for more extreme sports on the mountain such as hang gliding and cycling down the summit. Hikers are attracted to the summit area for its natural and scenic qualities. With easy access and increases in numbers concerns about safety, liability, resource impact and compatibility with the spiritual values of the mountain have begun to emerge.

OPPORTUNITIES

Recreational activities need to be managed to reduce potential conflicts of use, enhance recreational opportunity, avoid damage to cultural and environmental resources, and improve safety. Facilities could be provided in the summit and mid-elevations areas to support the safe use of the mountain.

The discussion above highlights many of the issues that have persisted in the Mauna Kea Science Reserve over time and reviews past plans for the management of the area. The physical and management plans which follow (Sections IX and X) will offer solutions which are aimed at resolving problems/issues that exist today and enable the potentials of tomorrow to be realized.

PHYSICAL PLANNING GUIDE

The following are the four objectives of the Master Plan for the Mauna Kea Science Reserve:

1. **Prepare a Master Plan consisting of a physical planning guide, maps, geographic information system, and criteria, which manage the use of the resources of the Mauna Kea Science Reserve.**

   - **Protect natural resources (e.g. Wēkiu bug habitat, alpine ecosystems);**
   - **Protect historic and Hawaiian cultural resources and practices (e.g. archaeological sites, cultural landforms);**
   - **Protect and enhance education and research (e.g. astronomy, ecology, geology);**
   - **Protect and enhance recreational opportunities (e.g. skiing, hiking).**

   The physical planning guide will enable the sustainable use and enhancement of these four resource components. The natural resource component documents the extent of significant habitat areas and unique geology areas, and delineates preservation areas. The historic and Hawaiian cultural component identifies archaeological sites and culturally significant landforms to be preserved. Appropriate sites for the future locations of astronomy facilities are identified, with respect for natural and cultural resource preserve areas. Lastly, the recreational uses of the mountain are defined.

2. **Analyze and depict the physical implications of uses and address and propose mitigation of environmental impacts.** The Master Plan considers the physical presence of astronomy facilities, and other buildings and infrastructure on the mountain. A Geographic Information System (GIS) is utilized to provide a resource-based siting analysis of environmental conditions.

3. **Guide the planning of physical development in the summit area, not only in terms of the location of facilities, but in regard to character, size, mass, color, and other physical attributes.** The plan locates proposed new facilities and includes design criteria, which are intended to mitigate potential visual and environmental impacts. These include topographic shielding, setbacks, scale and colors. A three-dimensional simulation program is used to evaluate the potential visual impacts and effectiveness of mitigation proposals that guide the siting and design of new facilities.

4. **Define the infrastructure and support facility elements required for natural and cultural programs, education and research programs, and recreation uses.** The plan addresses the infrastructure support elements for facilities in the Science Reserve, including the roadways, electrical power supply and communications network.

METHODOLOGY FOR THE PHYSICAL PLANNING GUIDE

The updated Physical Planning Guide for the Mauna Kea Science Reserve consists of four components, including: (1) Natural Resources, (2) Cultural Resources, (3) Education and Research, and (4) Recreational Resources. Resource elements were overlaid upon each other to create a base for the master plan, identifying opportunities for both preservation and uses.

This resource overlay process employs a Geographic Information System (GIS) format. A Geographic Information System is a computer-based tool for mapping and analyzing resource data that integrates spatial and non-spatial information to provide tailored analytical and mapping capabilities. Resource data are compiled in the GIS to show the extent of resources and uses. New information is obtained directly from government and consultant surveys, field research, and literature studies conducted since the 1983 master plan. Additional information is derived from the meetings of the Mauna Kea Advisory Committee, the findings of consultant studies, individual interviews, and meetings with authorities with expertise in relevant disciplines.

Criteria are developed for each of the resource maps to delineate boundaries for areas to be proposed for preservation and areas for potential use. The key factors considered in recommending areas either for preservation or compatible use are the presence or absence of important natural, cultural, education and recreational resources. The methodology used in creating individual plan components is described below.

Natural Resources Components. This component of the master plan delineates the presence of unique geology, flora and fauna resources within the Science Reserve. Significant natural resource areas are identified in the plan. GIS mapping is used to produce composite studies of each resource layer, including a graphic overlay of natural resources. Refer to Section IV for detailed information on the natural resource components of the Science Reserve.

Cultural Resources Components. GIS mapping is used to present each cultural resource component, including archaeological sites, places of cultural importance, and culturally significant landforms in the Science Reserve. Refer to Section V for detailed information on the cultural resource setting.

Educational and Research Components. Sites for new education and research facilities are determined utilizing the natural and cultural resources GIS layer components. The boundaries of a proposed development area are defined by balancing the sites needed by proposed astronomy facilities and specific natural and cultural resource elements, being limited to those areas where impacts to important natural and cultural resources can be avoided or minimized. The Hale Pōhaku mid-elevation facilities are also studied for potential future improvements to facilities and infrastructure. Refer to Section VI for detailed information on the education and research components of the Science Reserve.

Recreational Resources Components. The component for the recreational resources in the Science Reserve addresses areas for skiing, snow play, and hiking. This component addresses the suitability of areas for continued or expanded recreational use, with recommendations for area limits and support facilities. Refer to Section VII for detailed information on the recreational resource components of the Science Reserve.

NATURAL AND CULTURAL RESOURCES COMPONENTS

The first integration in the Physical Planning Guide is the relationship of natural resources and cultural resources. From a Hawaiian perspective, there is not a differentiation between the natural and cultural resources of the land, rather they are a unity. In this plan, the natural and cultural resource elements are addressed in an integrated approach to carry equal importance in the Master Plan.

Overall objectives for natural and cultural resources:

1. Promote a greater knowledge base and understanding through the planning process, focussed on:
   - Critical natural resources, to include flora, fauna, and natural landforms, and
   - Archaeological and cultural resources, Hawaiian cultural practices, modern practices and significance of sites, names, and geophysical elements.

2. Protect and preserve, through planning and management:
   - Unique geological features and biological communities, recognizing the symbiotic relationship between the two in the Science Reserve which form unique ecosystems, and
   - Cultural resources in a sustainable manner so future generations may share in the understanding and knowledge of the mountain's archaeological sites and culturally significant landforms and places.

3. Enhance opportunities and protect:
   - Natural resource areas for recreation in a manner that both sustains the resources and promotes the safety of individuals, and
   - Opportunities for individuals and groups to engage in cultural practices.

4. Allow for current and future use of natural resources for educational programs and cultural practices for the community, schools and universities, and visitors.

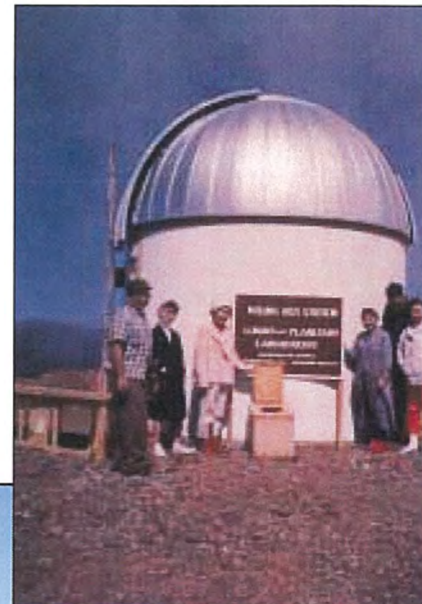
5. Protect the mountain's natural landscape to preserve its scenic values, and preserve the cultural landscape to enhance meaning, relationships, and resources for modern appreciation, research, and practice.

6. Define specific areas and criteria for natural resource use and cultural resources and practices, as applicable, to allow for sustainable, integrated planning and management.

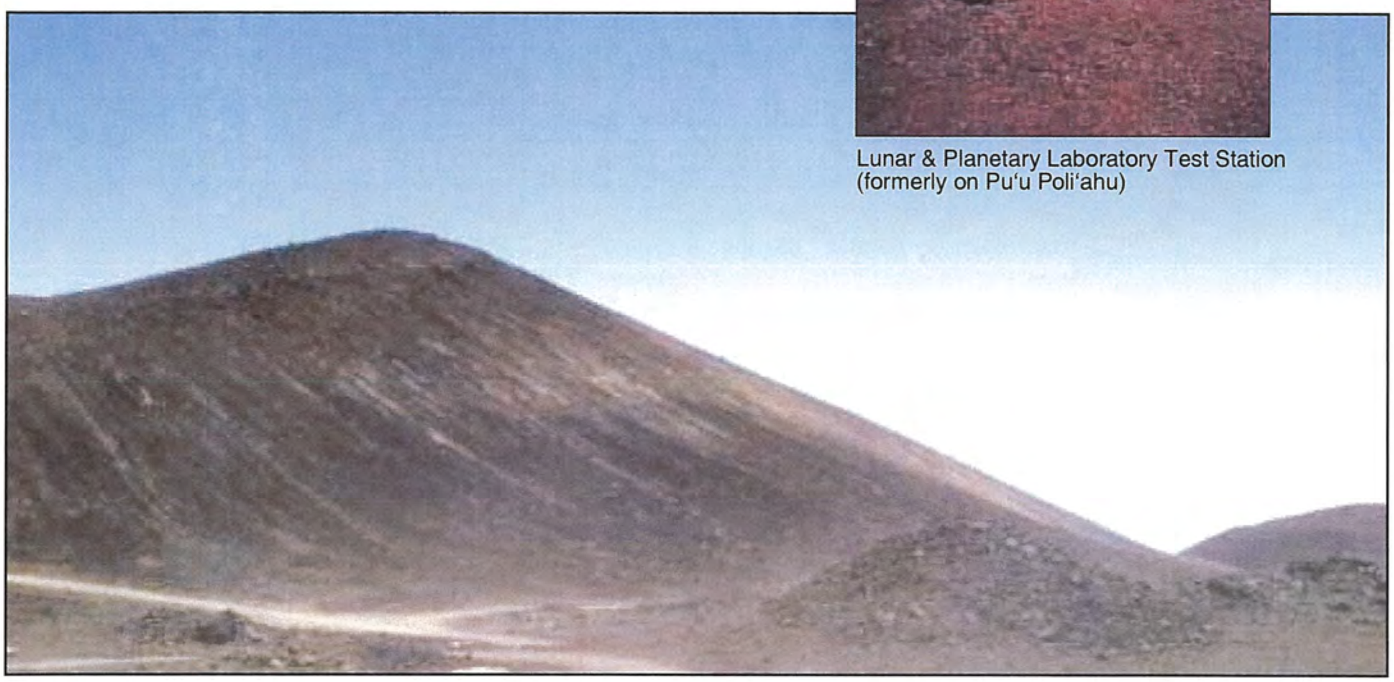
Natural and Cultural Resources Map. The objectives and goals for the natural and cultural resources map arise from the issues surrounding the past and present uses of the mountain. In the recent past, the mountain's natural and cultural resource issues have each been handled in an isolated manner, whether it has involved the Wēkiu bug population, archaeological sites, or the use of the *pu'u* to locate astronomy facilities. We now have better knowledge of these resources and understand that they are inter-related and need to be planned in an integrated fashion, not individually. For example, the natural direction for past astronomy development has been to utilize the highest elevation locations found at the tops of the *pu'u*. Years ago, Pu'u Poli'ahu was tested for its qualities as an astronomy site, and from a technical basis, it is considered to be a prime potential site (See Figure IX-1). However, our increased understanding of the Hawaiian cultural importance of the mountain's *pu'u*, as well as their unique ecological components, now guide future planning toward preserving these important features.

From a natural resource perspective, the primary issues concern the Wēkiu bug and scenic views. The major *pu'u* in the upper slopes of Mauna Kea provide the only known habitat area for the Wēkiu bug. Some *pu'u* have been found to contain the Wēkiu bug, while others have similar habitat qualities and have the potential for supporting populations of this endemic arthropod, thereby motivating plans to preserve all *pu'u*. Scenic views of the summit are experienced within the Science Reserve and from off-mountain locations. All major cinder cones which are undeveloped will be protected from future development by astronomy or other interests. These include the following *pu'u*: Ala, Hau Kea, Hoaka, Kūkahau'ula, Lilinoe, Mahoe, Makanaka, Poepoe, Pohaku, Poli'ahu, Ula, and Wai'au. Prohibition of development of modern man-made features on all the currently undeveloped *pu'u* will protect the scenic natural views to and from these landforms (See Figure IX-2). Preservation of each *pu'u* will also retain the integrity of a cultural landscape spanning from Kūkahau'ula (the summit) through Poli'ahu, including Lake Wai'au and the adze quarry at Keanakāko'i in the adjoining Natural Area Reserve. A principal recommendation of this plan is the preservation of the natural and cultural landscape of the Science Reserve by protecting all of the major undeveloped *pu'u* and the intervening areas from disturbance.

The Master Plan also envisions the preservation of the natural cultural landscape in the Science Reserve (See Figure IX-3). Archaeological sites are found with the greatest frequency in a band below the summit area, mostly evident at about the 13,000 ft. level.

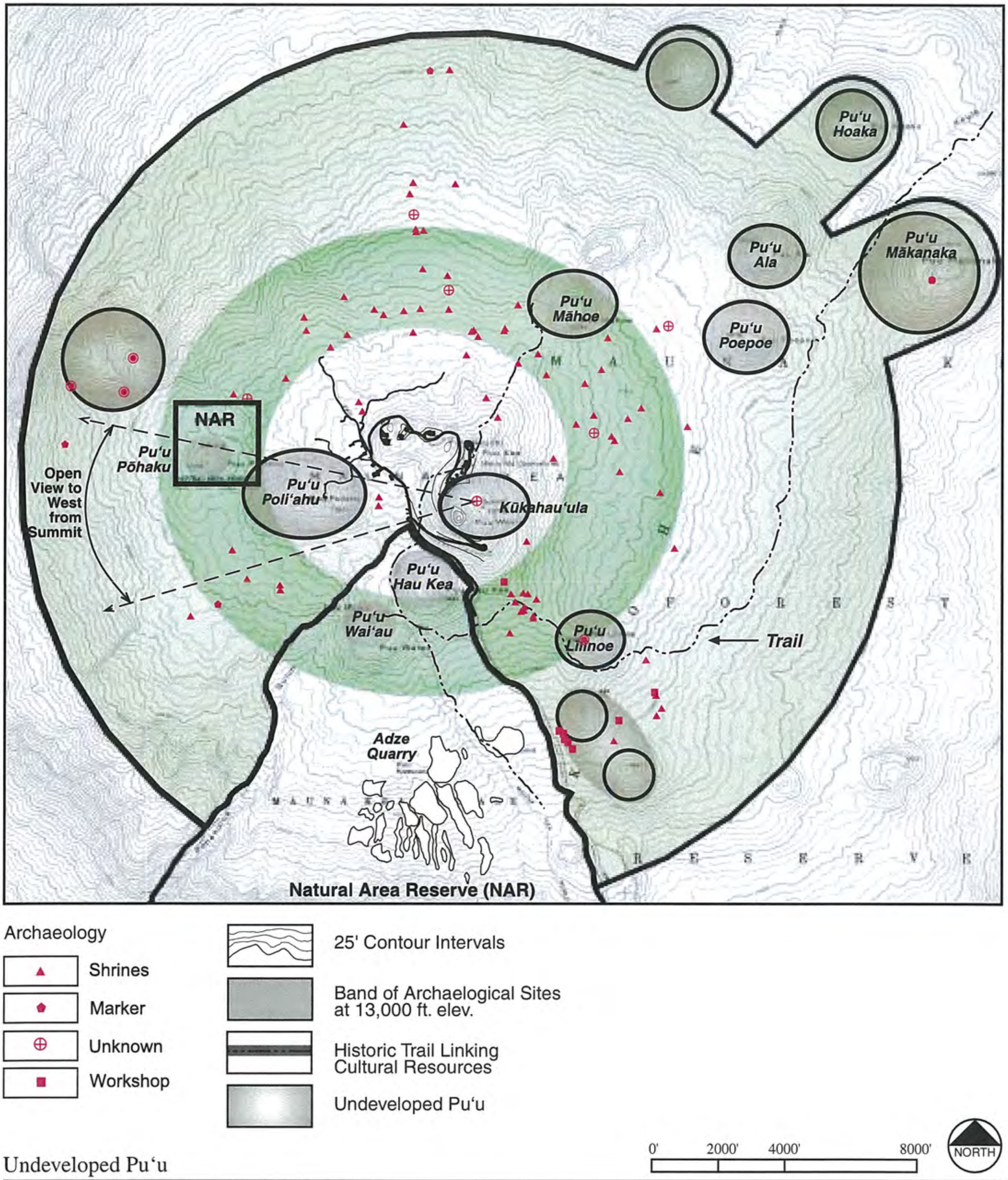


Lunar & Planetary Laboratory Test Station
(formerly on Pu'u Poli'ahu)

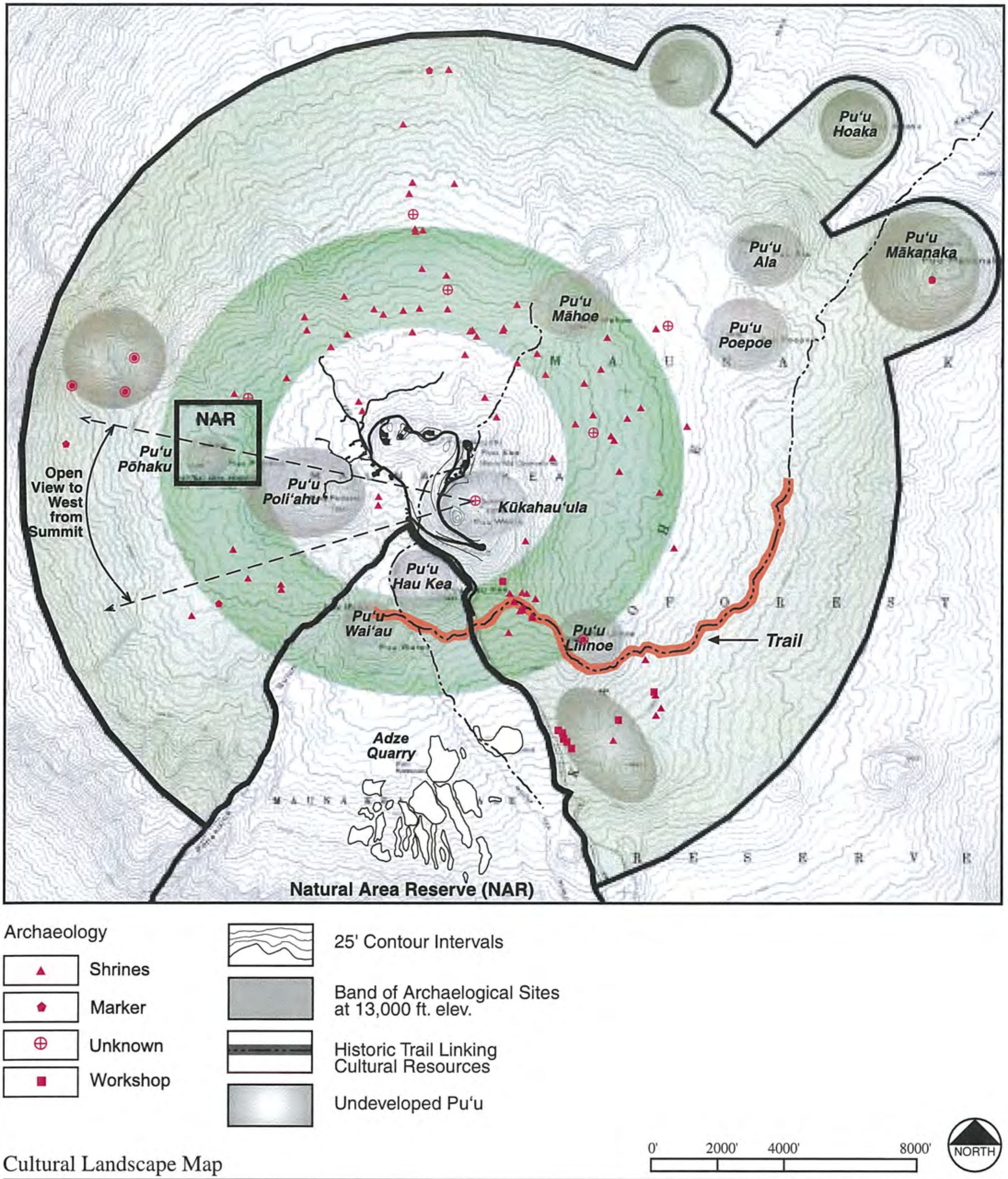


Pu'u Poli'ahu

Pu'u Poli'ahu and Lunar and Planetary Laboratory Test Station



Undeveloped Pu'u



Cultural Landscape Map

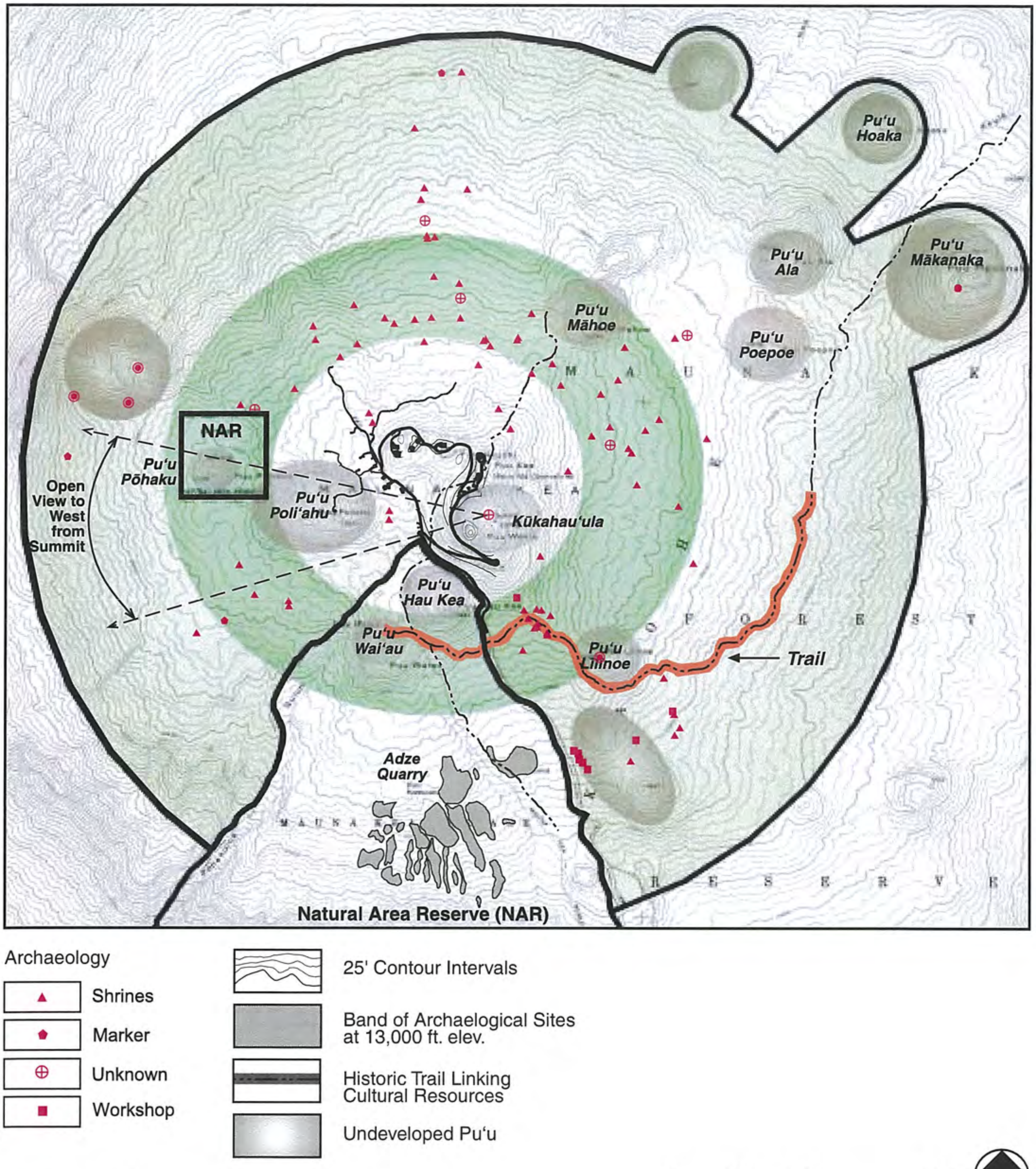
According to cultural sources, Lake Wai'au (in the NAR) and its surroundings, including the *pu'u* within the Science Reserve, are all culturally significant places. The Plan views the archaeological sites of the summit region as a whole rather than in an isolated context. According to McCoy (February 1999), the abundance of shrine complexes and the accounts of cultural importance of the *pu'u* in the upper slopes, indicates that the area was a ritual center. Therefore, the physical plan links the significant landforms with the archaeological sites clusters, Wai'au and the adze quarry at Keanakāko'i. There is an historical trail that extends through this area, and the map delineates this trail as providing a linkage between all of these elements (See Figure IX-4). The cultural landscape is thereby preserved within the Science Reserve and to the NAR, in a manner where people may experience the cultural resources of Mauna Kea in the traditional manner at the 13,000 ft. elevation without interacting with the modern astronomy facilities. Simulated views from Wai'au are shown in Figure IX-5.

<u>GIS Mapping of Natural and Cultural Resources</u>

Unique Surface Geology. There are numerous unique areas of surface geology within the Science Reserve, including cinder cones, glacially scoured rock surfaces, glacial moraines, rock structures formed by sub-glacial eruptions, texturally sorted soils, and an alpine lake. Outcrops of uniquely fine-grained, dense lava found along sub-glacial vents and lava/ice contacts within the Mauna Kea Ice Age Natural Area Reserve and adjacent areas were extensively used as quarries (Keanakako'i) for ancient Hawaiians to obtain adze materials. The distribution of these features is shown in Fig IX-6. These areas are included in the GIS as unique geological resource areas, and will be protected from disturbance by development and intensive recreational activities. Slopes in excess of 20 percent are shown in Figure IX-7.

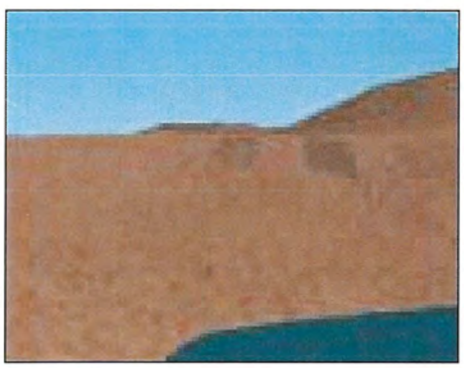
Flora Habitat. Flora species distribution within the Science Reserve relate directly to the surface geology character. Lichens and ferns occur strictly where there are craggy andesitic lava outcrops to provide shade, some soil (ferns), physical protection and moisture collection. Mosses are more widely distributed on rock mounds across the upper slopes. GIS mapping of flora resources shows the general extent of lichens and ferns. As shown in Figure IX-8, areas of concentration of lichen habitat are identified within the andesitic lava flows to the north and west, with the more limited fern habitat on the slopes to the north of the summit (Char, 1999, 2000).

Flora species could be affected by the construction of new paths, roads, and facilities. The natural habitat for concentrations of the unique floral resources of lichens and ferns found in the summit region will be protected in the plan. Site specific surveys would be needed to determine siting choices to minimize effects upon sensitive flora habitat. Selective replanting/reintroduction of silversword is proposed for the cinder cones within the Science Reserve. Upper slope flora species that could also be reintroduced upslope from their current distribution include *pūkiawe* and *'ōhelo.*

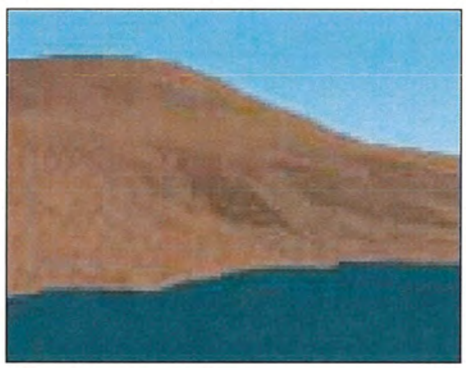


Existing Trail Linking Hawaiian Cultural Resources

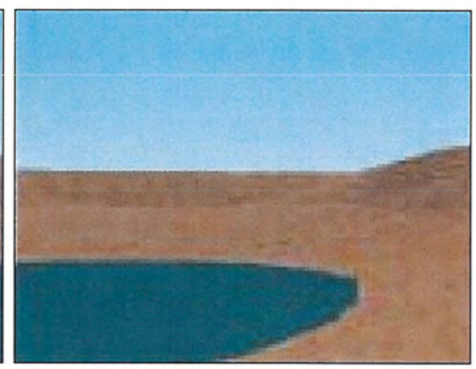
View of Pu'u Poli'ahu



View North

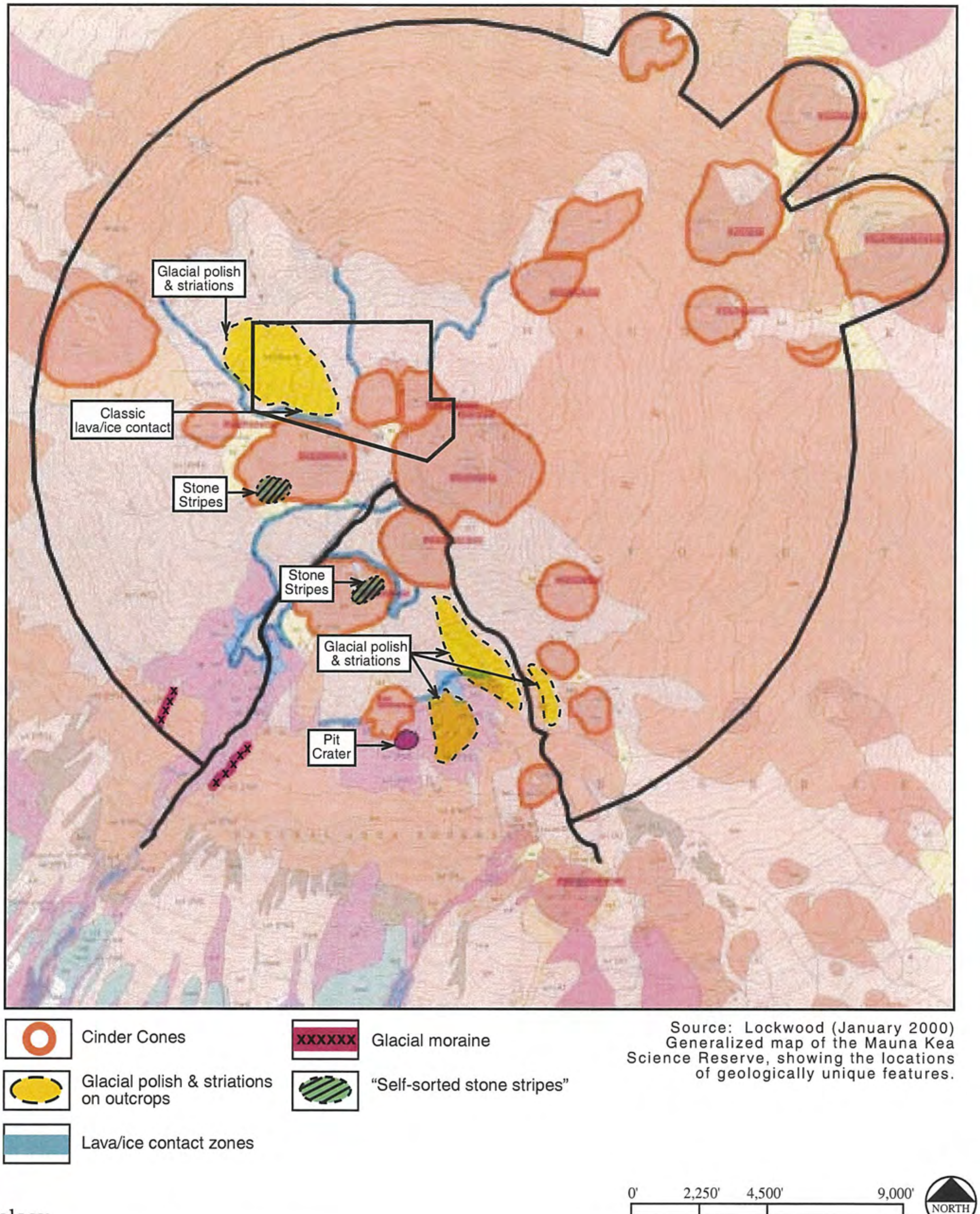


View of Pu'u Hau Kea

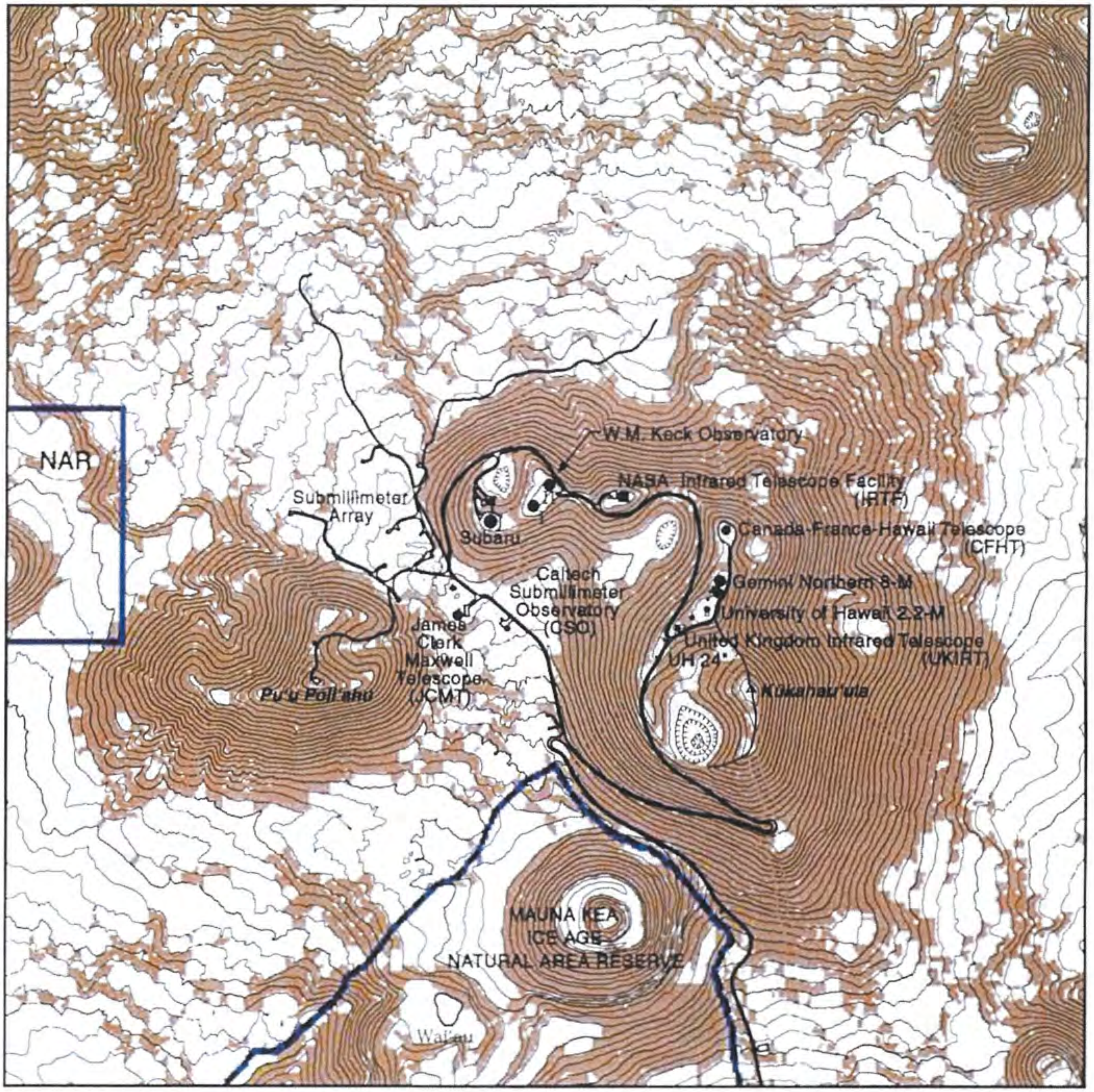


View of Pu'u Wai'au

Simulated Views from Wai'au



Source: Lockwood (January 2000) Generalized map of the Mauna Kea Science Reserve, showing the locations of geologically unique features.



Source: R. M. Towill Topographic Survey, 1997
Group 70, Slope Analysis, 1998

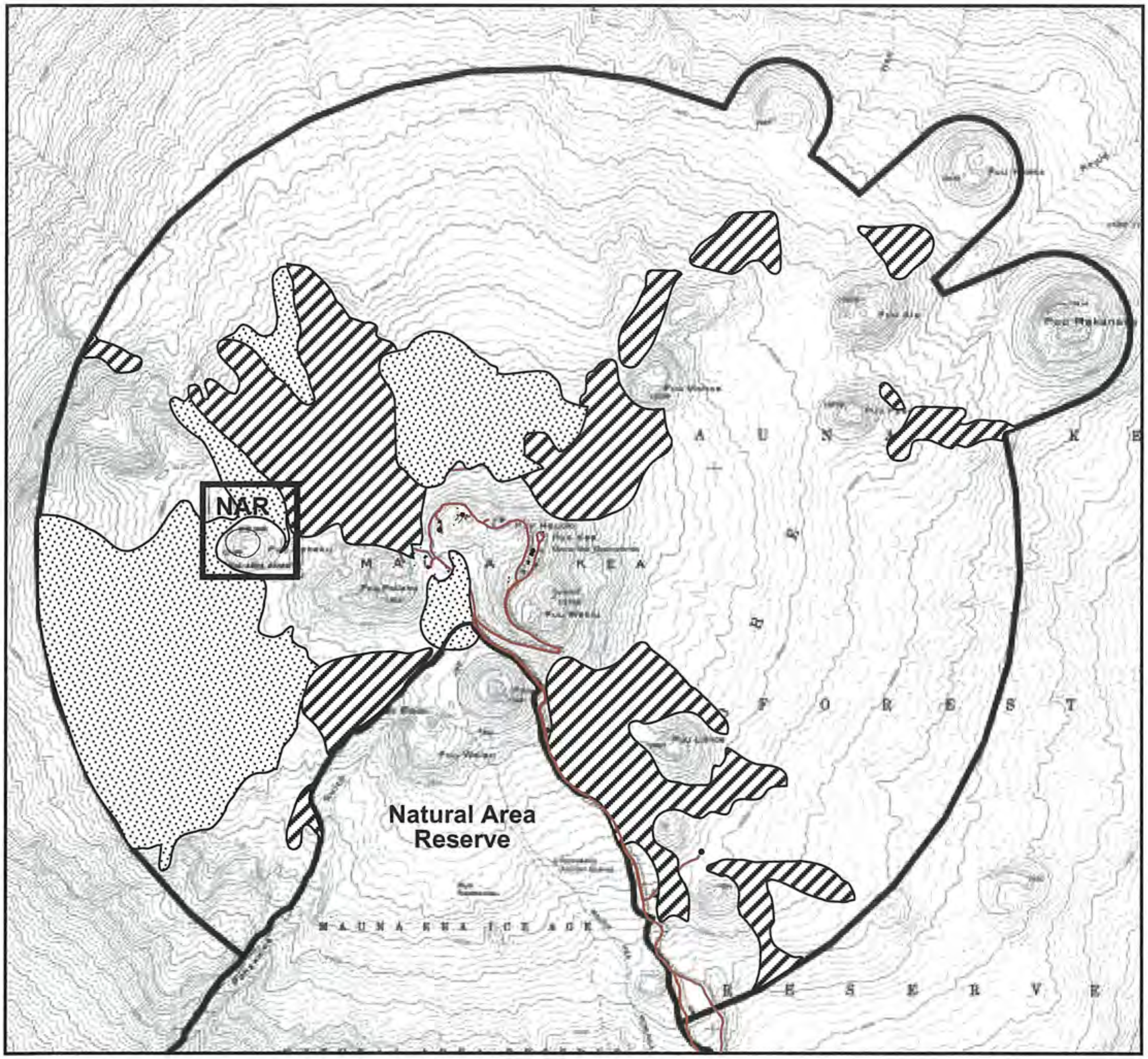
Slope 20% or Greater

25' Contour Intervals

Natural Area Reserve

0' 750' 1500' 3000' NORTH

Slope Analysis



40' Contour Intervals

Potential *Cystopteris* fern habitat

Potential lichen habitat

Source: Winona Char, 1999
Note: Mosses are found throughout the summit area, primarily on rock outcroppings with crevices and fissures.

0' 2000' 4000' 8000'

NORTH

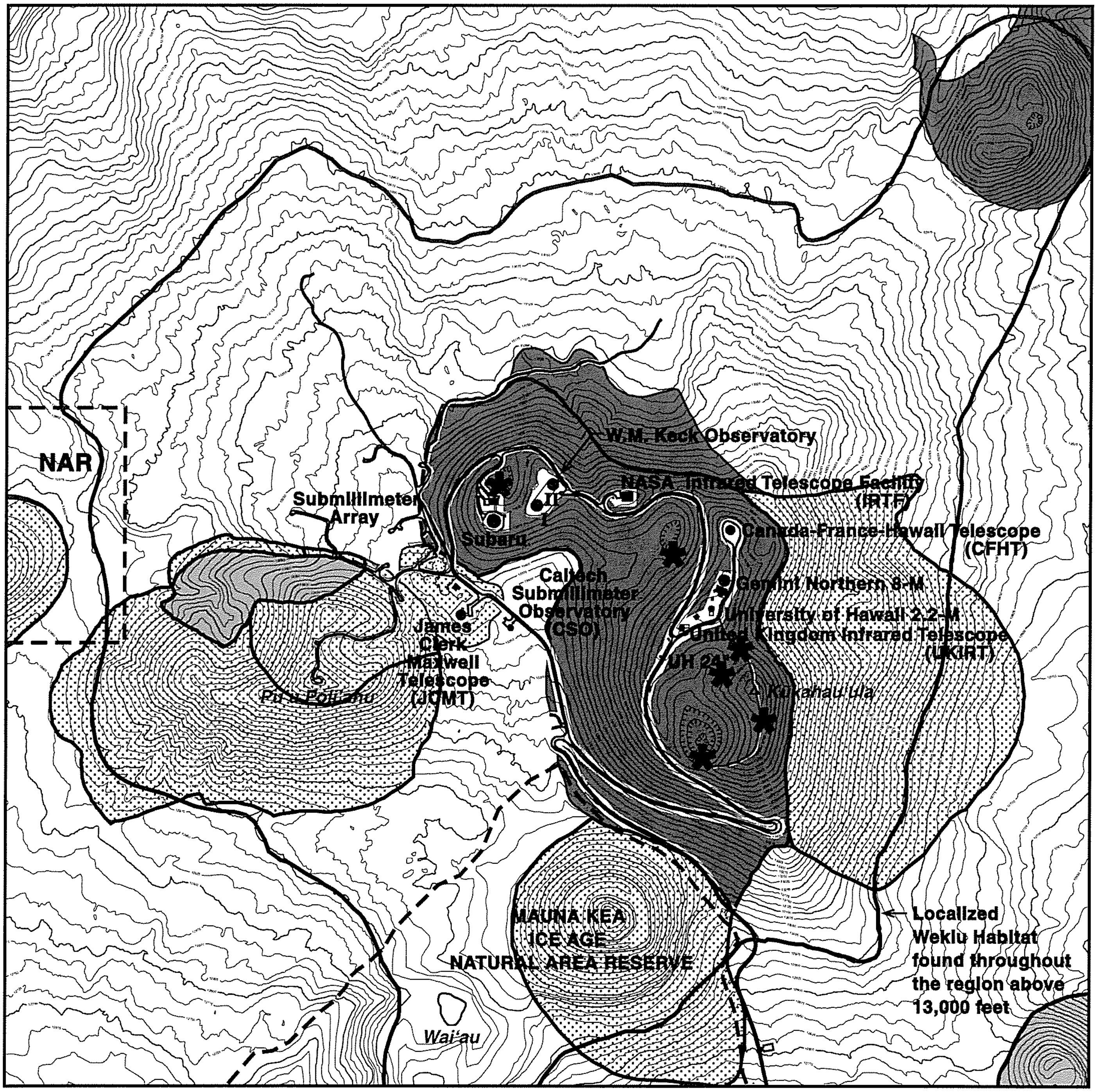
Summit Flora Habitat

Fauna Habitat. Arthropod distribution on the upper slopes of Mauna Kea relates directly to the surface geology. The Wēkiu bug *(Nysius wēkiucola)* is found primarily in the undisturbed cinders of the large cinder cones at Mauna Kea's summit, as shown in Figure IX-9. Other arthropod species such as the Lycosid wolf spider and Noctuid moths are more widespread within the Science Reserve. Lower elevation areas on Mauna Kea, outside the Science Reserve, include faunal components relating to the *māmane* and *naio* forest ecosystem.

GIS mapping shows the extent of areas of Wēkiu bug concentration, including areas with documented presence of the bug and areas of suitable habitat. The Master Plan will minimize disturbance of the cinder cone habitat for the Wēkiu bug within the Science Reserve. Expansion or redevelopment of existing sites on the summit ridge will have contained localized effects to the cinder cone habitat in the immediate vicinity of the older telescopes. As a result of the overall preservation measures, the habitat of the Wēkiu bug in the Mauna Kea Science Reserve will be protected. A composite of natural resources in the summit area is presented in Figure IX-10.

Archaeological Resources. Archaeological sites are found in the upper slopes of the Science Reserve, yet sites are virtually absent in the proximity of the summit *pu'u*. Shrines are clustered around the summit at approximately the 13,000 ft. elevation. Refer to Section V for more detailed information about archaeological sites. The clustering of sites appears around Lake Wai'au and the adze quarry in the NAR, at site complexes adjacent to the summit access road, and large numbers of shrines on the north slope at the edge of the plateau around the 13,000 ft. elevation. A consistent pattern was found, suggesting that shrines were erected by Hawaiians travelling up the mountain as tributes to their deity. Based on the field research, archival studies and oral histories, there are no burial sites in the vicinity of the summit *pu'u*. The plan preserves the areas near the higher concentrations of archaeological sites, restricting these areas from future development and most activities. Figure IX-11 shows the extent of archaeological sites.

Cultural Properties/Landforms. Culturally-significant landforms and places at Mauna Kea have been identified based on interviews and historical archival research. Refer to Section V for more detailed information about the cultural setting. A Cultural Landscape Map is presented in Figure IX-3. The Master Plan avoids adverse effects to cultural properties/landforms. The area of critical cultural importance encompasses the area of Poli'ahu to Wai'au to Kūkahau'ula at the summit. The *pu'u* within the summit region are the natural cultural landscape of Mauna Kea, with a visual linkage to the area of the sacred alpine lake at Wai'au and the adze quarry at Keanakāko'i. Preservation of the major *pu'u* of the summit in an unaltered state is essential to retaining their cultural significance, and will retain the integrity of vistas and site relationships. This approach is consistent with the perspective taken by the Historic Preservation Plan DLNR (March 2000), that Mauna Kea's numerous shrines and culturally significant landforms along the upper slopes altogether constitute an historic district.



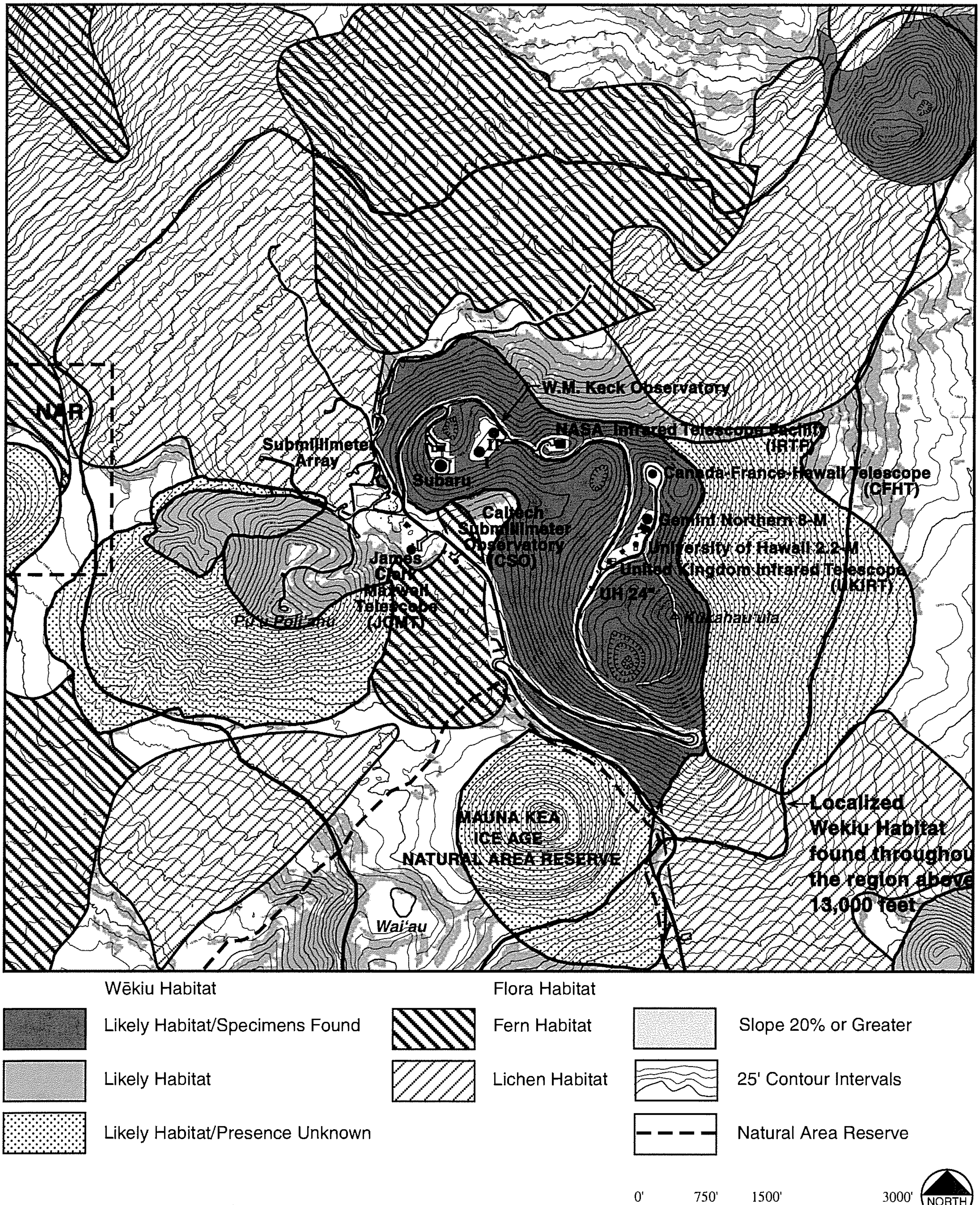
Source: Dr. Frank Howarth, Bishop Museum, 1999

Likely Habitat/Specimens Found	25' Contour Intervals
Likely Habitat	Natural Area Reserve
Likely Habitat/Presence Unknown	Specimens Found 1997-1998

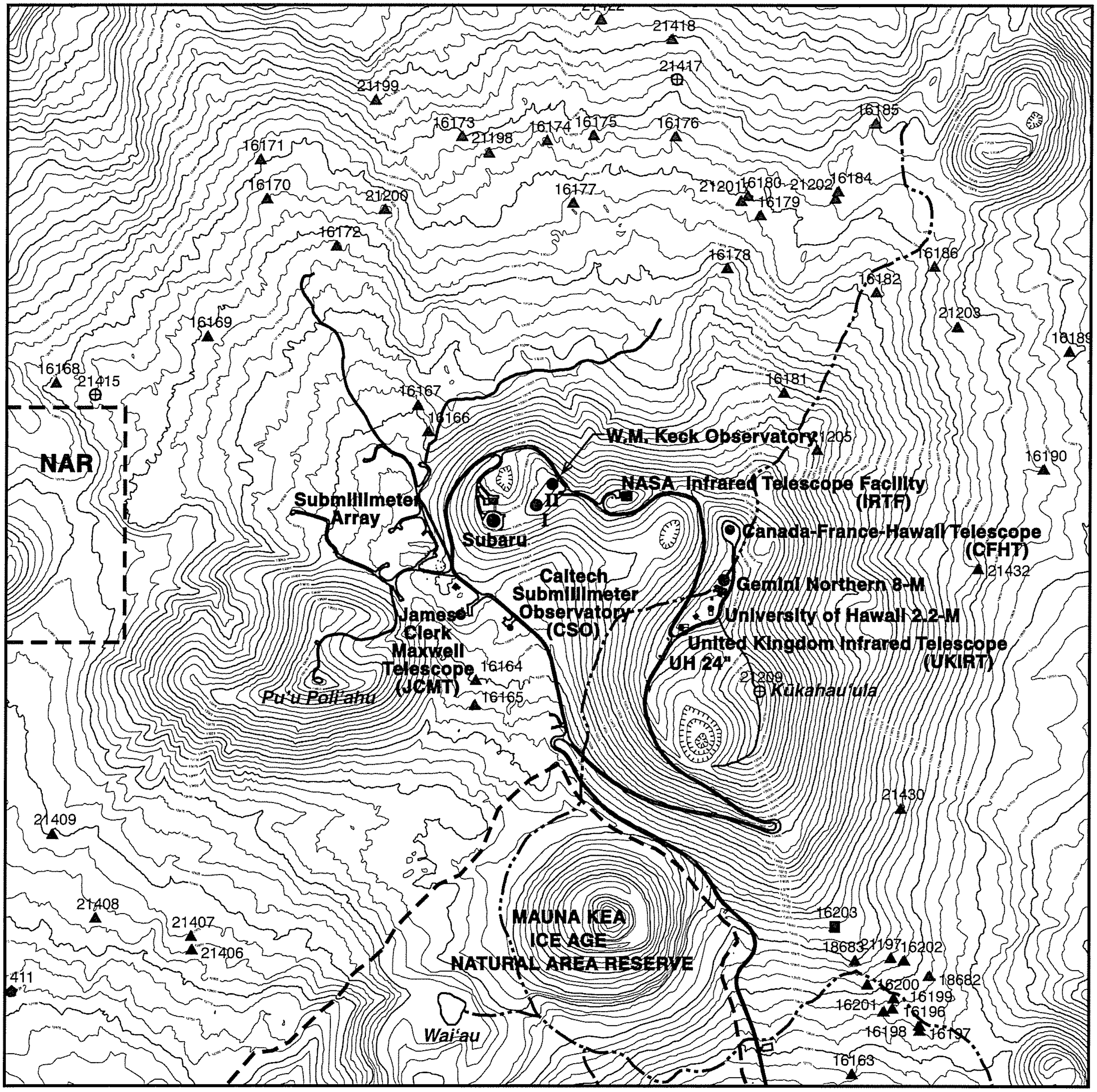
0' 750' 1500' 3000' NORTH

Potential Wēkiu Habitat

Figure IX - 9



Natural Resource Composite



▲	Shrines
⬟	Marker
⊕	Unknown
■	Workshop
	25' Contour Intervals
– – – –	Natural Area Reserve
–··–··–	Historic Trails

Source: Hawaii Department of Land and Natural Resources Historic Preservation Division, Feb. 1999

0' 750' 1500' 3000' NORTH

Archaeology Sites Map

Summary of the Natural and Cultural Resources Physical Planning Guide. The plan provides a clear future direction toward preservation of natural and cultural resources, by directing proposed new development to locations within the summit region where the resource values would not be diminished. A Natural and Cultural Resources Composite map is presented in Figure IX-12. Since these resources are physically adjacent, they are planned and managed together in a living, evolving and sustainable approach. Traditional access to the resources for cultural practitioners is unimpeded, as long as laws are not violated. Natural resources will be preserved consistent with a growing interest in the restoration of the overall mountain ecosystem. The relationship to existing plans and laws regarding natural and cultural resources is addressed in the environmental review (EIS) process.

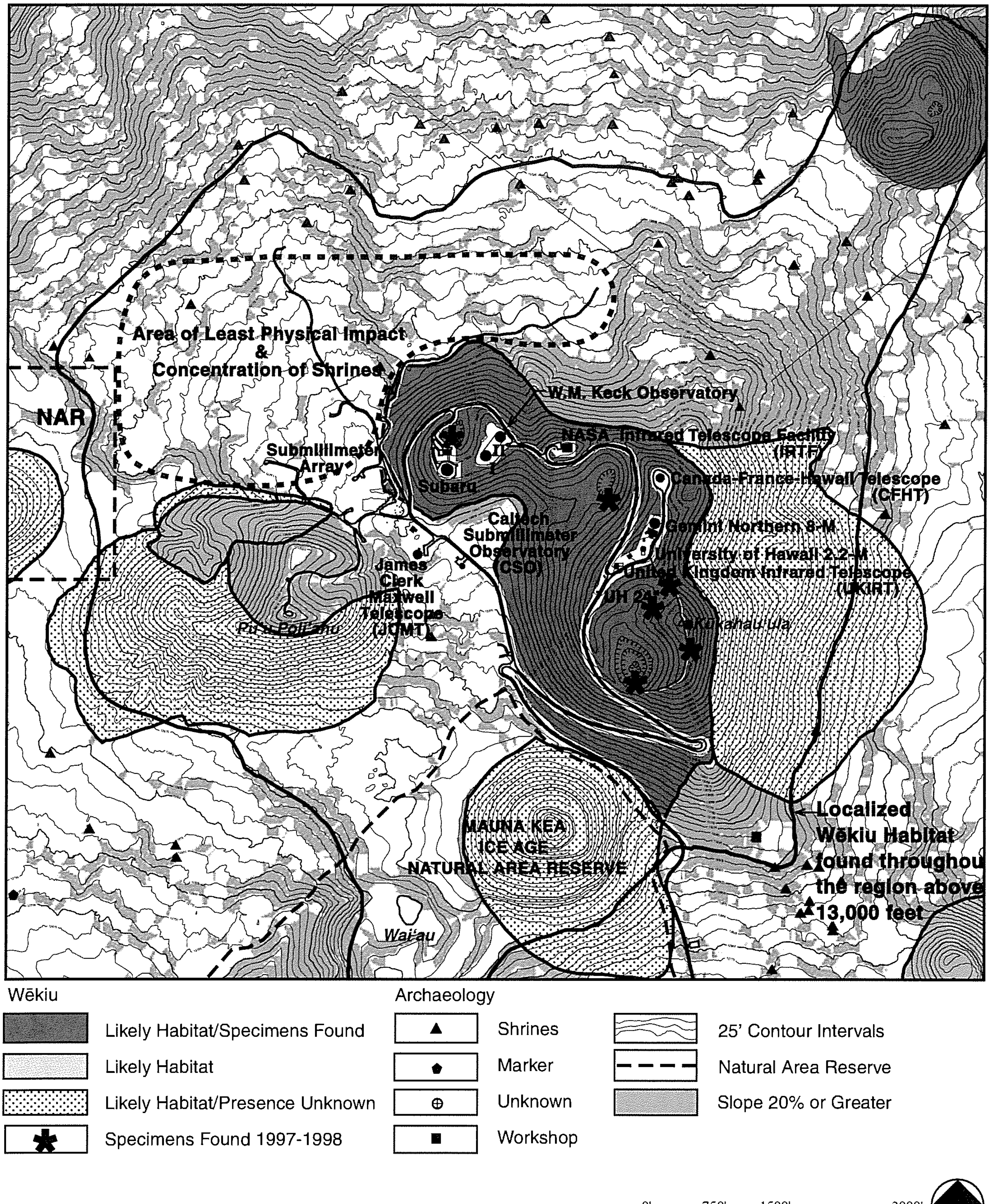
EDUCATION AND RESEARCH COMPONENTS

Mauna Kea has long enjoyed a revered place in native Hawaiian culture, in the lives of those who live on its slopes and all who come in contact with this, one of the world's tallest mountains. Study and research of the cultural and natural features of Mauna Kea are integral to contemporary use of Mauna Kea. Mauna Kea is also the world's premier astronomical research location, and astronomy on Mauna Kea is an essential element of Hawai'i's economy and high technology future. The evolution of astronomy technology, and world-wide interest in astronomy research at this location, presents a current need to upgrade and expand telescope facilities. However, since the time the first telescopes were proposed on Mauna Kea, there have been differing viewpoints about astronomy development, as discussed in the previous section. There is a concern that astronomy development has been distributed across the summit in an unattractive fashion, and that this development might eventually overtake the mountain. There also are concerns about the potential impacts of development to natural resources, such as the Wēkiu bug habitat, archaeological sites and Hawaiian cultural resources.

The education and research component is the second integration of the physical planning guide, which joins the projected education and research uses with the natural and cultural resource component. The natural and cultural resources map identifies the preservation areas where resource values are highest, and development activity is guided elsewhere.

Overall objectives for education and research:

1. Expand knowledge of the Science Reserve as an educational resource for the benefit of the community, students, researchers, and visitors, through the planning process.



Natural & Cultural Resources Composite

2. Protect natural and cultural resources and insure managed access to the Science Reserve for education and research use.

3. Protect and enhance astronomy research at Mauna Kea as it is the premier observatory site in the Northern Hemisphere.

4. Define areas, criteria and support facilities for education and research as applicable, to allow for sustainable, integrated planning and management.

Astronomy Precinct

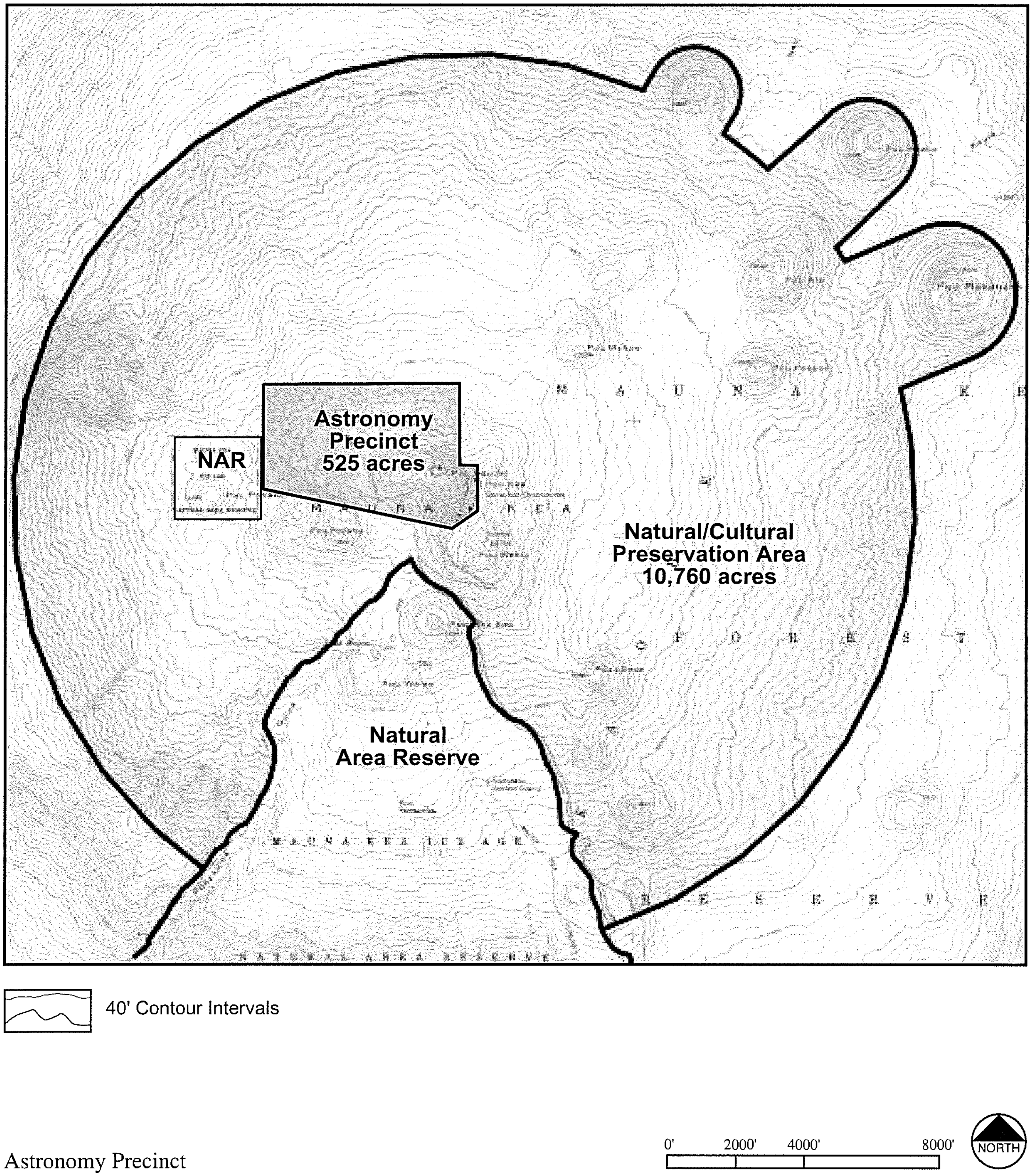
An "Astronomy Precinct" is defined where development will be consolidated to maintain a close grouping of astronomy facilities, roads and support infrastructure. This approach minimizes the potential impact to the natural and cultural resources of the summit region. The criteria to be followed for new facilities proposed in the Astronomy Precinct include:

- Emphasize the recycling of existing sites so as not to disturb existing habitat areas, archaeology and landforms;
- Limit visual impact and scattering of facilities by clustering within the existing development area, recognizing that facilities have already been built in this area and presently have a visual impact;
- Utilize the natural forms in the summit area to shield views of built facilities, from both off-mountain and atop this mountain;
- Implement design measures to allow facilities to blend in better with the natural landscape, to minimize the sense of disruption to the landscape; and
- Minimize infrastructure development by locating near the existing roadway and utility network.

As shown in Figure IX-13, the Astronomy Precinct is defined by the limits of the critical resource areas identified within the natural and cultural resources component of the Master Plan, as well as by considering the siting needs of future astronomy facilities. The Astronomy Precinct will be approximately 525 acres, or less than five percent (4.65%) of the existing Science Reserve. The boundaries of the Precinct have been established based on the following resources:

- Northern boundary: The boundary to the North avoids clusters of archaeological sites (shrines) found at the 13,000 ft. elevation, providing a minimum 200 ft. setback. This setback distance is 10 times the setback distance required by the Hawai'i Island Burial Council for development near existing burials.

- Eastern boundary: The Eastern slope of the summit is a broad natural area, with no development at present and which is highly visible from the Hilo area. This will ensure no development on this slope.



Astronomy Precinct

- Southern boundary: The culturally significant places of Poliʻahu and Kūkahauʻula, and the intervening area between Poliʻahu and Waiʻau, set the Precinct limits to the south. This also respects the Wēkiu bug habitat associated with the summit cinder cone. The precinct boundary also retains an open view from Kūkahauʻula toward the western slope of Mauna Kea, which some have identified as a potentially important resource of cultural and religious significance.

- Western boundary: The NAR and Pu'u Pōhaku and steep slopes set the western limit.

Included within the Astronomy Precinct are three shrines out of the 93 archaeological features which have been identified in the Science Reserve. The Precinct includes relatively flat areas, and the potential development locations within the Precinct are largely shielded from Waiʻau and the existing roads. In addition, the implementation of design guidelines outlined at the end of this chapter will minimize the visibility of proposed new astronomy facilities within the Astronomy Precinct.

Astronomy Precinct Detailed Plan - Siting Criteria. Specific siting criteria have been set for locating new facilities within the Astronomy Precinct. These criteria include:

1. Minimal impact on existing facilities. Existing astronomy facilities require a clear line of sight to approximately 12 degrees above the horizon in a full circle. The location of proposed new facilities cannot obscure the observation function of the existing telescopes on the mountain. Proposed new facilities must be spaced accordingly within the Astronomy Precinct.

2. Minimum impact of Wēkiu bug habitat. The major puʻu in the area of the summit all possess confirmed or likely habitat for Wēkiu bug where the cinder cone surface geology is present. Only the existing disturbed locations on puʻu or areas outside of the Wēkiu bug habitat will be considered as potential siting areas.

3. Avoidance of archaeological sites. There are three existing archaeological shrines within the Astronomy Precinct, and these sites must be avoided in future facility siting. In addition, any new facilities will be set back at least 200 feet from the clustered group of shrines found outside the Precinct boundary on the northern slope. This setback distance is 10 times the setback distance required by the Hawaiʻi Island Burial Council for development near existing burials.

4. Suitability for Observations. Potential sites for new observatories within the Astronomy Precinct must meet specific standards for conducting astronomical observations, including acceptable obscuration and wind flow conditions.

5. Minimum visual impact from significant cultural areas. Views from the puʻu and archaeological sites will be respected in the siting of future facilities. The location of new facilities will avoid interference with the visual connections between the major puʻu and the shrine complexes.

6. Avoid or minimize views from Waimea, Honoka'a and Hilo. Sites for proposed new facilities will maximize the use of the existing topography to shield views from the downslope communities. Prominent sites along the ridges or pu'u will not be selected for new development of astronomy or other research and education facilities.

7. Close to roads and existing infrastructure. Sites for proposed new development will be selected close to the existing roadways to minimize the amount of disturbance to the natural terrain. Utilities and communications service to new sites will be extended along the existing roadway routes to minimize disturbance.

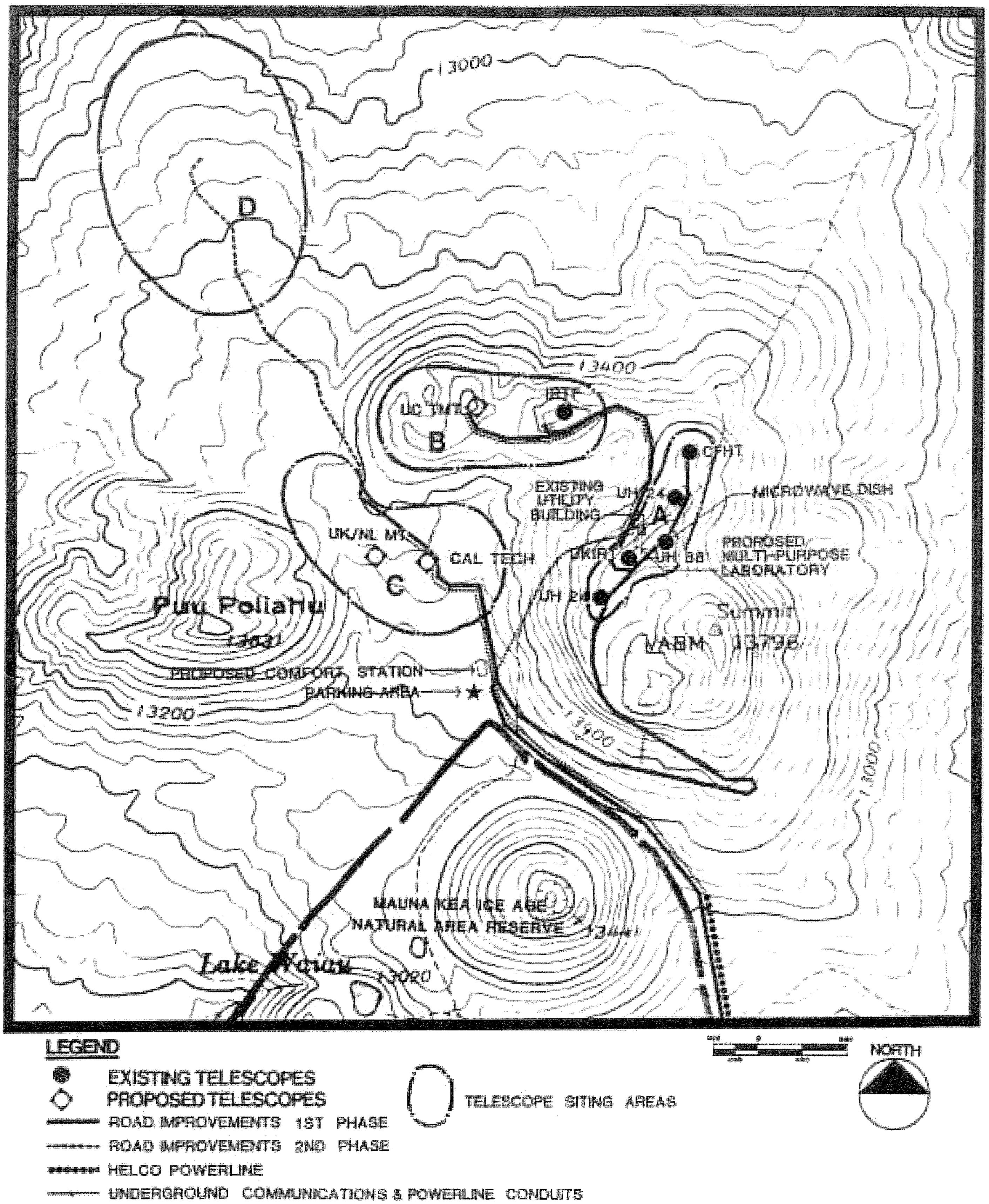
Astronomy Precinct – Telescope Siting Areas. The 1983 plan included seven areas in the Science Reserve that were designated as Analysis Areas, as shown in Figure VIII-3. Of these seven areas, four areas (A-D) were designated as Telescope Siting Areas. There was an ample allocation of space in each of the 1983 Siting Areas, to allow for flexibility in the siting of telescopes that had yet to be designed and built on the summit.

The total area allocated in the 1983 plan for telescope siting in the four areas totaled approximately 160 acres. All of the existing observatories and anticipated new facilities in the 1983 Plan were to be sited within these four areas, as shown in Figure IX-14. Only the Siting Areas A, B and C have been utilized for observatory development up to this point.

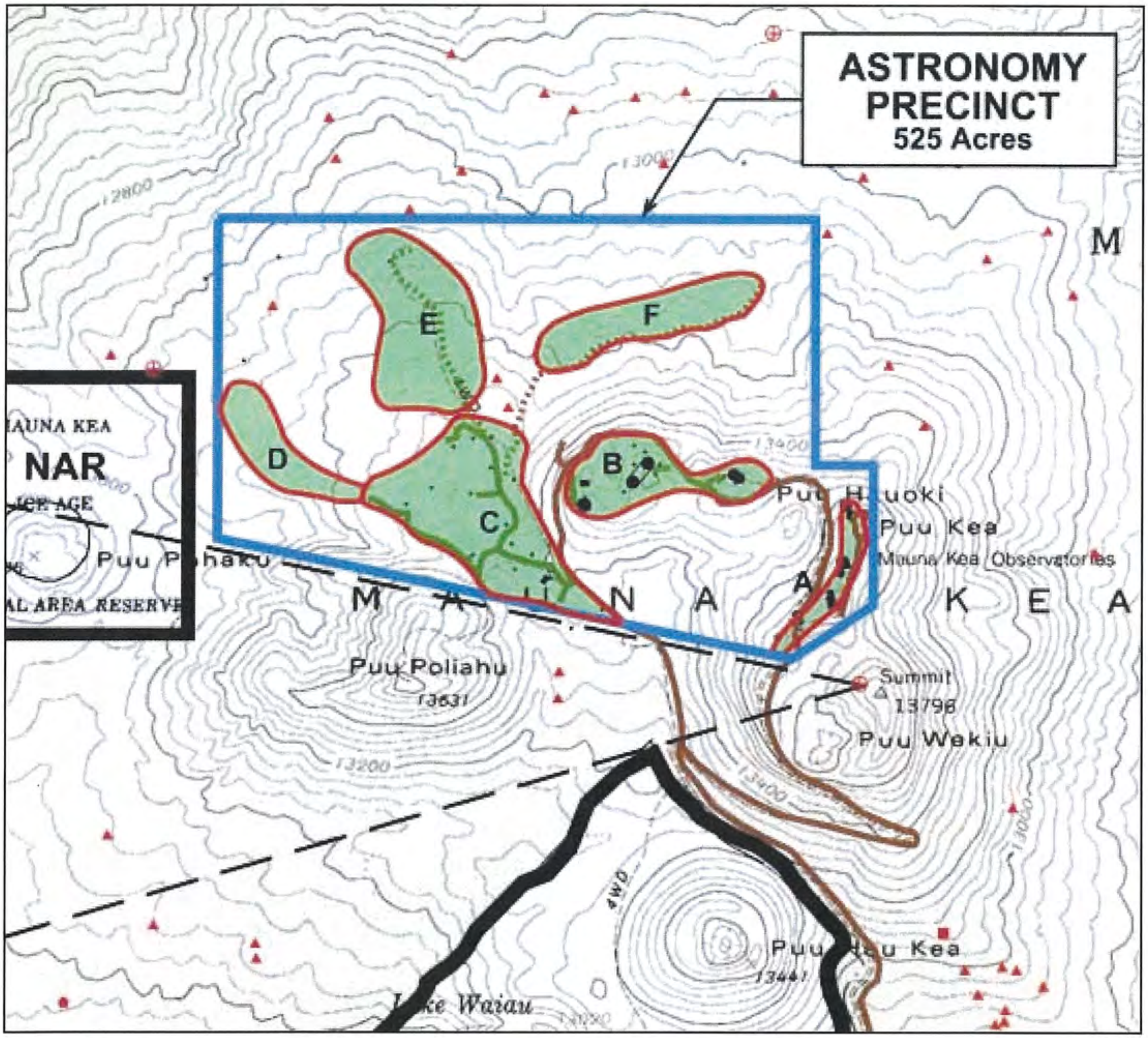
The update of the Master Plan enables the refinement of the Telescope Siting Areas within the Astronomy Precinct, to include all existing observatories, proposed redeveloped facilities and new facility sites. Proposed Telescope Siting Areas (2000-2020) are shown in Figure IX-15, consistent with criteria described above.

Siting Areas A, B and C are already developed with observatories. All the instruments proposed in the previous plan are constructed, and the limits of these observatory sites define Areas A, B and C. There is little area available for new telescope development in these three siting areas, however, redevelopment of existing facilities would be possible.

Within the Astronomy Precinct, new telescope siting areas were identified consistent with the siting criteria described earlier. The areas which are anticipated to provide suitable observation conditions with minimum impact on existing facilities, wekiu bug habitat, archaeological sites and minimal visual were selected as the new telescope areas D, E and F, as delineated in Figure IX-15. Each expansion area is linked to the existing unpaved roads, which minimizes disturbance to the natural terrain. In the new plan, Areas D and E are expansion areas that are located in the vicinity of Area D from the 1983 plan; however, the new Areas D & E will avoid sensitive shrines that were previously located in the siting area. Area F is located in the vicinity of an Analysis Area V from the previous plan (Figure VIII-3).



Telescope Siting Areas (1983)



40' Contour Intervals

A-F Telescope Siting Areas

0' 750' 1500' 3000'

NORTH

Telescope Siting Areas (2000-2020)

Compared to the 1983 Telescope Siting Areas, the current plan reduces Areas A and B, reconfigures Areas C and D, and adds Areas E and F. The current Master Plan reduces the total area allocated for Telescope Siting Areas to approximately 150 acres, as compared to approximately 160 acres in the 1983 plan.

Telescope Siting Areas (1983 Complex Development Plan)		**Telescope Siting Areas (Updated Master Plan 2000-2020)**	
Area Designation	**Approximate Area (ac.)**	**Area Designation**	**Approximate Area (ac.)**
A	18	A	10
B	34	B	22
C	35	C	43
D	75	D	16
		E	36
		F	23
Total	**162**	**Total**	**150**

Astronomy Precinct - Definition of a Telescope. The 1998 report by the State Legislative Auditor recommends departing from the simplistic counting of "telescopes" at the Mauna Kea Science Reserve. To help clarify the issue of counting telescopes, it is appropriate to examine the definition of a telescope. Webster defines "telescope" as follows: *An instrument for collecting and examining electromagnetic radiation.* This is consistent with the working definition for telescopes within astronomy. A telescope must have the capacity to *collect* as well as *examine* visible light and/or invisible radiation – i.e., it must be capable of making astronomical observations.

By this definition, Keck, Gemini, Subaru, Canada-France-Hawaii, both U.H. facilities, UKIRT, JCMT (Maxwell), VLBA, and Caltech are telescopes. The Submillimeter Array (SMA), when taken as a whole, is a telescope, but not each antenna. Each antenna collects radiowaves, but is not capable of providing astronomy observations. If a control building were attached to each antenna, then these antennas would be considered telescopes. The control buildings would, of course, be larger than the antenna. In the same way, the proposed 4-6 Keck outriggers are collectors which are part of an interferometer and not individual telescopes. When connected to the control building within the existing Keck, they would form one interferometric telescope.

An analogy for an array telescope is a stereo system. Each speaker is not a stereo system in itself but all the components make up one system. Each part is considered a component with a specific name and purpose. The use of the term "stereo" to refer to a speaker, receiver, tape deck, etc. is inappropriate. In the same way, the use of the term "telescope" for components is inappropriate.

The approach taken by the Master Plan is to describe the actual components of proposed astronomy development. This approach provides for full disclosure to the extent possible when viewing the future of astronomy facilities atop Mauna Kea, and is consistent with the Auditor's recommendation to get away from the simplistic counting of "telescopes".

Astronomy Precinct - Anticipated Program for Astronomy Development. The projected expansion of astronomy research facilities at Mauna Kea is specified in the Institute for Astronomy's Research Development Program (2000-2020), which is included in Appendix A. The anticipated program for astronomy development envisions five different categories of facility development projects (Types I-V), as listed below.

Type I. Redevelopment of Existing Observatory Sites on the Summit Ridge:
Redevelopment or "recycling" of up to five existing telescopes, including NASA/IRTF, CFHT, UH 2.2 m, UKIRT, and UH 0.6 m. It is anticipated that up to three or four facilities may be redeveloped over the next 20 years.

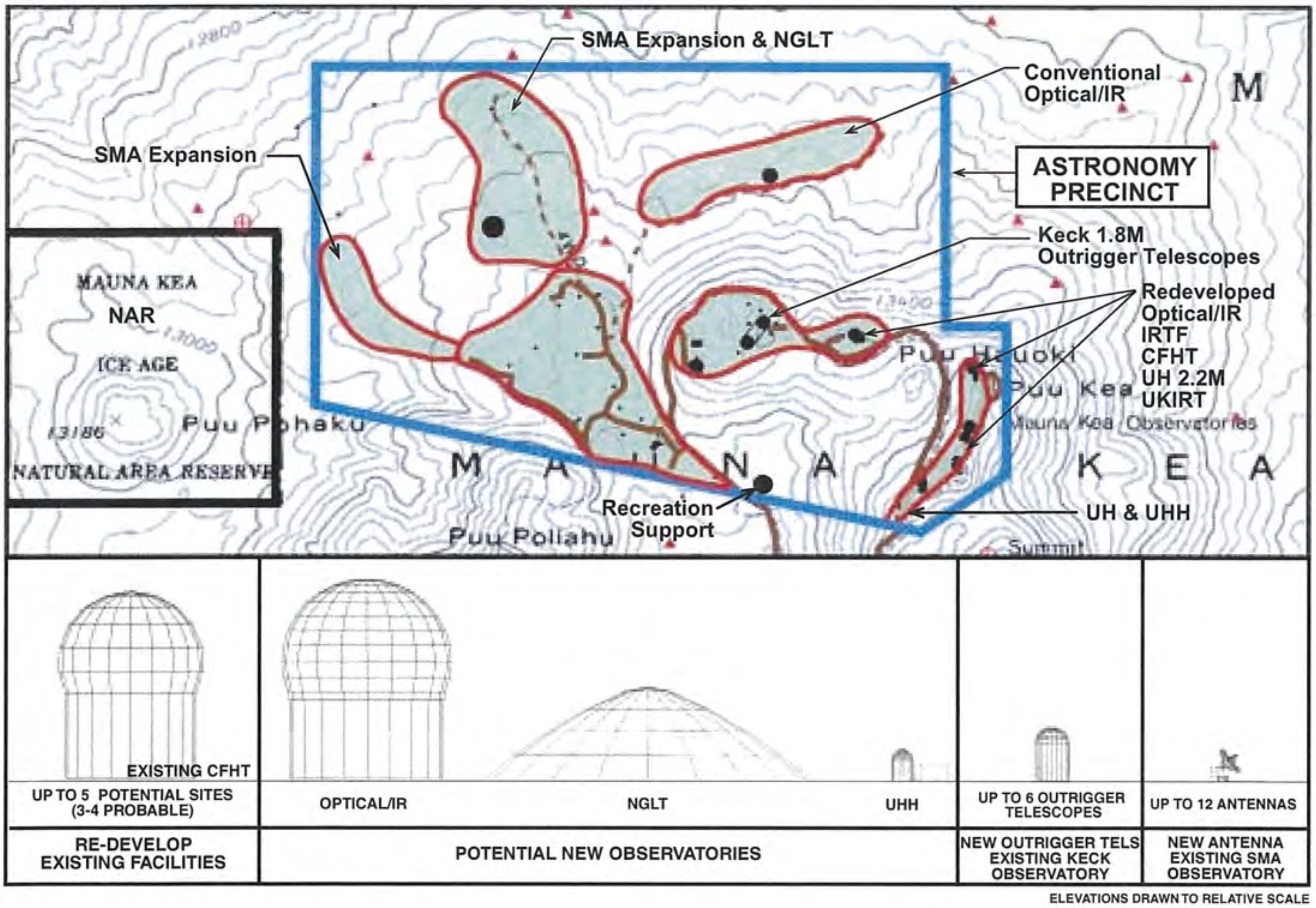
Type II. Expansion of Existing Observatories:
Expansion of the Keck Observatory with the addition of four to six 1.8-m. outrigger telescopes. Four are being proposed to start development in 2001. The Submillimeter Array may add up to 12 new antennas and 24 new pads over the next 20 years.

Type III. New Conventional Optical/IR Telescope
A new conventional telescope comparable to the Keck or Gemini Observatories at a currently undeveloped site. An instructional telescope for UH-Hilo is also projected.

Type IV. Next Generation Large Telescope (NGLT)
A single optical/IR telescope of 25 m. aperture or greater. This is currently only being discussed in the astronomy community and there is a 50 percent possibility that this facility may be developed in the next 20 years.

Type V. Optical/IR Interferometer Array Site
A general area is proposed for this observatory. No facilities are included in this Plan. Facilities must undergo the major Master Plan amendment process for approval.

Given the prescribed criteria for site selection, and UH's anticipated program for astronomy development in the next 20 years, specific sites or areas within the Astronomy Precinct have been identified. A summary of all proposed research facilities development in the Astronomy Precinct is presented in Figure IX-16. An expanded discussion of each of the proposed facility type and locations is presented below.



Physical Plan and Proposed Astronomy Facilities

Type I. Redevelopment of Existing Observatory Sites on the Summit Ridge.

The most likely type of astronomy development at Mauna Kea would be the replacement or upgrading of facilities at existing sites, as a first preference, or the development of new sites as a second preference. It is expected that the proposed new or upgraded conventional optical/IR telescopes will come in a range of sizes, from 2 to 15 m. mirror sizes. The 10 m. mirrors of the existing Keck, Gemini and Subaru telescopes represent the current state-of-the-art instrument.

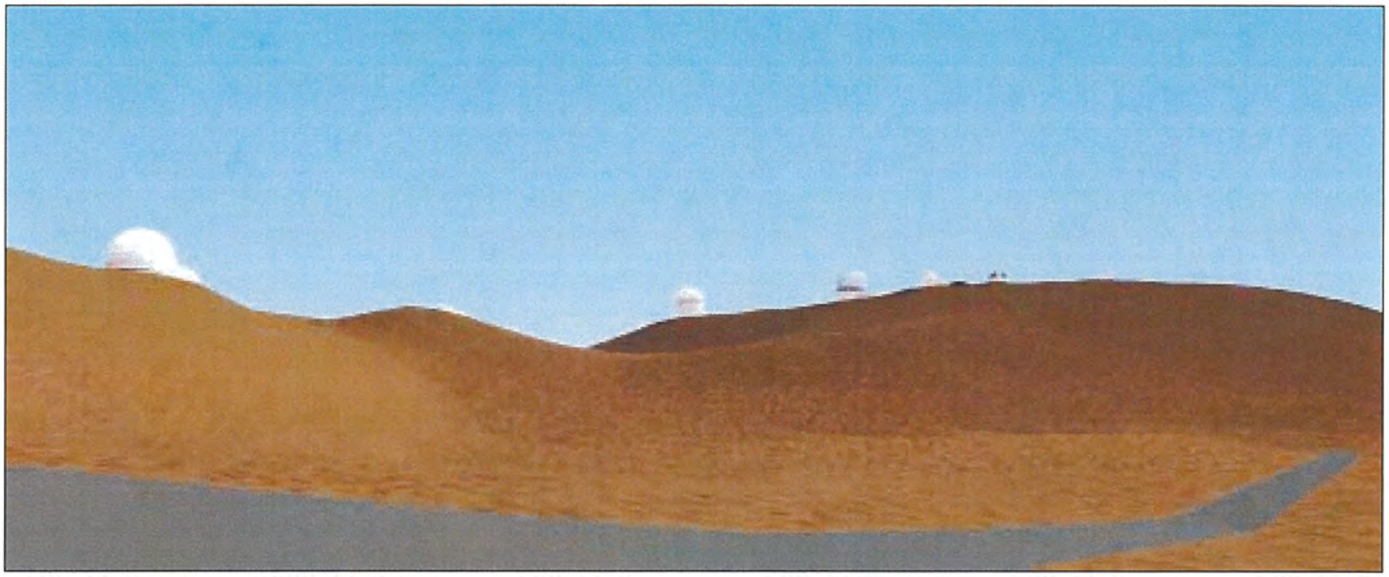
The first priority for siting these facilities will be the recycling of existing facilities that have aging technology, such as the IRTF, CFHT, UKIRT, UH 2.2 m. and UH 0.6 m. These five telescope sites have already been disturbed by development activities, and the facilities are part of the existing visual setting. The IRTF, CFHT, UKIRT, UH 2.2 m. and UH 0.6 m. are all over 20 years old, and the current technology for conventional telescopes is far superior. The present sites on the summit ridge are attractive for locating new or upgraded facilities because of known high quality locations and existing infrastructure. Most of the existing observatory organizations may be unable to operate both a new facility and the existing one, so they will prefer to recycle their existing site.

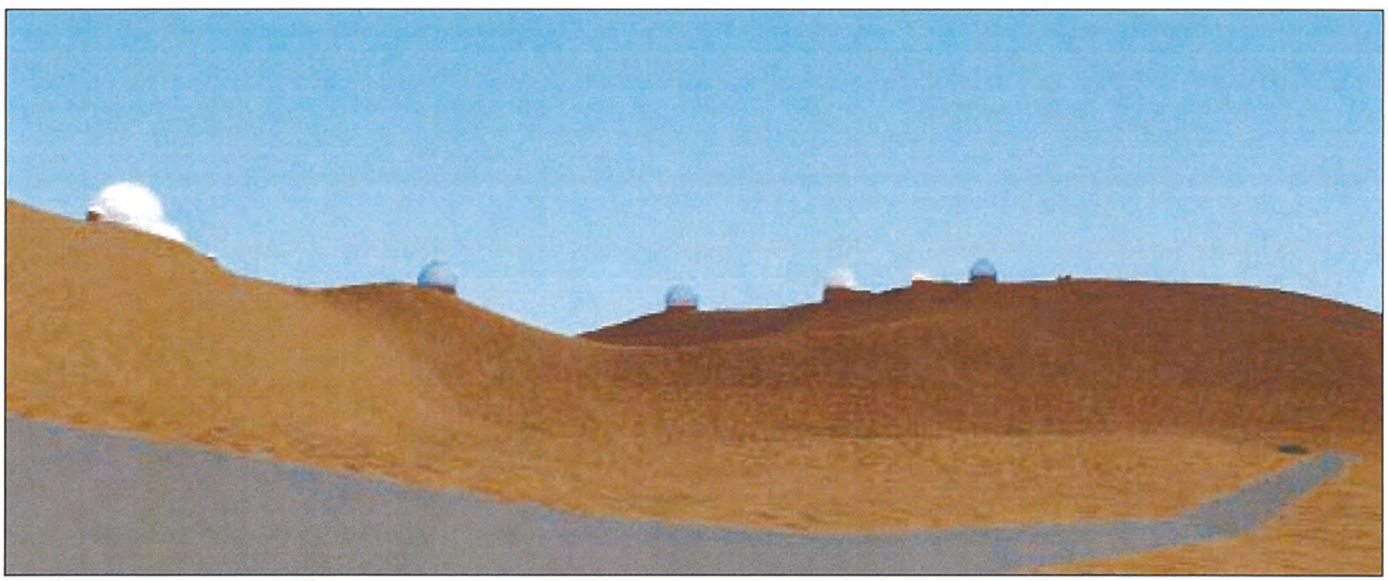
We expect to see a trend toward specialization for these conventional-size optical/infrared telescopes. For example, one facility may decide to concentrate on wide-field imaging, while another focuses on using adaptive optics to achieve the highest possible angular resolution over a small field. Specialization will allow the telescope facility to achieve the ultimate in performance within the chosen area of research, while at the same time simplifying the operation and thereby reducing costs. Specialization will provide a strong incentive for joint operating arrangements and shared use among the observatory organizations.

During the 20-year period of this Master Plan, it is expected that there may be proposals to upgrade or replace each of these five telescopes on the summit ridge with conventional optical/IR telescopes. Over the next 20 years, it is estimated that only three or four ridge facility upgrades will actually be constructed over this time period, including the replacement of the UH 0.6 m. telescope with a facility in the 2 to 3 meter mirror size range.

In addition to the replaced/upgraded conventional optical/IR telescopes on the ridge, UH-Hilo plans to construct an instructional telescope (1 m. mirror) adjacent to the existing UH 0.6 m. telescope on the existing site of a utility/storage building. Use of the facility is anticipated to be primarily instructional, with research uses only for programs with substantial academic or other instructional content, or when the telescope is not needed for such programs.

Figure IX-16 identifies the sites with the greatest potential for upgrades, expansion or redevelopment. A perspective view is shown in Figure IX-17.


Existing Summit Ridge Telescopes


Redeveloped Summit Ridge Telescopes

Existing and Redeveloped Summit Ridge Telescopes

Future telescope redevelopment on the summit ridge will limit these facilities to a maximum height and diameter of approximately 130 feet, to limit the visual impact along the ridge. This standard is derived from the approximate dimensions of the existing Gemini and Keck class of telescope. For more specific standards for these facilities, refer to the design guidelines at the end of this chapter.

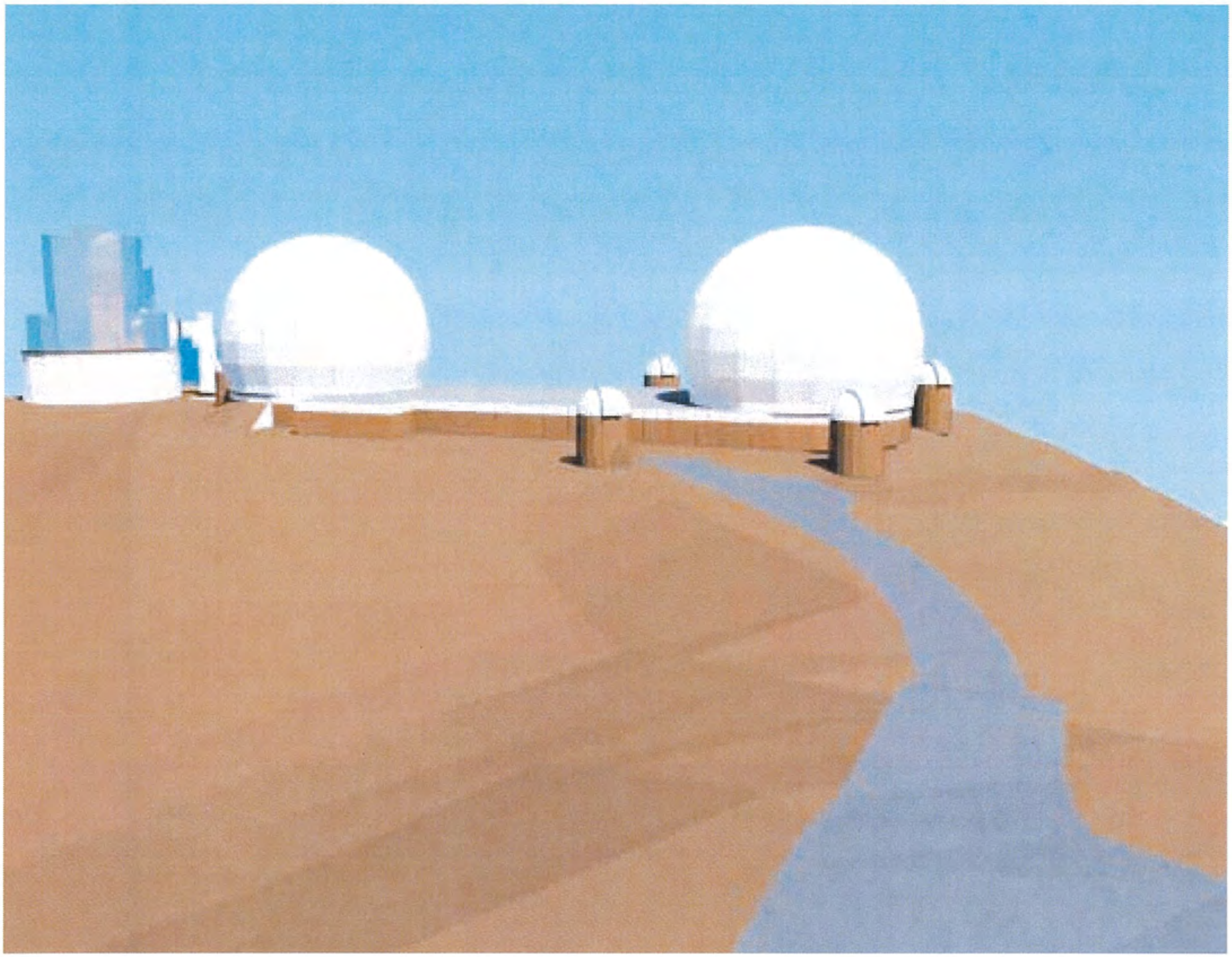
A three-dimensional perspective of the summit ridge under existing conditions and with recycled/upgraded telescopes, as viewed from the access roadway in "Millimeter Valley" near the James Clerk Maxwell Telescope, is included in Figure IX-17. The view from off-mountain locations of the summit ridge with the redeveloped conventional Optical/IR telescopes is shown in Figures IX-22, 23 and 24.

Type II. Expansion of Existing Observatories.

Expansion of the W. M. Keck Observatory. The addition of four to six 1.8-m. outrigger telescopes is planned to create a powerful infrared interferometer on the existing Keck site. The primary purpose is to study planetary systems around nearby stars. Funding is to be provided by NASA, with four of six outriggers already funded. The outrigger telescopes will test the feasibility and capability of IR interferometers, as a precursor to space-based interferometry missions including the Terrestrial Planet Finder. On a tight schedule because of its link to planned space missions, NASA would like to start construction in 2001. The Keck Outrigger Telescopes project is the only new project proposed for Mauna Kea at present.

The location of the Keck outrigger telescopes on the existing Keck site is shown in Figure IX-16. This site is already disturbed from the development of the two Keck facilities, and the outrigger telescopes will not extend beyond the existing site. From a natural and cultural resource perspective, the impact of the project is negligible. There is no better location for this facility since it requires a combination with the existing Keck facilities. The proposed use of the existing site allows for the project to be built without damaging existing Wēkiu bug habitat found in the surrounding area.

A three-dimensional view of the outrigger telescopes is presented in Figure IX-18. The new outrigger telescopes will be much smaller in scale in comparison to the existing Keck telescopes, only about 35 ft. in height. The visibility of the outriggers telescopes from areas at the summit is very limited, and off-mountain views will not be affected. A simulated view of the summit from off-mountain locations at Hilo, Honokaʻa and Waimea, including the completed Keck outrigger telescopes, is shown in Figures IX-22, 23 and 24.



W.M. Keck Observatory with Proposed Outrigger Telescopes

Expansion of the Submillimeter Array (SMA). The existing SMA is anticipated to be operating in 2001. Within the next 20 years, it is likely there will be a need to expand the existing SMA, to include up to 12 new antennas and 24 additional pads. Some of these antennas may differ somewhat in size and structure from the current SMA antennas and operate independently of the others. This expansion will increase the sensitivity and angular resolution of the SMA and will allow for multiple studies to take place concurrently within a densified and elongated array.

Location issues involved with the submillimeter involve technical siting issues (slope and obscuration) and natural/cultural resource constraints. One of the potential array configurations, considered prior to this Master Plan, included the area to the south of the existing array, extending between Poli'ahu and Wai'au. Use of this area, however, would not fit with the natural and cultural resource component of the Plan. The inter-relationship between Poli'ahu, Wai'au and Kūkahau'ula (summit) is recognized as culturally significant, and the placement of antennas in the valley between these features would detract from this resource.

The expansion area will extend the baseline for this antenna complex approximately 0.5 km to the north and west of the existing array. Figure IX-16 shows the potential expansion area for the submillimeter array. A three-dimensional perspective view of the expanded submillimeter array is included in Figure IX-19.

The submillimeter array expansion will be concentrated in the area to the north of Pu'u Poli'ahu, and will not be visible from Hilo and Honoka'a. It will probably not be visible from Waimea, as shown in Figure IX-23.

Due to the relatively small size of the SMA antennas (25 ft. in height) they are virtually invisible from a distant perspective. To further diminish the visual impact of the SMA facilities, the concrete pads for the new antennas should be colored in a brown tone to match the surrounding lava/ash landscape. To the extent possible the SMA facilities will be sited to utilize the existing road and pathways.

Proposed Submillimeter Array Expansion

Type III. New Conventional Optical/IR Telescope

The second priority for siting proposed conventional optical/IR telescopes will be at a new site within the Astronomy Precinct, and only if a suitable summit ridge site cannot be utilized for redevelopment. In the event there is no existing site available, there is an area to the north of the summit ridge that could potentially support a new conventional optical/IR telescope. Infrastructure expansion issues are a potential concern for any new facility that is not accessible from existing roadways. The north shield has not been thoroughly tested for seeing conditions, and a future site for facility development in this area would be contingent on positive findings from seeing analysis.

The proposed site for a new conventional optical/IR telescope is shown in Figure IX-16 and a perspective view is shown in Figure IX-20. The selection of this new site within the Astronomy Precinct generally satisfies the specific siting criteria, including:

1. Minimal impact on existing facilities. A facility proposed at a location to the north of the summit ridge will not cause obscuration for any existing telescopes on the mountain.

2. Minimum impact of Wēkiu bug habitat. The area to the north slope is outside of the known Wēkiu bug habitat with no pu'u or cinder cone surface geology.

3. Avoidance of archaeological sites. There are no existing archaeological features in the north slope portion of the Astronomy Precinct. The new facility will be set back at least 200 feet from the clustered group of shrines found outside the Precinct boundary further to the north (toward Honoka'a and Waimea). This setback distance is 10 times the minimum setback distance required by the Hawai'i Island Burial Council for development near existing burials.

4. Minimum visual impact from significant cultural areas. Telescope sites on the north slope would be visible from archaeological sites when looking toward the summit, but would not obstruct the visual connections between the major pu'u and these shrine complexes. By locating a new conventional optical/IR telescope site off the summit cinder cones, this will mitigate further diminishment of the integrity of the summit ridge as an historic property.

5. Avoid or minimize views from Waimea, Honoka'a or Hilo. This location is not a prominent site such as the ridges or pu'u. The existing topography of the north slope shields views of new facilities from Hilo. A new telescope at this location would be visible from the Waimea and Honoka'a communities.

6. Close to roads and existing infrastructure. The proposed site for the conventional telescope was selected near to the existing roadways to minimize the amount of disturbance to the natural terrain. Utilities and communications service to the new site will be extended along the existing roadway routes to minimize disturbance.

Proposed Conventional Optical/Infrared Telescopes

Figure IX-20

The proposed site for a conventional optical/IR telescope satisfies the selection criteria. A perspective view of the new conventional optical/IR telescope on the north slope is shown in Figure IX-20. In order for visual impact to be minimized, the enclosure for this new telescope should be colored to match the surrounding lava/ash terrain. Further, if a new observatory is proposing to develop a mirror with an aperture of greater than 10 m., a partial buried strategy must be applied to diminish the visual impact of these facilities. These requirements are specified in the proposed Design Guidelines.

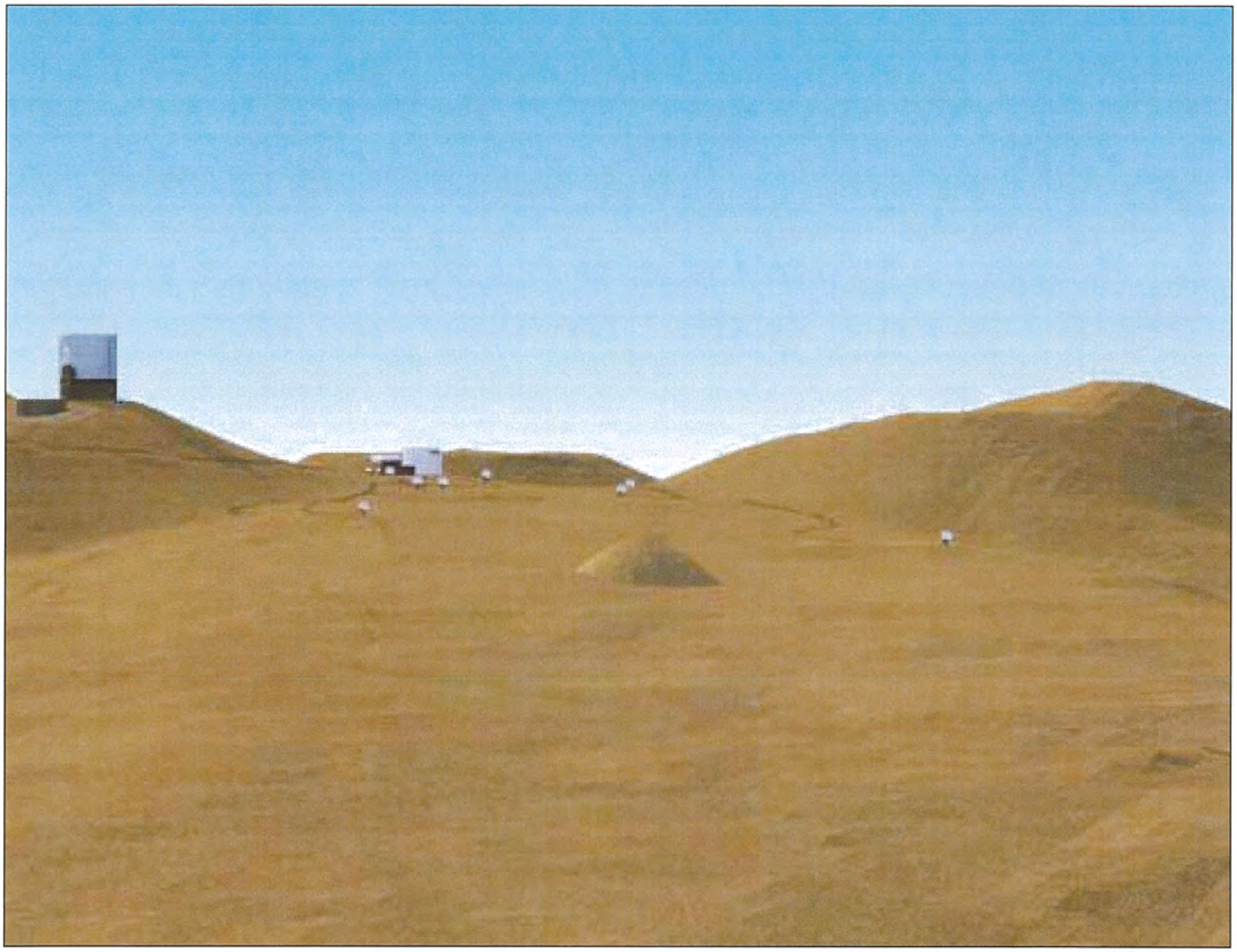
Type IV. Next Generation Large Telescope Site

A single large optical/IR telescope may be proposed for Mauna Kea in the 20-year life of this plan. A ground-based telescope with a mirror of 25 to 50 m. in diameter is being considered by the astronomy community, which would complement the planned Next Generation Space Telescope. This facility would be the largest telescope in the world, and is currently called the Next Generation Large Telescope (NGLT).

The large scale of this instrument makes the visual impact considerations very important in the facility siting and design. The NGLT would not be appropriately located at Mauna Kea's summit ridge, due to the major earthwork requirements that would disturb Wēkiu bug habitat and the visibility of a large telescope placed atop the ridge. In addition, telescope engineers have indicated that wind forces acting on the structure are expected to be severe and problematic. To minimize potential obscuration of existing observatories, the potential site for this facility must also be located in an area that is distant from the prominent topography at the summit ridge and nearby *pu'u*.

A location that would minimize its visibility and reduce wind shear forces, and minimize potential obscuration impacts, would be on the slope to the northwest of the summit ridge. The proposed location of the telescope will take advantage of a northerly extension of the summit ridge to entirely block views of the new facility from Hilo, and partially block views from Honoka'a. Figure IX-16 shows the proposed location for the NGLT, which is located between the SMA service roadway and a jeep road that was built decades ago for preliminary testing of viewing conditions to the northwest of the summit ridge. The presence of the existing roadways will help minimize potential site disturbance for the infrastructure extension to this site.

Strict design guidelines will dictate the size and color of the NGLT. The preliminary design concept proposed for the NGLT employs a unique sliding dome mirror enclosure with a sub-grade foundation, as shown in Figure IX-21. The lower half of this observatory will be built below grade to minimize the apparent height and mass of the facility. The facility shown in the concept has a 30-m. mirror, with a dome shaped and colored to simulate a small *pu'u* to blend well with the surrounding landscape.



Proposed Next Generation Large Telescope (NGLT)

The siting criteria for locating proposed new facilities were applied in selecting the site for the NGLT, discussed as follows:

1. Minimal impact on existing facilities. The observation function of the existing telescopes on the mountain would not be affected by new facilities located to the north or northwest of the summit ridge. The proposed location of the NGLT in the center of the SMA expansion area could potentially obscure some antennas in the SMA expansion. These potential obscuration effects can be minimized or eliminated by cooperative planning for these two facilities.

2. Minimum impact of Wēkiu bug habitat. The proposed site is outside of the Wēkiu bug habitat.

3. Avoidance of archaeological sites. The closest archaeological feature to the proposed NGLT site is a shrine located approximately 1,200 ft. to the east. For reference, this distance is 60 times the minimum setback distance required by the Hawai'i Island Burial Council for development proposed near existing burials.

4. Minimum visual impact from significant cultural areas. The siting of the NGLT respects views from the pu'u and archaeological sites. The NGLT is located to the northwest of the summit ridge, which does not interference with the visual connections between the major pu'u and the shrine complexes.

5. Avoid or minimize views from Waimea, Honoka'a or Hilo. The existing topography shield views of the NGLT from Hilo, however, the facility will be partially visible from Waimea and Honoka'a. The proposed design guidelines for the NGLT will minimize the visual impact of the facility, as discussed previously.

6. Close to roads and existing infrastructure. The NGLT site is close to the existing SMA service roadway, which will minimize the amount of disturbance to the natural terrain. Utilities and communications service to the NGLT site will be extended along the existing roadway routes to minimize disturbance.

To mitigate the visual impact of the telescope, requirements will be imposed to color the telescope enclosure to blend into the surrounding site. The technology for coloring telescope enclosures has yet to be applied in practice, however, this technology is presently being considered by telescope engineers. This design measure will serve to significantly diminish the visual impact of the telescope from both on-mountain and off-mountain locations. Coloring of the telescope enclosure and other strategies are included in the Design Guidelines.

Type V. Optical/IR Interferometer Array (General Area Only)

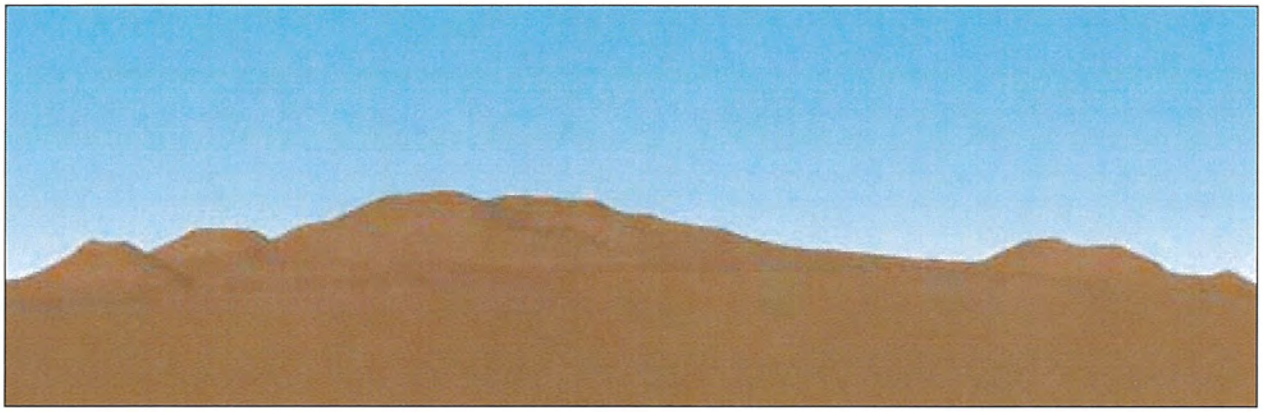
Development of an Optical/IR interferometry array requires a large and relatively level area of up to 1.0 km. in diameter. Within Mauna Kea's Astronomy Precinct, there is a plateau area to the northwest of the summit ridge that is approximately 0.8 km in diameter. At this location, this type of facility could extend approximately 0.8 km in diameter, with multiple telescope elements collecting light, arranged in a roughly circular array. The number of collecting elements cannot be accurately quantified at present due to the current state of the technology for optical/IR interferometry. The light collected by these devices would be combined at a central location to resolve the image of the target object.

At present, the technology has yet to be developed which would allow for the light to be combined from an optical interferometer of this scale, without the construction of large light combining structures and miles of vacuum tube being installed. These types of support facilities are deemed inappropriate for Mauna Kea. Advances in the use of fiber optics and light processing technology for this purpose are required before a facility such as this could be appropriately built at Mauna Kea. These advances are currently being studied intensively by telescope development engineers.

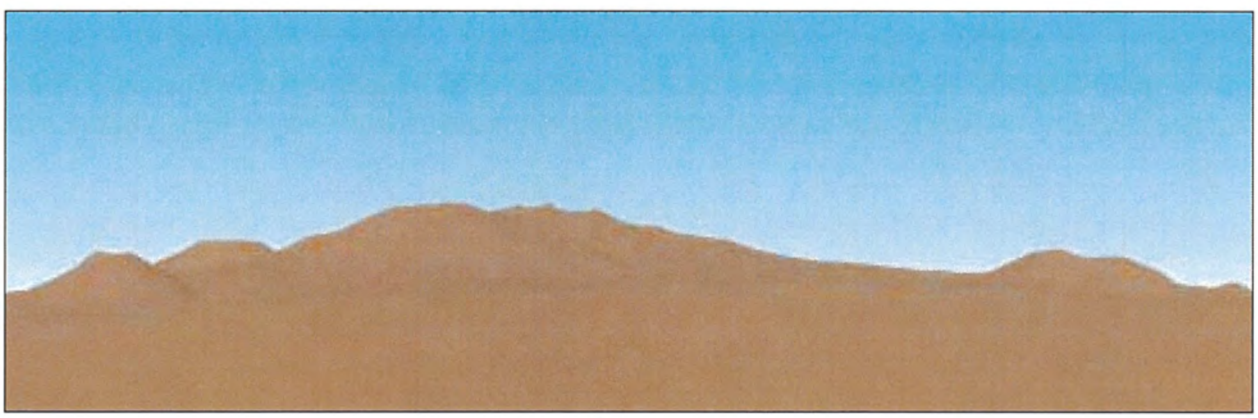
In anticipation of the advances of the light combining technology, and to provide direction for telescope designers, the physical plan guides the possible placement of this instrument within the northwestern quadrant of the Astronomy Precinct. There is no Telescope Siting Area defined to accommodate this possible instrument. For general planning purposes, the Master Plan presents a general area to provide an opportunity for possible further study of the instrument at some point in the next 20 years. A lengthy and thorough process of a General Amendment to the Master Plan would be required to advance this project to the facility siting, design and permitting phase, including a full EIS and CDUA.

A proposed design strategy for minimizing the visual impact of the interferometer includes partial burial of the interferometer elements and creating visually-minimized enclosures. A clamshell enclosure with "pop-up" collecting device should be considered. Along with these design measures, the enclosures should be colored to match the surrounding landscape. Together with the low profile of the instruments, these measures would essentially shield and camouflage the interferometer from view.

Due to the unspecified project characteristics at this time, only a general area for the optical/IR interferometer is proposed within this master plan. If an optical/IR interferometer proposal is advanced in the next 20 years, the project will require a major master plan amendment, involving the full range of planning analysis, visual impact analysis, and preparation of an environmental impact statement (EIS), and final review by the UH Board of Regents.

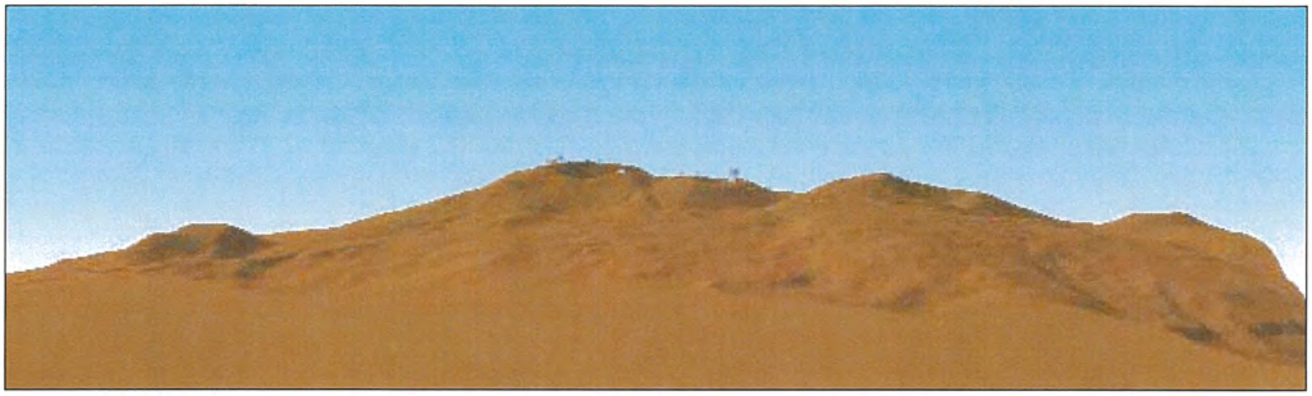


Existing View from Hilo



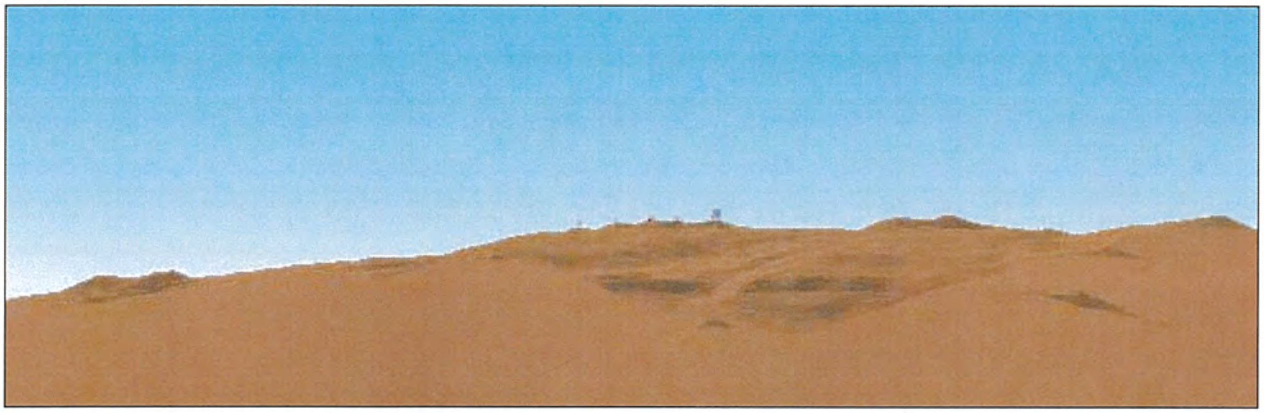
Future View from Hilo

Views from Hilo

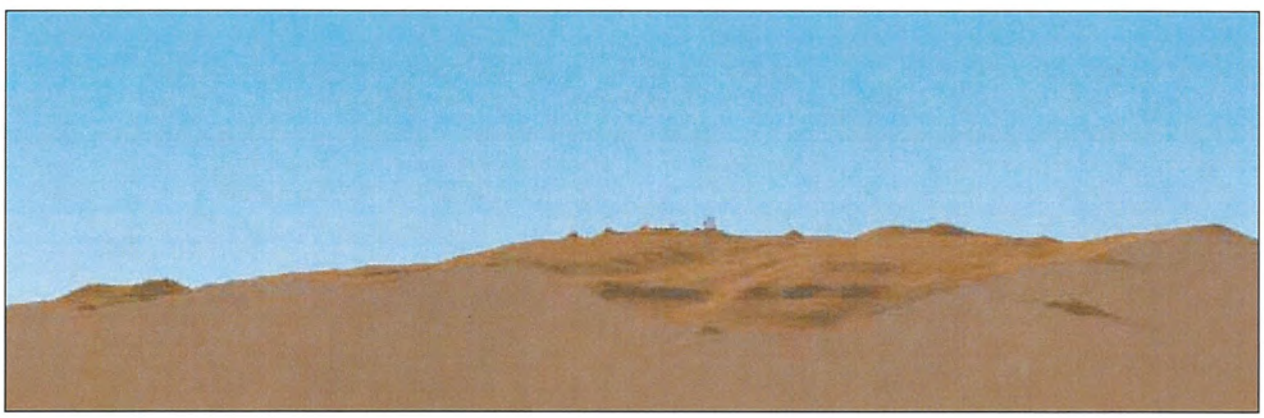


Existing View from Honoka'a

Future View from Honoka'a



Existing View from Waimea



Future View from Waimea

Views from Waimea

Planning Guide Summary and Approval Process for Astronomy Precinct

A list of the existing and proposed future observatories for which there are identified siting areas in this master plan is shown on Table IX-1 (page IX-45). The likelihood of all of the identified facility upgrades and proposed new facilities being developed is extremely remote, and the expected scope of development is 50 to 75 percent of the observatories listed. The timing for future development is undefined at present, except for the Keck Outriggers project. For some of the proposed new projects, significant technological advancements are needed before they could move forward. This is particularly true for the Next Generation Large Telescope.

As described in Chapter XI, the University of Hawai'i Board of Regents and the President retain project approval and design review authority over all developments within the Science Reserve. To assist the University in its evaluation of proposed new development, all applications will be reviewed by the Office of Mauna Kea Management, the Mauna Kea Management Board, and the Kahu Kūpuna Council (see Figure XI-2, page XI-8). In making any decisions on project approval, the Board will carefully consider the advice received from the above three groups.

Each of the redeveloped or proposed new facilities, including any non-astronomy facilities, will undergo individual project reviews, which include an environmental analysis pursuant to Chapter 343 Hawai'i Revised Statutes and a comprehensive analysis of the potential cultural impact. The Kahu Kūpuna Council will assist in establishing the criteria for these analyses. It is expected that some of the criteria will be specified by State requirements.

In addition, each new facility will be required to present a detailed justification addressing, but not limited to, questions such as the following:

(1) Why is the facility needed?

(2) Why is Mauna Kea the best site for the facility?

(3) What other location options are available?

(4) What are the expected benefits: research and education, employment and economic activity, potential revenues?

(5) What is the expected facility lifetime and term of the sublease agreement?

Table IX-1

EXISTING AND PROPOSED OBSERVATORIES AT MAUNA KEA SCIENCE RESERVE

Observatory (Aperture Diameter)	Proposed Master Plan Action
University of Hawaii (0.6 m.)	Redevelop: 2-3 m.
University of Hawaii (2.2 m.)	Redevelop: 4-12+ m.*
Canada-France-Hawaii Telescope (3.6 m.)	Redevelop: 4-12+ m.*
United Kingdom Infrared Telescope (3.8 m.)	Redevelop: 4-12+ m.*
NASA Infrared Telescope Facility (3.0 m.)	Redevelop: 4-12+ m.*
Caltech Submillimeter Observatory (CSO) (10 m.)	Remain As-Is
James Clark Maxwell Telescope (JCMT) (15 m.)	Remain As-Is
Very Long Baseline Array (VLBA) (25 m.)	Remain As-Is
W. M. Keck Observatory (Keck I & II) (10 m.)	Add 4-6 1.8 m. Outrigger Telescopes
Gemini Telescope (8 m.)	Remain As-Is
Subaru Telescope (8 m.)	Remain As-Is
Submillimeter Array (SMA) (12 6-m. Antennas)	Add 12 Antennas
New: University of Hawaii – Hilo	New Site, 1 m. (Instructional)
New: Conventional Optical/IR	New Site, 4-12+ m.*
New: Next Generation Large Telescope (NGLT)	New Site, 25+ m.

Note: All new and redeveloped facilities require individual project review and approval. The NGLT will require the development of new technology.

* It is expected there will be a range of telescope sizes proposed in this group. Exterior dimensions of those on the ridge will be limited by Design Guidelines.

RECREATION PLAN COMPONENTS

The final integration of the Master Plan involves the recreational resource components in the Science Reserve. This plan provides direction for future recreational uses within the Science Reserve, including any potential facilities to support recreation on Mauna Kea. Recreation components, such as hiking, hunting, skiing, snow play and tourism, are addressed in an integrated approach overlaid upon the integrated plan of natural and cultural resources and education and research resources. The overall objectives for recreational resources are listed below.

Overall Objectives

1. Expand understanding of recreational uses and potentials of the Science Reserve.

2. Retain and enhance recreational opportunities within the Science Reserve, while protecting natural, cultural resources, and cultural practices.

3. Define areas, criteria and support facilities for recreational uses, sight seeing and commercial tours, as applicable, to allow for sustainable, integrated planning and management.

Recreational Resources Plan. The traditional uses for recreation on Mauna Kea, and the pattern of these uses, determines the form of the recreational plan component. Access to recreational resources will be enhanced and managed to ensure the protection of the natural, cultural, education and research resources. Hiking trails, ski areas and scenic viewpoints will be delineated within the Science Reserve to allow people to witness the unique resource areas while ensuring their protection. As part of the plan, the following facilities are planned:

- Recreational support facility in the summit region to support skiing, snow play, visitor tours and scenic resource enjoyment;
- A parking area that is primarily planned to serve cultural resource interests, located along the access road at the 13,000 ft. elevation; and
- Cabin camping by organized groups, using the planned conversion of the construction cabins built by the Subaru observatory at Hale Pōhaku.

Further details of the Recreational Plan elements are discussed in the following section.

Physical Plan: Expanded Understanding of Recreational Resource

While there are physical components to the recreational plan, most recreational issues are addressed in the management plan. There are modest facilities needs for recreational support, and support facilities to serve the cultural resource component overlap in certain cases.

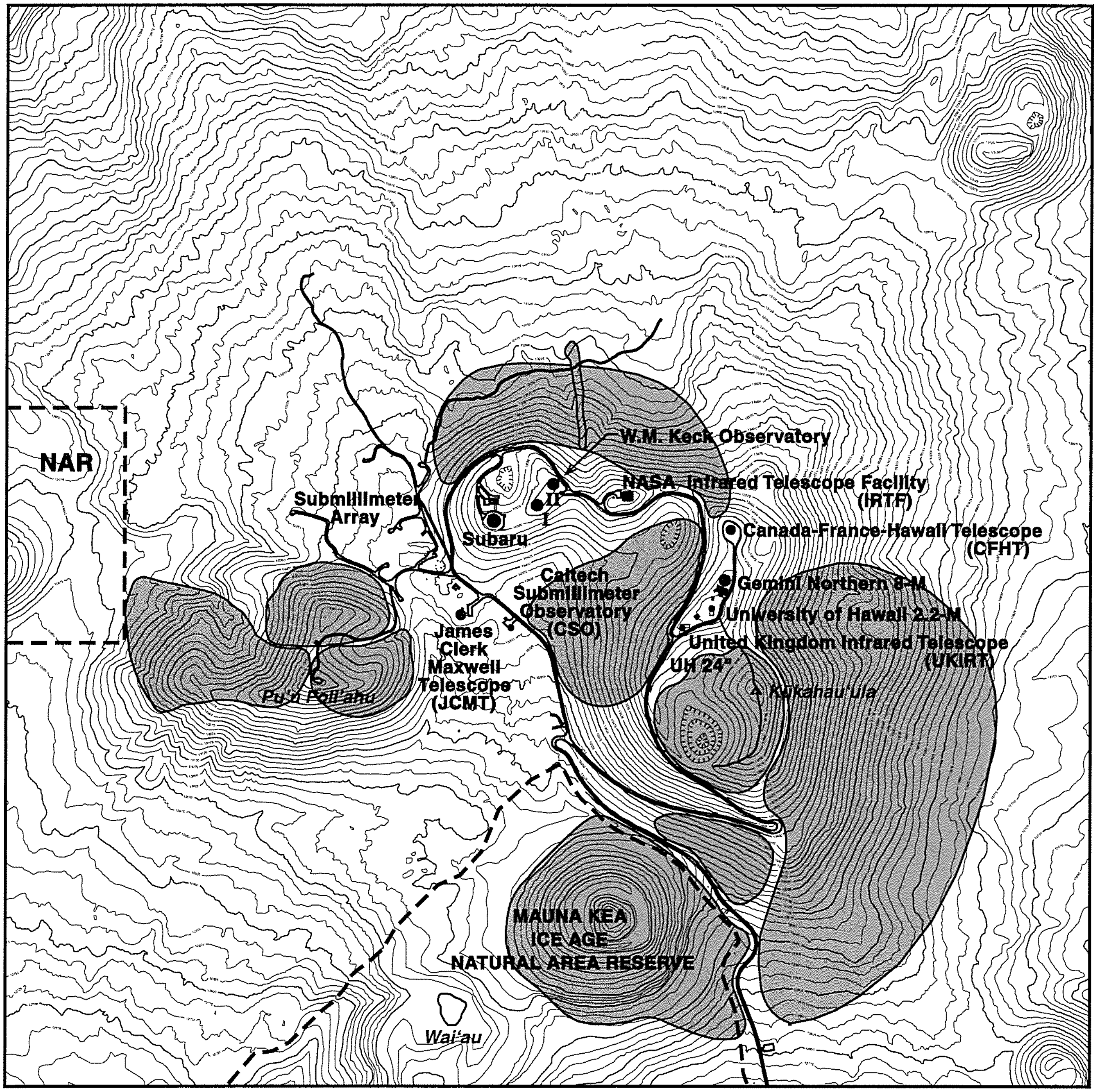
Skiing and Snow Play. Skiing and snow play activities are very popular recreational uses of Mauna Kea during periods of winter snowfall. Figure IX-25 shows the extent of popular ski runs and snow play areas in the summit area. It is also proposed that skiing and snow play use be restricted from the significant cultural landform of Pu'u Poli'ahu. Snow play activities are centered around the Poi Bowl area. Snow play will also be restricted to areas without archaeological sites and cultural preserve areas. Parking and bathroom facilities are existing needs to support skiing and snow play activities.

A recreational support facility is planned within the summit region to support skiing, snow play, visitor tours and scenic resource enjoyment. The support facility is planned to be located at the base of "Poi Bowl" along the summit access road in Millimeter Valley, at the center of skiing and snow play activity at the summit during winter months. The facility would include a shelter, rest rooms, emergency equipment storage, an emergency telephone, and possibly a small office space for the rangers. The design of the facility is envisioned as a building built into the surrounding landscape such that its presence will not detract from its natural setting. It is not to be a "ski lodge".

Individual Visitors and Tours/ Scenic Vista Out-Look Locations. The master plan defines areas for specific visitor stopping points in the Science Reserve and at the summit. Scenic lookout points will be organized at the summit at two locations where the observatories are willing to accommodate limited public access. Currently the Keck observatory sites allow such use, with the Keck Observatory providing a Visitor's Gallery including restrooms. Very limited parking areas are present to serve the visitor areas, and visitors will generally be directed to use the restroom facilities planned for the Poi Bowl area.

Trails. In the rugged terrain in the upper slopes of Mauna Kea, trails to Wai'au and the summit are evident on historic maps and on the ground today. Past ranching activities were responsible for creating the more defined trails. Interviews of informants with historical knowledge of Mauna Kea identified the routes of historical trails (Figure V-4).

The plan is to preserve the existing historical trails to Wai'au and the summit. To protect the resources of the Science Reserve, formal public hiking routes within the Science Reserve will be mapped in the future, and trail improvements will be planned as needed for safety. A recreational support facility, including a parking lot and restrooms, is planned for the Millimeter Valley area and will be available to hikers and other users.



Source: 1983 Mauna Kea Science Reserve Complex Development Plan, Dr. Jerry Johnson, 1998

Ski Areas

25' Contour Intervals

Natural Area Reserve

Existing Ski Areas

Another support facility is a parking area that is primarily planned to serve cultural resource interests, located along the access road at the 13,000 ft. elevation. This location will provide access to existing trails leading to Wai'au and the adze quarry. These uses are directed to defined areas of the Science Reserve to protect the sensitive natural and cultural resource components. Development of this support facility will be subject to approval by the DLNR.

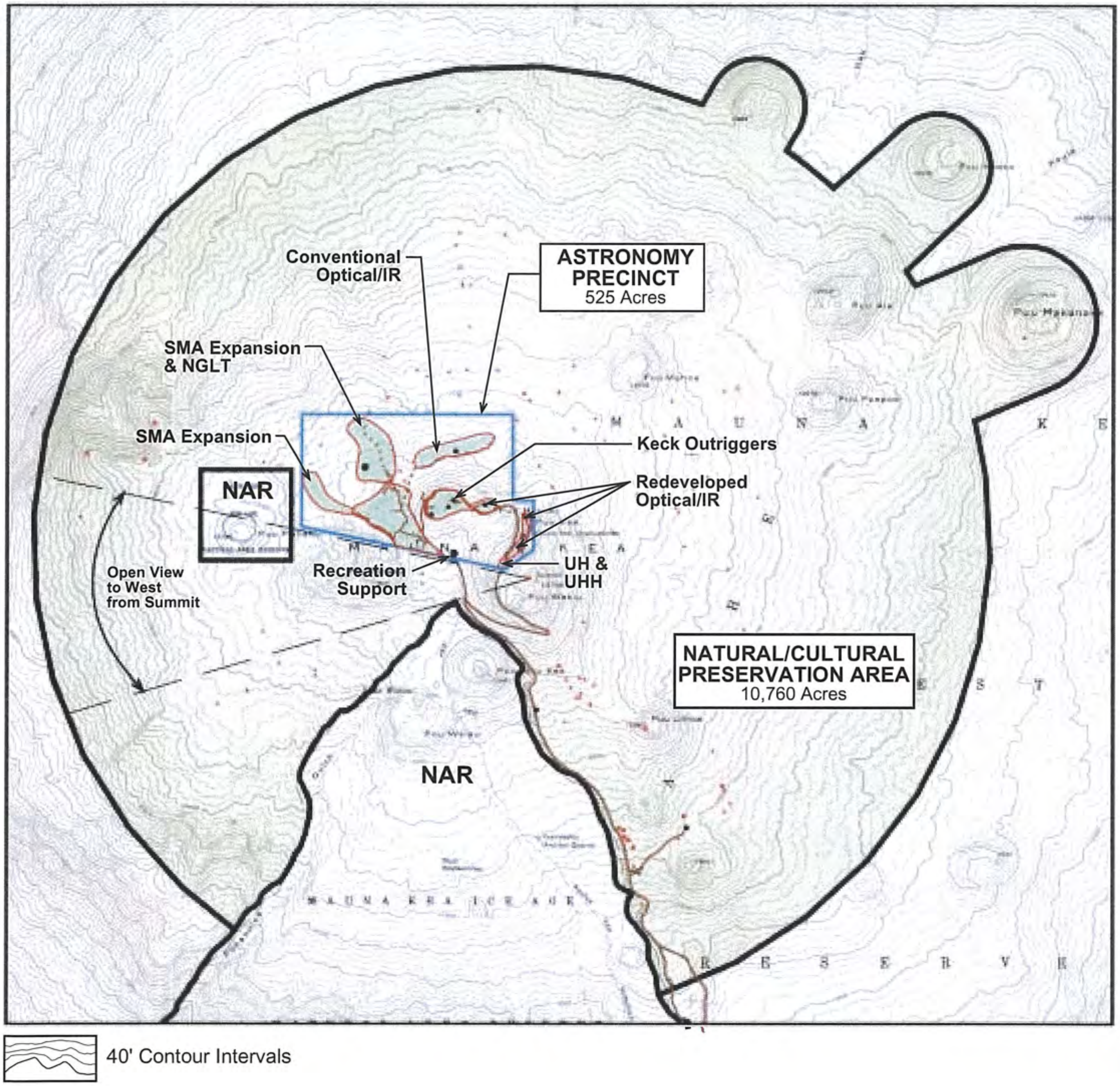
Camping. The public will also benefit from the planned conversion of the construction cabins built by the Subaru observatory at Hale Pōhaku. These will be turned over after construction operations cease (2001) and become available for public group stays.

Hunting. Hunting activity in the Science Reserve generally only occurs in the lower and mid-elevations of Mauna Kea. Hunting areas are shown in Figure VII-1. Access for hunters is available through Hale Pōhaku and Pu'u La'au. The Master Plan places no new restrictions on the future use of the Science Reserve for hunting.

Recreational Physical Plan. The recreational use elements of the Science Reserve are depicted as broad use areas for skiing, snow play, hiking and hunting. Specific landforms, such as Pu'u Poli'ahu have been designated as off-limits for future recreational use to respect the cultural significance of this *pu'u*. The plan includes informational signage for visitors such that a well-planned tour can be conducted without random stopping points that can result in adverse effects to important natural and cultural resources.

Overall Physical Planning Guide for Summit

An overall plan of the summit region is shown in Figure IX-26. The physical plan identifies all of the locations for existing and proposed astronomy facilities in the Astronomy Precinct. Also shown in the plan is the location of the recreational support building within the Precinct. This plan depicts a composite of all resource components into one integrated plan. Natural and cultural resources elements are preserved throughout the Science Reserve, with particular focus on the 10,760-acre Natural and Cultural Preservation Area surrounding the proposed Astronomy Precinct. Proposed facilities to support education/research and recreational elements are limited within the approximately 525-acre Astronomy Precinct.



ASTRONOMY
PRECINCT
525 Acres
Conventional
Optical/IR
SMA Expansion
& NGLT
SMA Expansion
NAR
Keck Outriggers
Redeveloped
Optical/IR
Recreation
Support
UH &
UHH
Open View
to West
from Summit
NATURAL/CULTURAL
PRESERVATION AREA
10,760 Acres
NAR
40' Contour Intervals
0'
2000'
4000'
8000'
NORTH

Figure IX-26

PLAN FOR HALE PŌHAKU MID-ELEVATION FACILITIES

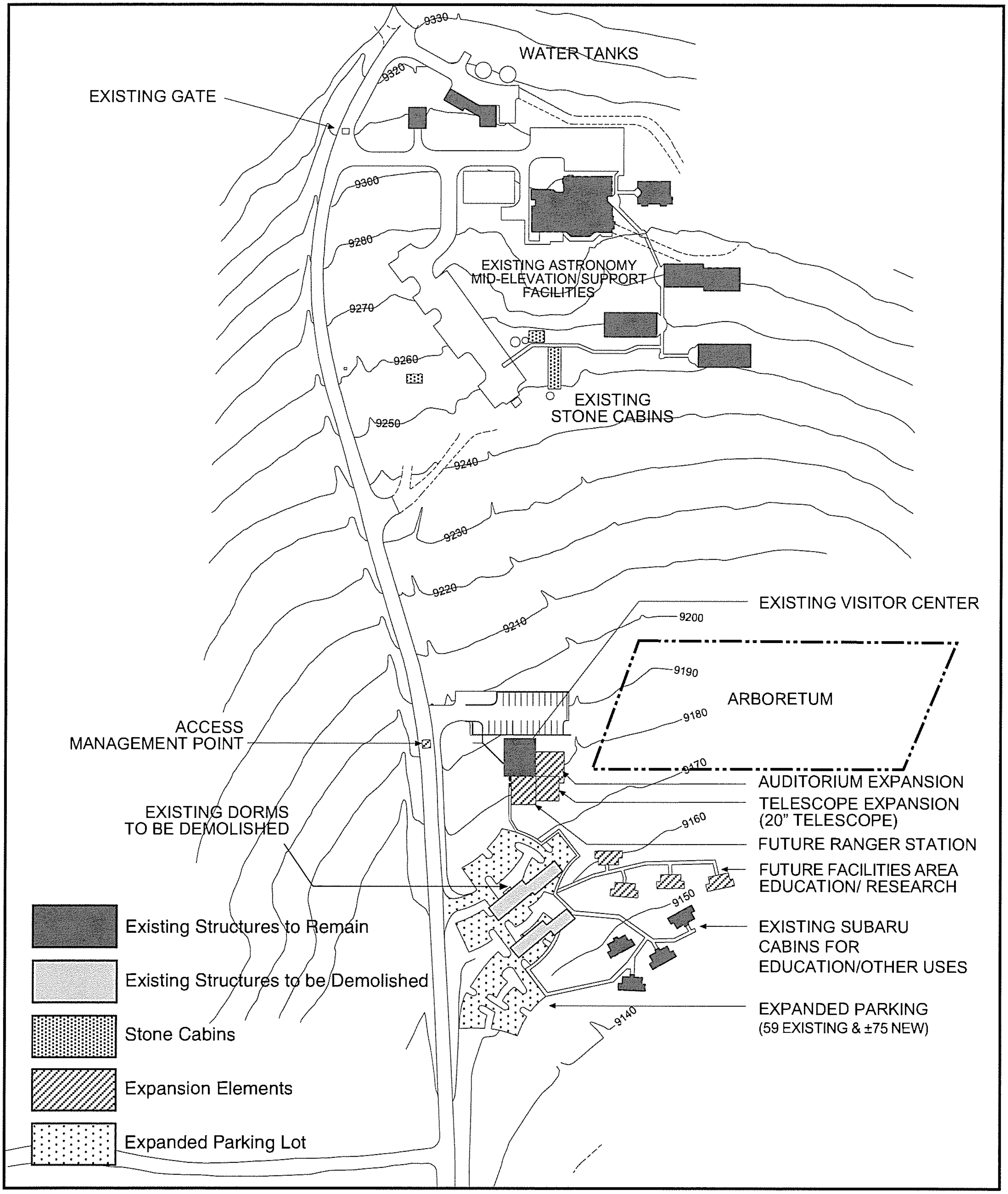
The mid-elevation facilities at Hale Pōhaku have typically been associated with support of astronomers, dating back to times when all facilities were operated by on-mountain astronomers and technicians. With today's technology and the fiber optic communications system, many of the studies occurring at these observatories can be operated remotely either from Hale Pōhaku, off-mountain Hawai'i locations (Waimea, Hilo), or via the Internet. Hale Pōhaku's role in providing public information and education about astronomy on Mauna Kea will be augmented by these base facilities and a planned planetarium in Hilo. Refer to the following section for additional detail regarding the off-mountain base facilities.

Even with the change in operating procedures, portions of the Hale Pōhaku facilities are being planned to accommodate increased non-astronomy use in the next 20 years. There are three components to the Hale Pōhaku facilities that are addressed in the plan, including: 1) Astronomy mid-elevation facilities, 2) Construction camp facilities, and 3) the Visitor Information Station facilities. Existing facilities at Hale Pōhaku, and uses planned at these locations, are described below and shown in Figure IX-27.

1. Astronomy Mid-Elevation Facilities. Due to the increased capability for off-mountain viewing, use of the existing astronomy mid-elevation facilities has been declining, and this trend is generally anticipated to continue or stabilize near current levels. As the total number of observatories on the summit will be increasing, overnight stays at the mid-elevation facility will generally decline on a per facility basis. This will result in a total number of overnight stays that is anticipated to be comparable to the present levels, therefore there will be no need for expansion.

2. Construction Camp Facilities. The older camp facilities are to be removed. The Subaru construction cabins will become fully available to the State in 2002. These cabins are proposed to be used for additional purposes including education, research and recreation, including:
   - Increased use by University of Hawai'i at Hilo, other college/university-level academic programs relating to geology, alpine and mountain forest ecology, astronomy and Hawaiian culture, as well as groups from schools and organizations.
   - Periodic temporary lodging for observatory construction crews for future projects.

3. Visitor Information Station Facilities. The visitor center facilities will require further expansion, which will complement the planned programs at UH-Hilo. A visitor information center will be included in the facility. Other possible uses could include natural and cultural resources interpretive center, and the ranger station offices and communications center. The new controlled access point on the summit road will occur at the Visitor Information Station, replacing the present (open) gate located at the astronomy mid-elevation facility. Current plans for the Visitor Information Station expansion include an auditorium addition and new observatory. The anticipated users of the Visitor Information Station are described below in several categories.


WATER TANKS
EXISTING GATE
9330
9320
9300
9280
9270
9260
9250
9240
9230
9220
9210
9200
9190
9180
9170
9160
9150
9140
EXISTING ASTRONOMY
MID-ELEVATION SUPPORT
FACILITIES
EXISTING
STONE CABINS
EXISTING VISITOR CENTER
ARBORETUM
ACCESS
MANAGEMENT POINT
AUDITORIUM EXPANSION
TELESCOPE EXPANSION
(20" TELESCOPE)
EXISTING DORMS
TO BE DEMOLISHED
FUTURE RANGER STATION
FUTURE FACILITIES AREA
EDUCATION/ RESEARCH
EXISTING SUBARU
CABINS FOR
EDUCATION/OTHER USES
EXPANDED PARKING
(59 EXISTING & ±75 NEW)
Existing Structures to Remain
Existing Structures to be Demolished
Stone Cabins
Expansion Elements
Expanded Parking Lot

- Visitors attracted or directed by the planetarium program at UH-Hilo's University Park. People visiting the planetarium will learn about the Hale Pōhaku facilities, and some will visit the Mid-Elevation facilities for a first-hand experience of the mountain's cultural and educational resources.
- Private tour groups and individual travelers are also expected to travel to Hale Pōhaku in greater numbers. With the improvement of the Visitor Information Station, its reputation will grow and people's interest in witnessing the facility and experiencing its programs about the mountain will expand. A 20-inch telescope will be installed at the VIS so the visitors and amateur astronomers can observe the sky in Mauna Kea's superior conditions. Other public astronomy facilities may also be developed in the future. All improvements at Hale Pōhaku are subject to design review.
- Non-astronomy research groups (e.g. geology, botanical, faunal, cultural, etc.) will also increase over time. These types of groups will travel to the Visitor Information Station to experience exhibits and programs highlighting the unique natural and cultural resources of the mountain.
- Recreational use by naturalists and cultural groups will expand. Individuals and organizations are anticipated to utilize the Visitor Information Station for their own recreational enjoyment or for organized functions.
- Primary-level educators will utilize the Visitor Station for school field visits and educational programs (e.g. geology, botanical, faunal, cultural, etc.)

The anticipated increases in use will create the need for additional parking area at the Hale Pōhaku Visitor Information Station. The number of parking spaces is currently planned to increase by 75 spaces to a total of approximately 150 spaces. More parking may be needed at the Visitor Center in the future.

The number of travelers to Hale Pōhaku utilizing Saddle Road and the Mauna Kea Access Road is expected to increase in the future. Future improvements planned for Saddle Road by Hawai'i County will also allow for better access to Hale Pōhaku. Mauna Kea Access Road is not currently planned for improvements. However, future use levels at the Visitor Information Station may warrant additional work such as increased signage, new pavement and striping, and minor widening of pavement for paved shoulders.

OFF-MOUNTAIN BASE FACILITIES

It is difficult to conduct research investigations for prolonged periods at the high altitude locations of the Mauna Kea summit or Hale Pōhaku. In addition, it is difficult to access the observatories in harsh winter weather periods. Several observatories have found it more effective to conduct their studies from off-mountain base facilities. With the installation of fiber optic communications to the observatories on Mauna Kea, they now have the capability to be operated remotely. Off-mountain base facilities for these observatories have been established in Waimea (CFHT and Keck) and University Park in

Hilo (UKIRT, JCMT, CSO, Subaru, Gemini, and IfA). The trend toward providing off-mountain base facilities is expected to continue.

Some facilities, such as the Submillimeter Array (SMA), can be operated remotely via the Internet from its home base in Cambridge, Massachusetts. SMA also has offices in Hilo from which it conducts its current operations in Hawai'i. Future telescopes constructed at Mauna Kea will be encouraged to develop their base facilities in Hawai'i to the greatest extent practical.

Future observatory construction at Mauna Kea may require additional base facilities to be constructed in either Waimea or Hilo. The most recent base support facilities have been developed at University Park on the campus of UH-Hilo. In addition, UH-Hilo proposes to locate the Mauna Kea Astronomy Education Center, an educational and interpretive facility designed to broaden, public understanding of the Universe, at University Park, as noted in Appendix B.

INFRASTRUCTURE REQUIREMENTS

Infrastructure elements serving the Science Reserve will require periodic updating and expansion to serve the various users of the mountain in the next 20 years. Education and research facilities within the Astronomy Precinct will have facility requirements for updating and expansion of roadways, communications system, and electrical power supply. Infrastructure maintenance will be an ongoing requirement, which is addressed in the management plan.

Roadways. Roadway expansion will be minimized through the development siting criteria, which guides future facilities to be developed near the existing roadways. The existing unimproved roadways serving the expansion sites within the Astronomy Precinct will require additional improvement. Although there are narrow road alignments present, these roads will require modest widening and grading to make them passable for new facilities operations located beyond the existing astronomy areas at Millimeter Valley and the summit ridge. The Master Plan recommends paving of the remainder of the access road from Hale Pōhaku and the remainder of the summit spur road which runs from the SMA building past the Subaru Telescope to the W.M. Keck Observatory. Paving will reduce the amount of dust generated by vehicles, thus improving conditions for astronomy observations and for Wēkiu habitat.

Communications and Power Supply. The fiber optic communications system and the electrical power system will be expanded to serve new facilities sites to the north and northwest. The main power supply to the mountain is adequate to serve the additional facilities anticipated under this plan. To minimize the visual impact of new utility pull boxes to be located along the new underground conduit routes, colored concrete will be used to match the surrounding ground surface.

Water Supply. There is no water supply extending to the summit of Mauna Kea, and future water supply to the summit will continue to follow current procedures. Water will continue to be provided from two 40,000-gallon water tanks located at Hale Pōhaku. Currently, 25,000 gallons of water are trucked to the mid-level facility from Hilo each week. Each of the observatories will continue to be supplied with potable water that is transported to the summit by tanker trucks from Hilo. About 15,000 gallons of water is presently trucked to the summit each week, and each facility has its own water storage tank. The supply rate will increase to serve new facilities that are planned for the summit. Changes to technology allowing remote (off-mountain) viewing access could reduce the number of workers and scientist actually present at new facilities, and a corresponding lower water use rate as compared to existing facilities.

Wastewater Management. There is no plan for construction of a sewer collection system to serve the summit area. Wastewater generated at the observatories will continue to be managed by each facility through individual wastewater disposal systems (cesspools and septic tank/leaching field systems). Due to the small number of workers and visitors utilizing these facilities on a daily basis, the volume of water use and wastewater generation is small, approximating domestic rates. Changes to technology allowing remote (off-mountain) viewing access could reduce the number of workers and scientist actually present at new facilities, and a corresponding lower water use and wastewater generation rates.

Drainage. Erosion due to storm water runoff will be controlled on all new roadways, such that there will be no adverse affects to the surrounding landscape. There are six culverts within the 4.5 miles of roadway from Hale Pōhaku to the summit. Culverts will be installed as needed along the extension of the access roadway system to the north to minimize erosion

Summary of Physical Planning Guide for the Science Reserve and Hale Pōhaku

The overall physical planning guide for the Science Reserve depicts a composite of all resource components into one integrated plan. Natural and cultural resources elements are preserved throughout the Science Reserve, with particular focus on the 10,760-acre Natural and Cultural Preservation Area surrounding the proposed Astronomy Precinct. Proposed facilities to support education/research and recreational elements are limited within the approximately 525-acre Astronomy Precinct, except for improvements to facilities at the Hale Pōhaku Visitor Center.

This updated physical plan, in conjunction with the updated Management Plan (discussed in the following section), creates a living planning and management document that has been developed in collaboration with the University, Mauna Kea Advisory Committee, native Hawaiian interests, and other stakeholders and interested community members.

MANAGEMENT PLAN

I. MANAGEMENT PLAN OBJECTIVES

The experience of the last three decades has shown the need for re-examination of the existing management procedures. The lessons from this experience are summarized in the following clusters of management objectives:

A. To create a structure for sustainable, focused management of the resources and operations of the Mauna Kea Science Reserve in order to:

- **Protect historic/cultural resources: e.g. archaeology sites, traditional cultural practices**. While actual damage to known archaeological sites has been minimal, there has evolved a greater sensitivity to cultural values and the importance of geophysical forms in the cultural landscape. The proposed management plan incorporates these values and sets up a supportive framework for current, traditional Hawaiian cultural practices. It proposes a framework for assessing the impact of current practices on historic sites, natural resources and other uses on the mountain. If there are conflicts, the management plan would establish a procedure for resolving disputes. The plan also promotes education and further research in ethnography and related disciplines.

- **Protect natural resources: e.g. Wēkiu habitat, alpine ecosytem**. The natural resources that should be protected begin with the mountain's geology and atmospheric qualities. These form the base for the unique ecosystems that make up the Science Reserve, Summit Road corridor and Hale Pōhaku. Tropical island alpine environments are extremely rare on the planet. The value of the mamane forest has been recognized in all plans. The passage of years has only reinforced the importance of this ecosystem. The impetus from the planning for astronomy and other activities has provided us with studies that have given us greater understanding of the uniqueness of the Wēkiu and other endemic species. This increased understanding has provided more information on potential protective and mitigative measures.

- **Protect and enhance education and research: e.g. astronomy, Hawaiian language and culture, archaeology, ecology, geology.** The continued recognition of the importance of astronomy in the Mauna Kea Science Reserve remains critical. Its economic impact to the island is significant. Mauna Kea's global importance has grown over the last twenty years until it is now recognized as one of the premier viewing places in the world. The qualities that make Mauna Kea such a desirable site need to be preserved. Facility and infrastructure improvements must continue for the complex to retain its continued prominence in the field.

Knowledge about the potential for other research disciplines has grown. Mauna Kea has many qualities and resources that make it a great outdoor laboratory and classroom for Hawaiian language and culture, archaeology, ecology, biology, geology and a host of other disciplines. This is recognized in the plan by the encouragement of joint use of support facilities and the identification of these other disciplines as important overall goals. Education is a major function of the State of Hawai'i and the University. The value of the mountain for educational purposes with particular emphasis on K-12 and post-secondary programs for native Hawaiian students, is recognized and incorporated in the use concepts for the mountain. The proposed management plan recognizes this greater diversity of interests.

- **Protect and enhance recreational opportunities: e.g. hiking, snow play and skiing.** Recreational opportunities are an adjunct to the existence of the natural resources of the mountain. The proposed plan recognizes the importance of recreational values by identifying it as a separate resource cluster. Proposed management plans hope to address the anticipated growth in recreational uses while protecting the resources.

- **Promote public safety**. Improved access and growing numbers of visitors and vehicles raise concerns about public safety. This is already a problem with accidents and injuries; especially on the Summit Road. The plan proposes various measures to increase public safety.

B. To create a structure which meets the following objectives:

- **Promote community input**. The inadequacy of opportunities for public input has been a long standing issue. The proposed plan addresses the issue with the creation of a new management structure and review procedures for amendments and proposals that include public participation.

- **Establish local management**. The need and sentiment for local management has been clear. The plan addresses this question with the creation of a management body located on the Big Island.

- **Establish a focal point for management responsibility**. For the general public, multiple jurisdiction has created vagueness and confusion in responsibility, authority, communication and policy. The need for a focal point of management responsibility and contact has became clear. The plan addresses this goal by creating a single entity as a hub for activity and management on the mountain.

- **Establish clear lines of decision making and accountability.** Within responsible agencies, lines of authority and communication must be clear. The proposed management structure must increase the accountability of all parties on the mountain and make sure each agency is aware of its responsibilities.

- **Economic and structural feasibility**. Funding for management has been inadequate. The proposed plan focuses on changes that can be achieved without statutory changes to existing regulations and responsibilities. Management functions would become a part of a funded function of the University supported by the Board of Regents.

- **Provides a base for future expansion of the scope of activities in the Science Reserve**. It is anticipated that activities supported in the Science Reserve will expand beyond astronomy to include a variety of other areas such as cultural practices, sports/recreation, education, other academic areas and environmental programs. The proposed plan provides a structure designed to manage these varied activities under a single management entity.

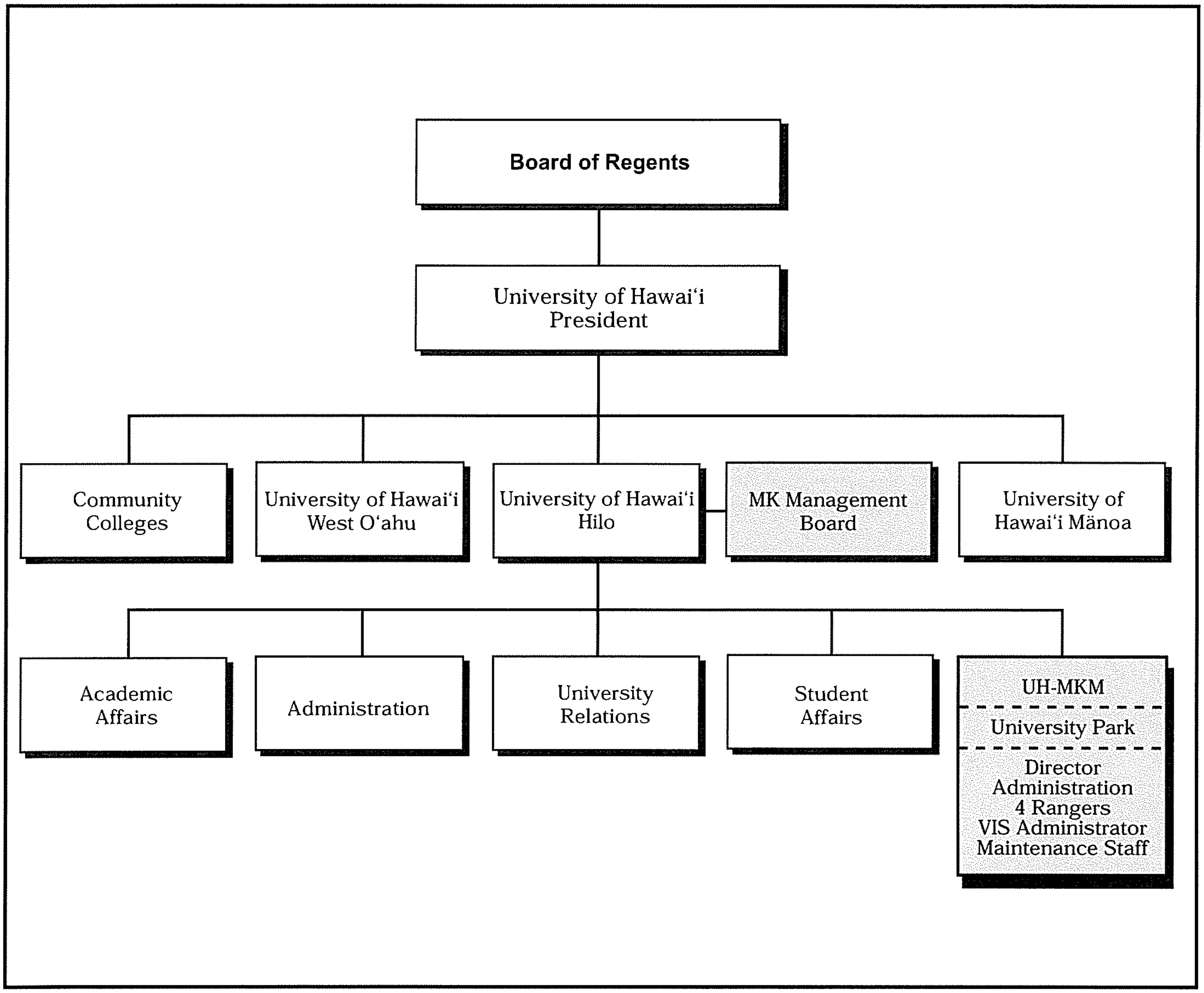
The management objectives and the proposed management plan evolved after many Mauna Kea Advisory Committee meetings and discussions with key individuals from the University of Hawai'i, Department of Land and Natural Resources and the community. Many alternative management structures were proposed, discussed, revised and/or discarded. The management plan delineated here addresses the issues mentioned in Chapter XIII and meets the objectives listed above. It can be implemented quickly with a minimum of consent or approval outside of the current University of Hawai'i system. The plan calls for the creation of a management organization capable of providing the necessary stewardship for the sustainable use of Mauna Kea. The structure can also evolve to take on more responsibility and authority as needed. The plan also considers the integrated nature of the resources and establishes clear relationships with the adjacent NAR and other DLNR lands.

II. MANAGEMENT ORGANIZATION AND PROCEDURES

Three levels or tiers of responsibility comprise the structure at Mauna Kea: land ownership, policy setting/regulatory compliance, and management. The following is proposed:

Management Organization Proposal: There is a need for a single entity to manage a comprehensive integrated plan for the Mauna Kea Science Reserve. This management organization should be based on the Big Island and recognized by the general public as the point of contact for the summit region. It could be housed within the University of Hawai'i system and funded as a separate, ongoing program unit out of the University of Hawai'i at Hilo (See Figure X-1). Housing it within a permanent unit of the UH system makes a clear statement that the University accepts the responsibility for this function, including its funding.

A suggested name for the organization is the University of Hawai'i Office of Mauna Kea Management (UH MKM or Office). It is also proposed that a Mauna Kea Management Board be recommended by the UH Hilo Chancellor and appointed by the Board of Regents to guide the operations of the UH MKM. This Board will be advisory

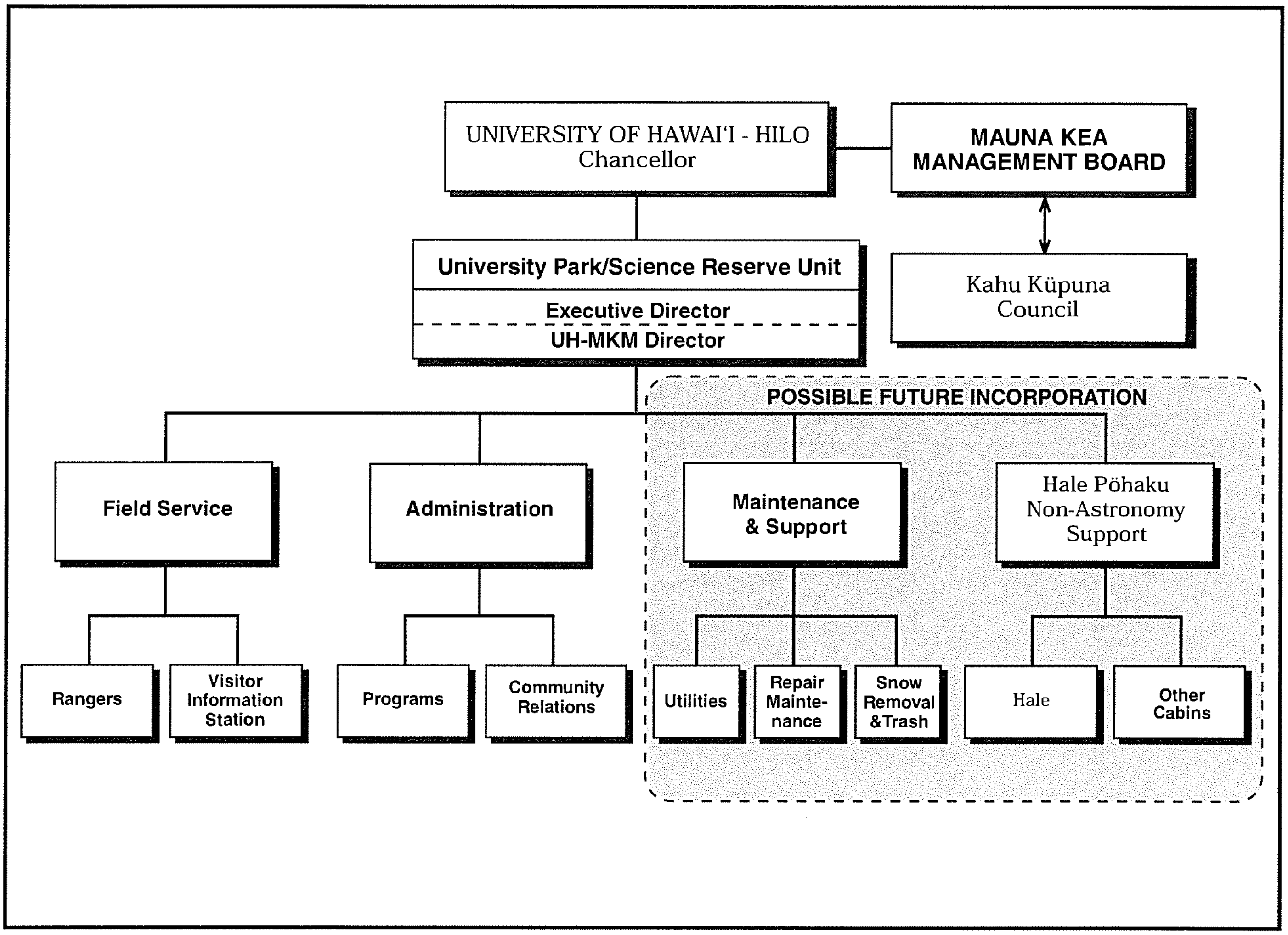


Office of Mauna Kea Management Position in UH System to the Chancellor. It is further proposed that the Office be housed within the unit for UH Hilo which is projected to manage the University Park. The Office should be responsible for the management of the Science Reserve, Summit Road and Hale Pōhaku. It would be responsible for establishing and enforcing management policies within the parameters of General Lease S-4191. The Office would be the focus of contact for the general public and would function as a referral and facilitative agency for issues that are outside its authority but related to the mountain.

It is projected that the UH MKM would have an initial staff which includes a director, administrative assistant, mountain rangers and general maintenance and support staff (Refer to Figure X-2). For general maintenance and support services, except for functions retained by IfA for existing leases and agreements, most of the current Mauna Kea Support Services could be transferred to the UH MKM. This transfer would be projected to occur over time after the updated master plan is adopted by the Board of Regents and the new structure is implemented.

Within the UH system, the director would have overall management responsibility for the Office. The director would be the key representative of the Office and the daily point of contact for the general public and tenant organizations on the mountain and at University Park. Any permitting and rental arrangements that may be established could be processed through UH MKM. Except for facilities managed by IfA at Hale Pōhaku for astronomy support, scheduling and requests for use of facilities or support services should be processed through the director. The Office would also address other requests, grievances and requests for information. Monitoring programs and databases would be coordinated through UH MKM to provide integrated management of the mountain.

Rangers, located at Hale Pōhaku, should be trained as cultural and natural resource specialists and it is recommended that some of the ranger staff be bilingual Hawaiian and English speakers. Their primary role would be education, coordination, monitoring and resource management. They would have a secondary enforcement role with possible assistance from DLNR DOCARE officers and County of Hawai'i police. It is envisioned that there would be a minimum of two rangers on the mountain at any time; one at Hale Pōhaku managing the entrance and one roaming in the Science Reserve. The ranger at Hale Pōhaku should register and orient visitors and coordinate programs that may be occurring at the Visitor Information Station (VIS) or other parts of the mid-elevation facilities. The ranger that is roaming would monitor people activity and make periodic field checks in resource areas. They would assist with safety and emergency procedures. Rangers would assist and educate visitors at all times. Rangers should monitor all field activities in the summit area from sports activities to volunteer rubbish sweeps and outdoor educational programs.



Organization Chart

General maintenance and research support services are currently provided by Mauna Kea Support Services (MKSS). At present these functions include:

- Food and lodging at Hale Pōhaku;
- Gas, diesel and water to existing astronomy facilities and their staff;
- Provision of utility support services, including trash removal;
- Safety and emergency services;
- Road maintenance and snow removal;
- Visitor Information Station services and manpower;
- Library and office services at Hale Pōhaku;
- Maintenance of the communications network;
- Servicing the construction camp.

After negotiations with IfA and current tenants, portions of MKSS functions, budget and personnel would be transferred to the MKM and become a permanent part of the new management organization. Existing agreements specify IfA involvement in the provision of specific utility services and support functions and any transfer of responsibilities would be contingent on agreement from existing sublease holders.

Hale Pōhaku: The mid elevation facilities at Hale Pōhaku are projected to accommodate much of the anticipated growth in facilities and programs for astronomy education and non-astronomy purposes. As the facility expands with new equipment and spaces, program specialists in education, culture and natural resources may be added to the staff as funding increases. These specialists would assist in program development and coordination and may be accommodated at either Hilo or Hale Pōhaku. New programs in culture, Hawaiian language, geology, biology, ecology, habitat restoration and others are potential areas of growth. These programs may have field, classroom and distance learning components. Facility and infrastructure support may be provided in the Science Reserve, at Hale Pōhaku or elsewhere.

Community Involvement: Mauna Kea is a community resource. Community involvement in the management of the mountain begins with the membership of the Mauna Kea Management Board. The Board should be composed of members representing the major stakeholders of Mauna Kea.

The Board's primary role is to advise the Office of the Chancellor at UH Hilo on management of the Mauna Kea Science Reserve. The Board should be the main community voice for activities and development planned for the Science Reserve. The Board would be a public forum for future uses, activities and development on the mountain. Finally, the Board could act as a facilitator during grievance procedures and assist in the resolution of conflicts.

The Board is encouraged to establish special committees on culture, environment and education, as needed, to assist it in its functioning. For cultural issues the Burial Council model is suggested. The Burial Council is a group of appointed citizens which provides guidance on the disposition of human remains. A special Kahu Kūpuna Council made up of representatives of native Hawaiian organizations as well as individuals recognized for their specialized knowledge could function like the Council. Other special advisory committees may be formed for environmental and education issues. These committees could focus on docent and other programs for Mauna Kea.

Docent programs are suggested to expand knowledge of the mountain and to encourage greater community participation. Docents could teach visitors about the rich and complex resources of the mountain. Volunteer organizations and alliances are also encouraged in order to broaden the pool of people who value and support the stewardship of the mountain. These groups could be called upon for various functions such as the periodic maintenance sweeps, special programs or fund raising events. Groups should be encouraged to "adopt the mountain". The UH MKM should encourage and coordinate community participation.

Grievance Procedures: The MKM should establish grievance procedures to address issues as they arise. All grievances should be presented to the director of the Office who will make an assessment about the appropriate resolution of the issue. If the issues represent broad plan or policy questions beyond the management authority of the MKM, the director should refer the questions and/or questioner to specific contacts at the appropriate agencies; usually the DLNR or the UH Board of Regents. The Office should follow the progress of the grievance and assist where it is able. Where the grievance is about management issues or items within the jurisdiction of the Office, the director will receive and respond to the questions. If the issue requires management or rule changes by the Office, the director will research the question and bring it before the Management Board for review. All grievances should be handled in a sensitive and timely manner.

Coordination and Other Agencies: A major role for the Office of Mauna Kea Management will be its role in coordinating actions that are peripheral to its responsibilities but still important to the management of the mountain. This is because authority on the Mountain is distributed among many governmental entities. Besides the University of Hawaii, the Department of Land and Natural Resources retains a major role in management of the mountain. The Office will communicate issues and concerns that it receives to the appropriate agencies and follow through in their resolution.

It needs be re-emphasized that while the University of Hawaii has the master lease for the Science Reserve, the Board of Land and Natural Resources holds the title to the lands that make up the summit of Mauna Kea. In the master lease, DLNR specifically reserved its authority over activities that are not related to the educational and research mission of the University of Hawaii. Even in the Science Reserve, DLNR is still the primary agency responsible for protection of natural and cultural resources, managing recreational activities such as hunting and hiking, as well as controlling commercial uses. These responsibilities are written into the Hawaii Revised Statutes and cannot be delegated without legislative or constitutional action. Of special importance is the DLNR authority and responsibilities related to historic sites and cultural practices. These responsibilities remain with DLNR and are not delegated through the master lease.

Other lands related to the management of the summit of Mauna Kea are under the jurisdiction of DLNR and DHHL. The two natural area reserve areas which are part of the summit region are not part of the Science Reserve. Also, the summit access road passes through land belonging to the Department of Hawaiian Home Lands and lands managed by the Forestry Division of the Department of Land and Natural Resources. Beyond the roadway reserve the responsibility for management remains with DLNR. Finally, except for the acreage specified in the lease, Hale Pōhaku is located in the forestry reserve managed by the Division of Forestry. Access and management of the lands around Hale Pōhaku are the responsibility of DLNR.

Finally, during medical emergencies and special events like forest fires or inclement weather other agencies such as the County fire and police departments as well as the military units at Pohakuloa may play lead or major roles in responding to these emergencies. The Office of Mauna Kea Management will assist and coordinate during these situations.

III. POLICIES AND STRATEGIES

The management plan proposes policies and strategies to integrate and balance the natural, cultural, educational/research and recreational values of Mauna Kea within a framework that provides responsible stewardship of the resources. It seeks to allocate resources and priorities toward sustainable use and enhancement of the Mauna Kea Science Reserve as a Hawaiian place with a unique and significant meaning, both locally and globally.

The management plan has several sub-components: A, General Policies, B, Natural Resources, C, Cultural Resources, D, Education/Research E, Recreation and F, Commercial Uses.

A. General Policies

Access Management: Vehicular access to the summit area should be managed but not curtailed. Hiking will remain unrestricted. Pack animal access should be managed. Detailed policies and guidelines for access should be adopted and implemented by the University of Hawai'i. Access through the summit region should be managed through a control point at Hale Pōhaku. The management plan seeks to integrate the developments at Hilo, Hale Pōhaku and the Summit Region. Access management will be consistent with the provisions of the DLNR Historic Preservation Plan (March 2000). The following are some guidelines:

1. Registration, Orientation and Permits: Visitors may be required to register at the Visitor Information Station before they go beyond Hale Pōhaku. Specified visitors and pre-authorized groups may be allowed to proceed on their own schedule without the normal orientation. Acclimatization is recommended for all visitors. During registration, visitors should be given information about risks associated with the summit area, times of use, road conditions, inclement weather and cultural and environmental resources. Information about the adjacent NAR should be included in the orientation package.

   The list of permitted uses is presented later in this plan. The Office may issue permits and assess fees where desired. Special permits should be processed through the director. No fees will be assessed for traditional cultural access.

2. Hours of Operation: Hours of operation will be established by the UH MKM and communicated visually and electronically. Special permission for public vehicular use of the road outside these hours would require permission from the Office. The Visitor Information Station is currently open 7 days a week and at night for stargazing programs and special events.

3. Control Point: A kiosk and/or entrance control protocol should be developed to manage the Summit Road. Primary access management would be by the ranger at the Visitor Information Station. Signage about hours of operation and access policies should be displayed prominently at the control point.

4. Shuttle: A shuttle service may be developed for summit access as traffic increases. Visitors would park at the Visitor Information Station parking lot and access the summit via shuttle. The shuttle schedule would be developed after completion of a more detailed assessment of demand and cost.

5. Helicopters: Helicopter landings will be permitted for emergencies and special purposes.

6. Private vehicles: standard sedans and 4 wheel drives: Standard sedans would normally be restricted from the Science Reserve. Private 4-wheel-drive vehicles would be allowed beyond the control point with appropriate registration. The policy for private 4-wheel-drive vehicles should be re-evaluated if a shuttle service is developed. Travel would be restricted to designated roadways. For cultural, research, education, special recreation and other approved special uses private 4-wheel-drive vehicles may be used in the Science Reserve, with passes, even if the shuttle is developed.

7. Other means: hiking, horses, motorcycles, bicycles, snow mobiles etc.: Hiking will remain unrestricted. Access by horseback or mule should be managed to minimize impacts on the fragile summit environment. Horses and mules should generally stay on established trails and roadways. Recreational activities

involving "off road" vehicles are not allowed. This restriction should apply to both the general public and commercial vendors and their clients. "Off-road" vehicles include motorcycles, dune buggies, snowmobiles and 4-wheel-drive passenger vehicles. This restriction does not apply to emergency rescue, medical or service purposes.

Facilities and Physical Maintenance: The UH MKM will be responsible for the physical maintenance of the Science Reserve, Summit Road and Hale Pōhaku.

1. Visitor Information Station (VIS): The Visitor Information Station is proposed to be managed by the Office. It should also be expanded into a facility where the Mauna Kea experience can be made satisfying at this elevation such that people may be less inclined to go to the summit. This should reduce the pressure on the summit region and also reduce the risk of potential health and safety problems. Safety concerns would otherwise increase as greater numbers of people head to the summit. The VIS should also be the headquarters for the mountain rangers.

2. Hale Pōhaku Mid-Elevation Support Facilities: Hale Pōhaku should remain the physical management Station for the mountain. The UH MKM should manage the services and facilities at Hale Pōhaku. Dormitories for researchers on the mountain would remain in this location. IfA may retain services and facilities that specifically support astronomy and/or are included in its sublease agreements. Other functions should be transferred to the UH MKM. New concessions, other subleases and subcontractors would be managed through the UH MKM.

3. Subaru Cabins/Construction Camp: The Subaru construction cabins will become fully available to the University in February 2002. At that time they should be managed and made available for educational/research/cultural uses. Faculty and student groups should be given preference. Secondarily, they may be offered to recreational and commercial users. These cabins should be administered by the UH MKM. Cabins and the area around the dormitories would be managed to avoid potential conflicts between day users and night users of Hale Pōhaku. Astronomers tend to work at night and sleep during the day while other users are likely to be active during the day. Programs and activities should be limited to those which do not generate excessive noise.

4. Stone Cabins: The historic stone cabins at Hale Pōhaku may be renovated to accommodate other uses. The exterior facades should be preserved as is. Interior renovations may be made to allow appropriate adaptive re-use. Renovation plans should be reviewed by the State Historic Preservation Office early in the planning process. If the restroom facility is restored, new methods of wastewater disposal should be reviewed in concept by both the Department of Health and the SHPO before detailed designs are started. The renovated buildings may be used for cultural programs, education, other research, environmental restoration or similar

programs and purposes. If they are renovated as cabins they may be used in a manner similar to the construction cabins.

5. Roads and Parking Areas : Roads and parking areas from Hale Pōhaku to the summit will be maintained on a regular schedule. Over time, guardrails should be installed along all segments of the road identified as potentially hazardous. A schedule for guardrail installation should be developed after a road safety study is completed. As new facilities are planned or new recreational or service roads and trails are needed, the UH MKM should be responsible for construction and maintenance. Significant new roads should be identified in the physical plan before development.

6. Trails: It is proposed that the Office of Mauna Kea Management maintain trails in the Science Reserve. Historic trails should be identified. Other trails, if developed, should be designed and maintained in a safe and environmentally sensitive manner. The Office should consider enhancements such as signage or *ahu* markers for trail identification and interpretation. The SHPO would be consulted for activities or improvements that may impact known historic or pre-contact trails.

7. Utilities and Infrastructure: The UH MKM should manage utility and infrastructure support in the Science Reserve. Agreements in existing subleases will be managed as contracted unless revised by mutual consent. The Office would be responsible for development, implementation and management of all new infrastructure and utility systems. Utility services, gas, oil and water support, and repair and maintenance facilities should continue to be managed from the mid-elevation facilities.

8. Trash and Solid Waste: Solid waste and trash are generated from three sources: construction activity, visitors and ongoing observatory activities. Construction trash is expected to abate with the slowdown in construction. When new construction begins again, the development agreements with the facility developer should include strict guidelines for trash pick-up and removal. Agreements would also include provisions for securing supplies in a manner that prevents them from being blown by high winds and scattered over the summit region. Compliance monitoring for these conditions would be the responsibility of the UH MKM. Visitor generated trash should be managed in two ways: First, there should be routine service provided by UH MKM. Second, periodic clean-ups should be organized with various community groups to sweep the summit area of windblown trash. Broad sweeps are periodically needed because strong winds in the summit region spread trash over large areas. These sweeps should be conducted in an environmentally sound manner with sensitivity to environmental and cultural features, sites and practices. Volunteers involved in sweeps should be given instructions to avoid unintentional damage to the mountain's resources. Solid waste pick-up from existing astronomy operations could become the

responsibility of the UH MKM. Regular pick-ups should be organized to serve the Science Reserve and Hale Pōhaku.

All trash receptacles in the Science Reserve should be designed, and secured to withstand high winds which may blow over normal containers and spread the trash over wide areas. Containers should be sited to encourage usage by visitors.

Handouts, paper cups and other similar items that may be disposed should be minimized to limit the supply of potential sources of trash on the mountain. This precaution should be a part of the orientation presentation at the Visitor Information Station.

Safety, Security and Liability: The UH MKM should develop and maintain safety and security plans which include the following:

1. Weather: The summit region is subject to severe weather conditions that may be life threatening. The Office will restrict access when conditions dictate. Additionally, since weather changes can occur quickly on the summit region, rangers should monitor activity to warn people when weather becomes inclement. Rangers should be trained in emergency rescue procedures. Hale Pōhaku may serve as the weather station for the summit.

2. Altitude: High altitudes may affect people visiting or working on the summit. During registration, visitors should be oriented to the potential hazards of high altitude environments. Rangers will have access to oxygen and other first aid supplies at the summit region. Even frequent visitors will be invited to spend time acclimating at the Visitor Information Station.

3. Medical Emergencies: The existing medical emergency system involves IfA, the observatories, the military, County emergency services and hospitals. Helicopter landing areas could be identified in the emergency evacuation plan. The UH MKM should coordinate medical emergencies in the Science Reserve.

4. Security and Vandalism: While this is not a serious problem UH MKM should maintain security programs. Registration at the VIS and the control point at Hale Pōhaku will aid in monitoring activity. The mere presence of uniformed personnel will often act as a deterrent. Rangers would monitor activity as they roam the summit area. Enforcement will continue to be handled in coordination with DOCARE and County police officers.

5. Other Hazardous Site Conditions: Road and site conditions may occasionally require closure of the road or certain sections of the mountain. UH MKM may coordinate such emergencies. The UH MKM should also prepare an emergency evacuation plan should there be a need for such action.

6. Fire Protection: The UH MKM fire plan would include education for visitors, a trained volunteer fire crew, emergency procedures (especially from the summit area) and a habitat fire plan for the Hale Pōhaku māmane-naio forest area.

7. Alcohol and Drugs: Alcohol and drugs are prohibited from the Science Reserve.

Jurisdiction: The management plan applies to the Mauna Kea Science Reserve, the summit access road and Hale Pōhaku. It does not include other state lands in the upper mountain region managed by the DLNR or DHHL.

Compliance with Regulatory Requirements: The Office will oversee permitting and compliance activity for uses on the mountain in areas of the University's jurisdiction. MKM will work with DLNR in areas of DLNR's jurisdiction. MKM could prepare annual reports on the status of activities and include regulatory compliance as a part of this annual report. The Office will monitor sub-lease holders and permit holders to check on the status of CDUA conditions, EIS mitigation measures, historic sites treatment, endangered species monitoring and other similar conditions and requirements.

Language: As a general policy, Hawaiian and English languages should both be used for signs, pamphlets, videos and other material developed for the general public. Where practical, the Hawaiian language should be given the position of prominence in the communication format.

B. Natural and Environmental Resources.

Special plans to protect and enhance the natural and environmental resources of Mauna Kea for their perpetual enjoyment and use into the foreseeable future are suggested. Baseline studies of geology and biology have been completed and can be used to protect the resource. Some of these studies have data over time that may be used to discover trends. More detailed mitigation response plans may be developed as knowledge of the resource increases. The information is contained in a GIS database and it seems desirable for the office to maintain the database.

Recommendations for geological resource management (Lockwood, January 2000) and botanical resources management (Char, January 2000) will be implemented to avoid impacts to sensitive resource areas.

UH MKM policies to support educational and research programs in these areas may call for provision of support facilities for these programs. While information about potential programs and requests are limited at the current time the demand is expected to grow. Sharing existing and future facilities developed for astronomy requires coordination with IfA and the observatories. New support facilities would also require programming, permitting, construction funds, and operations and maintenance support. Overall management is needed when the facilities at Hale Pōhaku and the summit area are made available to these programs. Uses may be as simple as a small storage area and desk space or it may include computer hook-ups, meeting rooms and libraries. At Hale Pōhaku the impact of sharing facilities should be considered before permission is granted. If compatibility is a problem, expansion at the mid-elevation facility may be considered to provide resting, storage and work spaces for other disciplines and programs.

The two adjacent NAR areas contain some of the best natural, cultural and environmental resources in the summit area and are accessed through the Science Reserve. It is suggested that protocols be developed at the Visitor Information Station and the road/trail interface between the Science Reserve and the NAR to inform people of the importance and proper treatment of these resources.

C. Historic and Cultural Resources

This plan protects archaeological sites and provides guidance for traditional Hawaiian cultural practices. Known archaeological sites within the Science Reserve are identified in the GIS database. These sites have been identified using GPS coordinates. Additional information should be added to the database as more information becomes available.

The State Historic Preservation Office (SHPO) has prepared a plan for the historic and cultural resources within the Science Reserve (Appendix F). SHPO's proposed plan describes policies and management guidelines for archaeological sites, cultural properties, and cultural practices. The physical plan was developed with a consideration for the cultural landscape. View planes, no-build areas and restoration plans are based on an understanding of the significance of geomorphological features such as the summit *pu'u* complex, Wai'au and locations of known archaeological sites. The following policies and activities are recommended:

1. Orientation: An educational program should be developed to inform all visitors of the cultural, spiritual, historic and archaeological values of Mauna Kea. This program should be a part of the registration process.

2. Archaeological and Historic Sites: Known sites on the summit area should be preserved. Preservation sites near potentially heavy traffic areas should be identified with signage. Some of the features are difficult for layman to notice and the danger from inadvertent destruction seems greater than from deliberate tampering. Periodic photographic monitoring of sites is suggested.

3. Geo-physical Features: These features are identified in the physical plan. Educational programs should be developed to heighten the sensitivity of visitors to the natural landscape and its role in Hawaiian culture. The concept of *wāhi pana* is of special importance here. Signage from key vantage points could describe their significance. Earlier or more authentic place names should be used where they are

known. Future studies may provide more information on this topic and adjustments should then be made accordingly.

4. Current Practices: Hawaiian cultural and religious practices should be generally unregulated. However, practices that have potential to significantly impact the physical landscape or traditional Hawaiian spiritual values of sites should be managed or coordinated. Examples of this would be a revival of adze making (requiring resource extraction), and building new religious or cultural activity areas with their affiliated structures: *ahu*, platforms, shelters, walls. The operative word is "significant" which needs to be defined more specifically after discussions with potential Hawaiian practitioner groups and knowledgeable individuals. Modern non-Hawaiian cultural and religious practices would be reviewed for sensitivity to Hawaiian cultural values. Where conflicts are unresolved, native Hawaiian practices and values should take priority.

5. Advisory Committee: A Kahu Kūpuna Council of individuals knowledgeable about native Hawaiian cultural practices should be formed to advise the Mauna Kea Management Board. This Committee should be:

   - Organized by the Board;
   - Review current cultural activities and programs and recommend programs and policies to support cultural programs on the mountain;
   - Advise the Board on questions about cultural practices;
   - If needed, be available to assist in dispute resolution.

Awareness and understanding of the cultural significance of Mauna Kea is growing. The following protocols and programs are suggested as possible activities to improve the management of the cultural values and resources of the mountain:

Protocols

- Before any facility siting or infrastructure alignment decision has been finalized, if warranted, an inventory level archaeological survey of the area should be conducted to ensure that no unrecorded sites are located in the area.
- In addition to the archaeological inventory survey, it is recommended that geophysical features, *wahi pana* and other aspects of potential cultural significance be evaluated.
- Where possible, avoid impact to cultural and historic sites.
- If unavoidable mitigate the impacts.
- The treatment of historic and cultural features will be governed by the Historic Preservation Plan for Mauna Kea. The Preservation Plan includes designation of the summit area as a historic district and various protocols for use and activities on the summit area. The Plan proposes inventory surveys, significance evaluations, potential impact on cultural properties, mitigation measures and the presence of a qualified archaeologist during excavation activities. The Plan also

expands on the treatment of potential and inadvertent burials that may be discovered as well as permanent long-term monitoring programs needed to protect the resources of the mountain.

Suggested Programs

- Support ongoing ethnographic and archaeological research programs.
- Create an education oriented docent program.
- Develop a signage plan to protect resources and educate the public.

D. Education and Research

1. Astronomy: A goal of the plan update is the maintenance of Mauna Kea as one of the premier astronomical observing locations in the world. Most of the factors necessary for its continued desirability as an astronomical site are addressed in the physical planning guide for the mountain (Chapter IX). IfA will remain the lead UH entity responsible for astronomy development in the Science Reserve. However, since development and upgrades occur in the context of the master plan the UH MKM would be responsible for other activities and overall property management. Issues that need to be addressed from a management standpoint include:

- Upgrades of equipment, facilities and support facilities are needed to retain its global position. In partnership with IfA, the UH MKM would be responsible for maintenance of support facilities and infrastructure.

- Dust and light conditions near the summit must be controlled to ensure a continued high quality environment for ground based astronomy. Vehicular headlights and other night activities need to continue to be managed to avoid negatively impacting astronomical activities. The gate at Hale Pōhaku may be closed for this reason. Where possible, activities that increase atmospheric dust or otherwise degrade air and environmental quality should be prohibited or minimized. IfA and the UH MKM would monitor and manage activities that may affect these conditions.

- No new fixed radio frequency transmitters will be allowed in the Science Reserve because of their potential to interfere with radio telescopes and other sensitive astronomical detectors. The only possible exception would be a low-powered repeater for emergency use only. The use of low-power handheld transmitters (walkie-talkies and cellular phones) is permitted if they do not interfere with telescope detector systems.

- Interference from other radio transmitters: Radio transmitters can negatively affect astronomy observations. The growth of private telecommunication companies creates pressure to develop these facilities in high elevation sites. The MKM should discourage these facilities from developing in locations where they would affect astronomy operations.

2. Non-astronomy related academic and research areas: The sentiment supporting the growth of other research disciplines on the mountain is growing. Facility implications of such support are unclear. If new spaces are needed, these proposals would be evaluated for their conformity to the plan vision before they are sent to the Board of Regents or DLNR. The following needs further definition before this support can be realized:

   - Define program areas and activity zones.
   - Relate to academic plans and programs.
   - Identify resource needs and manage support facilities requirements and standards.
   - Assess potential impact to existing uses.
   - Identify functional relationships and alternative sites and strategies.
   - Train rangers and other personnel to manage these areas and policies.

   When programs are defined, plan amendment proposals can be developed for facility and resource support and processed through the UH MKM.

3. Education: Mauna Kea is a great outdoor classroom. Policies should encourage the use of the mountain for educational purposes. Approvals and logistical support should be coordinated through the UH MKM. The following activities are suggested:

   - Set up policies and procedures to accommodate and encourage educational use of the mountain.
   - Identify areas and zones of the mountain appropriate for field activities and outdoor classrooms.

   The interpretation and educational components of the DLNR Historic Preservation Plan include a "Public Interpretation Plan" which addresses four major tasks. The first is an interpretive plan which designates those historic properties which are suited for public access and proposed ways in which visitation will be informative and cause the least amount of disruption to the historic properties. Second, a brochure will be prepared for distribution at the Visitor's Center at Hale Pohaku on the historic properties found within the summit region and in the area surrounding Hale Pohaku. The third task, according to the scope of work, was to prepare a display for the Visitors Center. Instead, the plan may only propose an appropriate display or display options because plans to renovate or expand the current center have been proposed. If this is the case, then it would be premature to produce a display that might not conform to the size of general lay-out of the rest of the Visitor's Center. The fourth task is to provide background materials that would help staff prehistory and history of Mauna Kea and to answer many of the routine questions asked by the public.

E. Recreational Activities

The existence of natural resources draws recreational users to the mountain. Recreational uses need to be managed to avoid conflicts of use and degradation of resources. Education is the best tool for reducing the impact of man on natural resources. All visitors should be given a brochure and/or briefing on the proper treatment of resources; both natural and cultural. Signage should be developed in areas of sensitivity and high traffic. The presence of rangers will also enhance resource protection while accommodating recreational activities.

1. Hiking: Hiking will be unrestricted but hikers should be encouraged to stay on known trails for safety and minimization of impact to natural and cultural resources. Simple rules of sustainability such as walking gently in the wilderness and carrying out what one brings in should be emphasized. Signage is suggested at appropriate places on trails to provide information necessary for safety and sensitivity to area resources. The creation of formalized trails may be necessary if monitoring determines that multiple paths or tracks are being created because of repeated visitation to specific areas.

2. Sightseeing and Tourism: Most visitors will come by vehicle and stay on paved roads and stay near developed facilities.

3. Snow Play, Skiing and Snow Boarding: Private four-wheel-drive vehicles may be allowed for skiers and snow players. Brochures could be developed to educate recreational visitors about the cultural and environmental resources that may be impacted if they ski or snow play outside of designated areas.

4. Hunting: Hunting is unrestricted in the Science Reserve. Hunters should be cautioned about safety regarding the presence of other people on the mountain. Commercial hunting operations are prohibited in the Science Reserve.

5. Extreme Sports: This term refers to any number of recreational activities that seek dangerous or unusual thrills such as down hill biking or hang gliding. While these activities are not categorically prohibited they must be evaluated on a case by case basis and require a permit. A fee may be attached to such activities. Some activities may be prohibited if they may impact resources, appear too dangerous or require support services that are unavailable.

F. Commercial Activities

Limited commercial activities would be allowed in the Science Reserve. These activities and operations should be small and low impact in nature. Commercial operations should remain small to avoid negatively impacting the primary missions of protecting natural and cultural resources and the promoting educational and research activities. It is suggested that the UH MKM manage the permitting responsibilities for these functions.

The following commercial activities are allowed in the Science Reserve and Hale Pōhaku:

1. Commercial Sightseeing Tours: At present commercial tours are allowed in the Science Reserve. Tour operators apply for a permit and pay a fee for these activities to the DLNR. These tours would continue to be allowed. Tours should generally stop at Hale Pōhaku for registration, orientation and acclimatization.

2. Movies, Commercials and similar productions: These activities would be allowed with special permits. Logistical support could be provided from the construction cabins. These activities should be allowed with the condition that they will not negatively impact the natural and cultural resources of the mountain or the priority uses for education/research and culture.

3. Concessions: Concessions may be allowed on a limited basis at Hale Pōhaku; especially around the Visitor Information Station. These concessions would be an accessory to the major activities and provide support services and items. Special care must be taken to ensure that trash does not become a problem in the operation of concessions.

4. Special Events: Facilities at Hale Pōhaku may be rented for special events if they do not interfere with education/research activities or contractual obligations. Small conferences and cultural festivals are possible activities. Additionally, with special permits the Science Reserve may be used for events like snowboarding contests.

5. Eco-education Tours: Commercial eco-tours may be allowed. These tours should be conducted on established trails and designated areas and designed to avoid impact to natural and cultural resources. The facilities at Hale Pōhaku may be used to support these tours as long as they do not conflict with education/research use of the facilities.

6. Cabin/room rentals: The facilities at Hale Pōhaku may be rented to individuals and small groups as long as education/research uses take priority and are not compromised. Commercial rentals should generally consider the rental of the construction cabins to avoid conflicts with the research dormitories.

IV. FUNDING

As part of a permanent program unit within UH - Hilo funding is anticipated through normal University procedures. In addition to basic program funds from the University of Hawai'i, the following potential funding sources may be pursued to improve management and program implementation.

1. Existing observatories. Existing facilities at Mauna Kea may be willing to provide additional contributions for the proposed management entity and new programs.

2. New astronomy development could share in the broader management and maintenance responsibilities of the mountain. New license agreements could consider monetary contributions to support programs and personnel needed to protect and manage environmental and cultural resources.

3. User fees and licenses: Commercial and quasi-commercial uses such as tours, and ski operations should be charged fees. If allowed, extractive uses like quarrying done for commercial purposes should be monitored closely and charged. Traditional Hawaiian cultural practices should not be charged. A general Science Reserve vehicle entrance fee may be considered. A charge should be considered for the proposed shuttle transport. Transfer of fees from existing DLNR permits to a Mauna Kea management account should also be considered.

4. Hale Pōhaku: If compatible with astronomy activities, Hale Pōhaku could be made available to other parties. Small conferences and retreats may be held. Education/ research/ culture related gatherings should have preference but other uses could be accommodated with fees.

5. Construction Cabins: When the Subaru cabins are turned over to the University of Hawaiʻi in 2002, they could be made available to other users. The construction cabins may also be renovated to serve as rental accommodations. Support services could be provided from the Hale Pōhaku kitchen and housekeeping staffs.

6. Stone Cabins: These facilities may also be rented in a similar fashion as the construction cabins.

7. Visitor Information Station: Fees could be charged for private or non-UH use of the Visitor Information Station and related facilities. Concessions may be permitted.

8. Research and other grants: Funding could be sought from foundations and governmental agencies for research and management objectives.

9. Private and non-profit donations: A tax exempt trust fund for the maintenance of Mauna Kea could be set up. This fund could be the repository for special funds that may be received. This would support, not replace, the normal O&M budget.

10. The Department of Land and Natural Resources is responsible for many of the management responsibilities on the mountain. It may be possible to obtain additional DLNR resources to assist in some of the overall management responsibilities.

In summary, management functions must be funded. Funding would be from the UH system in cooperation with astronomy interests and supplemented by other sources.

IMPLEMENTATION PLAN

SCHEDULE

Implementation of the updated Mauna Kea Master Plan began with the adoption of the Plan by the University of Hawai'i Board of Regents. The Regents adopted the Master Plan in June 2000. The major steps in implementation include:

- Establishment of organizational structure,
- Funding,
- Appointment of Management Board,
- Hiring staff and establishing offices and support facilities,
- Adoption of administrative rules,
- Development of programs.
- Development of facilities

The proposed overall implementation schedule is shown in Figure XI-1.

Program and facility development will follow their individual schedules as they receive funding.

ORGANIZATIONAL STRUCTURE

There are four new major components to the organizational structure surrounding the Mauna Kea Science Reserve. They are the University of Hawai'i Office of Mauna Kea Management, the Mauna Kea Management Board, the Kahu Kūpuna Council and the Design Review Committee. These components should be formed within six months of the approval of the updated Master Plan.

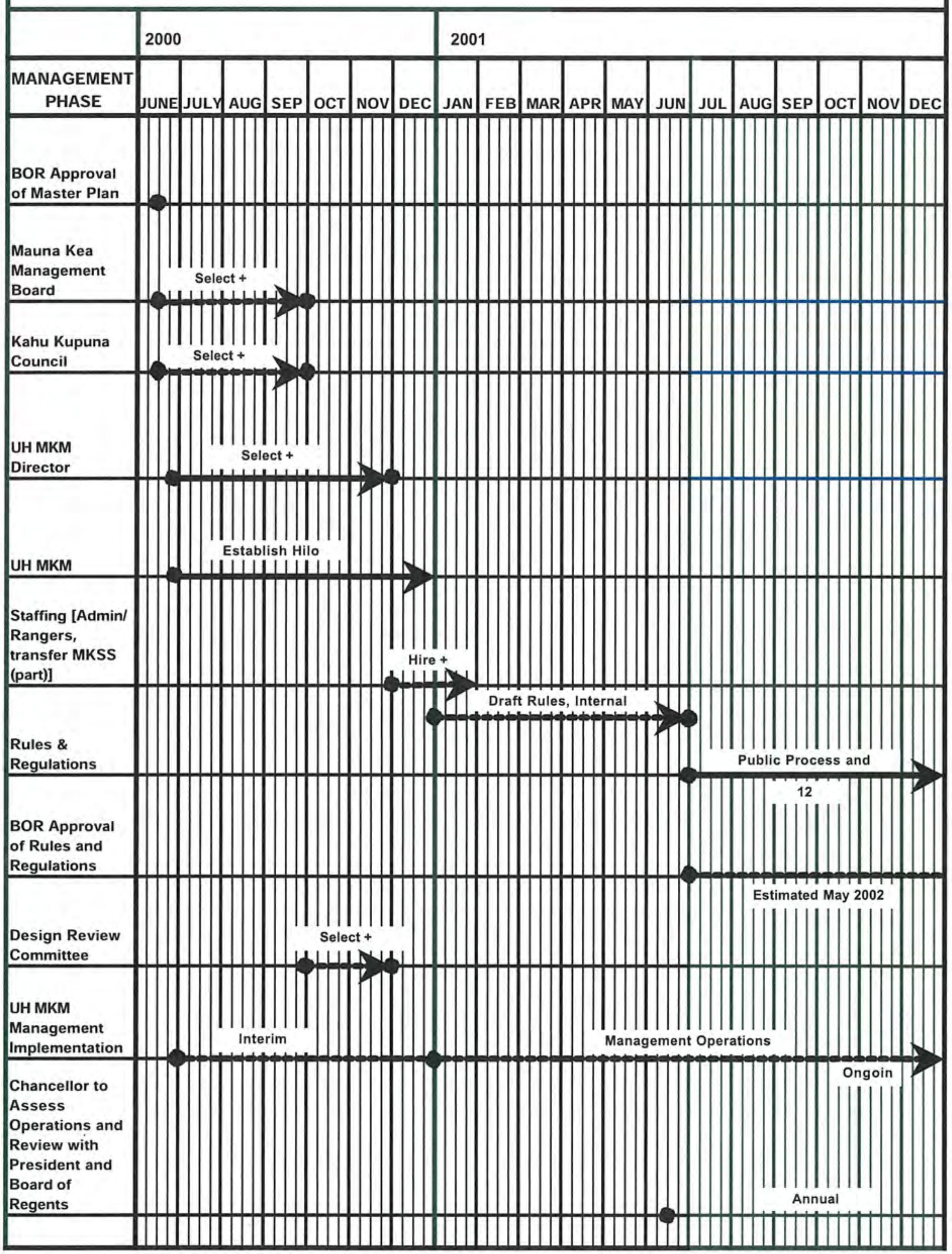
Office of Mauna Kea Management (UH MKM)
Steps in the development of this office will include the following:

1. ***Finalize Organizational Structure:*** Establish position descriptions and pay scales. Clarify the relationship of the Office of Mauna Kea Management to the Office of the Chancellor at UH Hilo. This will be done concurrently with the finalization of the Master Plan.

2. ***Establish Funding***: The President of the University of Hawai'i has committed to providing $400,000 funding per annum for this new office. Additional funds may be added as conditions dictate.

Figure XI-1

Management Plan Implementation Milestones



3. ***Select Director***: The director will be the key "face of the University" to the public and people who work on the mountain. This person needs to have the respect of and be able to communicate with scientists, the community and the UH Hilo community. Strong organizational and interpersonal skills are needed to cover the wide range of responsibilities and tasks involved in this position. Sensitivity and knowledge of Hawaiian cultural issues and natural resource management issues is required.

4. ***Hire and Train Staff:*** The director should be involved in the hiring of the rest of the staff to have ownership of the office team. The staff should be knowledgeable about the resources of the mountain and sensitive to community needs. Some of the staff should be bi-lingual; especially in Hawaiian. A training program for the staff is needed to inform them of the values, resources and protocols on the mountain. The hiring and training of the staff should occur within two months after the director has been selected.

5. ***Develop Administrative Rules:*** Rules should be adopted pursuant to Chapter 91. These rules would guide the daily operations of the UH MKM and the management of the Science Reserve. Draft rules should be prepared within approximately six months of the hiring of the director. Final rules should be adopted within approximately 18 months of the formation of the UH MKM. These rules should be based on the Master Plan policy guidelines.

6. ***Establish Hilo Office:*** The main office of the MKM should be established at UH Hilo in the Research Park to keep it close to the community, UH Hilo and the Research Park tenants. The Office should be established as soon as the Master Plan is adopted.

7. ***Reorganize Hale Pōhaku Operations:*** The Visitor Information Station should be renovated to headquarter the rangers and accommodate the expanded VIS operations. Renovations should be completed within approximately one year of operations under the UH MKM. Registration protocol and educational materials and programs should be established as soon as the positions are filled. A control point kiosk should be developed within the first year of operations. VIS expansion should be completed within three years.

8. ***Mauna Kea Support Services (MKSS) functions (partial) transfer***: Maintenance and management functions currently provided by MKSS would be reviewed and with the agreement of affected parties shifted to the UH MKM on a timely basis. Services that are related to existing agreements and efficiently managed by IfA will remain as is. Initial transfers of personnel and functions should occur within the first year of the establishment of the UH MKM.

Mauna Kea Management Board

1. ***Appoint Management Board:*** Members will be recommended by the UH-Hilo Chancellor and appointed by the Board of Regents. Terms and responsibilities will be detailed in administrative rules. The Board should be appointed and organized concurrently with the establishment of the UH MKM.

2. ***Establish Administrative Rules:*** The Board should adopt formal rules within one year of its formation. Procedures for public participation should be included in the adopted rules.

3. ***Kahu Kūpuna Council***: The Board should organize the Kahu Kūpuna Council to assist in deliberations of cultural and community values. This committee should be formed soon after the adoption of this Master Plan.

Design Review Committee

This Committee should be appointed with the adoption of the Master Plan. It should include design professionals such as architects, landscape architects and civil engineers.

DESIGN GUIDELINES

The purpose of the design guidelines is to direct development in a manner which integrates it into the summit environment. The design guidelines would apply to both renovations of existing facilities as well as new construction. General goals include the following:

Facility Siting: Siting decisions are the first steps in design and often determine the range of options that are available. Siting of various facilities are identified in the Physical Planning Guide. Candidate sites for recycling, expansion and new facilities are designated. New facilities are sited generally. Individual instrument locations are not specified. The NGLT and facilities on new site locations may require adjustments after viewing tests and archaeological inventory level surveys are conducted. The following siting criteria should be considered early in project development:

- Site facilities to avoid negative visual or functional impacts to existing facilities.
- Where known archaeological, cultural and natural resources exist the following sequence of evaluation is to be followed: 1) avoid disturbance of the resource, 2) minimize impact if unavoidable and 3) mitigate impact as needed. Natural resources include biological populations and geo-morphological features and geo-chemical resources.
- Set sufficient buffer distances between the facility and the cultural or natural resource. Buffer distances should be assessed individually based on the feature and the proposed facility.

- Site facilities to minimize visual impact from both the summit areas and off-mountain locations such as Hilo, Hāmākua and Waimea.
- Cluster facilities for proximity to roadway and utility lines. This should reduce site development costs and minimize visual impacts and unnecessary disturbances of the natural environment.
- If possible, avoid steeper areas and drainage paths.

Scale: Facilities should be scaled to minimize their impact on the natural landscape of the summit area. As much as practical, telescope enclosures should be designed to minimally accommodate the instrument. Where the size of the enclosure is necessarily large, strategies should be considered to blend it into the surrounding landscape. The following are some strategies for reducing apparent scale:

- Bury portions of the structure as practicable.
- Place berms against the building to reduce visible areas.
- Shape superstructures using natural and curved forms which blend into the environment rather than orthogonal geometries.
- Color surfaces to blend into the landscape.
- Design exterior articulations and changes in color and texture to break up large continuous surfaces.
- Use materials that blend into the natural landscape.

Heights & Widths: Heights and widths of ridge facility designs should seek to minimize visible heights above existing ground as much as practicable. The following are maximum dimensions established to guide the design of facilities and to regulate the impact of new development.

- Facilities developed on ridge sites may be developed to a maximum height of approximately 130 feet measured from finished grade, and a maximum width of 130 feet.
- Support facilities in the astronomy precinct should be designed to reduce the height of vertical planes on exterior walls.
- Facilities that can be built underground are encouraged to do so to reduce the part that must remain above grade.
- Mounding cinders around telescope bases could be considered to reduce visible heights.
- Where practical, build into existing slopes to reduce the visible height.
- Facilities at Hale Pōhaku should be a maximum of two stories and designed to look like one story structures by techniques such as building into attic spaces as per the existing buildings.

Colors: Color plays an important part in visibility and thermal impacts. Color choices should seek to minimize the visual impact of the facility from surrounding areas. While it is understood that the mitigation of thermal impacts on observatory functions is an important consideration, domes should be colored to aid in masking and blending facilities into the natural landscape. The following strategies are to be employed:

- For ridge facility domes, a combination of detailed geometrical design, surface treatment (i.e. reflecting vs. non-reflecting) and color (blues and grays) to minimize visibility against the daytime sky.
- For base sections, use browns and other earth colors to blend facilities with the natural cinder cone surroundings.
- For off-ridge facility enclosures use colors and patterns such as the mottled brown tones of the surrounding lava landscape.
- Color concrete utility pull boxes installed along underground utility routes, antennae pads and miscellaneous structures with mottled brown tones to blend with the surrounding lava landscape. No raw, uncolored concrete surfaces are to be allowed.

Surfaces, Textures and Material: Surfaces, textures and material used for construction in the Science Reserve should seek to blend the facility into the landscape. Selection criteria are as follows:

- As much as possible, surfaces should be non-reflective in the visible spectrum to minimize glare and visibility from distant areas.
- Wood and other native plant materials may be used, as appropriate, at lower elevations near Hale Pōhaku or for support facilities that relate to natural and cultural programs. Natural materials are suggested for walls and surfaces as much as possible.

Parking: Parking areas should be designed with sensitivity to existing topographic contours and fitted into the existing landscape. Parking layouts should be designed to retain natural landforms and vegetation as much as possible.

Roadway and Utility Development; Minimize roadway development in the Science Reserve to what is needed to support functions approved in the master plan. Follow existing road and utility corridors and alignments as much as possible. Utility lines should be buried. Accessory utility structures will be screened or designed to blend into the natural terrain. Road designs should minimize slope cutting.

Roofs: Roof design and material and color selections in conventional structures should merge the facility into the natural landscape. Reflective materials are to be avoided. At Hale Pōhaku, roof designs, colors and materials should be compatible with those of the existing mid-elevation facilities.

Fences, Walls, and Barriers: Fences, walls and barriers will generally be designed to fit into the landscape. Where possible, alignments should follow natural contours. Grading cuts and fills should be minimized. The use of locally available construction material is encouraged.

Signage: Signs should generally be small and unobtrusive. A possible exception may be the entry sign at the control point at Hale Pōhaku. This sign should be clearly visible during the day and night. Print colors should be black, blue or dark earth tones. It is suggested that interpretive signage be located in natural entry points and lookout areas and designed to blend into the natural landscape. The potential impact of snowfall should be considered in the design of signs. Signage should be placed to orient and educate visitors about safety issues and the protection of natural and cultural resources. It is recommended that there be a consistency of signage styles and symbols for the Science Reserve and Hale Pōhaku.

Language for signage should generally be in both Hawaiian and English. An exception to this policy would be traffic signs which would remain in English for safety reasons.

PROJECT REVIEW AND DESIGN GUIDELINES

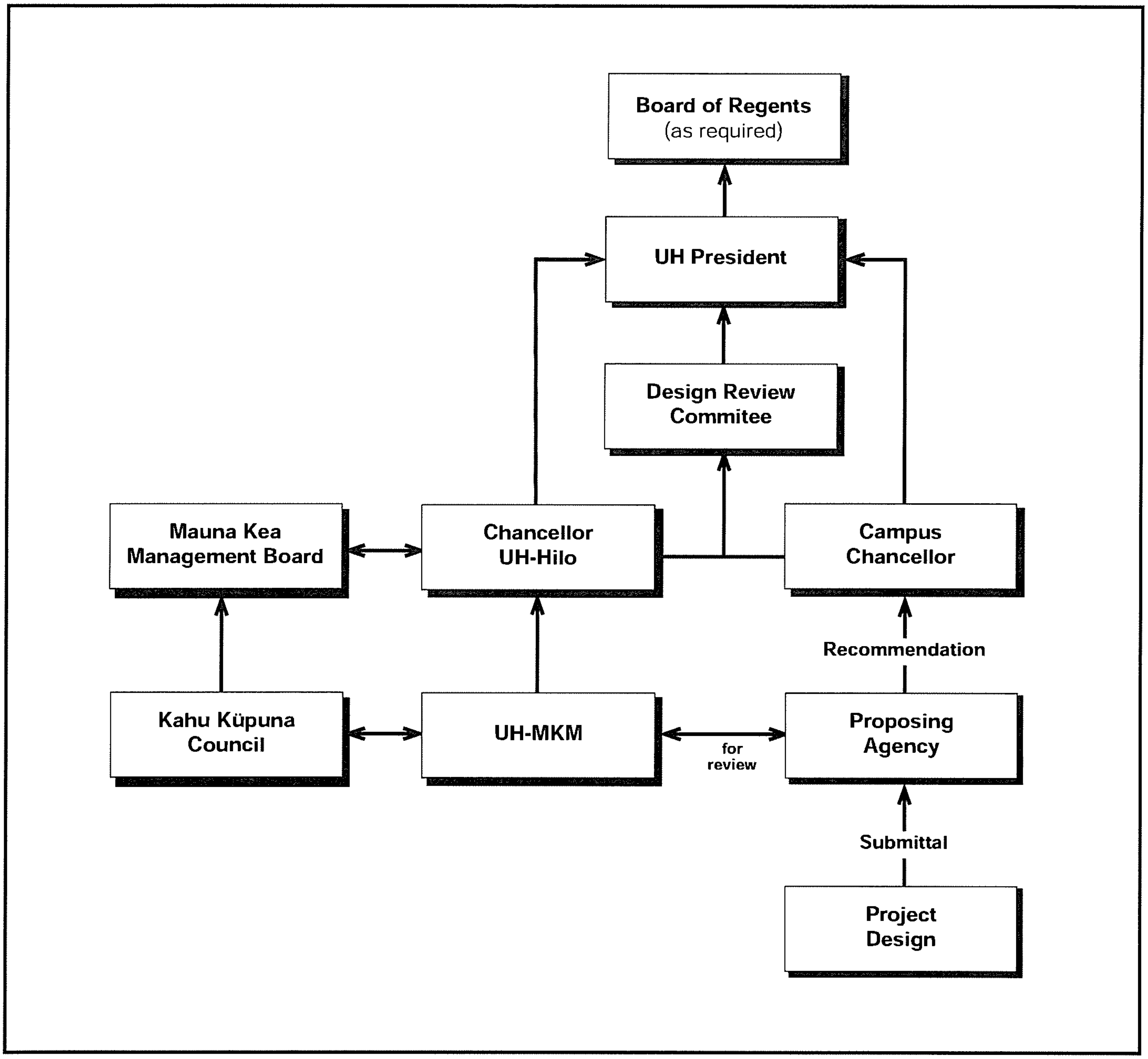
Purpose: A project approval and design review process is to be established to ensure that projects conform to and implement the concepts, themes, and development standards and guidelines set forth in this plan. Plans should support the Master Plan goals and objectives and contribute to the mountain's overall character and environmental quality.

Applicability: Any construction, installation or alteration upon any site, roadway, utility line, building, or other type of structure; any excavation, filling or change to surface topography; and any planting or removal of vegetation at a site may be undertaken in conformance with these procedures.

Participants: The University of Hawai'i Board of Regents and the President of the University of Hawai'i retain project approval and design review authority over all developments in the areas covered under General Lease S-4191. In order to assist the President and the Board of Regents in interpreting the design guidelines and intent of the Master Plan, the establishment of a Design Review Committee (DRC) comprised but not limited to professionals in the fields of architecture, landscape architecture, and engineering is recommended. UH MKM and the Mauna Kea Management Board will also review projects for overall conformance to the Master Plan while the DRC conducts design reviews (Figure XI-2).

General Review Standards: In reviewing plans and specifications the DRC, Mauna Kea Management Board and UH will be concerned with both the overall design concept, design details and overall impact. General concerns will include whether the proposed project:

- Conforms to the goals and objectives of the Mauna Kea Master Plan;
- Is consistent with the Design Guidelines in the plan;



Note: This process is applicable for projects proposed in the Master Plan.

Project Approval and Design Review Procedures

- Will not negatively impact adjacent facilities or uses;
- Promotes resource conservation and sustainability;
- Relates harmoniously to the surrounding landscape.
- Does not add significantly to negative cumulative impacts.

Plans found to be inconsistent with the Master Plan concepts and objectives shall be rejected. Major variations from development standards shall also be rejected. Determinations of consistency shall be at the sole discretion of the University of Hawai'i.

Minor and Major Projects: Separate processes are established for the review of "Minor Projects" and "Major Projects." Minor project review would end with the Office of the President. Major projects would be given final approval by the Board of Regents. Examples of minor projects are providing small structures or changing a building's color. The determination of which process is applied rests with the Office of the President. The decision is open to appeal to the President of the University of Hawai'i.

Design approval for projects that are described in the Master Plan will follow two review paths. The first path would be through UH MKM, the Mauna Kea Management Board and the Chancellor of UH Hilo. The second path would flow through the chancellor of the campus from which the proposal is initiated. For example, IfA proposals would be processed through the Chancellor at UH-Mānoa. Proposals generated out of UH Hilo or the Community Colleges would be processed through the Chancellor of UH Hilo or the Chancellor of Community Colleges. Regardless of the source of the proposal, the one constant would be that all proposals would include reviews and comments by the UH MKM, the Mauna Kea Management Board and the Chancellor at UH Hilo.

Review Procedures – Minor Projects: Upon notice of a proposed action, UH MKM will make an initial determination of the major/minor review process for the President who will make the final determination. The project would be reviewed at various phases. Phases of the review will generally be as follows:

1. ***Schematic Submittal:*** At the initiation of the project, a verbal and graphic submission should be made which outlines the action, describes its major characteristics, and briefly assesses its impacts on any existing or approved facility or use.

2. ***Design Development Submittal:*** After approval of the schematic phase, drawings addressing schematic design comments should be submitted for design development review. Emphasis should be given to relationships (setbacks, colors, materials, etc.) to adjacent properties and existing buildings.

3. ***Final Submittal:*** Should approval be given at the design development phase, final drawings and other documents should be submitted for final approval.

The Offices of the Chancellor will complete all phases of the review within 30 days of the submission of the review documents.

Review Procedures – Major Projects: UH MKM will make an initial determination on major projects for the President who will again make the final determination. This determination is for processing category; not project approval. Actions determined to be major by the President would go through the following process:

1. ***Pre-design Meeting:*** This meeting may include the following participants: the applicant, the project architect/engineer, a representative of the University, a representative of IfA, and a representative of the DRC.

   The purpose of this meeting is to introduce the applicant and the project architect to the design and environmental goals of the Mauna Kea Science Reserve, and to provide a context for further work and reviews. The applicability to the project of the overall design framework and the specific development standards and guidelines established in this Master Plan will be discussed. In particular, information regarding infrastructure and elements such as roadways and landscaping will be clarified. Information regarding the character of the Mauna Kea Science Reserve and Hale Pōhaku will also be provided.

2. ***Schematic Design:*** This meeting is to include the following participants: the applicant, the project architect and other appropriate consultants, representatives of the University of Hawaiʻi and the DRC.

   At least seven days prior to the meeting the applicant is to submit seven half-sized schematic plans to the University for distribution. The schematic plans should include sufficient information to show how the proposed design satisfies the parameters established at the pre-design meeting and the design guidelines of this Master Plan.

   The review will include the following:

   a. Site plan considerations including vehicular and pedestrian circulation, parking, service areas etc. The site plan should show relationships to adjacent facilities and resources.

   b. Overall building massing considering view planes, heights, setbacks, etc. All major sections and elevations should be indicated.

   c. Building characteristics including architectural style, volumetric forms, building materials, colors, etc. and perspective drawings and/or models are encouraged. Models may be physical or 3D computer files.

   d. Landscape plans showing general concepts, plant, rock and ground features.

e. Basic environmental effects (i.e. sunlight and shade, wind surface topography and drainage), especially on adjacent properties and resources.

f. Energy and other resource conservation methods.

g. Provisions for recycling and use of recycled materials.

Whenever possible, recommendations arising from the review will be forwarded to the applicant within thirty (30) days of the meeting. Other meetings in the schematic stage may be necessary if the design is not initially approved. The review period may be extended for up to thirty (30) additional days to review plans for large projects or projects which require more study. Schematic design submittals will also be reviewed by the Mauna Kea Management Board.

3. ***Design Development:*** This meeting is to include the following participants: the applicant, the project architect, representatives of the University of Hawai'i and the DRC.

At least seven days prior to the meeting the applicant is to submit seven half-sized design development plans and outline specifications to the University for distribution.

The information to be provided on the design development plans include the following:

a. Site plan drawings shall at a minimum include the following information: all building locations and sizes, number of stories, setbacks, locations of roads and walks, location and size of parking areas and service bays. Ground elevations with existing and finished grades, drainage, earthwork, utility lines, etc. should be indicated. Special attention should be given to relationships to adjacent facilities and nearby natural or cultural resources. Energy and resource conservation methods should be identified.

b. Review of conceptual floor plan drawings at a scale of at least 1/8" = 1.0' for all building types.

c. Review of elevation drawings. Inclusion of perspective drawings and a physical or computer 3D model is encouraged. Special attention will be given to dome and roof colors, forms and materials. Building colors and materials will also be evaluated.

d. Review of sections of buildings and site. Attention will be given to any major changes in ground elevations in regard to drainage, views and adjacent facilities and natural and cultural resources.

e. Review of landscape drawings. These drawings should show the location, type, size, and quantity of all plant materials, walks, landscape lighting, signs, paved areas, rock and ground surface materials, etc.

The design development review will be completed within thirty (30) days, and a report forwarded to the applicant containing the recommendations and requirements arising from the review and meeting. The review period may be extended for up to 30 additional days to review plans for large projects or projects which are deemed to require more study. Design development documents would also be reviewed by UH MKM and the Mauna Kea Management Board.

Approval will depend on the extent to which the proposed design satisfies the objectives, standards and criteria established in previous reviews, as well as those identified in this Master Plan. Other meetings in the design development stage may be held if the design is not initially approved. In no case should the applicant proceed with construction documents prior to design development approval.

4. ***Construction Documents Review:*** Construction documents will be checked for compliance to design review comments. Two half-sized construction drawings and specifications should be submitted to the University. Approval of the documents or a report listing modifications will be forwarded to the applicant within thirty (30) days of their receipt. The review period may be extended for up to 30 additional days to review plans for large projects or projects which are deemed to require more study. Drawings should, if possible, be accompanied by a computer disk containing the overall site plan and landscape plan.

Approval of construction documents by the Design Review Committee and the University of Hawai'i does not constitute authorization to proceed with the project. Compliance with applicable codes, laws, ordinances, and governmental agency conditions of approval is the responsibility of the applicant.

Construction Review and Approval:

1. ***Duration of Final Approval:*** Any approval provided shall be effective for a period of 12 months and shall be deemed revoked if the approved construction, reconstruction, refinishing, alteration, or other work approved thereby has not begun within the 12 month period. The University may authorize an additional 12 month extension on the approval.

   If approval lapses hereunder, the owner or lessee may be required to resubmit the final plans and specifications for approval. The DRC and the University of Hawai'i shall not be bound by any previous decision in reviewing such plans and specifications, but shall either approve or disapprove the same in writing within thirty (30) days after such resubmission.

2. ***As-built Plans:*** Upon completion of construction, a complete set of as-built plans and specifications for infrastructure improvements will be provided to UH MKM.

Temporary Facilities: Temporary facilities are facilities that, when constructed, are planned for removal within five years of completion of construction. These facilities include test optics, facilities for short term experiments, constructions support structures, temporary cultural, educational or recreational activity shelters and structures and small test facilities.

1. ***Approval Process:*** Temporary facilities will go through the same project review and assessment procedures identified in this section for permanent facilities. As with the permanent facilities there will be a distinction made between Class A and Class B facilities paralleling the Class A and B amendment criteria identified in this chapter. Those that may have potentially significant impacts will be processed through the major projects review channels. Facilities deemed to have minor impact will be processed through the minor projects review track. It is anticipated that most temporary projects may be processed through the minor projects review process. Appeals may be processed through the Director's to the Office of the President of the University of Hawai'i. Temporary facilities need not go through the formal amendment process which would then require a subsequent amendment to remove the facility from the Master Plan when the facility or activity is terminated.

2. ***Pre-application review:*** When proposals for temporary facilities are received, in addition to the normal project review criteria they will be evaluated according to the following additional criteria:
   1. Duration of existence;
   2. Likelihood of extension requests.

3. ***Extensions – Single or Multiple:*** Requests for the extension of a temporary use will be sent to the Director of the Mauna Kea Management Office. Appeals for the granting or denial of extensions would be sent to the Office of the President of the University of Hawai'i. Reasons for the approval of extensions may include the following:

   1. Unusual hardships or delays due to budgets and financing,
   2. Inadvertent delays in the start or conduct of the,
   3. Discoveries that suggest additional areas of investigation,
   4. Mitigation requirements that required additional time.

   The Director may approve extensions from one year to two years as appropriate. A maximum of two extensions may be allowed for a total extension not exceeding three years. Uses extending beyond this would require a formal amendment to the plan.

4. ***Removal After Term:*** All temporary facilities will be demolished and/or removed after completion of the use term unless otherwise exempted by the President of the

University of Hawai'i. The site will be restored to the pre-existing natural site as much as practicable. The Office of Mauna Kea Management will monitor compliance with this condition. The President will receive a report and recommendation from the MKM and the Mauna Kea Management Board before making final decisions on any exemptions to this requirement.

Variances:

Variance requests will be approved or rejected by the President of the University of Hawai'i. Requests for variances from development standards and guidelines may be approved if they are minor in nature and otherwise consistent with the overall goals and objectives of the Master Plan. Variance requests found to be substantially inconsistent with the provisions of this document will not be approved. Variances will be approved after receiving input from the DRC, the Mauna Kea Management Board and UH MKM.

AMENDMENT PROCEDURES

Plan Amendments

The Mauna Kea Master Plan is adopted by the University of Hawai'i Board of Regents and will guide the use and development of the Science Reserve. It is anticipated that there would not be many amendments to the plan during its life. Amendments would be required for large new facilities and major renovations only if they are not anticipated in the Master Plan. Projects identified in the Master Plan would not require plan amendments unless there are significant changes in design or location that have major impacts on the plan itself or the environment. It is proposed that plan amendments be separated into two categories: Class A and Class B amendments.

Class A amendments would be major amendments for proposals that require approval by the Board of Regents. Examples of these include:

- New projects not identified in the Master Plan with site coverage over 2,000 square feet or a building envelop over 24,000 cubic feet (40' x 50' x 12');
- Major expansions of existing facility sites not anticipated in the Master Plan (more than 50% of existing floor area or 2,000 square feet, whichever is greater);
- Improvements identified in the Master Plan which require significant changes in size or location;
- New utility alignments and corridors.

Class B amendments would be administrative. Final approval for Class B amendments would rest with the President of the University of Hawai'i. Class B amendment requirements also apply only to projects that are not anticipated on the Mauna Kea Master Plan. The following are examples of Class B amendments:

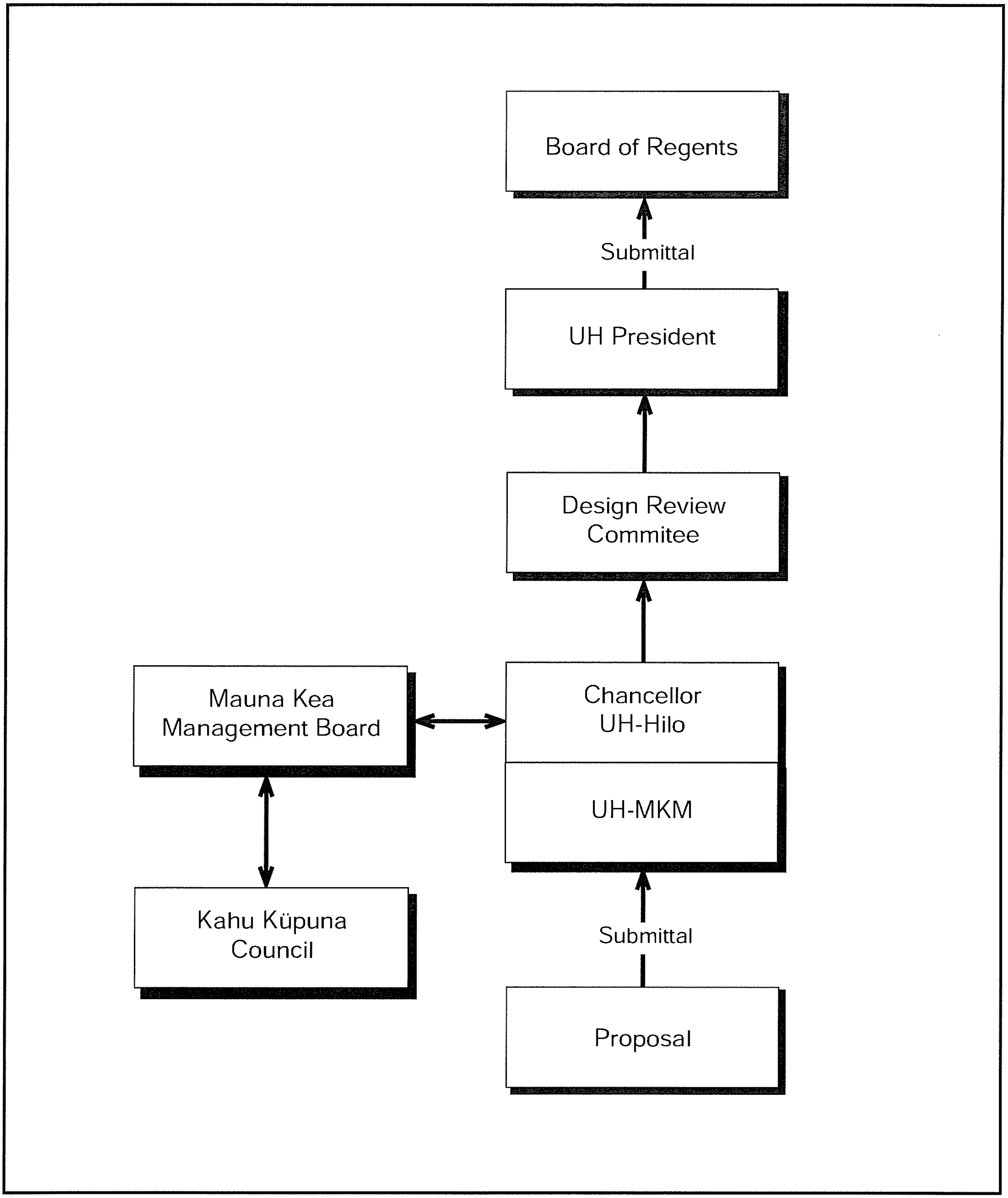
- Significant land altering proposals unanticipated in the Master Plan with a ground coverage of less than 2,000 square feet and a volume of less than 24,000 cubic feet;
- Unanticipated additions (less than 50% of existing floor area or 2,000 square feet, whichever is greater);
- Accessory support facilities;
- Comfort stations;
- Temporary structures;
- Roadway and utility improvements within existing alignments and corridors;
- Other unanticipated proposals such as significant equipment platforms, parking areas or cultural facilities such as *heiau* over 2,000 square feet.

Exempt Activities: Many improvements would not require plan amendments even though not explicitly anticipated in the plan. Exempt actions would be reviewed by the UH MKM, Office of the Chancellor. Questions of qualification for exemption would be decided by the President of the University of Hawai'i. Exempt activities include but are not limited to the following examples:

- Small *ahu* and shrines used for traditional cultural practices;
- Renovations within existing structures;
- Repairs to existing facilities;
- Exterior renovations which do not significantly change the scale or character of the structure;
- Utility repairs and upgrades within existing lines, conduits and utility corridors;
- Routine and emergency roadway repairs, guardrails or vehicle ramps;
- Minor drainage improvements;
- Addition or deletion of signage;
- Installation or removal of walls and fences;
- Minor landscaping;
- Other minor activities such as the placement of instructional and safety signs and movement and placement of rock boulder lines.

Rules for amending the Master Plan are guided by the rules of policies of the Board of Regents. Board of Regents procedures for plan amendments are specified in their rules entitled "The Facilities Planning Process for Implementation and Management of Long-Range Development Plans, University of Hawai'i". Board of Regents information requests include program justification, functional relationships, square footages, design requirements, alternative sites analyses and special studies, as needed.

All amendments would be processed through the UH MKM and the Chancellor of UH Hilo (See Figure XI-3). All amendment proposals would be reviewed for general conformance with the Mauna Kea Master Plan goals and objectives.



General Master Plan Amendment Procedures for Science Reserve

For Class A amendments, the office would receive and process all applications. UH MKM would review the application, suggest changes or additions and send the proposal with its review and recommendations to the Office of the Chancellor at UH Hilo. The Office of the Chancellor would transmit proposal material to the Mauna Kea Management Board for their comment. The Board would submit its comments and recommendations to the Office of the Chancellor. If the proposal is a building or a project that may have an impact on the physical or aesthetic qualities of the mountain the Office of the Chancellor may request additional review by a design review committee attached to the Office of the President. The design committee would review the proposal and submit its comments and recommendations to the Chancellor. The Office of the Chancellor at UH Hilo would prepare a report and forward the Management Board's comments, design review comments and its own recommendations to the President of the University of Hawai'i for consideration by the Board of Regents.

Class B amendments would follow the same procedure as Class A amendments except that final decisions would rest with the President of the University of Hawai'i.

Classification of a proposal as either Class A, Class B or Exempt does not obviate the need for any other pertinent federal, state or county requirements set by statutes or ordinances. Many plan amendments are likely to require Chapter 343 Environmental Assessment or Environmental Impact Statement documentation. If the UH MKM is not the proposing agency, it should begin its review of these documents at the pre-consultation stage. Other frequently needed reviews are historic sites review and Section 7 endangered species consultation. Proposals that may impact significant historic sites or traditional cultural properties would require DLNR review and approval even in the Science Reserve. Consultation with SHPO is recommended at an early stage in project development.

ADMINISTRATIVE RULES

Administrative Rules should be adopted within one year of the formation of the UH MKM and the appointment of the Mauna Kea Management Board. Rules should be adopted for both the MKM and the Management Board.

AUDITOR'S REPORT RESPONSES

As noted in Section 8 the Legislative Auditor's Report concluded with a number of comments and recommendations. The following section responds to the Auditor's Report. The bold sentences and phrases are the auditor's comments and recommendations.

Management:

- ***Develop rules and regulations for development and public access in the summit area and Hale Pōhaku.***
  Rules for the Science Reserve and Hale Pōhaku are to be developed and processed by the UH MKM. Rules and regulations will be adopted pursuant to Chapter 91. Tentative schedule for rules adoption is June 2002. Public access will not be restricted but it will be managed.

- ***Hire ranger/guides at Hale Pōhaku who will be there on a daily basis.***
  Rangers will be an integral part of the UH MKM. There will be a minimum of two rangers on the mountain every day. They will operate out of Hale Pōhaku. These rangers will be trained in cultural and natural resource management.

- ***Require registration of visitors for education and safety reasons.***
  This is the primary reason for managed access. Visitor registration procedures will be part of the proposed rules being developed. It is anticipated that registration will occur at the VIS at Hale Pōhaku and managed by the ranger. Registration will include orientation on safety, environmental and cultural aspects of Mauna Kea.

- ***Develop milestones, specific timeframes & other controls to ensure implementation.***
  The implementation schedule presented in this chapter identifies milestones and time frames. Other controls and assurances of implementation are identified in Section 10 under Management Plan. Incorporating the UH MKM as an integral part of UH Hilo makes the management of Mauna Kea a clear responsibility accepted by the University of Hawai'i. It also establishes a sustainable funding platform for the office.

- ***Develop a forum for continuous community input.***
  The appointment of the proposed Mauna Kea Management Board provides a forum for continuous community input. Additionally, the creation of a Kahu Kūpuna Council creates an added dimension and authority to the community's voice. Finally, as programs are developed it is anticipated that docent programs on many subject areas will be created providing ongoing partnership with volunteer organizations and community members. Volunteer groups will be encouraged to assist in the stewardship of the mountain during events such as clean-up days or possible future programs such as silversword re-vegetation or habitat restoration in the māmane-naio forest around Hale Pōhaku.

- ***New method for measuring impact.***
  Telescope counting was criticized in the Auditor's report as an inadequate method for measuring impact which did not take into account changes in technology. Interferometers were specifically identified as needing special treatment. The updated Master Plan measures impact more specifically by observatory type, external impact as measured by design guidelines and improvements evaluated by site location

and type. Maximum sizes and color are included in the evaluation criteria. Proposed projects are grouped into recycled sites, expansions of existing facilities and new locations. Adoption of this Master Plan and its project review process provides a new and specific methodology for assessing the Master Plan impact of each facility. The Plan also requires that projects which deviate from the Master Plan's descriptions or are not described in the Master Plan must under go full environmental review (EIS) as major amendments to the Plan.

- ***Measure impacts individually and cumulatively.***
  Individual and cumulative impacts are addressed in the Master Plan EIS process. State and Federal EIS laws both require analysis of individual and cumulative impacts. This is addressed by the formation of UH MKM and the Mauna Kea Management Board. These two entities will now be a part of every EIS review process and ensure broad and comprehensive reviews which will include individual and cumulative impacts. In addition, all individual projects must be individually and cumulatively addressed in project specific Environmental Assessments and/or Environmental Impact Statements.

- ***State specific carrying capacity.***
  - The issue of carrying capacity was discussed with the Office of the Legislative Auditor. It was clarified that the comment was generic and not a specific reference to a methodology or specific study product. It is understood that the technical carrying capacity of the Science Reserve is huge; limited only by available sites, infrastructure, critical habitat, historic sites and the interference of one facility by another. The Science Reserve is large and capable of housing many more instruments or observatories. The concept of social carrying capacity used in recreation and wilderness planning does not result in clear limits to capacity because of differences in opinion and tolerance. The concern implied behind the comment was addressed by limiting physical development to an Astronomy Precinct of approximately 525 acres and re-designating the rest of the Science Reserve as a Natural Cultural Preservation Area. Several factors relating to carrying capacity were instrumental in the defining the boundaries of the precinct. First, all undeveloped summit puʻu were removed as future development sites. Additional Wēkiu bug habitat was avoided. Specifically, the precinct was defined on the west by eastern edge of the Puʻu Pōhaku NAR boundary. To the north, consideration of the concentrations of archaeological sites at the outer edge of the summit plateau defined the limit. On the eastern side, view protection and the retention of the pristine character of the eastern flank limited development to the developed areas of the summit ridge. The southern boundary was based on the protection of a westward view corridor from the true summit (Kūkahauʻula), and an analysis of views and relationships between Puʻu Poliʻahu, Waiʻau, Kūkahauʻula, Līlīnoe and the adze quarry (Keanakākoʻi). Attempts were made to minimize future disturbance of the southern edge with the idea of protecting a relatively intact cultural landscape. These factors relate to the concept of carrying capacity implied by the Auditor's report and the companion recommendation to identify no-build areas.

- ***Require management plans that have time frames.***
  The management plans described in this Plan include the time frames identified in this chapter. While some deviations may occur due to unforeseen circumstances, the inclusion of major stakeholders and the community as partners with the University of Hawai'i in the decision process ensures its timely implementation.

- ***Ensure internal deadlines prior to release of land or sub-leases.***
  The Auditor's report states that sub-leases and other land management issues are not completed in a timely manner. This criticism was largely aimed at the Department of Land and Natural Resources. In its report to the Legislature, the DLNR mentioned the following:

  1. It will work with the UH Institute for Astronomy to ensure the completion of sub-leases prior to the start of construction.
  2. Land Division has begun a computerization plan to track and administer permits and sub-lease issuance in a timely manner.
  3. Ongoing discussions with the University regarding lines of authority and management responsibilities on the mountain.

  Development of UH MKM will facilitate the performance of these responsibilities.

- ***Make sure all responsibilities are assigned; either UH or DLNR.***
  It is noted that all responsibilities are currently assigned by legal requirements. The problem in the past has not been in the assignment of responsibilities but in the resources and personnel needed to address them adequately. Additionally, overlapping responsibilities, the complexity and generality of rules and policies has led to a public perception of mismanagement, unfulfilled responsibilities and ignored promises. The creation of the UH MKM at UH Hilo addresses this issue by creating a lead agency based on the Big Island that can receive concerns and make sure they are addressed or brought to the attention of the responsible agency. UH MKM will function as the public point of contact with the University and its responsibilities. For other responsibilities UH MKM will act as liaison and bridge to the appropriate agency and assist in the follow through of community concerns.

Historic/Cultural Resources:

The Auditor's report was critical of the neglect of cultural issues and resources. The criticism is one of not valuing and protecting both cultural sites as well as traditional cultural practices. Specifically, the report calls the University to do the following:

- ***Address cultural and historic issues.***
  Cultural and historic issues have been addressed in a number of ways. First, the planning process has resulted in new knowledge about the cultural and historical resources of Mauna Kea. In the development of the updated plan a detailed

archaeological study was conducted by Dr. Patrick McCoy of the State Historic Preservation Office. His final report is currently being completed. Additionally, ethnographic studies have been conducted by Kepā Maly which include archival searches into Hawaiian language documents dating back to the 19th century and oral history interviews with cultural practitioners, kūpuna and kama'aina. The information gathered in the ethnographic studies have been assessed by PHRI, Inc. Input was also received through the Mauna Kea Advisory Committee appointed by the President of the University of Hawai'i. Committee members solicited additional input from other community sources. Holly McEldowney is working on a historic preservation plan for the Science Reserve and the SHPO is considering the designation of the summit area as a historic cultural landscape.

The information from the archaeological survey, ethnographic study and the President's Mauna Kea Advisory Committee were incorporated in a GIS database. The components and configuration of the Physical Plan within the Master Plan incorporates both physical, spiritual and symbolic cultural issues in a balanced way. The importance of the cultural values in the Science Reserve are emphasized and formalized by the designation of 10,763 acres as a Natural/Cultural Preservation Area. Astronomy development areas were reduced to a 525-acre precinct.

The Cultural Resource Management Plan, siting criteria and design guidelines all consider potential impacts to cultural and archaeological site and resources. Site specific inventory level surveys are requirements prior to facility siting. Cultural sensitivity to view impacts are considered and minimized where practical. All undeveloped summit pu'u are removed from future development.

A permanent Kahu Kūpuna Council is recommended to help guide the University's management of Mauna Kea's cultural resources and cultural practices. The committee would also assist in the resolution of questions and potential conflicts.

New protocols during visitor registration will improve sensitivity to cultural resources and values. Signage plans and the cultural resources management plan are geared to the protection of these resources by directing visitors to less sensitive areas and educating them about the value of these resources. Rangers will be especially trained in this area to educate the public and protect resources.

New protocols for construction are also proposed to protect cultural resources. The details of the protocols will be delineated in the Preservation Plan being prepared by the State Historic Preservation Office. Some features of this plan will include monitoring programs and the presence of qualified archaeologists during excavations and related construction activities that may have the potential to impact cultural properties.

- ***Complete the Historic Preservation Plan.***
  A memorandum of agreement was signed between the University of Hawaiʻi and the DLNR for the State Historic Preservation Office to prepare the Historic Preservation Plan at the University's expense. A detailed outline has been developed to date. As noted earlier, a proposal in the Historic Preservation Plan to designate the summit region as a historic, cultural property is being considered. A full draft of the Plan was completed in March 2000 by the State Historic Preservation Office with adoption following public review.

Maintenance:

- ***Periodic inspection and documentation of trash control.***
  This is occurring. In the future, this responsibility will be handled through the UH MKM.

- ***Remove remnants of old equipment.***
  The two instances that led to this comment have been removed. New sublease agreements will include this requirement as a routine condition and UH MKM will monitor compliance.

Physical Planning Guidance:

- ***Identify areas suitable for astronomical development.***
  Areas suitable for astronomy development have contained in an "Astronomy Precinct" of approximately 525 acres.

- ***Identify critical habitats for plants, invertebrates and other endangered species.***
  There is no officially designated endangered species in the Mauna Kea Science Reserve. The Wēkiu bug (*Nysius wēkiucola*) is being considered for endangered status but this has not yet occurred. The notion of critical habitat is an unclear parameter in the absence of knowledge about the life cycle of the species, critical population size or area distribution. However, new biological studies identified habitat areas for ferns, lichen, moths, spiders, and Wēkiu. These areas were identified, placed in a GIS database, and mapped. Areas considered sensitive habitat were avoided as much as possible. The importance of the māmane-naio forest as a critical habitat of the palila has always been considered a given. Development at Hale Pōhaku recognizes the importance of this habitat and follows guidelines which avoid or minimize disturbance to this ecosystem.

- ***Identify no build zones.***
  The area outside the Astronomy Precinct is a "no build" area. Theoretically, without such a restriction, development could occur anywhere in the 11,288 acre Science Reserve. The VLBA is a case in point.

- *Include facilities besides telescopes.*
  A recreation support pavilion is identified in the summit area. Other non-telescope facilities were not included because there were no specific requests from other users. It was decided that facilities would not be proposed unless there were users groups requesting them since it was not the intent of the Master Plan to encourage unsupported development in the summit area.

  At Hale Pōhaku the Plan proposes sharing some facilities and encouraging the use of former construction cabins for other non-astronomy purposes. The Subaru Cabins are specifically targeted for this function. The VIS is also planned for expansion to accommodate other uses. The stone cabins at Hale Pōhaku might also be renovated for other uses.

Statutory Recommendations/Sublease Agreements:

- *Incorporate EIS mitigation measures as CDUA conditions.*
  This is a recommendation to the Board of Land and Natural Resources since the BLNR issues conservation district permits. The Department of Land and Natural Resources has stated in its December 1998 response to the State Legislature that it agrees with the purpose of this recommendation and will pursue its implementation more diligently in the future.

- *Relate permit conditions to sub-leases.*
  DLNR and the University of Hawai'i will review this recommendation and where applicable include permit conditions in the subleases to any future tenants. This will also be considered in the renewal of existing subleases.

- *Adopt rules for Chapter 6E, Historic Preservation Program.*
  Draft rules for Chapter 6E were published and circulated for review in May 1999 and Fall 2000. After a period of public review and revision, it is anticipated that these rules will be adopted in late 2000 or early 2001.

All items in the Legislative Auditor's report have been addressed (see Table XI-1). Several items have already been completed and the remainder is projected for implementation with the adoption and commencement of this Master Plan Update.

Table XI-1
Response to Auditor's Recommendations

	Addressed in MP	Implementation Milestone
Management		
Development rules and regulations for summit area and Hale Pōhaku	✓	Draft 6/2001 Final 6/2002
Hire ranger/guides at Hale Pōhaku who will be there on a daily basis	✓	7/2000
Require registration of visitors for education and safety reasons	✓	
Develop milestones, specific timeframes & other controls to ensure implementation	✓	6/2000
Develop a forum for continuous community input	✓	6/2000
New method for measuring impact	✓	11/1999
Measure impacts individually and cumulatively	✓	8/1999
State specific carrying capacity	✓	
Require management plans that have time frames	✓	6/2000
Make sure all responsibilities are assigned; UH or DLNR	✓	6/2000
Historic/Cultural Resources		
Address cultural and historic issues	✓	11/1999
Compile the Historic Preservation Plan	DLNR	6/2000
Adopt rules for Chapter 6E, Historic Preservation Program	DLNR	Draft 9/2000 Final 4/2001
Maintenance		
Periodic inspection and documentation of trash control	✓	4/1999
Remove remnants of old equipment	✓	Completed
Physical Planning Guidelines		
Identify areas suitable for astronomical development	✓	6/2000
Identify critical habitats for plants, invertebrates and other endangered species	✓	6/2000
Identify no build zones	✓	6/2000
Include facilities besides telescopes	✓	6/2000
Statutory Recommendations/Lease Agreements		
Incorporate EIS mitigation measures as CDUA conditions	DNLR	Completed
Relate permit conditions to lease	DLNR	Ongoing
Ensure internal deadlines prior to release of land or leases	DLNR	2000

COMMUNITY INPUT: PROCESS, COMMENTS AND RESPONSES

The community-input process was multi-tiered and very involved. It began with the formation of a Mauna Kea Advisory Committee established by President Mortimer. Twenty-four members were appointed. Nine of these members were part Hawaiian. This committee met for 15 months (often twice a month), participated in field trips and heard expert testimony from IfA, advisory committee members and a panel of cultural experts.

The advisory committee held two series of public meetings. The first set of meetings were a preliminary set of informational hearings in September of 1998. These meetings were held in Hilo, Waimea and Kona. The committee held another series of public meetings at the same communities after a draft 2 of the Plan was developed in May of 1999. Input was received at both sets of public meetings.

Input from the committee played a major role in shaping the Master Plan. The committee approved draft 2 for circulation and review in the community. The committee later recommended the proposed new management structure but voted to withhold recommending the draft 3A version of the Plan until the management plan was in place and native Hawaiian cultural issues were addressed further.

A committee recommendation was drafted on June 2, 1999 and reiterated in a final letter to the Board of Regents in August 25, 1999. The final recommendation stated,

"Our committee was charged in June of 1998 to provide needed input to the University of Hawai'i regarding the conditions under which future development should occur on Mauna Kea on the Island of Hawai'i. Our committee has collected important input regarding Mauna Kea. A considerable portion of this information has been incorporated into Draft #3 of the Mauna Kea Science Reserve Master Plan developed by Group 70.

It is our recommendation that any future development on Mauna Kea be coordinated closely with the community. This coordination of community input should be via the Mauna Kea Advisory Board and the Kahu/Kupuna Advisory Committee in a formal and permanent manner. Along these lines, we reiterate our recommendation of June 2, 1999 that there be no further construction until a plan is approved, the Mauna Kea Management Authority is funded and the Mauna Kea Advisory Board is established. The Mauna Kea Science Reserve Master Plan might be approved by the Board of Regents upon further attention to Native Hawaiian concerns."

Throughout the planning period the project team met with other organizations and gave individual presentations as requested. Groups that were contacted included the Hawaiian Civic Clubs, DHHL homestead associations in Keaukaha, Waimea and Kona, Hawai'i County Mayor's office, State and local units of the ILWU and Big Island Labor Coalition, Hawai'i Environmental Coalition and business organizations such as the Hawai'i Economic Development Board and the Kona Kohala Chamber of Commerce. The team also spoke to many individuals.

As part of the master planning process an ethnographic study was commissioned and an 800 ± page oral history report compiled representing 25 interviewees.

Additionally, the EIS process provided another avenue of input for public comments. The EIS was completed prior to the finalization of the Master Plan.

Recognizing the complexity and depth of the Master Plan, the need for a vehicle for broad public dissemination of the Plan was expressed in a summary circular (Appendix O). This 8-page, newsprint, graphic format document highlights the educational, management and physical elements of the Master Plan, and it incorporates community voices expressed during the evolution of the Final Plan.

Mauna Kea inspires all who work and live on the mountain, feel its shadow and view it from afar. This is true of those who favor development or oppose it.

While a detailed listing of the issues, questions, concerns and comments would be too voluminous, the following is a summary of major comments and how they were addressed in the planning process.

Cultural Sensitivity: Issues of cultural sensitivity were raised repeatedly. The sensitivity of the plan to Hawaiian cultural values was mentioned and questions were raised as to whether community voices would be heard. Also, the initial plans were criticized for showing the location of burial sites identified from studies conducted by the State Historic Preservation Division. Part of this criticism was based on the perception that native Hawaiian voices were not part of the advisory or decision making agencies. At the same time some native Hawaiians mentioned that the voices that were loudest did not necessarily represent the majority of the community.

The Master Plan responds to these concerns in many ways. First, responding to comments about the cultural and spiritual importance of the mountain, the Plan reduced the potential area for astronomy development from the full Science Reserve of 11,288 acres to an astronomy precinct of 525 acres. Further, specific siting areas for telescopes were designated comprising 150 acres of land within the Astronomy Precinct. This is a reduction of 10 acres from the areas specified in the 1983 Long Range Development Plan for telescope siting.

The remaining area is proposed as a natural cultural preserve where astronomy facilities would not be developed. The auditor's report had suggested a "no build" line but the initial view was that this would be excessively restrictive to astronomy. Upon further review and responding to the input on the cultural importance of the summit area, the idea of the precinct was developed. The precinct is essentially the boundaries of a no build line for astronomy to contain its impact on the cultural landscape of the summit. The shape of the precinct was specifically tailored to avoid historic sites, preserve view corridors related to possible cultural lines of sight and maintain the integrity of the cultural landscape as much as practicable. The southern boundary was moved northward to create greater distance from Lake Wai'au, which is clearly one of the most significant sites in the summit region. The northern boundary was pulled back to avoid the ring of shrines at the 13,000 foot elevation. The line was adjusted to leave Pu'u Poli'ahu out of the precinct. The eastern boundary was pulled back to reduce the potential visual impact from the Hilo side of the mountain.

Second, the Master Plan gives greater sensitivity to historic sites, cultural values and Native Hawaiian issues. The designation of the vast majority of the Science Reserve as a natural cultural preserve is a recognition of the cultural resource value of the mountain. All designations of burials were removed from the Plan. Where known, earlier indigenous place names are used instead of English names or Hawaiian names of later derivation. An example of this is the use of the name Kūkahau'ula for the summit cone. Historic trails are identified and marked for preservation. Larger Shrine complexes are identified for better protection and management. An ethnographic study and archaeological study were specifically commissioned for the master planning process. Both studies were the most extensive studies of their kind on the mountain to date.

Third, the Plan protects all undeveloped summit pu'u. As mentioned previously, Poli'ahu was deleted out of the astronomy precinct even though it is recognized as an excellent observatory site and a roadway and test telescopes were previously placed on the cone. The Plan specifically identifies undeveloped pu'u as features that need special consideration. The recognition that these pu'u were seen as the kino, physical manifestation, of akua played a role in this special consideration. The potentially negative visual impact on the cultural landscape of development on the ridges and pu'u was also a consideration in this decision.

Finally, to maintain sensitivity to these issues, the master plan proposes a Mauna Kea Management Board as an integral part of the management of the mountain. These community voices will play an important role in keeping a broad management perspective. Beyond the Board, the Master Plan recommends that a Kahu Kūpuna Council be established to assist the Office of Mauna Kea Management in addressing these issues. This is a recognition that Native Hawaiian concerns are of special value and require special knowledge and wisdom to address appropriately. This committee will be composed of experts in Hawaiian culture and practice and will advise the Office in developing appropriate protocols and programs for the mountain and its management. Docent programs and training sessions will be developed to improve the cultural management skills of staff and broaden the sensitivity of workers and visitors.

Land Ownership: The question of land ownership was brought up many times in different forms. The summit of Mauna Kea is State land controlled by the Department of Land and Natural Resources and leased to the University of Hawaii. Sometimes the comments would focus on the ceded lands issue and how this meant that OHA or some other representative organization of kanaka maoli should receive rent for the land and have decision making authority over the land. Comments were made that Mauna Kea is not "your" land, it is Hawaiian land, and that ceded land is just a legal euphemism for stolen colonized lands.

The Master Plan does not respond to comments on sovereignty, ceded land revenues and the public trust because these issues are larger than the Mauna Kea Science Reserve Plan or the University of Hawai'i. They are beyond the scope of the Plan. The Plan is based on the 1968 lease from the Department of Land and Natural Resources (Lease No. S-4191) to the University of Hawaii and the provisions contained in that lease.

Regarding ceded land, current negotiations between OHA and the State of Hawai'i will set the tone for the manner and type of compensation. Also, the University, as an educational institution, is a beneficiary of the trust and is exempt from the payment of the 20% revenues to Native Hawaiians. As a co-beneficiary, the University is also a recipient of public trust revenues. Additionally, the position that the land belongs to native Hawaiians and not the broader public, as represented by the State of Hawai'i, is not addressed in the study because that issue is also beyond the scope of this plan.

Sacredness of the Mountain/Summit: Along with reverence for the beauty and grandeur of Mauna Kea there is a broad sentiment about the sacredness of Mauna Kea as the piko (highest point) in the Hawaiian Islands and the Pacific Basin. Also, the mountain's association with Wākea the sky father and the snow goddess Poli'ahu and her kin add to this belief. The shrines on the summit area enhance the sense of sacredness, as do the one known and three suspected burial sites on the upper slopes. There has also been oral testimony about burials of important ancestors in the summit area. Others have said that the region is wao akua, the realm or wilderness of the gods. Some have stated that construction on the summit should stop because it is a desecration of the sacred mountain. Some have claimed that development has disturbed the iwi of ancestors. As a comparison it has been questioned whether astronomers would build on the sacred sites of other people.

These sentiments have been some of the most difficult to resolve. Distinctions between the sacred and the profane are not the same in Hawaiian culture as they are in western societies. Wao aku is not heaven as the literal translation would imply. It did not mean people did not do things or build things in the sacred place. If this were so, the existence of Keanakāko'i in the summit region would not make sense. Keanakāko'i is the largest known paleolithic adze quarry in the world. The adze quarry is literally a manufacturing place for stone implements with shelters, work stations and shrines. What seems important is the protocol, the attitude of respect and appreciation for nature and gods. Worship and daily life were one in the ancient culture. One asked permission of the gods and the aina before one took or used the resource and then thanked the gods for their forbearance and generosity.

Process is as important as substance in this situation. Each situation must be viewed individually with the appropriate sensitivity. The Master Plan responds to these concerns by creating a new management office and Kahu Kūpuna Council. The Office of Mauna Kea Management should develop new protocols that express this attitude. These protocols should be developed with the advice of the Kahu Kūpuna Council and include broad representation from the Native Hawaiian community. These protocols are appropriately a part of the management rules and regulations that will be adopted pursuant to Chapter 91. The rule making process is separate from the Master Plan process and takes anywhere from one and a half to two years to complete. We already know that the values of aloha ʻāina, lōkahi and malama pono need to be respected. Ahupuaʻa management principles should also be used as guides where they are appropriate. The incorporation of these values into the rules and management structure of the mountain will be the responsibility of the Office of Mauna Kea Management.

Traditional Cultural Practices: Concerns have been expressed in public testimonies that traditional cultural practices will be restricted and sites desecrated. Some of this fear and anger stems from an unfortunate incident that occurred because of misdirected policy on the part of a member of the University of Hawaiʻi maintenance staff. A current cultural practitioner had created new ahu type shrines with special stones, pōhaku, in the summit region. Maintenance staff removed the rocks. Apologies have been made and the staff instructed to leave such features alone in the future, but suspicion and hurt feelings remain. Other comments stem from the implications of the State Supreme Court's PASH decision and what this means for cultural resources in the Science Reserve. A specific example that has been raised is the modern day removal of adze material from Keanakākoʻi to make adzes and other stone tools. Another example is the alternation of shrine sites in renovation and repair efforts as modern practitioners re-use these sites in revivals of earlier worship activities.

In early discussions there were suggestions that modern cultural practitioners be given designated areas to engage in cultural practices. This suggestion was rejected because it was felt that there was no reason to place such restrictions on cultural practitioners.

The Master Plan does not restrict traditional cultural practices anywhere in the Science Reserve. The single exception is to activities that may impact known historic sites. The responsibility for protection of historic sites rests with the State Historic Preservation Office and they are statutorily required to protect these sites. These procedures will be incorporated into rules and regulations that will be guided by Dr. Holly McEldowney's Historic Preservation Plan which was commissioned for the Master Plan. DLNR does not have enforcement personnel on the mountain and will rely on the management staff of the University of Hawaiʻi to assist in this mission. Additionally, staff training programs and docent programs will raise the awareness level of all people who would be involved in some aspect of the management of Mauna Kea. Finally, while the common perception is a fear of restrictions on traditional practices, in reality the Plan represents a restriction on astronomy development.

Historic Sites: Charges have been made that historic sites have been damaged and bones have been desecrated. Others have stated that only a portion of the summit area has been surveyed and a complete inventory is needed. The concept of viewing the summit region as a cultural landscape rather than scattered distributions of individual sites has taken on greater value. Comments have often noted that landforms are often significant features and that the relationships between forms is as important as the features themselves; including areas that are devoid of features.

One incident of the disturbance of a lithic scatter site near Hale Pōhaku has been documented. The State of Hawaii has not been able to verify charges relating to the desecration of bones because the people making the statement have not disclosed the locations where the incidents took place. Also, no reports about bones being exposed were filed during construction of the observatories to verify the charge. Finally, the archaeological survey conducted by DLNR for the master plan did not identify any burial sites impacted by construction. Without information it has been impossible to verify or deny the charge. However, these comments have been persistent. The veracity of this criticism is difficult to assess since cultural protocols often prohibit knowledgeable people from disclosing this information.

The Master Plan response was to commission DLNR to conduct an archaeological survey, evaluate the cultural significance of the summit area and develop a management plan for the cultural resources. These studies were commissioned a year and a half ago. The completed inventory is the most extensive study of its kind done to date. The management plan is still in a preliminary draft stage. While a more comprehensive inventory would be good to have, due to limitations of time and funding the study focussed on the areas that have greater potential of being impacted. The university will institute a monitoring program for historic sites and encourage future studies in this area.

Based on the study commissioned for the Master Plan, DLNR is considering designating the summit region as a traditional cultural property, with appropriate regulatory criteria, which have not yet been developed. The Office of Mauna Kea Management will need to consider these criteria in developing their rules and regulations. The Master Plan recognized the concept of natural landforms being the kino or physical embodiment of gods and spirits and the plan protects all undeveloped pu‘u. The concept of the cultural landscape is recognized in the designation of the vast majority of the Science Reserve as a natural cultural preserve. The Astronomy Precinct was deliberately framed to maximize the visual panorama of the cultural landscape.

Environmental: Testimony on environmental mismanagement has covered a broad range of issues but centered mostly on three areas: the decline of the wēkiu bug population and the destruction of its habitat, the lack of adequate information and monitoring programs and the lack of carrying capacity studies of the summit. The decline of the wēkiu population has been noted in many comments. Some comments express concern about the Palila habitat at the Hale Pōhaku elevation.

Much of the known information about environmental resources is a result of studies commissioned for master planning efforts in the early 1980s and the current effort. Recent studies commissioned for the Master Plan show a significant decline in the population of the wēkiu bug. While the reason for the decline in population is not known (several theories have been postulated from lack of snowfall, loss of habitat to new alien predators) future monitoring programs are expected to provide more information that will address the question and suggest solutions. The habitat of the endemic wēkiu bug is the cinder cones in the summit plateau region. Destruction of some prime wēkiu habitat was expected to occur during the development of the ridge sites for observatories.

The Master Plan responds to the issue by minimizing the potential destruction of additional sites by protecting undeveloped summit cones (the primary wēkiu bug habitat) from future development. Additionally, within the existing developed summit ridge, construction will be limited to recycling of existing sites, which are already impacted to minimize areas of disturbance. It should be noted that in the most recent study, more wēkiu were found near disturbed sites close to the observatories than in relatively undisturbed sites along the summit cone.

Carrying capacity is a broad, vaguely defined concept that refers to the capacity of a place to receive or "carry" an activity or population. This capacity is often defined in terms of density related to the supporting infrastructure or resource base. The term originates from biological population studies of animal and plant species, which proliferate beyond the ability of the resource base to support them and the population crashes. It is closely related to the notion of sustainable yield. Others have suggested measures such as social carrying capacity but these concepts are vague, culture bound and highly subjective. There is no clear consensus about what social or cultural carrying capacity should measure and how they should be measured. Without identified criteria or methodology it was decided that defining social or cultural carrying capacity would not be a fruitful exercise to pursue further. Therefore, a carrying capacity study was not conducted because it was clear that regarding physical carrying capacity, the mountain is huge, existing infrastructure has available capacity and the site's physical capacity far exceeded what was proposed for the mountain. The Plan responds to the concern behind the question by severely limiting telescope development well below physical limitations and regulating development of facilities.

Visual Impact: Many comments were made about the visual impact of the observatories. Some said they were ugly like pimples on the mountain. A few thought they were beautiful and inspiring. Others said the scale was inappropriate to the mountain and they alter the natural pristine quality of the landscape with an industrial look. Some suggested burying sections of the observatories to reduce visual impact.

The Master Plan responds to these issues by recommending color changes, directing material selections, recommending design solutions and other methods to reduce impact. Top scientists and technicians have been contacted and they have indicated a willingness to address the challenge of reducing the visual impact of observatory facilities. In addition, the master plan has set up design criteria and a design review process that will ensure designs that minimize visual impact. The criteria and guidelines that have been recommended are the most challenging in the world for astronomy facilities.

Commercial Activity: Some have expressed concern about commercialization of the mountain. People seem generally opposed to commercial uses of the Science Reserve. Some have stated that astronomy is a commercial activity. Others have said 20% of revenues from commercial uses should be given to OHA.

Other than minor concession operations and the possible periodic rental of cabins at Hale Pōhaku no commercial operations are proposed in the Master Plan. The University of Hawai'i views astronomy as an educational and research activity, not a commercial activity. Under current DLNR licensing procedures, purely commercial uses will pay 20% to OHA.

The Master Plan establishes the Office of Mauna Kea Management to address commercial activities and their coordination with the Department of Land and Natural Resources.

Hunting: The Master Plan places no restrictions on hunting. It should be noted that DLNR continues to retain all jurisdiction over hunting from the forest reserve to the summit in the lease of the Science Reserve to the University. At an early stage in discussion there were suggestions of placing a fence around the summit at a certain elevation to reduce the impact of feral ungulates. However, this suggestion was not accepted as part of the Master Plan.

Positions on Development: Many voices in the public hearings and the oral history interviews expressed the sentiment that there should be no more expansion of facilities. A smaller number have supported expansion of quality facilities and the needs of astronomy. Some have called for the dismantling of what is there. Others have said it is a clean industry providing good jobs. Others have said that while astronomy is good development has been unbalanced toward astronomy and other disciplines not supported.

The goal of the Master Plan has been to balance the various interests and uses on the mountain. A no-build option would have a severe negative impact on astronomy. Like any high technology enterprise, astronomy must continually upgrade and innovate in order to remain competitive. On the other hand, the possibility of development occurring anywhere in Science Reserve (VLBA is an example) was also changed because that position unbalances the scale too much in astronomy's favor to the potential detriment of other interests such as cultural and environmental resources. The Master Plan response was to designate the remainder of the area outside the Astronomy Precinct as a natural and cultural preserve. During discussions in the Advisory Committee some people felt recreational snow play and skiing were inappropriate in a sacred area. However, the Plan accommodates recreational uses with a support facility near the "poi bowl" area of the summit. The Plan hopes to achieve a balance that protects resources and promotes valuable uses.

Management: Many concerns about management were raised in the various meetings. Issues ranged from poor trash removal to hours of operation of the visitor center; non-management of cultural and environmental resources was raised. Most of the complaints were about what was not done and the lack of resources provided to achieve the management responsibilities. A related issue was a perception of confusing and overlapping jurisdictions resulting in certain functions being neglected. Inadequate safety measures and lack of enforcement of CDUA conditions and lack of oversight over construction practices and a number of similar issues were raised. Lack of local decision making authority was frequently cited in the early discussions. Some concern was raised about the mountain being controlled by foreign, national and international agencies. Criticism was raised that IfA only took care of the interests of the astronomy community to the detriment of other interests.

The master planning process responded to the suggestion of alternative management schemes very early in the process. Due to multi-agency responsibilities a third party alternative that supercedes UH and DLNR was suggested. The independent third party commission modeled after the Kaho'olawe Commission was seriously considered and ultimately dropped as infeasible by the Advisory Committee because it would take legislation to authorize, create a whole new bureaucratic organization and require the agreement of the Board of Regents and the Land Board to implement. Also, preliminary discussions with the Board of Regents and the Board of Land and Natural Resources indicated that neither Board was willing or able to delegate the authority necessary to create a new agency with the suggested authority. Other management options that were discussed included DLNR taking complete responsibility for management but this idea was dropped when it was pointed out that DLNR's Statewide responsibility made it unlikely that sufficient resources would be available and dedicated to Mauna Kea. The idea of the University of Hawai'i taking full responsibility was also suggested but objections related to off island decision-making and lack of accountability to the local community resulted in this option being dropped. There were suggestions of the UH hiring the equivalent of a third party land manager, like a property manager, to manage the land. RCUH and the Nature Conservancy were mentioned as possible management entities. Questions of accountability were raised and some of the agencies suggested were not eager to take on the responsibility. A final option mentioned was to treat the mountain like a park. Some even considered moving the mountain into the National Park Service jurisdiction and letting the Service manage the mountain like Volcanoes National Park. Committee members cooled to the idea when they considered the loss of local control and the change in the mission of the managing entity.

The Master Plan proposes the creation of the Office of Mauna Kea Management out of the Office of the Chancellor of UH Hilo. By placing the Office under the Office of the Chancellor it becomes a visible and integral part of the University system and represents a more permanent and direct commitment. The lack of funding commitment to management was addressed by President Mortimer in a letter to the advisory committee wherein the administration stated that $400,000 dollars would be committed toward the establishment of the Office of Mauna Kea Management upon adoption of the Plan. The importance of managing the broad resources of Mauna Kea is now well understood. This was not the case earlier as management was conducted with a more narrow focus. This broadened focus also creates the potential for other revenue sources. The creation of the Mauna Kea Management Board also maintains a community voice that will insist on maintaining the proper funding priorities and commitments and retaining a broad view of the mountain's resources.

The issue of local authority is addressed by placing the management office in the Office of the Chancellor of UH Hilo. While policy authority remains with the Board of Regents, management authority is now delegated to Hilo. Issues and concerns can now be addressed locally. Community input will have a clear and singular doorway through which its concerns can be addressed rather than the amorphous and remote structure that is currently in place. The suspicions about foreign control of the mountain will be addressed when the public realizes that the Office has real authority on the mountain and the observatories develop more outreach programs into the community.

Lack of Trust: Lack of trust is a special problem closely related to management but different and associated with specific past experiences and history of relationship between the University of Hawai'i, DLNR and the public. Many comments expressed skepticism about the commitment of the responsible agencies to the task of managing the resources of Mauna Kea. Both the University of Hawai'i and the Department of Land and Natural Resources were faulted. Lack of funding commitment for management purposes raised skepticism about the current promises. The issue of local control is also connected with the issue of trust. Reasons cited for this lack of trust included the following:

- Prior advisory committee was never convened.
- Previously promised monitoring was not conducted.
- Prior ranger positions never funded and the positions were cut during budget cutbacks.
- Trash control measures were not enforced and clean-up efforts were inadequate.

The Master Plan response is the creation of the Mauna Kea Management Board and the establishment of the Office of Mauna Kea Management on the Big Island. This should go a long way towards restoring trust as there will now be a face and physical presence with authority to address community concerns. The new agency exists outside IFA and has a broader mandate. The Management Board will be staffed and the Office will have rangers on the mountain to educate users and manage resources. The visitor center director will coordinate community programs on the mountain while the Hilo office will interface with the broader community. Additionally, trash clean-up has been greatly improved and the old equipment have been removed.

Access: The question of access has been raised many times: in committee, in public meetings and in individual presentations to special groups. Concerns included fears of restrictions for traditional practices, hunting and recreation.

In a rare unanimous vote the Advisory Committee recommended managed access as opposed to completely unrestricted access or restricted access. Unrestricted access was rejected because committee members clearly understood the safety issues involved when uniformed people travel into the high altitude environment. They also understood the potential damage to cultural and natural resources, especially through the use of all terrain vehicles and recreational activities that take people off the summit road.

Restricted access was not supported because members viewed the mountain as a resource for all the people of Hawai'i and there was strong belief that it should remain open to the many interests that exist.

The Plan repeatedly states that access will be managed, not restricted. Managed access means that visitors will need to register at the visitor center, receive an orientation about safety issues and the value of the resources on the mountain, receive information about any applicable rules and then be sent on their way. The purpose of the managed access is to protect resources and enhance public safety. Rules are suggested to prohibit the use of off-road vehicles. Weather conditions, repairs and emergencies will also dictate some level of management. Suggestions for nighttime vehicular movement also indicate additional guidelines.

Hazards: The following concerns about hazards have been expressed:

- High altitude can make people sick; they should be informed.
- The summit road is steep and unsafe for normal cars; brake failure is common.
- Weather changes quickly and can kill.
- Hypothermia and snow blindness are real dangers.
- Fires around Hale Pōhaku can be hazards to people and natural resources.
- Construction at high altitudes has special hazards such as pulmonary edema and lack of concentration due to low oxygen.

The Master Plan responds to hazards with the registration/orientation program and an emergency response system implemented by rangers. Management of access will also help address these concerns. A single point of management authority will also allow for oversight into construction and operational safety practices in the Science Reserve.

Process: The master planning process was criticized as exclusive, confusing and insincere. Keeping the Advisory Committee meetings closed generated suspicion and resentment. The multiple drafts have been confusing and there have not been enough copies for review. Some have stated that the approval process should stop while the community discussions are taking place; otherwise the effort is not genuine. The credibility of the consultants has been questioned. Others have said the results were foregone conclusions.

The closed meetings of the Advisory Committee was a decision made by the Committee early in its proceedings but the purpose was for manageability not exclusivity. The composition of the group is proof that it was not meant to be exclusive. The accessibility of documents was a problem and draft 3A was placed on the UH web page to increase its accessibility. The multiple drafts were the result of trying to keep the public informed of an evolving document. Normally, these would have been internal drafts not available for public review. Although some have viewed the process with suspicion, the efforts to create an open process added to the confusion.

Benefits to the Public: The benefits of the development on the mountain was the subject of a number of testimonies. People recognize the general economic, scientific and research benefits of astronomy. Local residents, including part Hawaiians, increasingly fill these jobs as the workforce receives training. However, many Native Hawaiian speakers questioned the value of the development to Native Hawaiians. Some questioned the quality of jobs given to local people.

The Master Plan creates a physical plan and management structure that seeks to preserve a balance that allows astronomy to continue its evolution as a premier ground based viewing location and its associated economic benefits. At the same time, the Plan protects cultural, environmental and recreational interests. It provides resource protection and improves safety on the mountain for all users by the placement of rangers on the mountain and opening Hale Pōhaku to more users.

Regarding direct benefits to the Native Hawaiian community, the Master Plan does not specifically address the issue as a separate topic. It is an area of ongoing discussion. The master planning process has heightened awareness about the need for more proactive programs in this area. Several are now being reviewed and considered. A positive note from the public testimony is the number of local people working in good jobs in the astronomy industry. Many young, part Hawaiian residents are part of this growing workforce. The October 1999 edition of National Geographic highlighted the role of local resident Gary Puniwai and his important role as operator (equivalent to ship's captain) of the Keck telescopes.

More work beyond the Master Plan needs to be done. This should be one of the major focus areas for the Office of Mauna Kea Management, UH Hilo, UH, astronomers and the Hawaiian community.

REFERENCES

Atta, George. June 2, 1999. Personal Communication with Holly McEldowney and Patrick McCoy.

Auditor, State of Hawai'i. February 1998. Audit of the Management of Mauna Kea and the Mauna Kea Science Reserve (Report No. 98-6).

Brennan, Joseph. 1974. The Parker Ranch of Hawai'i: The Saga of a Ranch and a Dynasty.

Carlquist, Sherwin. 1980 (2nd Ed.). Hawai'i: A Natural History. Honolulu, Hawai'i.

Cordy, Ross, Historic Preservation Division, Department of Land and Natural Resources, State of Hawai'i. 1994. A Regional Synthesis of Hamakua District, Island of Hawai'i.

Cordy, Ross, Historic Sites Section, Department of Land and Natural Resources. August, 1986. Archaeological Fieldcheck of Several Projects in the Hale Pōhaku Area of Mauna Kea.

DLNR and UH IfA. March, 1995. Revised Management Plan for the UH Management Areas on Mauna Kea.

DLNR. General Lease No. S-4191.

DLNR Historic Preservation Division. March 2000. Mauna Kea Historic Preservation Plan Management Components. Prepared for the Institute for Astronomy, University of Hawai'i. Honolulu, Hawai'i.

Group 70 for Research Corporation of the UH. Amended May 1987. Mauna Kea Science Reserve Complex Development Plan.

Hammatt, Hallet H. and Douglas Borthwick. May 1988. Archaeological Reconnaissance of Two Proposed Antenna Sites for the National Radio Astronomy Observatory, Maunakea, Hawai'i.

Handy, E.S. Craighill and Mary Kawena Pukui. 1972. The Polynesian Family System in Ka'u, Hawai'i.

Howarth, Francis, Gregory Brenner, and David J. Preston. May 7, 1999. An Arthropod Assessment within Selected Areas of the Mauna Kea Science Reserve – Final Report.

Juvik, J. O. and S. P. Juvik. 1984. Mauna Kea and the Myth of Multiple Use Endangered Species and Mountain Management in Hawai'i, Mountain Research and Development, Vol. 4, No. 3.

Juvik, James O. and interested UH-Hilo faculty. January 14, 1998. Proposal: Institute for Tropical Alpine Research and Management, University of Hawai'i Hilo.

Juvik, Sonia P. and James O. Juvik, Editors. 1998 (3rd Edition). Atlas of Hawai'i.

Kamakau, Samuel Manaiakalani. 1991. Ka Po'e Kahiko: The People of Old.

Kanahele, Pualani Kanakaole and Edward L.H. Kanahele. August, 1997. Social Impact Assessment Saddle Road Realignment and Improvements - Appendix B: Indigenous Hawaiian Cultural Values.

Kilmartin, Jerome O. March, 1974. "Na Mea O Mauna Kea (Things About Mauna Kea)", Explorer's Journal.

Kjargaard, Maile Stemmermann. July, 1985. Avian Survey of the Hale Pōhaku Area.

Langlas, Charles. July 1998 (Revised February, 1999). Archaeological, Historical and Traditional Cultural Property Assessment for the Hawai'i Defense Access Road A-AD-6(1) and Saddle Road (SR200) Project.

Malo, David. 1951. Hawaiian Antiquities.

Maly, Kepā. May, 1998. Mauna Kea Kuahiwi Ku Ha'o I Ka Mālie: A Report on Archival and Historical Documentary Research, Ahupua'a of Humu'ula, Ka'ohe, Districts of Hilo and Hāmākua, Island of Hawai'i. Prepared for Native Lands Institute. Kumu Pono Associates; Hilo, Hawai'i.

Maly, Kepā. February, 1999. 1999 Mauna Kea Science Reserve and Hale Pōhaku Complex Development Plan Update: Oral History and Consultation Study, and Archival Literature Research. Ahupua'a of – Ka'ohe (Hāmākua District) and Humu'ula (Hilo District), Island of Hawai'i (various TMK). Prepared for Group 70 International. Kumu Pono Associates; Hilo, Hawai'i.

MCM Planning for California Association for Research in Astronomy. March 1998. Project Description and Environmental Review - Temporary Optical Test Sites for the W.M. Keck Observatory Twin Keck Telescope Interferometer.

MCM Planning for GTE Hawaiian Telephone Company and University of Hawai'i, Institute for Astronomy. September 1995. Project Description and Environmental Review - GTE Hawaiian Telephone Company Fiber Optic Cable Project Pohakuloa to Hale Pōhaku Link.

MCM Planning for National Astronomical Observatory JNLT Project Office. January 1991. Project Description Japan National Large Telescope (JNLT).

MCM Planning for Smithsonian Astrophysical Observatory. January 1994. Project Description and Environmental Review - Smithsonian Astrophysical Observatory Submillimeter Array Telescope.

MCM Planning for University of Hawai'i, Institute for Astronomy. October 1985. Amendment to the Mauna Kea Science Reserve Complex Development Plan, Final Supplemental Environmental Impact Statement for Construction Camp Housing, Hale Pohaku.

MCM Planning for University of Hawai'i, Institute for Astronomy. September 1988. Amendment to the Mauna Kea Science Reserve Complex Development Plan, Final Supplemental Environmental Impact Statement VBLA Antenna Facility.

McCoy, Patrick C., Mountain Archaeology Research Corporation for UH Manoa Facilities Planning and Management Office. 1991 (Field Date: September, 1987). Survey and Test Excavations of the Pu'u Kalepeamoa Site, Mauna Kea, Hawai'i.

McCoy, Patrick, Bishop Museum. Mauna Kea Summit Region Survey: A Summary of the 1984 Fieldwork.

McCoy, Patrick C. February, 1999. Mauna Kea Science Reserve Archaeological Site Inventory: Formal, Functional, and Spatial Attributes.

McLaren, Robert. July 23, 1991. Letter to Office of Environmental Quality Control. Project Description for a Proposed Second Telescope (Keck II) on the W.M. Keck Observatory Site at Mauna Kea, Hamakua, Hawai'i (Tax Map Key 4-4-15:09).

Mortimer, Kenneth. May 8, 1998. Letter of invitation to Mauna Kea Advisory Committee members.

National Aeronautics and Space Administration. June, 1998. Temporary Optical Test Sites for the W. M. Keck Obvservatory Twin Keck Telescope Interferometer – Draft Environmental Assessment.

Palila Recovery Team. August, 1977. Palila Recovery Plan.

Parker, Barry. 1994. Stairway to the Stars: The Story of the World's Largest Observatory.

Paul H. Rosendahl, PhD, Inc. February 1997. Archaeological, Historical and Traditional Cultural Assessment for the Hawai'i Defense Access Road A-AD-6(1) and Saddle Road (SR200) Project.

Pukui, Mary Kawena. 1983. ‘Ōlelo No‘eau: Hawaiian Proverbs and Poetical Sayings. Bernice Pauahi Bishop Museum Special Publication 71. Honolulu.

Pukui, Mary Kawena and Samuel H. Elbert. 1986. Hawaiian Dictionary.

Robins, Jennifer J. and Hallet H. Hammatt for MCM Planning. September 1990. Archaeological Reconnaissance for Summit and Mid-Level Facilities for the Proposed Japanese National Large Telescope, Maunakea, Hawai‘i.

SMS Research. July, 1999. Economic Impact of Mauna Kea Observatories, Hawai‘i County, State of Hawai‘i.

Sierra Club, Hawai‘i Chapter. February, 1998. The Legislative Auditor’s Key Findings: Audit of the Management of Mauna Kea and the Mauna Kea Science Reserve.

Stearns, Harold T. 1966. Geology of the State of Hawai‘i. Palo Alto, California.

RM Towill Corporation. August 1997. Aerial Topographic Mapping – Portion of the Mauna Kea Science Reserve.

Townscape, Inc. for UH Institute for Astronomy. July 1992. Project Description Gemini 8-Meter Telescopes Project.

United States Department of Transportation, Federal Highway Administration, Central Federal Lands Highway Division. 9 October 1997. Draft Environmental Impact Statement Saddle Road (State Route 200) Mamalahoa Highway (State Route 190) to Milepost 6.

University of Hawai‘i Institute for Astronomy. September, 1981. Program Summary and Research Development Plan for the Mauna Kea Science Reserve and Related Facilities.

Wolfe, Edward W., William S. Wise, and G.Brent Dalrymple. 1997. The Geology and Petrology of Mauna Kea Volcano, Hawai‘i – A Study of Postshield Volcanism (USGS Professional Paper 1557).

Mauna Kea Science Reserve
Astronomy Research Development Plan 2000-2020--Summary
UH Institute for Astronomy
August 1999

I. Mission

The University of Hawaii, through its Institute for Astronomy, is actively and creatively advancing mankind's understanding of the physical Universe, and our place within it, through the operation and development of astronomical research and training facilities on Mauna Kea. These facilities are known collectively as the Mauna Kea Observatories. The astronomical activities in the Mauna Kea Science Reserve enrich the educational and research mission of the University, while at the same time expanding mankind's knowledge of the Universe, in the spirit of the early Hawaiian explorers.

II. Background

In January 1982, the UH Board of Regents approved the Institute's first Research Development Plan (RDP) for the Science Reserve. The basic goal of the RDP was to develop the Science Reserve as a pre-eminent State, national, and international resource for astronomical observations in cooperation with other State agencies and constituencies. For nearly 20 years, the RDP has served as the master plan for the development of astronomy research and related activities on Mauna Kea. The RDP identified the areas of the Science Reserve which were most suitable for the various types of telescope facilities, while making it clear that most of the Science Reserve was intended to remain undeveloped, as a buffer zone. The RDP foresaw the establishment of thirteen telescope facilities on the mountain by the year 2000, a number which was based on projected demand, not on physical capacity. That section of the RDP concludes with the following statement:

> *"It should be emphasized that the actual number of telescopes on Mauna Kea will be shaped by a wide variety of factors, many of them beyond the scope of this plan. However, this plan is clearly achievable and does not approach the capacity of Mauna Kea for telescopes nor does this plan compromise, in any way, the other uses of the mountain."*

Thirteen is, in fact, the number of telescope facilities on Mauna Kea today. That the actual scope of development should end up being so close to the RDP projection is quite amazing, in view of the time span and uncertainties involved. The RDP also foresaw the need for several major infrastructure improvements including: provision of commercial electric power; improvements to and paving of the access road; and expansion of the mid-level facilities. Commercial power is now in place, together with fiber-optics communications infrastructure of essentially unlimited capacity. The upper half (~4 miles) of the access road has been paved, and the addition of Dormitory D has expanded the astronomer bedroom count at the mid-level facilities to 72.

The purpose of this document is to extend the astronomy development component of the RDP for the next 20-year period. In doing so, we retain the underlying philosophy and methodology of the original plan. One of the basic goals of the 1982 RDP was the preservation and protection of the multi-use objectives of Mauna Kea. This goal is the dominant theme in the current master planning process. Another goal was to ensure that the potential sites for astronomy facilities were reserved for the highest and best use. The Institute's astronomy development plan for Mauna Kea for the period 2000-2020, as presented below, is strongly guided by these two top-level goals. As was true for the 1982 RDP, the scope of proposed development is not constrained by physical capacity, but rather by an analysis of the projected demand for appropriate facilities, combined with the need to avoid adverse impacts on environmental and cultural resources and on other uses.

III. Astronomy Development 2000-2020

III.1. Introduction

In the early decades of the next millennium, we expect that astronomy will focus on the questions posed in NASA's Origins program, which has the goal of understanding how our Universe evolved, how galaxies and the stars within them form, and how many stars contain planetary systems—most importantly planets like our own Earth, where life could have developed. Major space missions such as the 8-m Next Generation Space Telescope and various interferometric missions will be launched by NASA to address these questions, but much of the work will be done from the ground using the next generation of large optical and millimeter/submillimeter wave telescopes. It has already been decided that the next major millimeter/submillimeter telescope, the Atacama Large Millimeter Array, will be built in Chile by a consortium of the U. S., Europe, and possibly Japan. As a result, proposals for further development of major submillimeter facilities on Mauna Kea during the next 20 years will probably be limited to expansion of the existing Submillimeter Array. In the optical and infrared wavebands, however, we can expect that several international consortia, and possibly some private university groups, will want to build powerful 30-m class optical/infrared telescopes and possibly interferometers. With their much larger collecting areas, and in the case of interferometers, very high angular resolution, these powerful new instruments will complement the space missions. In addition, existing observatories will need to replace or refurbish their aging facilities with new technology. If Mauna Kea is to remain as the world's pre-eminent location for astronomical observations in the face of increasing competition from developing sites such as those in Chile, and if UH is to continue to maintain a world-class astronomy program, then our plans for the next two decades must include the elements outlined below.

III.2. Redevelopment of Existing Observatory Sites on the Summit Ridge

All nine of the optical/infrared telescopes at the Mauna Kea Observatories are located on the ridgeline of the summit cinder-cone complex (we count Keck I and II separately here). They extend in an arc counter-clockwise from the UH 24-inch (0.6-m), the smallest and oldest, around to Subaru, one of the largest and newest. The RDP identified this area as the most suitable for optical/infrared facilities, and indeed the Mauna Kea summit ridge is almost universally regarded by astronomers as the best location on the face of the earth for this type of telescope.

The most common type of development over the next 20 years will be the replacement or major upgrading of optical/IR facilities at existing sites on the summit ridge. There are two basic reasons for this. First, two of the nine existing facilities (UH 2.2-m and 0.6-m) are 30 years old, and three more (United Kingdom Infrared Telescope (UKIRT), Canada-France-Hawaii Telescope (CFHT), NASA Infrared Telescope Facility (IRTF)) are 20 years old. By historical standards, these telescopes would still be considered young, but the recent dramatic advances in telescope technology (thin mirrors, space-age materials, computer-assisted design, thermal control) and enclosure design have rendered them old beyond their years. The four organizations operating these telescopes will soon be very eager to replace them with modern state-of-the-art technology, so as to get the full benefit of the site conditions and to maximize the return from the substantial operational expenditures. The CFHT community is already discussing the possibility of replacing the existing 3.6-m telescope with a new-technology facility in the 8-m range, but with an enclosure of approximately the same size. Similarly, IfA, at the request of NASA, is exploring the scientific and technical aspects of replacing the 3.0-m IRTF with a 6.5-m New Planetary Telescope (NPT). The increased aperture and improved technology will dramatically increase both the sensitivity (ability to study faint objects) and angular resolution (ability to discern fine detail in images) for these facilities.

Any national or international organization wishing to develop a new world-class optical/infrared telescope of “conventional” size (4-12 m aperture) will almost certainly want to locate on the Mauna Kea summit ridge, unless a location in the southern hemisphere is preferred for programmatic or other reasons. This leads to the second reason for expecting substantial demand for the reuse of existing sites, as the summit ridge is already nearly filled to capacity. It would be possible to add one, or perhaps two modest-sized telescopes, but a large facility would require the replacement of an already existing one.

We expect that over the next 20 years, proposals will be developed to upgrade or replace each of the five telescopes mentioned above. As was true for the 1982 RDP, it is very difficult to predict the actual scope of development that far into the future. At present, we estimate that at least three, but perhaps all five of these aging telescopes will be upgraded or replaced within this time frame. Such replacement upgrades, with their minimal impact, must be a very high priority for future development.

We also expect to see a trend toward specialization for these conventional-size optical/infrared telescopes. For example, one facility may decide to concentrate on wide-field imaging, while another focuses on using adaptive optics to achieve the highest possible angular resolution over a small field. The NPT, mentioned above as a possible replacement for the NASA IRTF, is designed to minimize scattered light in order to study faint objects which lie close to bright ones (e.g., a planet in orbit around a star). Specialization will allow the telescope facility to achieve the ultimate in performance within the chosen area of research, while at the same time simplifying the operation and thereby reducing costs. Specialization will provide a strong incentive for joint operating arrangements and shared use among the observatory organizations. In this way, each affiliated astronomer community will have access to a wide range of observing capabilities, without the need to provide them all on any one telescope.

III.3. Expansion of Existing Observatories

Expansion of two of the existing facilities, the W. M. Keck Observatory and the Submillimeter Array (SMA) is planned for the period 2000-2020.

III.3.a. W. M. Keck Observatory

At Keck, the expansion will be the addition of four to six 1.8-m "outrigger" telescopes to create a powerful infrared interferometer on the existing Keck site. This is primarily a NASA project, with funding for four of the six outriggers already in hand. The primary scientific mission is to search for and study planets around nearby stars. This is an important step in answering the fundamental questions of how unique our Earth is and whether there may be life elsewhere in the Universe. The Keck Interferometer is a stepping stone to future NASA space-based interferometry missions such as the Space Interferometry Mission (SIM) and the Terrestrial Planet Finder (TPF), which are aimed toward these questions. It will also test the feasibility and capability of large-aperture ground-based optical/infrared interferometry. This information will be extremely valuable in assessing the scientific potential for a large-scale optical/infrared interferometer array (see III.6 below). The Keck Outrigger Project is the only new project for which a detailed proposal exists at present. Because of the link with space missions, for which the planning is already well underway, this project is on a tight schedule and needs to start construction in 2000.

III.3.b. Submillimeter Array

The SMA is a collaborative project of the Smithsonian Astrophysical Observatory and the Institute of Astronomy and Astrophysics of Taiwan. The SMA is the world's first submillimeter-wavelength radio interferometer. Consisting of up to 12 interconnected 6-m antennas which can be arranged in various configurations on 24 antenna pads, the SMA will provide sub-arcsecond resolution in the submillimeter region of the spectrum. The SMA is expected to be in operation with eight antennas by 2001. During the ensuing 20 years, there will be a strong scientific need to enhance both the angular resolution and the imaging power of the array. The former is achieved by adding additional pads to provide longer baselines. Imaging power is directly related to the number of distinct baselines (antenna pairs) in the array. For N antennas, the number of baselines is $N(N-1)/2 \approx N^2/2$. Since the imaging power increases roughly as the square of the number of antennas, a modest increase in antenna count can produce a dramatic enhancement in scientific capability. The expansion plan for the SMA includes 24 additional antenna pads, increasing the maximum baseline by at least a factor of two, and the addition of 12 antennas for a total of 24. This will increase the imaging power by a factor of 4 and the angular resolution by more than a factor of 2.

III.4. New Sites for Conventional Optical/Infrared Telescopes

As explained previously, the preferred location for any new conventional optical/infrared telescope will be the summit ridge because of its proven superb astronomical quality and the already existing infrastructure. Space is limited there, however, and major new telescopes can be accommodated only by replacing existing ones. We expect that over the next 20 years, there will be one or two proposals for new conventional optical/infrared telescopes which have excellent scientific potential and offer strong benefits for the UH astronomy program, but for which there is no site on the summit ridge. In our master planning, we need to identify new sites for optical/infrared telescopes which are not on the summit ridge, but which have excellent observing conditions. Detailed seeing measurements will be particularly important.

III.5. Next Generation Large Telescope

The world astronomy community is just now completing the giant step from the 4-m class telescopes that have been its mainstay for the past 40 years to the 8-10 m class instruments such as the Kecks, Gemini, Subaru, and the European Southern Observatory's Very Large Telescope. It will be several years before we know the real impact of this major advance in both aperture size and technological sophistication. Nonetheless, astronomers are already beginning to discuss what the next step beyond the 8-10 m class will be (i.e., the Next Generation Large Telescope). Some of the impetus for this discussion comes from NASA's plan to launch the Next Generation Space Telescope (NGST) within the next decade. With an aperture diameter of 8m, NGST will have eleven times the collecting area of the Hubble Space Telescope. We know already that the current 8-10m telescopes are an excellent complement to Hubble, for example providing spectroscopy of objects which are discovered in Hubble images. The Next Generation Large Telescope (NGLT) is seen as playing the analogous role for the NGST. During the coming two decades, Earth-based telescopes will continue to retain some very substantial advantages over space telescopes in spectral regions which can be observed from the ground. First and foremost, they can be made larger, and for a given size, are 10-100 times less expensive to build and operate. In addition, they are much easier to service and upgrade; this is particularly important for the instrumentation attached to the telescope. Finally, recent major advances in adaptive optics allow ground-based telescopes to achieve angular resolution equaling or exceeding that from space telescopes in the infrared region of the spectrum.

Once every ten years, the U. S. National Academy of Sciences appoints a blue-ribbon panel to survey astronomy goals for the coming decade and to set priorities for new facilities. The latest Decadal Survey is currently underway, with its report due early in 2000. There is widespread expectation that the report will recommend some type of NGLT, possibly in the 25-50 m range. Only the most preliminary of design concepts exists at present, with most of them employing some type of segmented mirror.

We consider it likely that a NGLT will be proposed for Mauna Kea within the next ten years, with the expectation that such a facility could be completed before the year 2020. We need to identify a suitable site in our master plan. As with the new conventional optical/infrared telescopes, any final site selection would be contingent on detailed seeing studies.

III.6. Site for Optical/Infrared Interferometer

Another possibility for a next-generation ground-based optical/infrared facility is a distributed aperture telescope (i.e., an interferometer array). Currently there is a vigorous debate among astronomers concerning the relative merits of the interferometer and the filled-aperture NGLT. Roughly speaking, the former would emphasize high angular resolution, while the latter would emphasize sensitivity to faint objects. It appears likely that this debate will continue for at least five years and probably longer. During this period, a number of modest-sized interferometers, including the Keck (see III.3.a. above) and the European Southern Observatory's Very Large Telescope Interferometer will begin operation. These facilities are expected to inform this debate by providing a wealth of practical information about the feasibility and scientific potential of ground-based optical/infrared interferometry.

Should a large-scale optical/infrared interferometer be proposed for Mauna Kea, it would require a large and relatively flat area of up to 1 km in diameter. Such an area should be identified in the master plan. The number and size of the individual apertures cannot be accurately predicted at present, although an array of six 3-m apertures would appear to be a minimum. The light collected by each aperture would be transported to a central location and then combined with the light from the other apertures, after path-length compensation, to produce a high-resolution image of the object being studied. In current-day interferometers, light transport is achieved by directing collimated beams through pipes located either above or below ground. This approach appears both impractical and environmentally problematic for a large-scale interferometer such as might be proposed for Mauna Kea. Similarly, path-length compensation is currently accomplished with optical delay lines whose dimensions are similar to the size of the array. This also would be problematic for a large array on Mauna Kea. At present the most promising solution to these two problems appears to be the use of fiber optics. With fiber optics, light transport could be incorporated into the small utility line to each aperture, and the delay line system could be reduced to a manageable size.

For present planning purposes, we should reserve a suitable location in case we may wish to consider an optical/infrared interferometer during the coming 20-year period. Whether or not such a proposal will be forthcoming and favorably considered will depend on the scientific and technical issues outlined above.

III.7. Temporary Facilities

We also expect to receive over the 20-year period several strong proposals for temporary facilities. A recent example of a temporary facility is the Optical Test Sites installation at the W. M. Keck Observatory. This system, comprising two siderostats and underground light pipes, will be used for testing and debugging the beam-combining equipment for the Keck Interferometer. Once the Interferometer is operational, in 2002, the temporary test sites will be removed.

Taiwanese astronomers are currently developing a proposal for a temporary facility called the Array for Microwave Background (AMIBA). AMIBA would measure the spatial variations in the microwave background radiation which originated with the Big Bang and which allow us to understand the earliest stages of the formation of our Universe. In its current concept, AMIBA consists of 19 1-m antennas mounted on a single steerable platform measuring about 10 meters across. AMIBA would have an operational lifetime of approximately five years.

IV. Conclusion

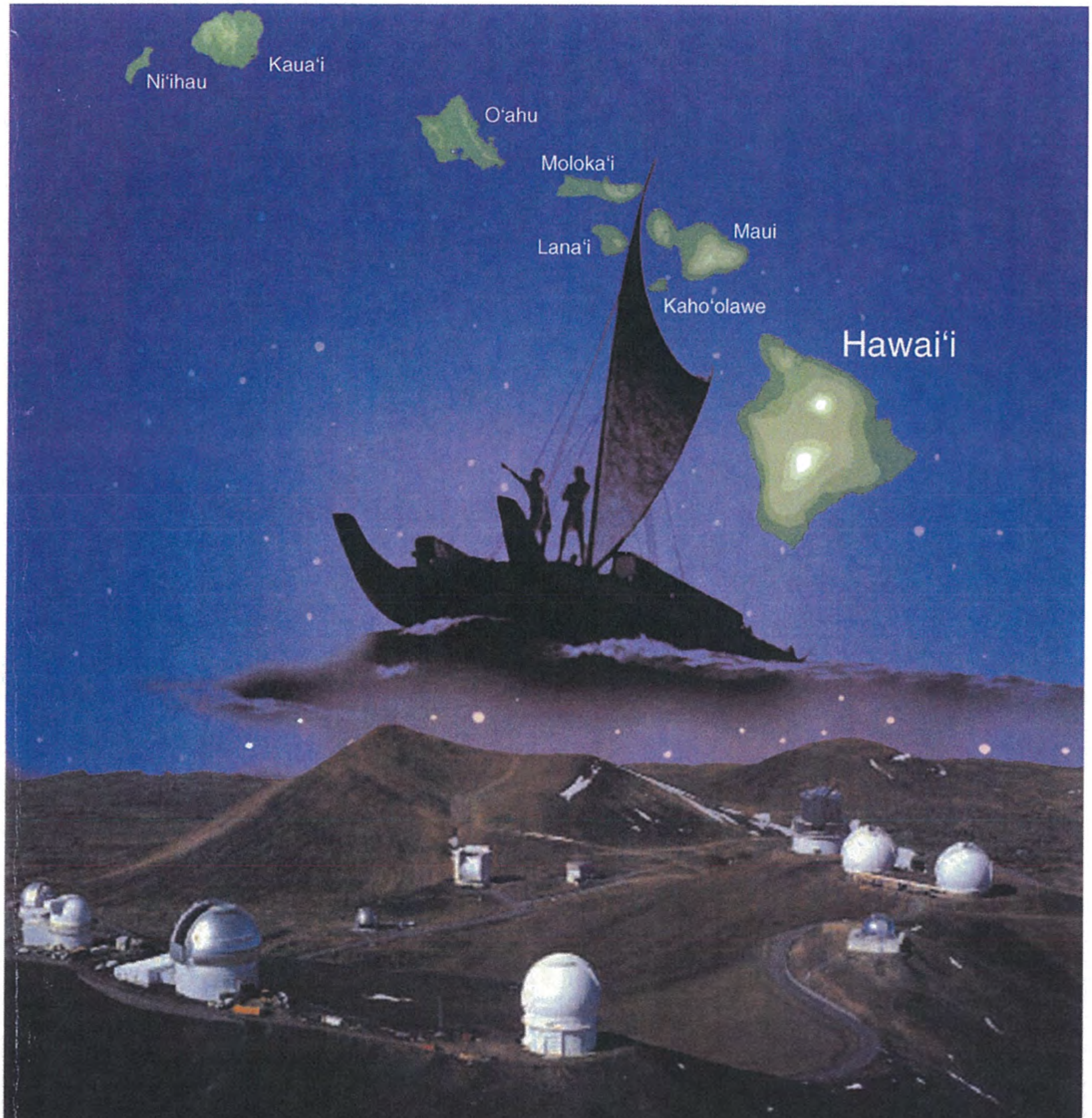
The Institute's Astronomy Research Development Plan 2000-2020 extends the astronomy development component of the 1982 Research Development Plan for the Mauna Kea Science Reserve, while retaining the fundamental philosophy and methodology of the original plan. The scope of the planned development is based not on physical capacity, but rather on the expected demand for facilities which would make the highest and best use of the Mauna Kea site, combined with the need to accommodate other uses and minimize adverse impacts. Although this plan is based on the best information currently available, it must be kept in mind that there are many large scientific and technological uncertainties outstanding, especially in view of the 20-year planning horizon. This plan will probably require adjustment as new information and scientific priorities arise.

MAUNA KEA SCIENCE RESERVE MASTER PLAN

APPENDIX B

Mauna Kea Astronomy Education Center

MARCH 2000



The Mauna Kea Astronomy Education Center

Hilo, Hawai'i

TABLE OF CONTENTS

<u>**Appendices**</u>

I. MISSION STATEMENT

Framed by Hawai'i's rich Polynesian tradition of exploration, the Mauna Kea Astronomy Education Center is the premier facility for sharing the discoveries of the deepest mysteries of the universe by the world's most important collection of telescopes; educating and inspiring students and teachers and communities worldwide; and presenting a global vision of integrated, scientific technological and cultural leadership for 21st century America.

II. EXECUTIVE SUMMARY

The University of Hawai`i at Hilo, working in collaboration with the W. M. Keck Observatory, Institute for Astronomy, Polynesian Voyaging Society, Bishop Museum, Gemini Observatory, Space Grant College and others, proposes the construction of the Mauna Kea Astronomy Education Center, a facility to be located on the slopes of Mauna Kea in Hilo, Hawai`i at a cost of $19,980,000. This project will launch America into a new frontier in astronomy education.

The State of Hawai`i is at a critical juncture in its history and economy. The plantation era is long over. Current reliance on a tourism service-industry leaves the state and its people vulnerable to unpredictable and often unmanageable global economic forces.

In the recent decade-long economic boom that encompassed almost the entire United States, Hawai`i was the only state to experience virtually no economic growth.

The reasons are myriad and complex. But the message today is loud and clear - diversification into clean, science-research, high-tech and educational industries can provide a level of economic stability with minimal environmental impact, and tremendous long-term payoff not just for Hawai`i's residents, but for all the nation and indeed, the world.

The proposed Mauna Kea Astronomy Education Center will serve as the premiere interpretative center for the world's largest and finest collection of operational astronomical observatories, currently located in Hawai`i, which daily are expanding our understanding of our Solar system, galaxy, the Universe and Earth itself. Not only will the Mauna Kea Astronomy Education Center excite students and teachers of science and technology in Hawai`i and across the nation, the center will facilitate astronomy education and the raising of scientific literacy worldwide.

The Mauna Kea Astronomy Education Center will have direct and constant communication with the 12 observatories atop Mauna Kea. No other major science interpretive center in the world works as closely and directly with premier research facilities such as Keck, Gemini, Subaru, NASA IRTF, the VLBA and others.

The Center will allow visitors and students across the nation unprecedented access to cutting-edge astronomy research via the Internet. The center's facilities, displays, and exhibits will utilize the most advanced exhibit technologies to present the ongoing work done on Mauna Kea. The close collaboration with research institutions and state-of-the-art exhibit and theater technology will result in a new level of scientific interpretation for the general public, and present numerous opportunities for students of today to begin preparing for the science-based and high-tech careers of tomorrow.

And in a vitally important parallel program, the cultural and historical significance of Mauna Kea (the mountain) to an indigenous people for whom astronomy was paramount in their voyaging migrations across the Pacific Ocean also will be presented. The cultural aspects of astronomy and cosmology throughout human history and particularly in Hawaiian and Polynesian navigation will provide a major theme for the Center, demonstrating the important role of astronomy in the development of civilization worldwide.

Mastery of science research and full understanding of cultural roots make us the sum of all that we have been, and all that we might become. This is the legacy we can give our children.

III. INTRODUCTION

The Mauna Kea Astronomy Education Center is a singularly unique facility designed to showcase and interpret the astronomy being conducted by observatories at the 13,000-foot summit of Mauna Kea on the island of Hawai`i. It will serve as the principal astronomy educational facility in Hawai`i and will be a substantial resource for astronomy programs around the world. Formal and informal education programs will expand public understanding of astronomy in ways never envisioned in the past, and thereby prepare the next generation of astronomers, space scientists, and a more knowledgeable public.

The observatories atop Mauna Kea house the finest telescopes in the world and represent research facilities of many nations, including Japan, Canada, England, France, Brazil, Chile, Argentina, Australia and the United States. The pristine viewing at the summit has attracted this international billion-dollar scientific investment; and in combination with today's technological advances, has propelled Mauna Kea to a world leadership role in astronomical research.

WINDOW TO DISCOVERY

Despite the presence of these world-class facilities on this magnificent mountain, there is no central place at sea level or on the summit where students or the interested public can directly access Mauna Kea's astronomical research. This proposed central facility for astronomy education and interpretation will provide visitors an opportunity to participate in the thrill of scientific and cultural discovery.

An extensive planning and advisory process to determine the scope and programs of the Center has included science educators, Mauna Kea observatory staff, experts in Hawaiian culture, University of Hawai`i astronomy faculty, and representatives of the Hilo community. A preliminary study to determine feasibility and market potential was conducted. A detailed preliminary business plan was also a part of the planning and advisory process.

The Center will be located at sea level within University Park, the Research and Technology Park developed by the University of Hawai`i at Hilo for just this kind of entity. As neighbors to the base facilities for summit observatories already located there, the Center will incorporate state-of-the-art theater and exhibit technologies to tell the story of Mauna Kea. These exhibits will include a planetarium, a 3D-projection theater, interactive virtual-reality simulations of the Universe, and individual observatory exhibits. A regular program of public lectures featuring Mauna Kea and visiting scientists, sky-watching events, and special programs on current discoveries would supplement permanent exhibits. Planetarium and 3D-theater programs will be produced for both visitor and school audiences and updated on a regular basis.

Live transmissions from Summit observatories will demonstrate ongoing astronomical research; while on-site Center experts will interpret the research and present current scientific findings to the visiting public. These explanations will be posted on the Center's website providing a major Internet resource for students worldwide. Additionally, a 1-meter telescope will be installed on the Summit for the exclusive observational use of student groups, affording a real-time view of the universe.

Electronic exhibit and projection technologies designed by leading experts in the fields of computer graphics and science education will accelerate our understanding and appreciation of our awe-inspiring and unique Universe. The observatories themselves will be major contributors to the Center's program development in exhibit content and instrumentation displays. Programs and exhibits will be developed jointly with educational experts to ensure program strategies and topics that are consistent with national science education standards and strategies. Cooperative partnerships with NASA, the Smithsonian Air and Space Museum, and other aerospace education and research facilities will be energetically pursued.

This educational and interpretive center, designed to broaden public understanding of the Universe through real-world applications and access to Mauna Kea observatories would serve the following constituencies across the nation:

- Primary- and secondary-grade students
- College and University Students
- School groups (local and visiting)
- Visitors to Hawai`i
- Residents of Hawai`i
- Scientists and Researchers
- Teachers and Educators

- Families

WHY IN HILO?

Hilo is the second largest city in the State of Hawai'i and is the closest major population center to Mauna Kea. The Mauna Kea Astronomy Education Center will be located in the University of Hawai'i at Hilo's **University Park** – home to high technology and research institutions such as:

- University of Hawai'i Institute for Astronomy
- National Astronomical Observatory of Japan (Subaru)
- Gemini 8-Meter Telescope
- Caltech Submillimeter Observatory
- Joint Astronomy Centre
- University of Hawai'i Agricultural Complex.

As a consequence, University Park has become the world center for modern astronomy, with a higher concentration of observatory base-facilities and scientific/technical staff than exists anywhere else in the world. This concentration is expected to increase as more observatories are built on Mauna Kea.

The Mauna Kea Astronomy Education Center will be located directly adjacent to these facilities, permitting frequent, fast, and direct access to the staff and resources of these observatories. In addition, all the facilities of the University of Hawai'i at Hilo are within walking distance of each other.

Recently, commitments to become residents of University Park were made by:

- Smithsonian Submillimeter Telescope
- Tropical Forestry Research Facility
- Institute for Agricultural Marketing and Education
- US Pacific Basin Agricultural Research Center

WHY NOT JUST GO TO THE TOP OF MAUNA KEA?

Simply going to the summit of Mauna Kea will always be an option. However, there are several obstacles or challenges making the 4-hour round-trip the least desirable alternative. The observatory complex is difficult to get to and not generally open to the public: a steep, rough terrain requiring a 4-wheel drive vehicle is the only access to the summit facilities. Currently, anyone younger than 16 is restricted from going up to the summit. In addition, anyone with a heart condition or asthma is also discouraged, as are the elderly or infirm.

Altitude Sickness

There is one risk that has the potential of affecting us all, regardless of age or health: Altitude Sickness. We all enjoy the tremendous view from a mountain peak, but there are risks in going to high altitude, and it's important to understand these risks. Altitude is defined on the following scale:

- **High** **8,000 - 12,000 feet**
- **Very High** **12,000 - 18,000 feet**
- **Extremely High** **18,000 + feet**

There are no specific factors such as age, sex, or physical condition that correlate with susceptibility to altitude sickness. Some people get it and some people don't, and some people are more susceptible than others.

Altitude sickness can affect anyone, regardless of age or physical condition, especially at the Mauna Kea Summit with altitudes close to 14,000 feet. The symptoms can be anything from a headache, nausea, vomiting or extreme shortness of breath to flu-like symptoms.

As a consequence, few visitors to Hawai`i are able to visit the observatory complex itself. The proposed center will open up the wonders of this unique site, and of the importance of the astronomical discoveries being made there to a much wider audience: the entire nation.

Protecting The Fragile Mauna Kea Summit Environment

The Center will contribute directly to the protection of the fragile environment and important archaeological sites on the summit by reducing the number of people attempting to visit the observatories on their own. There is not enough signage or instructions or even a protocol regarding the fragility of the irreplaceable archeological sites, which can be inadvertently damaged.

MAUNA KEA DISCOVERIES

There have been numerous discoveries at the summit observatories high atop Mauna Kea. The following list is only a partial example of the exciting research being conducted:

- The discovery of ***planets orbiting other stars***. For the first time in human history we know of the existence of worlds beyond the Sun's family of planets.

- Mapping the large-scale structure of the Universe, to show ***the location of Earth's Milky Way Galaxy in the larger Universe***.

- The discovery that most of ***the mass of the universe may be in a mysterious form of Dark Matter***. This material may in fact make up the bulk of the Cosmos – thus, the planets, stars and galaxies we see are just froth on the deeper ocean of reality.

- The detection and identification of ***organic molecules in comets***. Comets may have brought the building blocks of life to the early Earth.

- The development of new techniques of ***adaptive optics*** and ***sophisticated image processing*** that takes the twinkle out of starlight, and allows the acquisition of images that rival the Hubble Space Telescope's clarity and detail.

- The discovery that the ***expansion of the universe is accelerating***, with profound effects on our understanding of the nature of matter, and of the fundamental forces in the universe.

- The discovery of a ***new family of comet-like objects*** in the solar system – the Kuiper Belt – with implications for the formation of the solar system.

IV. GOALS

The Mauna Kea Astronomy Education Center will:

- **Serve as an astronomy interpretive center** for all of the Mauna Kea observatories, sharing past and current scientific discoveries in astronomy and through astronomical observations and their importance to visitors from the nation and around the world.

- **Provide education and public outreach** by exciting, inspiring and motivating young people about space and astronomy by creating interactive formal and informal learning experiences on-site and outreach programs to view science as a fascinating and exciting field of study founded in our cultural traditions.

- **Promote scientific literacy and interest** among the general public.

- **Establish the bridge between culture and science** by framing the Center's Facilities and Programs in a Hawaiian context. The Center will include Hawaiian and Polynesian cultural and navigational exhibits relating Mauna Kea and modern day astronomy to the social heritage and voyaging traditions of the Pacific island cultures.

- **Address all levels of formal and informal astronomy education** by providing curricular materials, on-site astronomy education facilities, and state-of-the-art computer applications and technologies.

- **Provide national and international real-time access to all educational institutions** from a remotely controlled telescope allowing educators at all levels to conduct inquiry-oriented astronomy activities.

- **Become the electronically accessible central repository for astronomy curricular materials** linked to the most recent discoveries.

- **Enrich teachers' professional experiences in astronomy education** either on-site or through distance education venues.

- **Support academic and research pursuits** on Mauna Kea by communicating the extraordinary range of explorations that are taking place on Mauna Kea.

- **Establish national and international conferencing capabilities** to facilitate the exchange of science information and to foster cooperation in the spirit of aloha.

- **Develop national science curriculum** focused on exploration, the common element that links Polynesian voyaging to the pursuit of scientific and technological development.

V. IMPORTANCE TO HAWAI`I AND THE NATION

The observatories on Mauna Kea are research institutions and therefore NOT designed as visitor or educational centers for the dissemination of educational material. They are NOT programmed for public access to their equipment, and with the exception of the Keck and Gemini observatories, neither are their employees trained and equipped to provide interpretive information about what they do. Significantly, the observatories do not have staff to provide often-needed medical attention. Therefore, observatory staff have expressed enthusiastic support for the Center's role in acting as their main interpretive center.

- The Center will provide extensive resources and materials in the form of online information, curriculum materials, and workshops for students and science teachers from around the United States.

- The Center will become the nation's leading resource for public presentation of astronomical research and the overall vehicle carrying the message of the importance of the study of science in our schools.

- This need is expected to be of worldwide scope given the international collection of research facilities and observatories located on the island of Hawai`i.

VI. KEY MESSAGES

The primary messages we want to communicate to our audiences:

- The astronomical discoveries of Mauna Kea already have revealed profound implications for our understanding of the nature of human existence and our place in the Universe.
- Mauna Kea has a rich cultural heritage and a diverse natural environment that has always played a significant role in exploration.
- The astronomical observation capability on Mauna Kea surpasses anything else on earth.
- Science is fun, fascinating, exciting and the frontier of our future.
- The Polynesian voyaging tradition was fueled by the same spirit of exploration that drives today's scientists to explore the universe.

The means by which these messages will be communicated (the elements of our program).

- Planetarium
- Interactive displays
- Web site
- Virtual tours of Mauna Kea
- School group programs
- Lecture series
- Year-round workshops
- College level educational courses
- 3-D and other theater

VII. CONCEPTUAL PLAN

Mauna Kea Astronomy Education Center programs will be determined by the visions and expectations encompassed by a Center serving as the public gateway to the discoveries of the world's finest collection of astronomical observatories. These programs fall largely into three broad categories: Visitor Center, Informal Astronomy Education, and Formal Astronomy Education.

VISITOR CENTER

The Center will, first and foremost, be a visitor center for all the observatories on Mauna Kea, interpreting the discoveries being made there, the unique qualities of the observatory complex and site, and the rich cultural backdrop of Mauna Kea to visitors from the State of Hawai`i, the entire nation and the world.

Visitors center programs will include:

- Interactive and flexible displays of Mauna Kea telescopes and instruments, and recent astronomical discoveries made at Mauna Kea observatories.
- Planetarium and flat-screen theater shows on all aspects of astronomy and the discoveries being made at Mauna Kea observatories.
- Video displays of live images of the summit of Mauna Kea, of activities within the observatories, and of astronomical objects imaged through Mauna Kea facilities.
- Public lectures on Mauna Kea astronomical discoveries by the many resident and visiting astronomers using the telescopes for their research.
- Scholar-in Residence program to enhance the connections between the scientific discoveries being made on Mauna Kea and elsewhere, and the broader cultural and human context in which science enriches our society.
- A research and historical data archive to serve as the basis for compilation of the history of this unique collection of scientific institutions.
- Educational field-trips to the Hale Pohaku Visitors Center. Located at the 9,000 foot-level of Mauna Kea, Hale Pohaku is a small facility designed to give the visitor an overview of Mauna Kea and the observatories at its summit.
- A traditional Hawaiian account of the creation of the cosmos with its remarkable similarity to the theory of evolution into the times of the Polynesian navigators and the early western contact history of Hawai'i until today when Mauna Kea is a focal point of the exploration of the cosmos for all mankind.
- Interactive displays of the natural and cultural features of Mauna Kea: human endurance of cold in the adze quarry, the indigenous plants of the mountain and their role in Hawaiian culture.
- Planetarium and flat screen theater shows that describe and demonstrate navigating by stars.
- Focus on the human activities associated with Mauna Kea.
- Video displays of live images of Hawaiian cultural activities including navigating.
- Public lecturers on Hawaiian culture on Mauna Kea.
- Scholar-in-Residence program to show the connections between Hawaiian culture revitalization and the revitalization of other indigenous cultures and languages.
- A research and historical data archive on cultural use of Mauna Kea.

INFORMAL ASTRONOMY EDUCATION

The Center will serve to inform and inspire national audiences about the wonders of the Universe being discovered daily with Mauna Kea observatories as well as the remarkable adaptability of native Hawaiian culture from time immemorial to the present. Primarily through electronic dissemination, the Center will serve students, teachers, visitors to other science centers and museums, and the worldwide community by providing materials and images relating to astronomy and the Mauna Kea observatories. By so doing it will serve to increase scientific and cultural literacy and inspire the next generation of scientists from all corners of the world including once isolated indigenous peoples. Programs to serve these purposes include:

- Electronic dissemination of live images from Mauna Kea, including images of astronomical objects seen through Mauna Kea telescopes.
- Electronic dissemination of explanations on the latest discoveries made with Mauna Kea observatories, their importance for human understanding of the Universe, and the cultural context of Mauna Kea.
- News conferences to release the latest and most important results of Mauna Kea astronomical research.
- Regional, national, and international conferences and videoconferences on astronomy, Hawaiian and Polynesian voyaging and navigation, and related subjects.
- Collaborative programs with other science centers worldwide in order to disseminate the research results of Mauna Kea and to explicate the cultural and historical context of the observatories.
- Electronic dissemination of latest explanations of Hawaiian sites, developments in Hawaiian cultural revitalization, connections to other indigenous peoples.
- News conferences on visits from other indigenous peoples to the center.
- Collaborative programs with other indigenous areas throughout the world.

FORMAL ASTRONOMY EDUCATION

The Center will serve to facilitate formal astronomy education and the integration of science into indigenous cultures at all levels. It will also serve as the principle center in the world demonstrating how the latest science can be integrated with indigenous cultures of great antiquity to maintain unique cultural identity and knowledge while participating at the scientific forefront of the international global society. The Center will help to train the next generation of space scientists and to raise the overall level of science literacy in our nation. Students, teachers, and institutions served by these programs will include K-12 students and classes, teachers and college instructors, and community college/baccalaureate students locally, nationally, and worldwide. Programs to support formal astronomy education will include:

- School class visitation programs, for visiting school groups from Hawai`i and throughout the world, utilizing all the Center observatory visitors center facilities and some of the academic support facilities.
- Professional development experiences for teachers and college instructors in the forms of year-round workshops, on-site and distance learning courses and programs, curriculum development, and research opportunities in collaboration with University of Hawai`i astronomy faculty.
- Enhancement of classroom astronomy instruction throughout the State of Hawai`i by in-class programs provided by Center staff and affiliated University of Hawai`i astronomy pre-service education students.
- Collaborative use of Mauna Kea telescopes to enhance astronomy instruction in cooperating community colleges, universities, and K-12 schools; locally, nationally and world-wide.
- Summer astronomy workshops and courses for astronomy students from secondary schools, community colleges, and universities; utilizing the Center's facilities and the Mauna Kea observatories.
- Electronic dissemination of scientific data from Mauna Kea telescopes, and live images, to schools and universities worldwide.
- Development of a National Astronomy Scholars Program in conjunction with the University of Hawai`i at Hilo.
- Year round Hawaiian and indigenous culture workshops.
- Development of curriculum materials on Hawaiian and indigenous cultures.
- Academic programs in Hawaiian and other indigenous languages and cultures at the community college, baccalaureate and graduate levels.

VIII. FACILITY PLAN

The facilities to deliver the Center' programs will be located on a ten-acre site on the University of Hawai'i at Hilo's University Park, which houses the base facilities for most of the Mauna Kea observatories (CalTech Submillimeter Telescope, Gemini North Telescope, United Kingdom Infrared Telescope, James Clerk Maxwell Submillimeter Telescope, Subaru Telescope, University of Hawai'i Observatory, NASA Infrared Telescope, Smithsonian Submillimeter Array).

The donated site (fee simple, owned by the University of Hawai'i at Hilo) is ready for development with all utilities and access roads installed. The Center will consist of several buildings arranged in a campus-like setting in a well-landscaped environment that enhances the visitor's experience and the Hawaiian context of the observatories. Most of the Center campus will serve as the observatory visitors' center and will be open to the public. Major components of the Center campus will include:

ENTRANCE

The Center entrance facilities will set the Hawaiian theme for the visit and immerse the visitor into the observatory complex. The astronomy portion of the entrance facility will feature large-screen live video from cameras on the summit and inside the observatories, and images of astronomical objects taken with Mauna Kea telescopes. The entrance area will include a large-scale diorama of the summit of Mauna Kea and the observatory complex.

OBSERVATORY EXHIBITS

The Center will include a large exhibit area for interactive and static displays that interpret the qualities of the Mauna Kea site, the properties of the telescopes, the operation of the instruments used on the telescopes, and the meaning of the astronomical discoveries being made by the Mauna Kea observatories. Other observatory and astronomy exhibits will be scattered throughout the Center, many outside (including full scale mock-ups of telescopes and mirrors).

PLANETARIUM THEATER

A modern, multi-media planetarium will provide shows using visual effects to explain the astronomy being done on Mauna Kea in an inspiring and wonder-inducing manner. The planetarium is designed to allow the images from Mauna Kea telescopes to be projected onto the dome in a unique fashion that is realistic, informative, and awe-inspiring. Planetarium shows will be produced to emphasize the latest discoveries made at Mauna Kea. The planetarium theater will also serve to support conferences held at the Center.

THEATER/CONFERENCE CENTER

A separate theater facility will serve as a general-purpose program delivery area for video theater presentations, live theater productions with astronomical and/or Hawaiian themes, conference center with simultaneous translation capability, public lecture hall, and a news conferencing facility with satellite up-link capability.

HAWAIIAN CENTER

A building housing many of the Hawaiian and Polynesian exhibits, especially those related to voyaging and navigation (other such exhibits will be integrated throughout the Center).

RESTAURANT & GIFT SHOP

A restaurant with indoor/outdoor seating overlooking the grounds with a panoramic view of Hilo Bay. Staff of nearby observatories would be encouraged to have their lunch here and mingle with Center visitors. Visitors would have a chance to "have lunch with an astronomer." The gift shop will offer a variety of souvenirs and educational gifts to the visitor.

EDUCATION BUILDING

A separate building, adjacent to the public facilities of the Center but not open to the general public, will house all the Center's administrative, support, and education facilities. Support facilities will include equipment maintenance, exhibits design and fabrication, program and media design, curriculum materials preparation and dissemination facilities, and telescope operation facilities. Education facilities will include several classrooms, seminar rooms, laboratories, and a small instructional planetarium. The classrooms and seminar rooms will also serve to support conferences held at the Center. In addition, this building will house the data and historical archives for all of the Mauna Kea observatories.

In addition, the Center's facilities will include several components on Mauna Kea to provide the imagery, astronomy instructional services, and research data needed by various Center programs. These facilities will include several video cameras providing live feeds of the summit area and activities inside the observatories; a small instructional telescope providing access to astronomical observations for cooperating schools and universities, and images of astronomical objects for use in the Center; and a heliostat/siderostat to provide live images of the Sun and Moon on a nearly continuous basis for electronic distribution to schools, universities, and science centers world-wide. The site for the telescope and associated equipment is in the summit Science Reserve, amongst the Mauna Kea research observatories; the University of Hawai'i, which will donate it to the Center's use, manages it.

IX. ESTIMATED CONSTRUCTION COST

The University of Hawaili at Hilo proposes the construction of the Mauna Kea Astronomy Education Center, a 36,000 square foot facility to be located on the slopes of Mauna Kea, in

Hilo, Hawai`i at a cost of $19,980,000. The following is a categorized breakdown of estimated construction costs:

Construction Cost	The proposed 36,000 square foot building is estimated to cost about $225 per square foot. The high cost of construction is due to the special structures needed to accommodate the two planetaria.	**$8,080,000**
Site Improvements	Preparing the site and providing the required grade level parking will add another $28 per square foot of building area to the project cost.	**$1,000,000**
Architectural & Engineering Fees	Fees are anticipated to cost about 10 % of the construction and site improvement cost.	**$1,000,000**
Equipment Cost	The centerpiece for the MKAEC is the large dome-theater with its Planetarium Projectors, and imaging equipment in the observatory complex on Mauna Kea.	**$4,750,000**
Exhibit Development Cost	Interactive exhibits typically cost from $200 to $500 per square foot to construct. $250 per square foot was used in this estimate. Outdoor exhibits were estimated at $150 per square foot.	**$5,150,000**
Total Project Cost		**$19,980,000**

X. BUSINESS PLAN

The Mauna Kea Astronomy Education Center will be a unique facility located in an area where it will stand out as an exciting educational opportunity. The Center is situated in a small local market; however, it addresses a large and growing visitor market looking for the kind of experiences that it will have to offer.

- The Hawai`i Volcanoes National Park, which reports 2.6 million entries annually, is an indication of the market potential for first-rate visitor attractions on Hawai`i Island.

Preliminary Estimates and Data Analysis

Preliminary estimates of customer numbers, revenues, staffing needs and costs are shown in exhibits appended to this plan. They show that the Center can, with prudent management and aggressive marketing, earn revenues in excess of $500,000 after its first year. Because these estimates are extremely conservative, it shows that operating costs will be appreciably higher, so the revenues will cover only part of the costs.

Market studies were estimated by SMS Research of Honolulu. These preliminary estimates were used as the basis for the market assumptions and project a negligible capture of the West Hawai`i market. SMS estimates that of the 722,589 independent visitors to West Hawai`i, only 3,613 initially and 7,226 finally, will find their way over to the center.

The SMS study also projects low population-growth on Hawai`i Island and a poor attendance rate by Island residents. Only about 3 percent are estimated to visit in the first year and about two percent each year thereafter (not counting school children and members and supporters). However, contacts with the National Science Teachers Association and the American Association of Physics Teachers indicates very enthusiastic support for the Center, and local science teachers are extremely enthusiastic about this new resource.

An additional market analysis will be secured to survey East and West Hawai`i visitors at the airport, in Kailua-Kona, in Hilo, at Waikoloa, and at Hawai`i Volcanoes National Park to determine Center attendance. We will also survey off-island people who happen to be in Hilo for business, family or other reasons including several large annual events such as the Merry Monarch Festival, the state's premiere hula competition with participants from across the Pacific Ocean, including Japan and California. These surveys will form a basis for determining more precisely resident, visitor and schoolchildren attendance.

We recommend phasing of the Center's construction to establish and implement the public programs as quickly as possible. Phase I (first year) should consist of all facilities except the planetarium, outdoor exhibits, and the exhibits spaces included within the planetarium. Phase II (second year) would then consist of these remaining facilities.

Estimated Capital Costs

The University of Hawai`i at Hilo has already secured the property on which the Mauna Kea Astronomy Education Center will be constructed. Therefore, the capital costs involved in the project only pertain to construction of buildings, site improvements, architectural and engineering fees, equipment and exhibit development cost. Exhibit 2 shows a complete breakdown of the costs. The following is a summary of these costs:

- Construction Cost – the proposed 36,000 square foot building is estimated to cost about $225 per square foot. The high cost of construction is due to the special structures needed to accommodate the two planetaria. Total cost: $8,080,000.

- Site Improvements – preparing the site and providing the required grade level parking will add another $28 per square foot of building area to the project cost. Total cost: $1,000,000.

- Architectural and Engineering Fees – fees are anticipated to cost about 10 % of the construction and site improvement cost. Total cost: $1,000,000.

- Equipment Cost – the centerpiece for the MKAEC is the large dome-theater with its Planetarium Projectors, and imaging equipment in the observatory complex on Mauna Kea. Total equipment cost is expected to be about $4,750,000.

- Exhibit Development Cost – interactive exhibits typically cost from $200 to $500 per square foot to construct. $250 per square foot was used in this estimate. Outdoor exhibits were estimated at $150 per square foot. Total cost: $5,150,000.

- Total Project Cost: $19,980,000.

Estimated Operating Costs

It is expected that the Mauna Kea Astronomy Education Center will be operated for approximately seven hours per day, seven days per week. Weekend hours will be slightly shorter, but on occasion, there will also be evening programs and sleepovers. The Center will function as a science center with interactive exhibits and educational interpreters. Furthermore, the Center will be developing its own planetarium programs. The staffing required for this type of operation is detailed in Exhibit 3. Approximately 29 full time equivalent personnel will be necessary to operate the facility, develop its programs, and market its services. Estimated operating costs are summarized as follows:

Salaries	$878,083
Payroll Taxes and Benefits	$263,425
Program development	$50,000
Utilities	$30,000
Advertising	$50,000

Supplies	$5,000
Insurance	$10,000
Maintenance and Cleaning	
General	$12,000
Contracts for Dome Planetarium	$140,000
Contract for Teaching Planetarium	$5,000
Legal and Accounting	$5,000
Licenses	$1,000
Telephone	$2,500
Miscellaneous	$31,050
TOTAL	$1,483,058

Pricing Considerations

Pricing has been estimated on the basis of experience with Hawai`i's attractions audiences and comparison with other East Hawai`i facilities. Key comparables are the Hawai`i Volcanoes National Park (charging $10/vehicle) and Hawai`i Tropical Botanical Garden, charging $15 per adult visitor. With the region's premier natural attraction available at a low price, a Hilo facility cannot charge prices comparable to those found in, for example, Maui. The suggested admission rate of $12 for adult visitors is intended to be well below the highest price in the region.

Surveys (conducted at the Bishop Museum in 1999) dealing with the amount visitors would pay for a separate planetarium show suggested that the optimal price was about $10. The suggested admission rate would be higher than that optimal price for independent visitors, and slightly below that optimal price for tour groups. Tour groups generally receive volume discount rates. It is also customary for local residents to pay a lower rate and school groups are admitted at a special, nominal rate. Overnight programs are projected at $30 per customer, which is what Bishop Museum charges. Exhibit 4 details the projected admission rate for the different customer categories.

Projected Operating Revenue

The operating revenue projections are based on SMS Research's estimate of the number of visitors expected (Exhibit 1) multiplied by the average admission charge for the various different groups of visitors (Exhibit 4). These attendance estimates are based on very conservative assumption regarding the attraction of the center for visitors and residents, and projected growth in visitor counts and population. In addition, 10% of the estimated average food/beverage and gift shop revenue was included. It is assumed that food service and the gift shop operation would be contracted out, and the Center would receive 10% of gross revenue. Operating revenue during the first year of operation is projected to be about $406,000. Once the operation stabilizes and a strong marketing program is established, revenues are likely to increase to about $710,000 per year (see Exhibit 5).

Support Revenue Requirements

The difference between the Center's operating cost and its operating revenue will be made up by "support revenue". Support revenue refers to income that is generated through contributions, grants, and subsidies from a sponsoring organization, legacies, and bequests. Once the organization stabilizes, it is expected that support revenue required will be no less than 50% of the total operating budget. This level of support is about average for most science centers in the United States.

The Center will be organized as a non-profit 501 (c) (3) corporation affiliated with the University of Hawai`i at Hilo to operate the Center after its completion. This corporation will have a major function to raise additional funds for the operation of the Center. The funding sources could be State and County of Hawai`i, private, national and international corporations affiliated with the observatories, international governments sponsoring the observatories, as well as public and private foundations. Additional funding could also come from the increase of visitors to the Center through marketing efforts, group tours to Hale Pohaku, and some restricted tours to the summit.

Marketing Considerations

Marketing can begin before the Center opens as an attraction through the Center's web pages. Housed at UH Hilo, the web site can help to create excitement about the construction of the Center. Once the Center is about to open, marketing tasks will include:

- Publicizing the Center and its programs to local and Honolulu tourism leaders (e.g., West Hawai`i resort tour desks and concierges, bus tour bookers in Honolulu, local eco-tourism operators).
- Encouraging local participation in Center development and support for its activities.
- Working with education specialists to identify school needs that can be served through visits to the Center, and scheduling Center programs for the current and future school years;
- Developing and distributing promotional materials; and
- Using Internet resources to reach astronomy enthusiasts and hobbyists, travel agents and others around the world.

Exhibit 1: Major Visitor Populations

Market Segment	Current size	Future	Initial Market	Year 3 Stabilization	Notes on Population	Notes on Estimate
Hawaii Island Residents	144,000	slow growth			DB : 98 round up	
School age : day	30,000	slow growth	2,000	3,000	DB: 107% of 1995	1 grade, then 2
School age: eves.			500	2,000		
At large	140,000	slow growth	4,400	3,000		BPBM planetarium exper.
Members/supporters	NA	DOE, astron, gen'l public	200	600		Adj comp, Oahu cultural museums
Hawaii, Other counties						
School age: day	191,000	stable	1,000	1,250	DB - 1996 K-12	1 grade; 10%, then 25%
School age: eves.			592	1,250		
At large	1,050,000	stable	1,000	1,000	DB	
US Mainland						
ARRIVING AT HILO	301,710				98 DB	
Independent	237,471		4,000	6,000		based on arrivals, BPBM e
Groups						
tour buses	42,239		8,448	16,896	97 VSAT % of Isl US Vi	est. 20% capture - to 40%
schools	NA		300	600		see note
Cruise passengers	22,000	30,000	2,200	6,000	DBED current	est. 20% capture
ARRIVING KONA	840,220				98 DB	
Independent	722,589		3,613	7,226		.5% to 1% est
Groups						
tour buses	117,631				97 VSAT % of Isl US Vis	
schools	NA					
Japan						
ARRIVING AT HILO	87,130				98 DB	
Groups (bus)	36,595	no growth	7,319	14,638	97 VSAT % of Isl J Vis	est. 20% capture - to 40%
Groups (school)	NA		300	600		see note
Independent	50,535		5,054	5,054		
ARRIVING KONA	243,190				98 DB	
Groups (bus)	102,140				97 VSAT % of Isl J Vis	
Groups (school)	NA					
Independent	141,050		705	1,411		.5% to 1% est
			41,631	70,524		

Exhibit 2: Initial Estimate of Facility Costs

Facility	Building Area	Exhibit Area	Cost/SF	Equipment Cost	Exhibit Cost	Building Cost	Total
Theater							
shell	3,000		$250			$750,000	$750,000
projector, furnishings			$250	$400,000			$400,000
program development					$450,000		$450,000
Entry Exhibits	5,000		$250			$1,250,000	$1,250,000
exhibit development		5,000	$250		$1,250,000		$1,250,000
Diorama	1,000		$250			$250,000	$250,000
diorama dev.		1,000	$250		$250,000		$250,000
Dome Planetarium							
shell	8,000		$385			$3,600,000	$3,080,000
exhibits (scopes, etc.)		5,000	$250		$1,250,000		$1,250,000
planetarium (2 systs.)				$2,500,000			$4,500,000
program development					$200,000		$200,000
Teaching planetarium				$350,000			$350,000
Education facility	10,000		$250			$2,500,000	$2,500,000
Garden exhibits		5,000	$150		$750,000		$750,000
Ancillary space	5,000		$250			$1,250,000	$1,250,000
Ancillary equipment				$1,500,000			$1,500,000
Hawaiian center	4,000		$250			$1,000,000	$1,000,000
Haw. Center exhibits		4,000	$250		$1,000,000		$1,000,000
Total	36,000	20,000		$ 4,750,000	$5,150,000	$10,600,000	$19,980,000

Exhibit 3: Projected Staffing

	Staff	Hours	FTE	Annual Salary	Total Salaries
Staffing by area					
3-D Theater					
usher, clean	2	50.7	2.5	$ 20,000	$ 50,676
Entry, ticket box	1	57.7	1.4	$ 20,000	$ 28,838
Exhibits, garden	2	50.7	2.5	$ 20,000	$ 50,676
Dome Theater					
show programs	1	50.7	1.3	$ 35,000	$ 44,342
program devel.	4	40.0	4.0	$ 45,000	$ 180,000
Exhibits near dome	2	50.0	2.5	$ 20,000	$ 50,000
Ed. Center planetarium	1	40.0	1.0	$ 35,000	$ 35,000
Electronics tech	1	40.0	1.0	$ 40,000	$ 40,000
Handyman, mech.	1	40.0	1.0	$ 35,000	$ 35,000
Grounds staff	2	40.0	2.0	$ 18,000	$ 36,000
Security	1	60.0	1.5	$ 18,000	$ 27,000
Reservations	1	40.0	1.0	$ 20,000	$ 20,000
Night programs	1.5	16.6	0.6	$ 25,000	$ 15,550
Marketing	1	40.0	1.0	$ 45,000	$ 45,000
Program devel.	1	40.0	1.0	$ 50,000	$ 50,000
Administrator	1	40.0	1.0	$ 60,000	$ 60,000
Site Manager	1	40.0	1.0	$ 40,000	$ 40,000
Administrative Asst.	1	40.0	1.0	$ 25,000	$ 25,000
Bookkeepers	1.5	40.0	1.5	$ 30,000	$ 45,000
Total			28.9		$ 878,083

Exhibit 4: Year 01 Revenues

REVENUES -- calculated by visitor type	Visitors	Average Admission	Food and Gift/person	MKC % 10%	Revenues
Hawaii Island Residents					
School age : day	2,000	$3	$0	$0	$6,000
night	500	$30 (1)	$0	$0	$15,000
At large	4,400	$8	$8	$1	$38,720
Members/supporters	200	$30 (2)	$30	$3	$6,600
Hawaii, Other counties					
School age: day	1,000	$3	$0	$0	$3,000
night	592	$30 (1)	$0	$0	$17,760
At large	1,000	$8	$8	$1	$8,800
US Mainland					
ARRIVING AT HILO					
Independent	4,000	$12	$8	$1	$51,200
Groups					
tour buses	8,448	$8	$3	$0	$70,117
schools	300	$8	$3	$0	$2,490
Cruise passengers	2,200	$8	$8	$1	$19,360
ARRIVING KONA					
Independent	3,613	$8	$3	$0	$29,987
Groups	-	$0	$0	$0	$0
tour buses					
schools					
Japan					
ARRIVING AT HILO					
Groups (bus)	7,319	$8	$3	$0	$60,747
Groups (school)	300	$8	$8	$1	$2,640
Independent	5,054	$12	$8	$1	$64,685
ARRIVING KONA					
Groups (bus)	-	$0	$0	$0	$0
Groups (school)	-	$0	$0	$0	$0
Independent	705	$12	$8	$1	$9,027
TOTALS	41,631				$406,134

NOTES: Population figures are from population worksheet, with overnight school groups broken out.

(1) Overnight fee. Covers visit and sleepover, not food.

(2) Annual membership fee for museum supporters.

Exhibit 5: Projected Revenues & Expenses

	Year 01	Year 02	Year 03
Projected Revenues			
All Visitors	$ 406,134	$ 557,844	$ 709,554
Projected Operating Expenses			
Salaries	878,083	878,083	878,083
Payroll Taxes and Benefits	263,425	263,425	263,425
Program development	50,000	50,000	50,000
Utilities	30,000	30,000	30,000
Advertising	50,000	50,000	50,000
Supplies	5,000	5,000	5,000
Insurance	10,000	10,000	10,000
Maintenance and Cleaning			
General	12,000	12,000	12,000
Contracts for Dome Planetarium	140,000	140,000	140,000
Contract for Teaching Planetarium	5,000	5,000	5,000
Legal and Accounting	5,000	5,000	5,000
Licenses	1,000	1,000	1,000
Telephone	2,500	2,500	2,500
Miscellaneous	31,050	31,050	31,050
TOTAL	$ 1,483,058	$ 1,483,058	$ 1,483,058
Net Loss from Operations	$ (1,076,924)	$ (925,214)	$ (773,504)
Projected Revenue as % of Total Cost	27.4%	37.6%	47.8%

XI. SUMMARY

Americans can be proud of the complex of observatories on Mauna Kea's 13,000-foot summit. They represent the world's largest and most sophisticated collection of research institutions dedicated to a single science – Astronomy.

We request approximately $20 million to build the Mauna Kea Astronomy Education Center, which will have direct and constant communication with these observatories. No other major science interpretive center in the world works as closely and directly with premier research facilities such as this.

The Center will allow visitors and students across the nation unprecedented access to cutting edge astronomy research via the Internet. Students and teachers across the nation will be able to directly access to the Center's facilities from their classrooms, wherever they are located.

The facilities, displays, and exhibits at the Center will demonstrate the most advanced exhibit technologies to present the ongoing work done on Mauna Kea. This combination of close collaboration with research institutions and state-of-the-art exhibit and theater technology will result in a new level of scientific interpretation available to the American public.

The Mauna Kea Astronomy Education Center will serve to excite and inspire our future generations of scientists and astronomers, and provide American children, students and teachers across the nation with the most sophisticated and current astronomy educational materials.

This project will catapult America into a leadership role in astronomy education using the world's premiere viewing site, Mauna Kea, at an elevation of 13,780 feet above sea level.

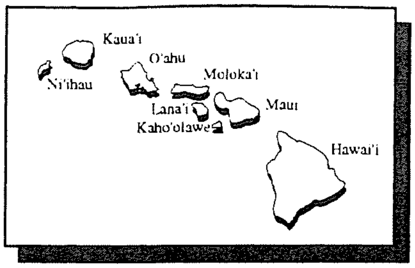
We ask you to make this investment in America's future.

Appendix A

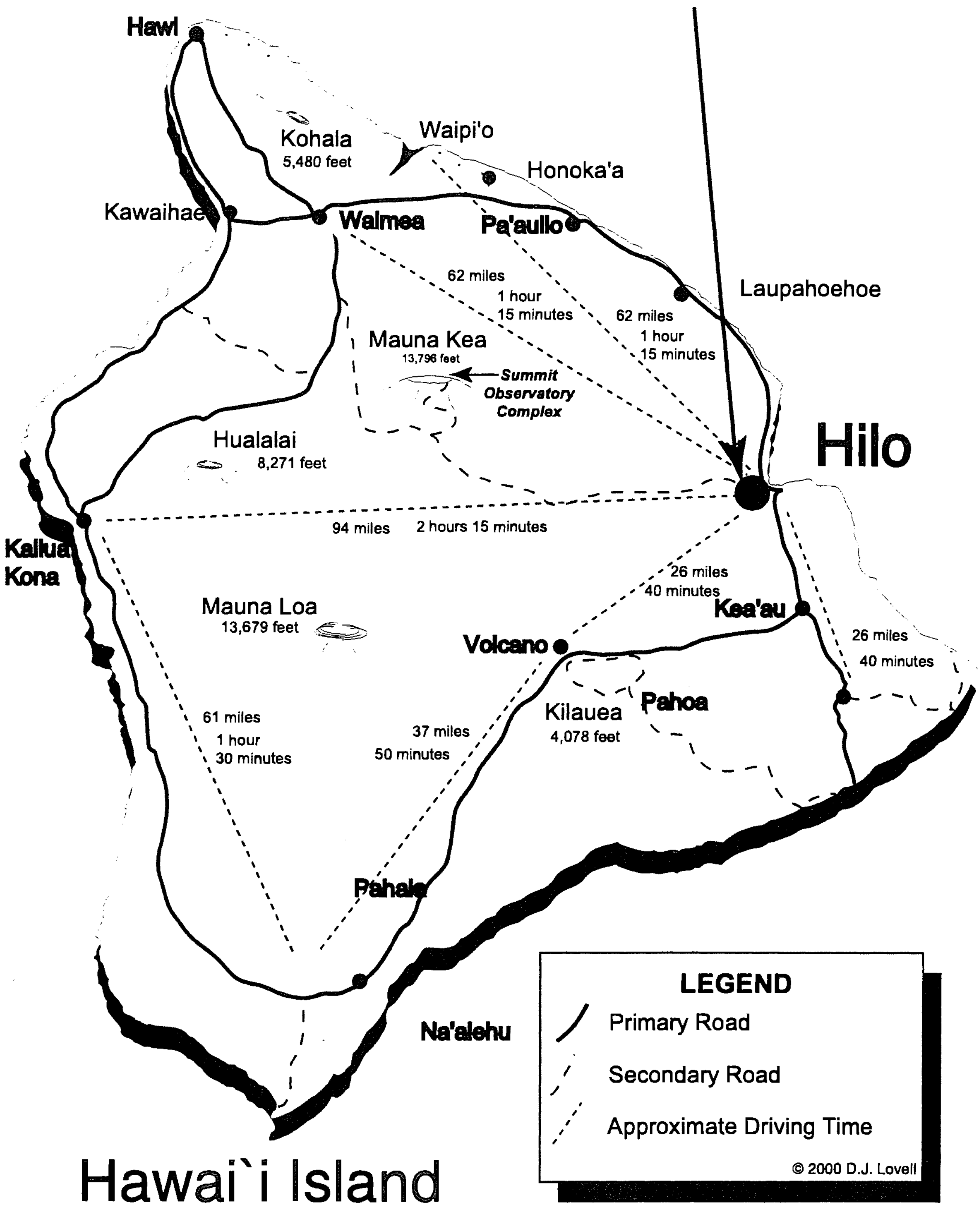
PLOT PLAN

The following illustrations are location and plot plans.

- Hawai`i Island – Proposed Facility Location
- University Park, University of Hawai`i at Hilo – Plot Plan



Proposed Facility Location



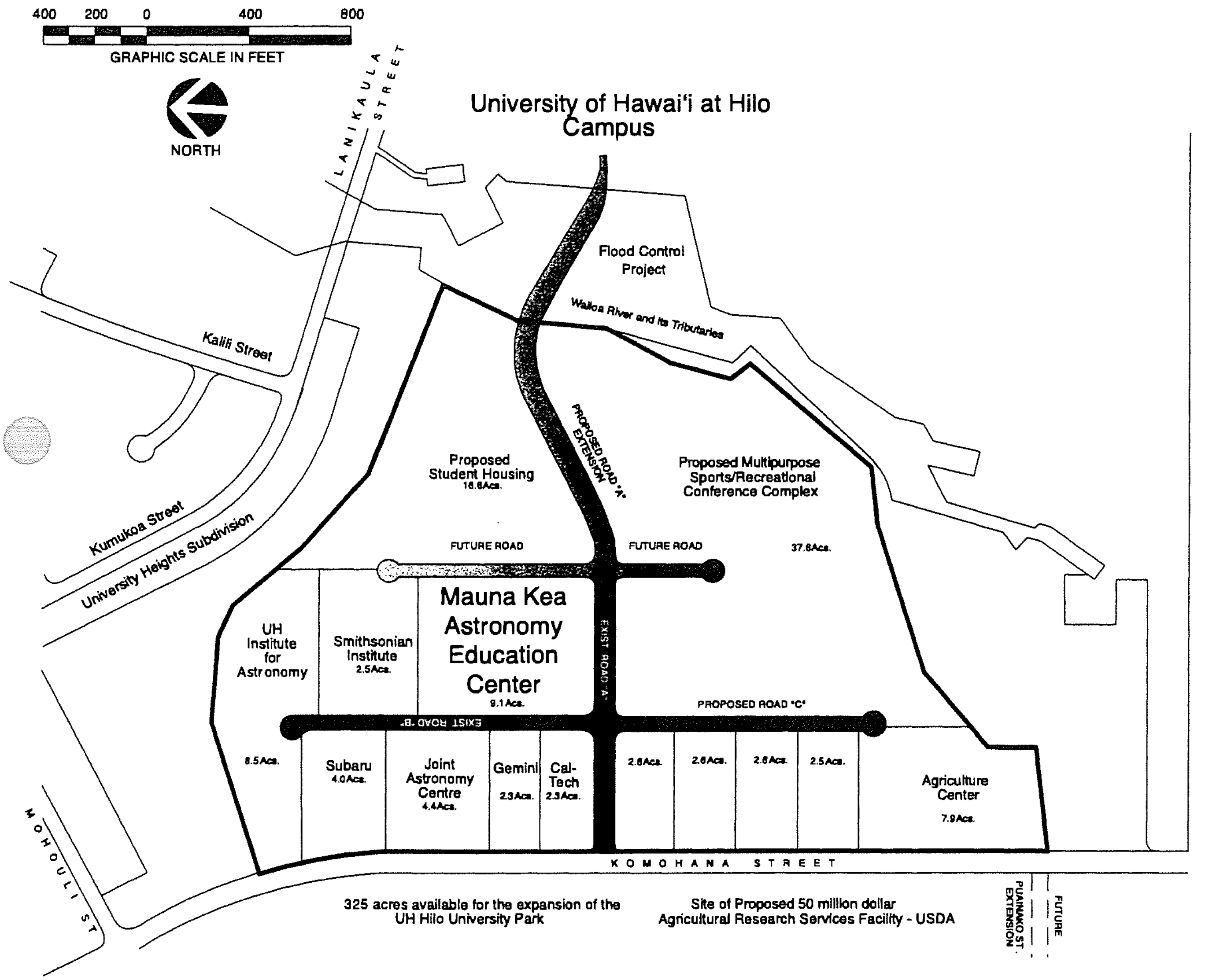
Hawai`i Island

Mauna Kea Astronomy Education Center

University Park, University of Hawai`i at Hilo

Mauna Kea Astronomy Education Center

Plot Plan



Mauna Kea

Appendix B

ARCHITECT'S CONCEPTUAL RENDERINGS

The following conceptual drawings and renderings are by the architectural design firm of Oda/McCarty Architects, Ltd.

- Aerial View
- Conceptual Site Plan
- Building Elevations
- Conceptual Site Section
- Entry and Parking in Hawaiian Rainforest Setting
- Exhibit Courtyard toward Planetarium
- Observation Deck View toward Hilo Bay
- Night View toward Mauna Kea

Graphics not included in this copy of the Master Plan

APPENDIX C. EXISTING ASTRONOMY FACILITIES

UH 2.2-meter Telescope
This decade of activity started with the first operations of the UH 2.2-meter Telescope in 1970. This optical/infrared telescope was one of the first in the world to be fully computer-controlled. This telescope is used for a wide range of observing programs and is an essential component in the Institute's graduate teaching program. Observations on the telescope are typically conducted by principal investigators associated with the University of Hawai'i.

Canada-France-Hawaii Telescope
In 1972, the French national agency responsible for research in astronomy chose Mauna Kea as the site for their nation's major telescope. An agreement was reached between UH and government agencies in Canada and France to cooperate in a joint venture to develop a 3.6-meter optical/infrared telescope. The Canada-France-Hawai'i Telescope (CFHT) became operational in 1979. Headquarters for the CFHT were developed in Waimea.

Infrared Telescope Facility
In 1973, NASA applied to the State to construct an infrared telescope on Mauna Kea. The 3-meter Infrared Telescope Facility (IRTF) was completed in 1979 to provide infrared observations in support of NASA's programs. It is the only U.S. national observatory dedicated to infrared astronomy and half of the observing time is reserved for studies of solar system objects. The IRTF is managed and operated by the UH Institute for Astronomy under contract to NASA.

United Kingdom Infrared Telescope
Like the IRTF, the United Kingdom Infrared Telescope (UKIRT) is designed for studies of cooler celestial objects such as planets and developing stars. With a 3.8-meter mirror, UKIRT is the world's largest telescope dedicated solely to infrared astronomy. Since it was first developed, several upgrades have been made on the telescope instrumentation to improve observation performance. Funded by the British government, UKIRT is operated, along with the James Clerk Maxwell Telescope, by the Joint Astronomy Centre (JAC), headquartered in Hilo.

Caltech Submillimeter Observatory
The Caltech Submillimeter Observatory (CSO), identified in the 1983 Plan as the California Institute of Technology 10.4-meter Telescope for Millimeter and Submillimeter Astronomy, was assembled and tested in Pasadena, California before being shipped and reassembled on Mauna Kea. At the time, submillimeter wavelength astronomy was an emerging field which promised to greatly complement traditional optical/infrared astronomy. The 10.4 meter telescope, dedicated in the Fall of 1986, is one of the easiest to use submillimeter telescopes and has been a leading edge facility for instrumentation development. It is located in "Millimeter Valley" near the James Clerk

Maxwell Telescope (JCMT) and sometimes participates in short baseline interferometry with the JCMT. The telescope is operated by Caltech under a contract from the National Science Foundation. Headquarters for the CSO are located in Hilo.

James Clerk Maxwell Telescope

The James Clerk Maxwell Telescope (JCMT) is a 15-meter submillimeter telescope operated by the Joint Astronomy Centre (JAC) for science organizations in the United Kingdom, Canada, and the Netherlands. This facility was identified as the United Kingdom/Netherlands 15-meter Millimeter Wave Telescope in the 1983 Plan. One of the goals of this instrument, as explained in the 1983 plan, is to understand the way galaxies have evolved to reach their present condition. The JAC also operates the UKIRT from its headquarters in Hilo. The JCMT is the largest of a new generation of radio telescopes designed to work at submillimeter wavelengths. During observations, the doors to the JCMT are opened and the viewing aperture is covered with a membrane that transmits 80 percent of the incident submillimeter radiation but reflects most of the incident Solar heat. Because of this, the telescope can be used during the day and may even look directly at the Sun.

The JCMT began operations in 1987 and has been used to study the Sun, comets, planets, molecular clouds, galaxies, quasars and cosmic background radiation. The telescope has been successful in mapping many star-forming complexes.

Very Long Baseline Array

The Very Long Baseline Array (VLBA) consists of ten identical radio telescopes, each 25 meters in diameter, spread across the United States from Hawai'i to the U.S. Virgin Islands. A small staff of technicians operate Hawai'i facility. The Operations Center for the entire array is located in Socorro, New Mexico. The Mauna Kea component of the VLBA was completed in 1992. Located far below the identified telescope siting areas, the VLBA was not a component of the 1983 Complex Development Plan. An amendment to the 1983 Plan was prepared in 1988 to allow development of this facility. The radio telescope is located east of the Access Road at approximately the 12,200 foot elevation level. The site, located between two *pu'u*, was selected because it is shielded from radio-frequency interference (RFI) in most directions. It was also placed at the lower elevation because there was no scientific advantage to having it much higher than the tropical inversion layer and snow loading at the summit would be problematic. The VLBA is used to observe galaxies, quasars, and gravitational lenses, and can be combined with other telescopes around the world. The antenna is operated remotely 24 hours a day by the national Radio Astronomy Observatory and is funded by the National Science Foundation. Support staff on island work on day-to-day technical issues at the antenna.

W.M. Keck Observatory

Envisioned in the 1983 Plan as the University of California 10-meter Telescope, the W. M. Keck Observatory (Keck I) was completed in 1993. Beyond specifically-defined facilities, the 1983 Plan anticipated proposals for two additional 10-meter class telescopes. Subsequently, NASA joined the Keck team and a second10-meter telescope, Keck II, was constructed. The second of the twin telescopes began operations in 1996. The largest optical and infrared telescopes in the world, each mirror is composed of 36 hexagonal segments that work together as a single piece of reflective glass. The observatory is operated by the California Institute of Technology, the University of California, and NASA. Astronomers perform much of their research, including remote observing during the night, and sleep at the Keck headquarters in Waimea. Electronics and adaptive optics laboratories and maintenance facilities are also included in the Waimea complex.

The large size of the telescope's mirror is significant in that it allows more light to be collected. This makes it possible to observe faint objects far away, allowing scientists to look farther back to the beginning of time. The Keck telescopes are also used in with the Hubble Space Telescope for detailed exploration of the deep images taken from. This collaboration between ground-based and space-based telescopes will continue as both types of astronomy serve distinct scientific purposes and together can be more powerful than each alone.

Gemini North

Gemini Northern, an 8-meter optical/infrared telescope, will see its first light in 1999. What ultimately has become Gemini North was first identified in the 1983 Plan as the National New Technology Telescope (NNTT). The NNTT was originally conceived as a 15-meter telescope funded by the US federal government. Over time the project evolved to comprise two smaller telescopes funded and operated by an international partnership which includes the United States, United Kingdom, Canada, Argentina, Australia, Brazil, and Chile. The Gemini North telescope on Mauna Kea is complemented by an 8-meter Gemini telescope in Chile in the Southern Hemisphere. Headquarters for the international project have recently opened in Hilo. Complete sky coverage will be available from the two telescopes. The telescopes are designed to exploit the best image quality allowed by the Earth's atmosphere at these sites.

Subaru

Site work for the Japanese National Large Telescope began on Mauna Kea in 1992. This telescope was generally described in the 1983 Plan as a 10-meter class optical/infrared that had not been specifically identified. It is the first large Japanese scientific instrument to be located at an overseas site. The optical/infrared telescope, called Subaru after the Japanese word for the star cluster Pleiades, has a 8.3-meter diameter mirror made from a single piece of glass. Subaru telescope gathered its first light in 1999 and will be in full operation in the year 2000. Scientists plan to use Subaru to study immensely bright but distant quasars and to image individual planets around other stars. While recent observations at other telescopes have indicated the presence of far away planets, no planet outside of our solar system has been imaged directly.

Submillimeter Array

The Submillimeter Array (SMA) is a collaborative project between the Smithsonian Astrophysical Observatory and the Institute of Astronomy and Astrophysics in Taiwan. The SMA is an instrument designed for high resolution observations at submillimeter wavelengths. The SMA will improve angular resolution by a factor of ten over single facilities such as CSO and JCMT. The SMA's four primary areas of research will be star formation, structure of galaxies, quasars and active galactic nuclei, and solar system studies. Twenty-four antenna pads will host varying configurations of up to 12 antennas. The antennas are transportable using a specially designed carrier. The SMA will begin operations in 2000. The SMA represents the major radio facility foreseen in the 1983 plan. As that time, this was expected to be a 25 m single-dish facility somewhat smaller than the VLBA antenna. Because of technological advances in radio astronomy in the late 1980's, the focus for submillimeter astronomy switched from single-dish instruments to interferometer arrays.

APPENDIX D. MAUNA KEA ADVISORY COMMITTEE

Mr. Larry Kimura Co-Chair	University of Hawai'i at Hilo Assistant Professor of Hawaiian Studies
Dr. William Wilson Co-Chair	University of Hawai'i at Hilo Professor of Hawaiian Studies
Mr. James Arakaki	County of Hawai'i County Council Chairman
Mr. Gerald DeMello	University of Hawai'i at Hilo Director, University Relations
Ms. Virginia Goldstein	County of Hawai'i Planning Director
Dr. William Heacox	University of Hawai'i at Hilo Professor of Astronomy
Mr. Richard Henderson	Retired State Senator
Mr. Rex Johnson	The Nature Conservancy
Dr. Jerry Johnson	University of Hawai'i at Hilo Professor
Dr. James Juvik	University of Hawai'i at Hilo Professor of Geography
Mr. Bill Kikuchi	Office of Senator Daniel K. Inouye
Mr. Herring Kalua	Hawaiian Homes Commission Department of Hawaiian Home Lands
Dr. Robert McLaren	University of Hawai'i Interim Director, Institute for Astronomy
Dr. Pat McCoy	State Historic Preservation Division Hawai'i Island Archaeologist
Mr. Alika Maikui	Hunter, former sugar worker

Mr. Nelson Ho	Sierra Club, Hawai'i Chapter Hawai'i Chapter Conservation Chair
Mr. Imaikalani Namahoe	UH APT
Mr. Monty Richards	Kahua Ranch, Ltd. Former Regent
Ms. Betty Snowden	Retired Alu Like Director
Ms. Hannah Kihalani Springer	Office of Hawaiian Affairs Trustee
Ms. Leinaala Teves	Native Hawaiian Speaker
Ms. Mililani Trask	Office of Hawaiian Affairs Trustee
Ms. Charlene Unoki	Department of Land and Natural Resources

APPENDIX E. GLOSSARY OF HAWAIIAN TERMS USED IN THE MAUNA KEA SCIENCE RESERVE MASTER PLAN

Definitions from Mary Kawena Pukui and Samuel H. Elbert's <u>Hawaiian Dictionary</u> (1986)

ahu – Heap, pile, collection, mound, mass; altar, shrine, cairn.

ahupua'a – Land division usually extending from the uplands to the sea, so called because the boundary was marked by a heap (*ahu*) of stones surmounted by an image of a pig (*pua'a*), or because a pig or other tribute was laid on the alter as a tax to the chief.

ali'i – Chief, chiefess, officer, ruler, monarch, peer, headman, noble, aristocrat, king queen, commander.

aloha – Love, affections, compassion, mercy, sympathy, pity, kindness, sentiment, grace, charity.

'aumakua – Family or personal gods, deified ancestors who might assume the shape of sharks, owls, *'elepaio*, *'iwi*, mudhens, octopuses, eels, mice, rats, dogs, caterpillars, rocks, cowries, clouds, or plants. A symbiotic relationship existed; mortals did not harm or eat *'aumākua*, and *'aumākua* warned and reprimanded mortals in dreams, visions, and calls.

hōkū – Star.

ho'okupu – Tribute, tax, ceremonial gift-giving to a chief as a sign of honor and respect; to pay such tribute; church offering.

'ili – Land section, next in importance to *ahupua'a* and usually a subdivision of an *ahupua'a*.

ilina – Grave, tomb, sepulcher, cemetery, mausoleum, plot in a cemetery.

iwi – Bone; carcass (as of a chicken); core (as of a speech).

kahu – Honored attendant, guardian, nurse, keeper of *'unihipili* bones, regent, keeper, administrator, warden, caretaker, master, mistress; pastor, minister, reverend, or preacher of a church; one who has a dog, cat, pig, or other pet. According to J.S. Emerson 92:2, *kahu* "implies the most intimate and confidential relations between the god and its guardian or keeper, while the word *kahuna* suggests more of the professional relation of the priest to the community."

kapu – Taboo, prohibition; special privilege or exemption from ordinary taboo; sacredness; prohibited, forbidden; sacred, holy, consecrated; no trespassing, keep out.

kinolau **–** Many forms taken by a supernatural body, as Pele, who could at will become a flame of fire, a young girl, or an old hag.

konohiki – Headman of an *ahupua'a* land division under the chief; land or fishing rights under control of the *konohiki*; such rights are sometimes called *konohiki* rights.

kupuna – Grandparent, ancestor, relative or close fiend of the grandparent's generation, grandaunt, granduncle (*kūpuna* – plural of *kupuna*).

luna – Foreman, boss, leader, overseer, supervisor, headman, officer of any sort.

mana – Supernatural or divine power, mana, miraculous power.

mauna **–** Mountain, mountainous region; mountainous.

moku – District, island, islet, section, forest, grove, clump, severed portion, fragment, cut, laceration, scene in a play.

mokupuni – Island.

piko – 1. Navel, navel string, umbilical cord. 2. Summit or top of a hill or mountain; crest; crown of the head; crown of the hat made on a frame; tip of the ear; end of a rope; border of a land; center, as of a fishpond wall or *kōnane* board; place where a stem is attached to the leaf, as of taro.

pu'u – Any kind of protuberance from a pimple to a hill: hill, peak, cone, hump, mound, bulge, heap, pile, portion, bulk, mass, quantity, clot, bunch, knob.

'ua'u – Dark-rumped petrel, an endangered sea bird, considered by some an *'aumakua*.

wahi pana – These are sacred sites such as *heiau*, shrines, sacred *pōhaku* or stones, burial caves and graves, geographic features, and natural resources associated with deities and significant natural, cultural, spiritual or historical phenomenon or events. (Definition from Hawai'i Externalities Workbook, Hawaiian Electric Company, 1997)

The god and their disciples specified places that were sacred. The inventory of sacred places in Hawai'i includes the dwelling places of the gods, the dwelling places of venerable disciples, temples, and shrines, as well as selected observation points, cliffs, mounds, mountains, weather phenomena, forests, and volcanoes. (Edward Kanahele in Ancient Sites of O'ahu by Van James, 1991)

wao akua – A distant mountain region, believed inhabited only by spirits (*akua*); wilderness, desert.

wēkiu **–** Tip, top, topmost, summit.

MAUNA KEA SCIENCE RESERVE
MASTER PLAN

APPENDIX F

Mauna Kea Historic Preservation Plan
Management Components

State of Hawaii
Department of Land and Natural Resources
Historic Preservation Division

March 2000

MARCH 2000

Mauna Kea Historic Preservation Plan

Management Components

Prepared by
State Historic Preservation Division
for the
Institute for Astronomy, University of Hawaii
March 2000

Table of Contents

List of Tables

List of Figures

Preface

The following outline defines and discusses the major management consideration of the historic preservation plan prepared jointly by the University of Hawaii (UH) and the State Historic Preservation Division (SHPD), Department of Land and Natural Resources (DLNR). Management commitments are made to a series of specified actions and procedures that are designed to protect the many significant historic properties located on state lands leased by the University of Hawaii on Mauna Kea and to insure their appropriate treatment over time. Currently, those uses that could adversely effect historic properties can be grouped broadly into two categories. The first focuses on those activities that are directly related to the development and use of astronomical observatories on Mauna Kea and to all the infrastructure, facilities, and maintenance work needed support the observatories. These activities are largely conducted by UH or individual parties operating the observatories. The effects of these activities are largely concentrated in already developed areas although, visually and indirectly, they have the potential to affect a much larger area. The second category looks more broadly at the long-term management of historic properties found in undeveloped and developed areas and at the potential effects caused by all user groups, including public and commercial users, on these properties. Particular consideration is given to establishing strategies to monitor the condition of historic properties over time, to compile a complete and detailed record of all historic properties in these areas, and to prevent or deter activities that will alter them. A number of commitments recognized the need to raise awareness of the mountain's cultural and historic past.

Throughout the plan, reference is made both to the numerous individual historic properties found in the defined management areas and to the Mauna Kea Summit Historical District. The State Historic Preservation Division is in the process of designating the summit region as a historic district that would be eligible for listing in the National Register of Historic Places (Fig. 1 and 2). This designation allows the significance of the many individual properties located within the district to be addressed collectively and within the context of the summit's natural landscape. It also allows the integrity of the district as a whole to be considered when the potential effects of particular activities or projects are evaluated.

While this plan defines the direction of management initiatives on Mauna Kea, it can not be finalized or implemented in detail until a number of steps are completed. First, the management structure proposed in the Master Plan, primarily the Office of Mauna Kea Management, needs to be established as it will be the primary entity responsible for

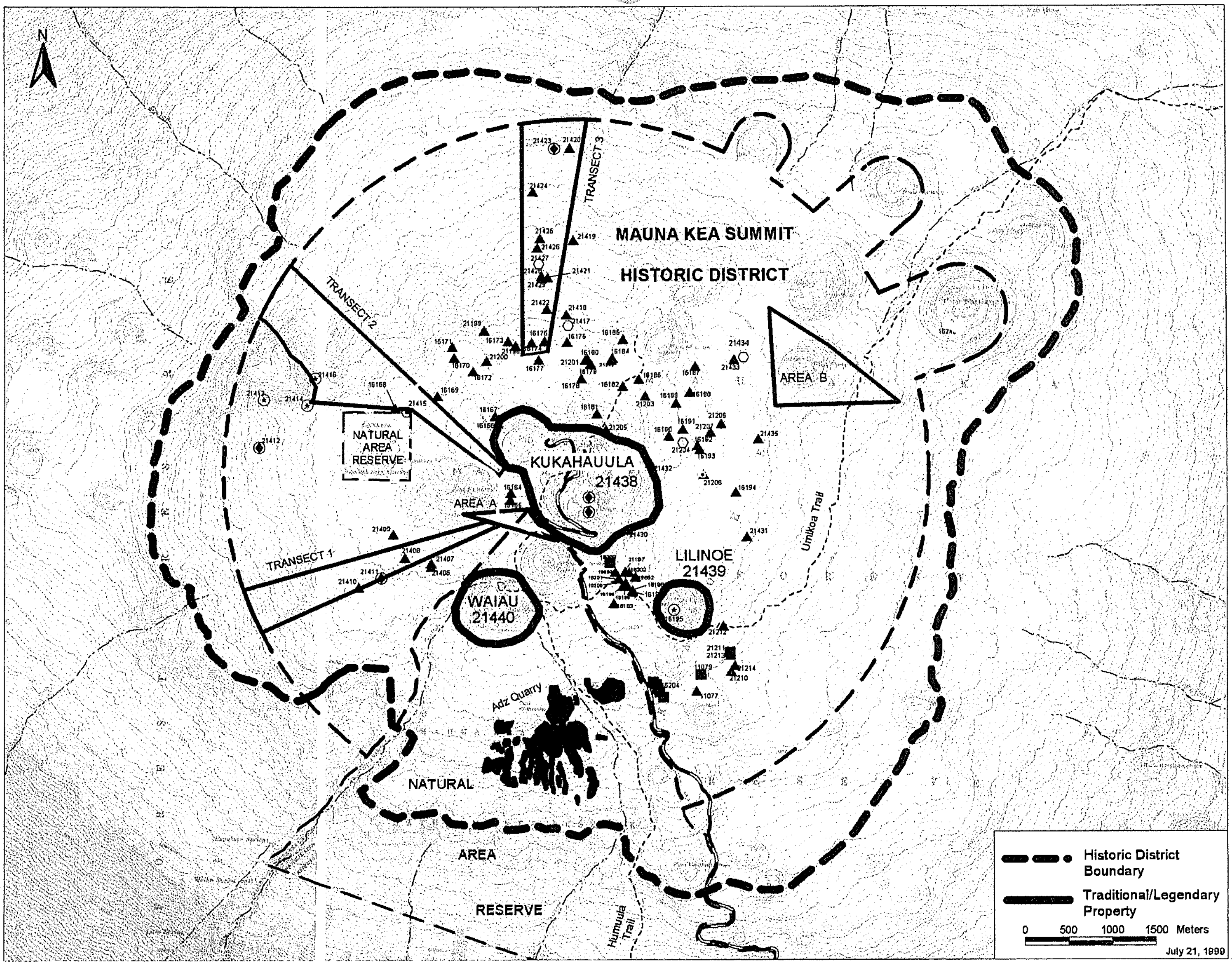


Figure 1 Mauna Kea Summit Historic District. Includes locations of the adze quarry, shrines, and traditional/legendary properties.

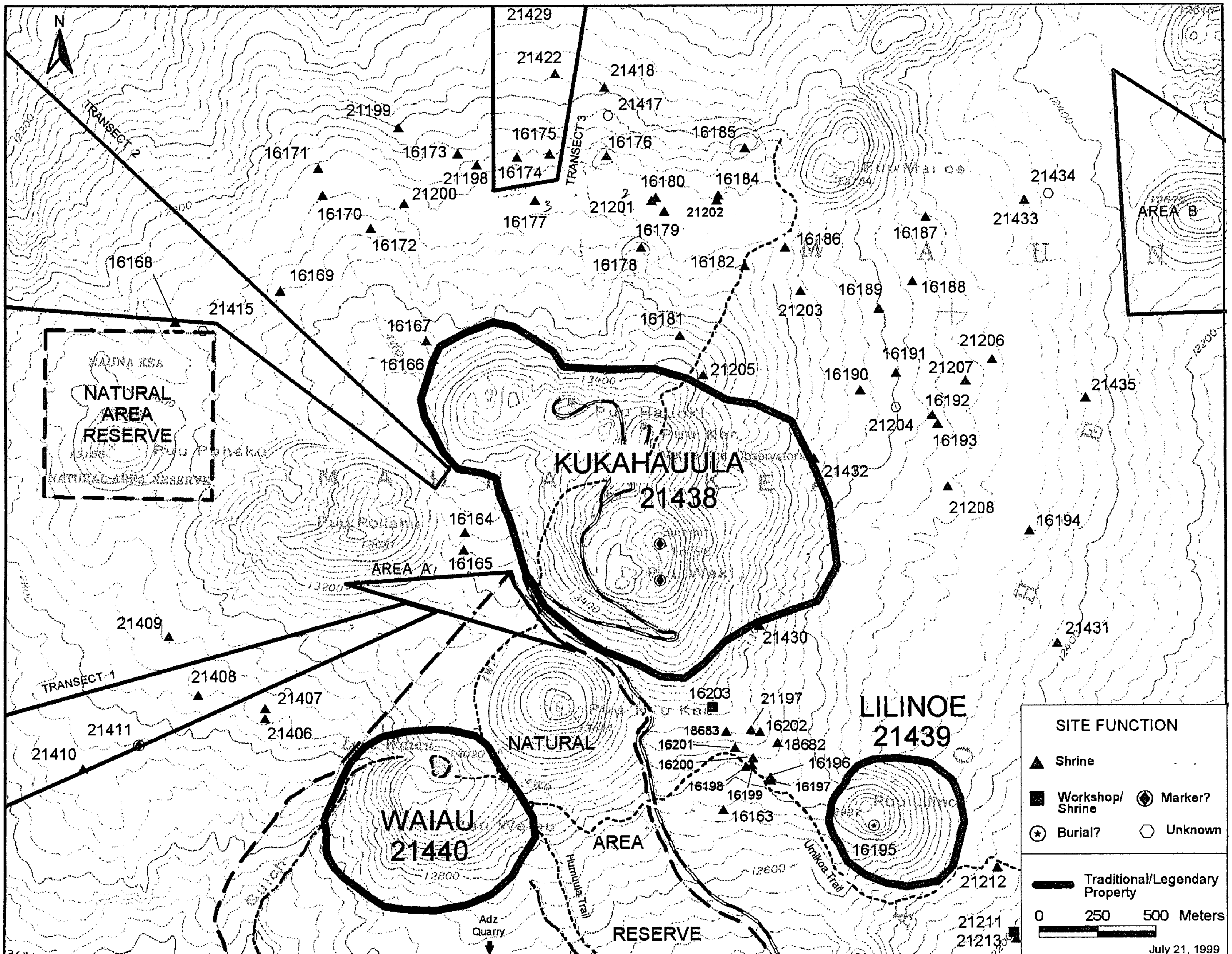


Figure 2 Distribution of shrines, adze workshops, and traditional/legendary properties at the summit.

implementing many of the plan's commitments. Its role and authority needs to be determined in more detail and in coordination with DLNR which now has primary management and regulatory authority over a number of activities occurring on Mauna Kea. Once these decisions are made, the plan can be revised to accurately reference the appropriate agency, rules, or agreements when discussing particular management actions. Second, the native Hawaiian community and other interested parties must be given the opportunity to review and comment on these major initiatives. This process will inevitably results in changes and refinements. Thirdly, the plan sometimes commits to the development and preparation of subsidiary plans, guidelines, or other document types to implement an initiative (See Appendix). These will be developed as the Office of Mauna Kea Management is being established and in coordination with these changes. In most cases, the absence of these secondary documents does not prevent the intent of the management initiative from being implemented.

Geographic Scope of the Plan

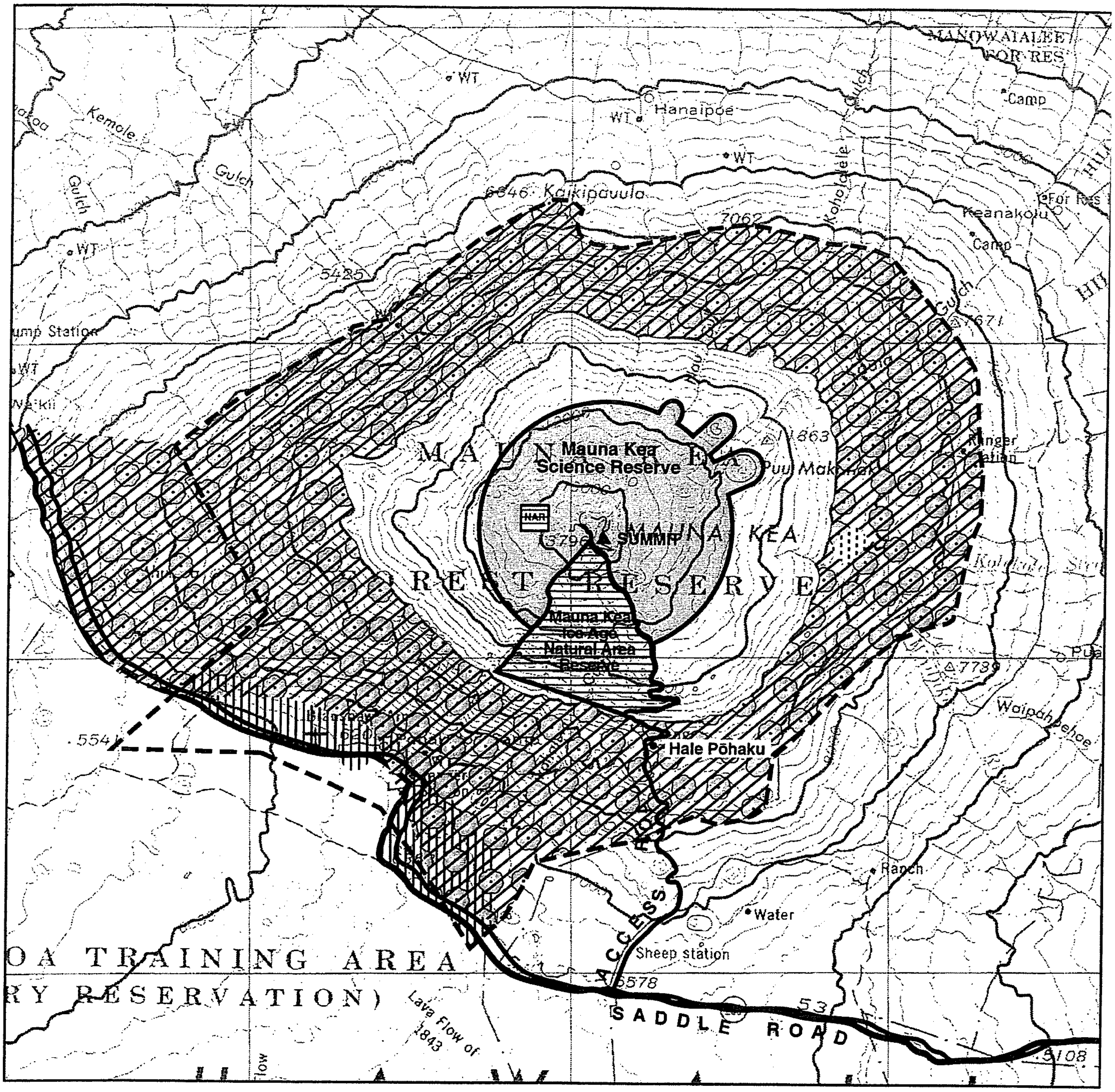
The plan addresses, in whole or in part, four major management areas. Three of them, the Mauna Kea Science Reserve, the summit road corridor, and a leased parcel at Hale Pohaku, currently fall under the joint jurisdiction of the University of Hawaii (UH) and the Department of Land and Natural Resources (DLNR). The first and largest of these areas is the Science Reserve which, as defined in a 1968 lease agreement (G.L S-4191, TMK: 4-4-15: 09), included all land falling within a 2.5 mile radius of the UH observatory (Fig. 3). Exceptions were three cinder cones to the north east of the Reserve which were included by extending the Reserve boundary around the outer bases of the cones (Pu`u Makanaka, Pu`u Hoaka, and an unnamed cone). The second area is a 19.3-acre parcel at Hale Pohaku (Fig. 4) which is the site of the Onizuka Center for International Astronomy, the Visitor Information Station (VIS), and the construction camp (TMK: 4-4-15: 12). Collectively this complex is commonly called Hale Pohaku or the mid-elevation facilities. The third area is the road leading from Hale Pohaku to the summit and a corridor extending 400 yards to either side of the road.

The fourth area considered by the plan are parts of the Mauna Kea Ice Age Natural Area Reserve which is administered by the Natural Areas Reserve System of DLNR. In 1981, two sections of the Mauna Kea Ice Age Natural Area Reserve were set aside from the 2.5 mile radius to form, at least in part, this NAR. One section became part of a 3,750 acre, pie-shaped parcel lying on the southern flank of the summit region and the other is a 149.5 acre rectangular area encompassing Pu`u Pohaku (Figs. 1 and 3). Where the 800 foot-wide road corridor managed by the UH extends over the NAR's boundary, that portion of the corridor remains under the sole jurisdiction of the NARS.

These two sections of the NAR are included in the plan because the infrastructure developed and maintained by the UH to service the observatories has made historic properties located within the NAR much more vulnerable. The summit road in particular has created higher levels of public access and use than would have been feasible otherwise. The threat to historic properties located within the large, pie-shaped section of the NAR is, in fact, probably greater than that posed to many properties in the Science Reserve. This is primarily because of the nature of the historic properties found within the NAR and the location of the summit road along the eastern boundary of the NAR. The Mauna Kea Adze Quarry, a National Historic Landmark, is particularly vulnerable because it is within relatively easy walking distance of the summit road and artifacts can be easily carried away. Lake Waiau and historic properties associated with the lake are also at risk because the lake itself is a major visitor attraction. For these reasons, the plan proposes that all provisions addressing the long-term management of historic properties, particularly those designed to monitor and protect the integrity of historic properties, be implemented jointly for the NAR and the Science Reserve. This is also appropriate because the historic properties found within the NAR and the Science Reserve share a unique landscape and history, face similar threats, and fall under the jurisdiction of DLNR in some form. The plan encourages the development of a historic preservation plan for the Mauna Kea Ice Age Natural Area Reserve which complements that prepared for the Science Reserve.

<u>Structure of the Plan</u>

The plan is structured in five parts. Part I addresses those maintenance and construction activities related to observatory use and development that could have an effect on historic properties within the three areas under lease to UH (i.e., the Science Reserve, the summit road corridor, and the mid-elevation area at Hale Pohaku). For routine or periodic maintenance work, the plan calls for identifying those classes of on-going or anticipated activities which should be subject to historic preservation review and which should not. When review is needed, the plan sets out procedures to expedite or clarify this process. For the construction of new facilities or infrastructure, the plan discusses standard procedures used to comply with state and federal statutes and regulations (e.g., National Historic Preservation Act and Section 106 [36 CFR 800]; Chapter 6E-8, -42, -43 [HRS]).



	Māmane - Naio and Associated Ecosystem		Military Area
	Natural Area Reserve		Palila Critical Habitat
	Silversword Area		Forest Reserve Boundary
	Science Reserve Area		

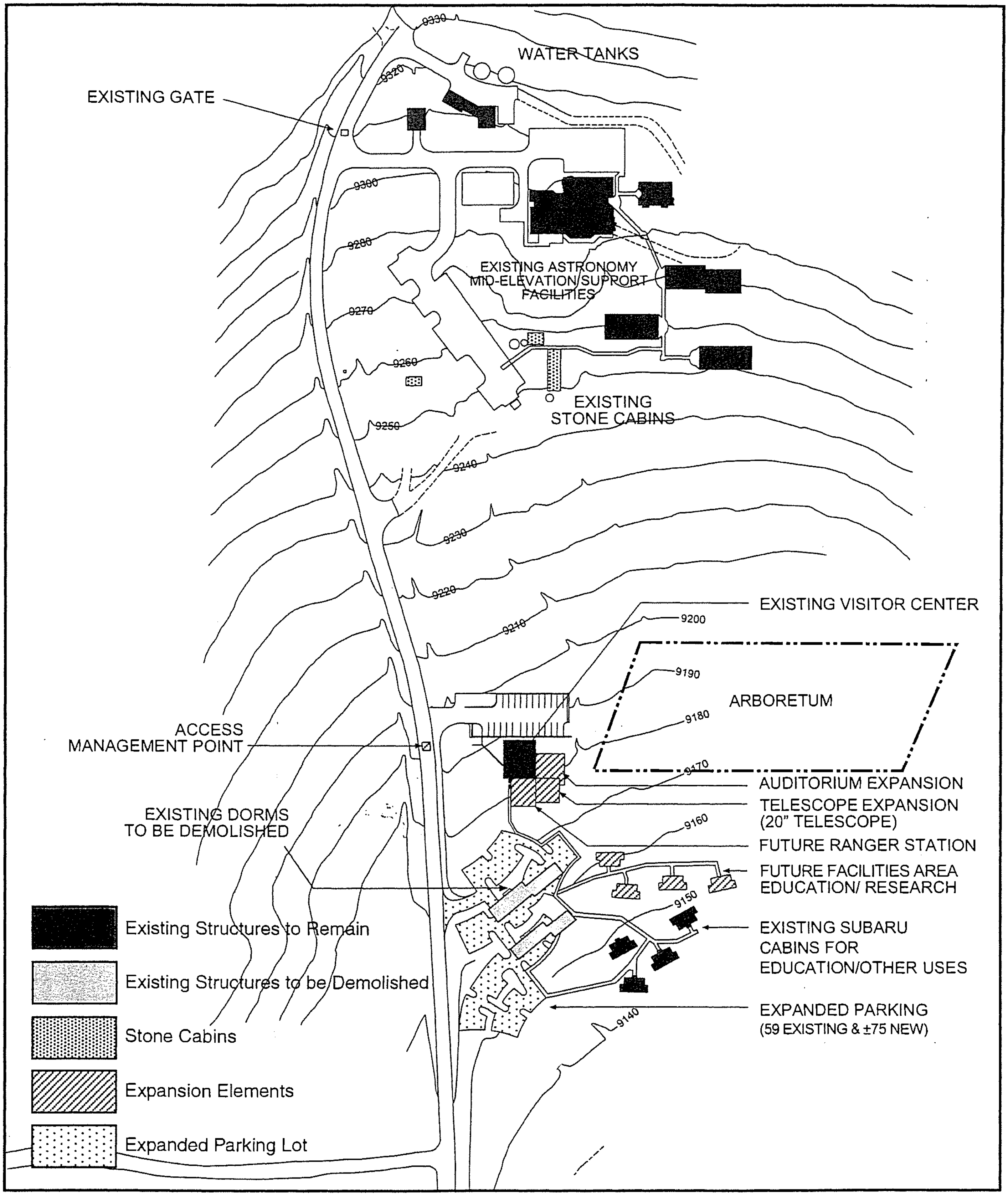
Source: The Mauna Kea Plan
Hawai'i Department of Land
and Natural Resources, 1977

1977 Mauna Kea Plan Management Areas

0' 7500' 15000' 30000'

NORTH

Figure 3 Location of the Mauna Kea Science Reserve, the Mauna Kea Ice Age Natural Areas Reserve, and Hale Pohaku



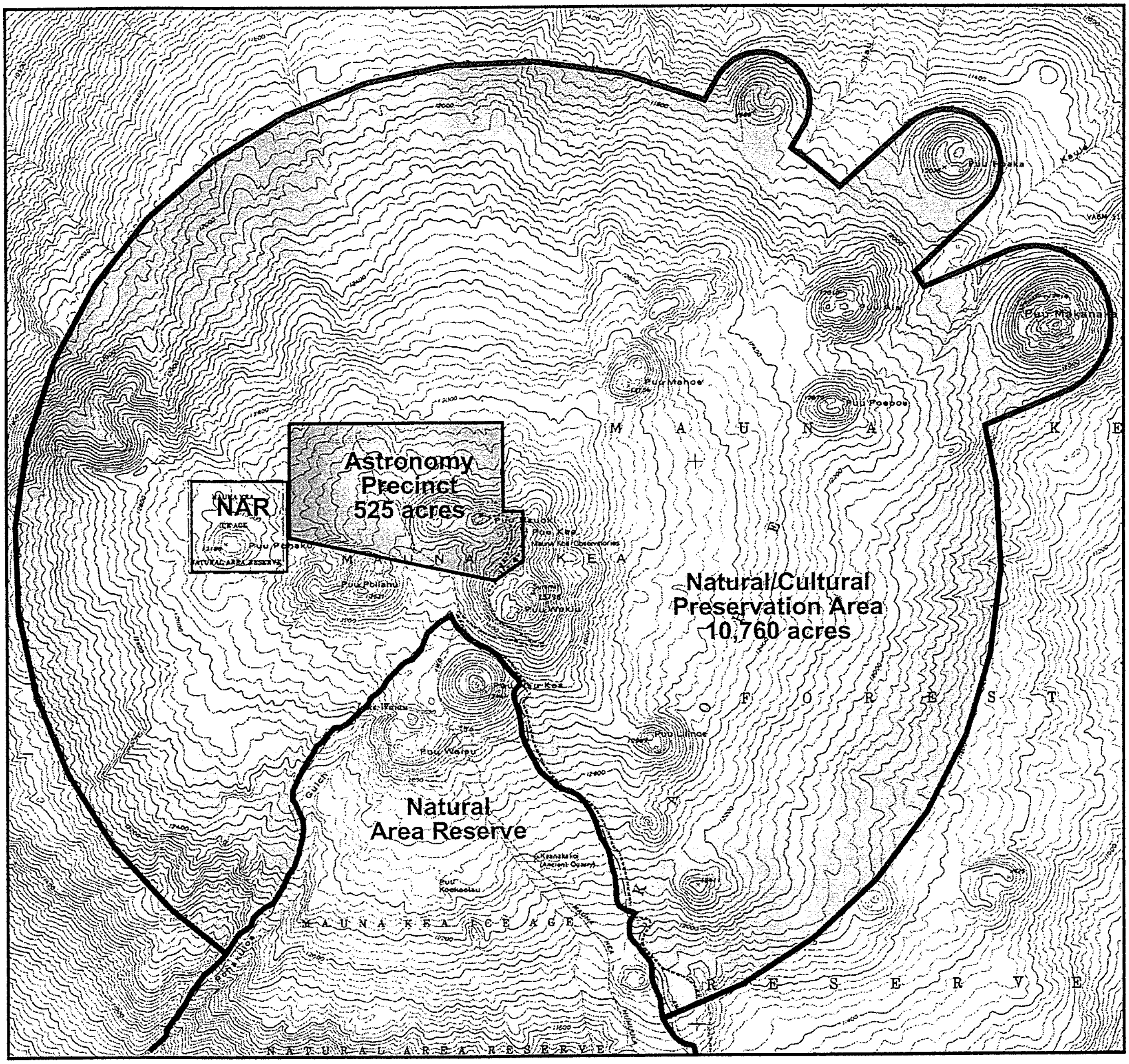
Hale Pōhaku Plan

Figure 4 University of Hawaii Facilities Located at Hale Pohaku.

Part II discusses the long-term strategies needed to protect and manage historic properties located within all the UH leased lands and the Natural Area Reserve. Many of these properties are unlikely to be affected by maintenance activities or construction projects because they are not locate in developed areas or within the Astronomy Precinct where future projects will take place (Fig. 5). Instead they are more likely to be affected by public and commercial uses. Within this part, the plan first describes several initiatives aimed at establishing an effect monitoring program so that managers can better understand which kinds of activities are adversely affecting historic properties and what preventative steps can be taken. This includes educational and interpretive efforts to focus visitor interest on selected properties and inform users of the need to protect historic properties and historic district. Several general management issues, control of debris, use of vehicles off-road, unrestricted public access, and enforcement, are also addressed. The remainder of Part II examines public and commercials uses occurring on Mauna Kea, the kinds of effects these uses can have on historic properties and the historic district, and how these effects can be mitigated. These uses include recreational activities such as skiing, hiking, hunting and stargazing and commercial activities such as weekly tours to the summit. Research and cultural practices are also discussed.

The last three parts address consultation with the native Hawaiian community, cooperative agreements that recognize the commitments made in the historic preservation plan, and the need for periodic review of the plan's effectiveness. Consultation with members of the native Hawaiian community and organization includes initiating consultation so that their views can be considered in completing the plan and sustaining consultation so that it becomes on-going process. Cooperative agreements insure that all entities operating observatories on Mauna Kea are equally aware of actions and procedures required by the plan and which they are also responsible for following. Periodic review of the plan provides an opportunity for all interested parties to recommend amendments or additions to the plan. This will be particularly important in plans formative years and if circumstances should change significantly at some point.

The structure of these management approaches is taken, to some extent, from that of programmatic agreements which are prepared to managing historic properties on federal lands in compliance with the National Historic Preservation Act. These agreements provide a mechanism by which interested parties can reach an understanding on which historic preservation review and compliance measures will be applied to particular classes of actions or activities within a single, generally large, land holding which is being actively



40' Contour Intervals

0' 2000' 4000' 8000'

NORTH

Figure 5 Astronomy Precinct and Natural/Cultural Preservation Area Proposed in Master Plan used and managed by an agency. These agreements are most effective when the effects of certain kinds of activities on historic properties are likely to be similar or repetitive; when the distribution of historic properties is relatively well known in the areas being managed, and when similar types of routine maintenance activities could have an effect on historic properties. Programmatic agreements can also contain provisions to assure that management actions are taken in large areas that are not routinely used or in historic districts. In this context, the agreement sets out procedures to reconcile or integrate the need both to use and preserve historic properties; to continue the process of identifying and evaluating historic properties in previously unsurveyed areas; to refine predictions on the distribution of unidentified historic properties; and to structure consultation with concerned individuals and organizations. The intent of these programmatic agreements is to reduce the need for repetitive and standard historic preservation compliance reviews. This allows more attention to be paid to those planned activities which could have significant impacts on historic properties or to management areas where little is known about historic properties located within them.

I. Current Activities, Construction Projects, and Planned Developments in Areas Leased to UH

A. Current Maintenance Programs and Routine Operations Performed by UH or Observatories.

1. Excluded Activities

   Many of the daily operations and routine maintenance activities performed by the Mauna Kea Support Services and the individual observatories will not affect historic properties and need not be subject to specific historic preservation review or compliance. In order to reach a clear understanding of which activities fall within this category, a detailed list of all routine activities occurring within the summit region, along the summit road, and at Hale Pohaku will be compiled with the aid of the Mauna Kea Support Services. The list will characterize these activities and group those which will not, or are highly unlikely to, affect historic properties and those which could. Generally all classes of activities that do not entail ground disturbance of any kind would be exempted from specific historic preservation review and compliance as would those occurring in highly altered areas. These would include, for example, water delivery, waste removal, transportation of observatory personnel, routine road maintenance, and actual use of the observatories. A map will also be prepared to depict those areas which have been highly altered. Defining disturbed areas and the degree of disturbance will be based on information drawn from aerial photographs, ground inspections, permitted construction plans and descriptions, and potentially the recollections of individuals involved in these projects.

2. Activities Needing Prior Review and Potential Compliance Measures

   Classes of routine or periodic maintenance activities which are listed and categorized as potentially having an adverse effect on historic properties will need to be reviewed by SHPD to determine if any compliance work is needed before the activity occurs. Any class of maintenance activity having the potential to alter previously undisturbed surfaces or subsurface areas will probably fall within this category and a surface survey or monitoring by a qualified archaeologist may be required. The classification of activities will also characterize nature of an activity's potential effect on historic properties and maps will be prepared to delineate those areas in which these classes of activities will be subject to SHPD review or specific restrictions.

Table 1

Historic Preservation Review and Compliance for On-Going and Maintenance Activities

Excluded Classes of Activities

General Characteristics	Examples	Review and Compliance	Plan Provisions
Entails no ground disturbance Entails ground disturbance in highly altered areas with no historic properties Does not alter the visual appearance of the historic district	Daily operations: Water delivery Waste removal Transporting observatory personnel Use of observatories Periodic or routine maintenance: Road maintenance Grading Snow plowing and removal Replace road markers Fix guard rails Repair electrical transmission lines Replace signs	None	Generate and update lists of excluded activities (compiled in consultation with UH) Prepare and update map of previously altered areas (includes degree of disturbance)

Table 2

Historic Preservation Review and Compliance for On-Going and Maintenance Activities

Classes of Activities Requiring Review and Potential Compliance

General Characteristics	Examples	Review and Compliance	Plan Provisions
Has potential to alter ground surfaces or affect historic properties and the historic district Activities are part of on-going or periodic maintenance program (not construction of new facilities or infrastructure) Occurs in previously unaltered ground surfaces or subsurfaces Any excavation of cinder cones forming the summit cluster	Replacement of buried transmission lines Improvements to drainage structures Creation or extension of push piles from road grading Removal of buried or partially buried structure Installation or replacement of guardrails or barriers along road	SHPD reviews proposed activity and asks for one or more of the following: No survey, consultation, or monitoring needed Consultation with native Hawaiian community should occur Inventory survey needed Monitoring of specified activities needed	Generate and update lists of activities requiring review (compiled in consultation with UH) Prepare and update map of areas potentially affected by activities requiring review Prepare and update map showing areas of high and low probably of historic properties within potentially affected areas (include areas in which activities are prohibited)

Examples of activities which could require compliance measures include any excavation occurring in previously undisturbed cinder cone deposits in the summit region, particularly when the activity is occurring within or along the rims of the cinder cones. These excavations should be monitored to ensure the immediate identification and, if necessary, recovery of any human remains or burials uncovered during excavation. This would include excavations needed to repair or replace existing underground utilities or infrastructure if there is a potential of affecting subsurface areas that were not previously altered during initial installation or construction. If, through time, no burials are uncovered during any of undertaking or planned development in the summit cones, this provision may need to be reassessed. Road maintenance is another example of an activity potentially requiring compliance measures. While most routine road maintenance activities, including snow plowing, are unlikely to affect individual historic properties, any activity that deviates from the current road alignment and shoulders (e.g., clearing soil or stones beyond the road alignment) or significantly changes drainage patterns, could have an effect on historic properties if any are present in these or adjacent areas and the integrity of the historic district.

To reduce the need for these activities to undergo SHPD review individually, systematic inventory surveys could be conducted of all areas in which these classes of activities are most likely to occur. Based on the results of this survey, a map could be prepared delineating those areas which are known to be free of historic properties and which require review of proposed activities and may need potential mitigation measures such as monitoring or the marking of restricted areas. This map would also depict the locations of known historic properties to ensure their avoidance and protection.

3. <u>Emergency Activities</u>

A number of emergency actions or rescues occurring in the summit region could directly and adversely affect historic properties or degrade the integrity of the historic district. To reduce this possibility, an emergency plan will be developed to set out contingency procedures to be followed when an emergency arises. Emergencies are considered those actions which would be difficult to predict specifically, which require a rapid remedy or response, and which involve health and safety issues. The plan will only address those emergency actions which involve ground-disturbing activities, take place on unaltered ground surfaces, or could affect undisturbed subsurfaces. Of particular concern are emergency actions that occur in unsurveyed areas. Examples could include the collapse of a road embankment or cinder cone face, the need to

Table 3

Historic Preservation Review and Compliance for On-Going and Maintenance Activities

Emergency Activities

General Characteristics	Examples	Review and Compliance	Plan Provisions
Activities could not be specifically and reasonably anticipated Rapid response or remedy needed Health and safety issues involved Activity involves ground disturbance activity Occurs in previously unaltered area or those not surveyed for historic properties	Rescue injured member of the public or employee (skiing accident, injured hiker, injured construction worker) Retrieve large objects Collapse of road embankment or cinder cone face Need to create detour road Chemical or fuel spill	Contact SHPD for verbal consultation when feasible and appropriate.	Prepare, update, and follow emergency plan that: Defines anticipated emergency scenarios Proposes contingency plans for each scenario to include: Map showing preferred routes or remedies for scenarios Defines measures to avoid historic properties and defacing the landscape: UH staff becomes well informed on the distribution and kinds of historic properties in areas potentially affected by emergency activities Staff will have ready access to maps with the locations and descriptions of historic properties

create a detour road, or having to retrieve large objects or vehicles that have, for whatever reason, become displaced from their normal locations. Another example is chemical or fuel spills which could require an extensive clean-up effort.

The emergency plan will set out a number of different scenarios which reflect those emergencies which have occurred in the past and those that can be realistically anticipated. Each scenarios would define one or more contingency procedures which, if followed, would avoid historic properties and minimize altering of the landscape. A map will also be prepared to show where the major kinds of emergencies are likely to occur and where they are possible. An important component of these contingency procedures to make sure that UH personnel responsible for overseeing emergency efforts have ready access to maps showing the distribution of known historic properties and are familiar with the kinds of historic properties known to exist in the Science Reserve and at Hale Pohaku. If time allows, SHPD should be notified verbally and have the opportunity to comment on any proposed remedy, particularly if the action deviates significantly from the anticipated scenarios.

B. Planned Development and Construction Projects

The following process shall be undertaken prior to the commencement of ground clearing or construction activities for any planned development or construction project. These procedures essentially follow those defined in the draft SHPD administrative rules which roughly parallel the process set out in the federal Section 106 (NHPA) review process. For the sake of discussion, some individual steps set out in rules or regulations have been grouped under five major headings. Discussions of the process also take into account the specific circumstances of each of the three areas under the direct jurisdiction of UH (i.e., the Science Reserve, the road corridor, and the mid-elevation facilities at Hale Pohaku). Historic preservation compliance for any project funded, in whole or part, by the federal government or requiring a federal permit or license, must be conducted in compliance with Section 106 of the National Historic Preservation Act. In these cases, compliance is technically the responsibility of the federal agency providing the funding or issuing the permit or license.

While this section is written primarily for the development of astronomy-related facilities and associated infrastructure, the process also applies to any project undertaken for non-astronomy purposes and by entities other than UH. An example would be parking areas or facilities established for public use. The results of any archaeological work undertaken to fulfill the requirements of the historic preservation review process must be presented in a report or, where appropriate, in written plans that meet standards set forth in the SHPD draft administrative rules. These reports and plans must be submitted to SHPD for review and acceptance.

1. <u>Inventory Survey of Historic Properties</u>

   All project areas, which will be physically altered by the development of astronomical facilities and associated infrastructure, should undergo an historic property inventory survey to determine the presence or absence of historic properties in the project area. This survey should comply with the standards set by SHPD's administrative rules for inventory surveys and should systematically cover 100% of the area to be altered and that which could be potentially affected by the project. The extent to which adjacent areas should be included in the survey can be determined in consultation with the SHPD on a case by case basis. Such developments would include new observatories, expansion of existing observatories, and any permanent and temporary facilitates or infrastructure needed to support these developments. (At least one historic property will automatically be present for the expansion of any observatories or infrastructure on the cluster of summit cones [Pu`u Kukahau`ula] because these cones are collectively believed to be an historic property.)

   This inventory survey requirement could be accomplished in another way. The proposed Master Plan greatly reduces and clearly defines an 525-acre Astronomy Precinct to which future developments will be confined (Fig. 5). A systematic inventory survey could be conducted of this entire development area. This would preclude the need for individual inventory surveys for each development within the proposed precinct. An exception, and one that occurs rarely, is that a new kind of historic property could be discovered after the survey is completed and would, therefore, not have been recognized or documented during the initial survey.

2. <u>Evaluation of Significance</u>

   After the inventory survey is completed, the significance of identified historic property is evaluated using criteria established to determine a property's eligibility for inclusion in the Hawaii and National Register of Historic Places. This step primarily creates the rationale for determining and justifying why and how identified properties should be treated (e.g., recorded and destroyed, preserved with specific conditions, etc.).

Table 4

Historic Preservation Compliance for Planned Developments or Construction Projects

General Characteristics	Examples of Projects	Review and Compliance Process	Plan Provisions
Creation of a new facility Expansion of an existing facility Creation or improvement of infrastructure Project will alter undisturbed ground surfaces or subsurfaces Has potential to diminish the integrity of the cluster of cones forming the summit Has potential to visually impact the historic district Has potential to increase access to larger or more remote areas	Constructing a new observatory or building Constructing additions to existing observatories or enlarging buildings Reconstructing or renovating an existing observatory or building which alters its outward appearance Creating or realigning roads Rest room or support facilities for public users Constructing or formalizing parking lots Reinforcing cinder cone slopes Constructing or formalizing hiking trails Removing an existing facility or structure which entails altering undisturbed subsurfaces	Almost always requires Conservation District Use permit If funded or sponsored by UH or a state agency: Requires written concurrence of SHPD prior to commencement SHPD determines procedural steps needed to comply with state laws and regulations Compliance actions must conform with SHPD draft program and archaeology administrative rules and the Burial Sites Program administrative rule If federal funding or federal agency involved: Requires compliance with Section 106, National Historic Preservation Act Federal agency in consultation with SHPO and others determines procedural steps needed to comply with federal laws and regulations	Aid decision making process by: Preparing maps and descriptions of previously altered areas Preparing maps of areas having a high and low probability of historic properties Completing historic property inventory surveys of Astronomy Precinct and road corridor Expedite compliance procedures by: Preparing guidelines for historic property treatment plans suited to the three management areas: Interim and long-term preservation plans Monitoring plans Burial treatment plans Inadvertent burial treatment plan Establish reference collection of existing historic preservation laws and regulations Preparing guidelines for consulting with native Hawaiian organizations and interested members of the Hawaiian community Create roster of native Hawaiians wishing to be notified of all actions or actions in particular areas

Table 4a

Historic Preservation Compliance for Planned Developments or Construction Projects

Procedures

Initial Review by SHPD	Determination of Review	Historic Properties Identified during Survey in Project Area	Inadvertent Discovery of Historic Properties
Project description submitted to SHPD for review and comment (may be submitted concurrently with Conservation District Use application or Section 106 consultation) Initiate consultation with native Hawaiian organizations and interested individuals	SHPD determines: No inventory survey needed if: Areas previously surveyed and no historic properties present Ground surface and subsurfaces altered so no historic properties present Inventory survey required if: Area not previously surveyed with 100% coverage Ground surfaces within project area not previously altered Historic properties possible within or near project area Burials possible in subsurface deposits if: Project involves subsurface excavation in cinder deposits Project located on cluster of cinder cones forming the summit	Evaluate historic properties using criteria for determining eligibility for inclusion in the Hawaii and National Registers of Historic Places: If located in historic district, determine if property contributes to the significance and integrity of the district If located at Hale Pohaku or in the road corridor, evaluate significance and integrity of individual property Evaluate if project will have "no adverse effect" or an "adverse effect" on identified properties and the historic district Determine treatment of adversely affected historic properties or district by: Committing to mitigation measures in preservation plans: Interim preservation plan (protects properties during construction, sets buffer zones, may include monitoring) Long-term preservation plan (protects properties during use of facilities, reduces visual impacts) Burial treatment plan if burial present	Historic property or burial found unexpectedly during construction or after inventory survey and acceptance of inventory survey report If burial is found: Stop all work in immediate vicinity and secure area Notify SHPD and police department to determine jurisdiction If older than 50 years, SHPD determines disposition in consultation with Hawaii Island Burial Council Prepare and implement burial treatment plan If historic property found: Stop all work in immediate vicinity and secure area Notify SHPD Document, evaluate, and determine treatment of property found Consult with native Hawaiian community

The process of evaluating properties identified within the Mauna Kea Summit Historic District differs somewhat from that used to identify those found in the road corridor lying downslope of the historic district or at the mid-elevation facilities. Although different, two processes are essentially based on the same rationale and principles. Within the historic district, the significance of properties is not evaluated individually because the summit region as a whole is considered eligible for inclusion in the National Register. Instead, the required assessments consider how each newly or previously recorded property potentially affected by a project contributes to the significance of the historic district as a whole. Within those sections of the road corridor located outside the historic district and the lease areas at Hale Pohaku, the significance of potentially affected properties will be evaluated individually as is more commonly the case during the historic preservation review process. Determining that a property is significant and eligible for the Hawaii and National Registers does not necessarily mean the property will be placed on the Register, only that it possess attributes and associations which would allow it to be considered eligible. Significance evaluation should conform with SHPD administrative rules or the National Register criteria (National Register Bulletin 15) if the project is federally funded or if the historic properties are located within the historic district.

3. Evaluation of a Project's Effect on Historic Properties and Proposed Mitigation Measures

Evaluating the effects of a project on historic properties will also differ for developments planned within the historic district (i.e., summit region) and those planned within the two areas outside the historic district (i.e., a portion of the road corridor and the mid-elevation facilities). Within the historic district, the effect of a project on the historic district as a whole needs to be assessed as well as the project's effect on individual historic properties located within or immediately adjacent to the project area. The effect of a project on the historic district must be addressed even if no individual historic properties are found within or immediately adjacent to the project area.

Effects on a district would consider the visual impact of a facility on the surrounding landscape (i.e., the various land forms creating the setting and context of the multiple historic properties encompassed by the district) and on those individual historic properties which contribute to the significance of the district. Creating a network of roads would affect the historic district because, in addition to altering the landscape, it creates easier access to more areas in the historic district and thus increases the possibility of historic properties being damaged by visitors. For projects located outside the historic district, the effect of a project would be assessed on individual historic properties identified within or adjacent to a project area. Effects on individual properties can include the complete destruction of a property or severe alteration of the terrain in which the property is located.

Once the project's effects are determined, treatment of the identified properties is proposed. Treatments, generally called mitigation measures, can include thoroughly documenting an historic property before it is destroyed or preparing a preservation plan to assure a property's protection during construction activities (i.e., monitoring, ample buffer zones) and during the long-term use of the constructed facilities or infrastructure. In all three areas leased by UH, strong preference should be given to avoiding and preserving all individual historic properties whenever possible. The proposed Master Plan commits to preserving all historic properties within the Astronomy precinct and establishing a 200 foot buffer around any properties found in or near a project area. For facilities located within the historic district, mitigation measures could be applied to the facilities themselves. These measures would attempt to minimize, for example, the visual or audible impacts of a facility on the historic district or any nearby properties.

All mitigation measures would be set out in mitigation plans such as a data recovery plan (i.e., if the historic property needs to be documented and studied before being destroyed); an interim preservation plan (i.e., if the property is at risk of damage during construction); and a long-term preservation plan (i.e., measures insuring a property's protection long-term). To help expedite the preparation of these individual plans, guidelines will be developed on preparing these different types of plans based on the historic properties known to be present in these areas. In general, guidelines for preparing interim and long-term mitigation plans should be the most useful given the proposed Master Plan's commitment to avoiding all historic properties.

4. <u>Treatment of Known and Potential Burial Sites</u>

Given that some native Hawaiians believe that human remains were uncovered during the construction of at least one observatory on the summit cones and burials are known to be present on other cinder cones in the summit region, any development or construction work requiring excavation near the rims of cinder cones will be subject to archeological testing prior to ground disturbance. Exceptions would be circumstances in which it can be demonstrated that previous grading or extensive excavations of the proposed construction site effectively precludes the possibility of any burials being present. When archaeological testing is required in a relatively small area, testing alone may be sufficient to establish, with a high degree of certainty, that burials are either present or absent before construction begins. If burials are discovered or if the area is relatively large and testing is not exhaustive, then any excavation undertaken during construction should be monitored by an qualified archaeologist. If the Hawaiian community wishes, provisions can be made for a cultural monitor. These provisions can be reassessed if no burials are ever uncovered during numerous test excavations or monitoring efforts and it thus appears highly unlikely that any will be found in the future.

a. Identified Burials. If a burial is found during test excavations and it is determined to be a native Hawaiian burial site over 50 years old, it is considered a previously identified burial site and its disposition falls under the jurisdiction of the Hawaii Island Burial Council. The council will determine if the burial should be preserved in place or relocated. Whether it remains in place or is relocated, a burial treatment plan must be developed by either the entity undertaking the project or UH. SHPD will ask the burial councils to review the plan and will consider the council's recommendations. If the burial is to be preserved in place, the plan details measures that will ensure the stabilization and long-term protection of the burial site. If it is to be relocated, the plan will describe the proposed reburial site, reburial procedures, and measures to ensure the long-term protection of the reburial site. Although testing procedures are not recommended for areas beyond the cinder cones (i.e., the glaciated, stony terrain of the summit region), the same procedures would be followed should a burial be identified during the inventory survey for any project. The burial treatment plan must conform with §13-300-33 or, if the remains are believed to be non-Hawaiian, §13-300-34.

b. Inadvertent Burials. If human remains are uncovered when construction work is being monitored or anytime after construction commences, the procedures set out in Chapter 6E-43.6 (HRS) and administrative rule §13-300-40 must be followed. This includes notifying SHPD and the police department who will determine if the remains are native Hawaiian and if the burial site is over 50 years old. If the burial site appears to be over 50 years old, SHPD has jurisdiction over the disposition of the remains but will seek the advice of the Hawaii Island Burial Council or the appropriate council members. A burial treatment plan will be prepared specifying how the burial will be protected in place or relocated and any appropriate procedures needed to carry out these actions. These procedures would apply to burials found inadvertently either in the cinder cones, stony terrain or along the rocky ridges.

c. Burial Treatment Plan Format. To help expedite preparation of burial treatment plans, should one be needed, the historic preservation plan will provide guidance on the general outline and contents of such plans and suggest some options for consideration. Many stipulations and procedures contained in these plans are relatively standard while others should consider the specific circumstances of the burial. These recommendations should be reviewed by the Hawaii Island Burial Council and other concerned members of the native Hawaiian community. Some options might include the designation of reburial areas to help assure the long-term protection of the remains or identifying those individuals or groups wanting to take responsibility for the care of these burial sites. This part of the historic preservation plan, as with the plan as a whole, should be reviewed periodically and revised when appropriate.

5. Inadvertent Discovery of Historic Properties.
Despite a thorough inventory survey, historic properties can unexpectedly be discovered in a project area after construction begins. If this occurs, the plan will follow the SHPD draft or finalized administrative rule which deals with the inadvertent discovery of historic properties. This includes stopping all construction within the immediate vicinity of the property, notifying SHPD, having the significance of the property assessed, and proposing appropriate mitigation measures. If the property can not be avoided due to construction or design constraints, it should be thoroughly documented before being destroyed. If it can be saved, appropriate measures are needed to protect the historic property during the remainder of the construction phase and when the facility is in use. Interested members of the native Hawaiian community should be consulted for properties believed to be associated with native Hawaiians.

6. Consultation with Native Hawaiian Organizations.
Both federal regulations and SHPD draft administrative rules, call for consultation with the native Hawaiian community in the process of identifying, evaluating, and treating

historic properties. Procedures by which the native Hawaiian community may be consulted in these decisions will be developed in accordance with advice received from the community. These procedures would need periodic review as more is learned about the nature and distribution of historic properties on Mauna Kea and as the concerns and perceptions of the native Hawaiian community may change accordingly.

II. Long-Term Management of Historic Properties in UH Leased Areas and within the Mauna Kea Ice Age Natural Area Reserve

As explained in the introduction, discussion of long-term management issues in this plan encompasses both those areas leased by UH and those adjacent lands administered by DLNR which are vulnerable to disturbance because of the infrastructure created to support UH facilities and those of the participating observatories. The DLNR areas covered by these management proposals include those portions of the Mauna Kea Ice Age NAR which fall within the historic district (i.e., Pu`u Pohaku and the larger, pie-shaped parcel) and a management area extending to the west and south of the parcel leased to UH for mid-level facilities at Hale Pohaku. Although we expect UH to assume responsibility for the proposed management tasks on these non-UH leased lands, we do not necessarily expect them to perform all of the proposed management tasks with the same frequency or degree of intensity as they would for UH holdings. At this point, the plan can only identify those management tasks and obligations which we feel should be undertaken or considered. How these tasks will be implemented, by whom, and at what funding levels, can not be settled until agreement is reached on the structure and role of the proposed Office of Mauna Kea Management. Some responsibilities may remain with DLNR while other could be held jointly with UH. All actions and plans generated by this plan which involve or affect the NAR should be prepared in conjunction with NAR staff and should be reviewed by the NARS Commission when appropriate.

A. Management Actions and Plans

1. Monitoring Plan

A monitoring plan will be prepared to determine strategies to systematically monitor the condition of identified historic properties located within the different management areas and the historic district. The primary purpose of monitoring is to determine what uses, if any, are affecting historic properties, the degree and frequency of these effects, and ways to prevent or minimize their occurrence. In addition to providing information on the current conditions of historic properties, monitoring also creates baseline information that can be used to track changes in these conditions through time. For individual properties, the strategy would focus on the periodic inspection of selected properties (i.e., shrines, known or suspected burial sites, significant cinder cones). Inspections would include qualitative descriptions of the condition of each property and

Table 5

Management Actions and Plans

Monitoring Long-Term Condition of Historic Properties and the Historic District

Action	Purpose	Strategy
Systematically monitor the condition of all historic properties and the historic district	Determine which activities are affecting historic properties Determine the degree and frequency of these effects Propose ways to prevent or minimize these effects Provide baseline information to track changes in potential effects through time	Periodic inspection of selected properties (shrines, possible burials, cinder cones) Routine inspection of vulnerable properties (close to roads, visible from a distance, evidence of past disturbance, representative types) Rotational inspection of all properties over five-year period (located far from roads, no evidence of past disturbance) Inspections note existing condition of properties (comparison with photographs, maps) Inspections note and document any signs of disturbance, visitation, or deterioration by natural causes

notes on the presence or absence of any signs of disturbance or visitation. Comparisons would be based on existing photographs and maps of a property and new photographs would be taken to systematically document any changes.

Several criteria would be used to select properties for routine inspection. The most important would be a property's vulnerability given its relative proximity to roads, visibility from a distance, or past history of visitation or disturbance. Another criterion could be shrines or other properties that are good representative examples of a type or are somehow unique. Attempts should also be made to visit all known properties on a rotational basis over a five-year period. The properties visited and the strategy used should be reassessed and changed as needed, particularly if changes in the kind or intensity of use in the summit region changes. For the historic district, observations would note, for example, the distribution of debris, changes in any off-road vehicle use, scarring of cinder cones, and unexpected visual intrusion by constructed facilities.

Given the number of known shrines, the potential burial features, the cinder cones, and the significant areas within the Mauna Kea Adze Quarry, such an annual monitoring program would probably take no more than of total of three weeks (i.e., 15 working days with a crew of at least two). The monitoring strategy for historic properties in the vicinity of Hale Pohaku could include more frequent inspections given their accessibility and the higher use of the area by the public.

In general, this is consistent with the NARS 1997 management policies which direct staff, potentially with the assistance of researchers and the community, to monitor the status of resources in all reserves using Division of Forestry and Wildlife (DOFAW) monitoring protocol. The intent of this monitoring is similar to that being called for in the historic preservation plan in that it tracks the overall status of resources and provides a means of measuring changes overtime. The DOFAW monitoring protocol, however, probably focuses on natural resources more than historic properties. Integrating the two monitoring strategies would probably could help broaden the monitoring mandate of the NAR which includes some of the most significant historic properties on the mountain.

2. Complete Inventory and Documentation of Historic Properties within Management Areas

The inventory of historic properties within the Science Reserve, the historic district, and the management area at Hale Pohaku should be completed as some large areas have never been surveyed or surveyed systematically. A general strategy and plan will be developed for completing these surveys incrementally over a five year period. This could be done in conjunction with the monitoring program if feasible. The primary focus of these surveys in the summit region is to complete the record of shrines and their distribution throughout the Science Reserve and to assess the distribution of potential burial sites on cinder cones located in the historic district. A complete inventory is needed not only to adequately manage all the historic properties in the Science Reserve, but it greatly enhances our ability to interpret how the summit region was used in the past, to discuss the possible functions of the shrines, and to assess their significance within this context. This in turn contributes to any on-going educational programs conducted on Mauna Kea.

Methods used to document and locate these historic properties should, at a minimum, conform with that used for the 1995 and 1997 surveys and the resulting records should be added to the catalogue of historic properties being prepared and submitted with this historic preservation plan. A survey report should be written after each increment which clearly describes and locates the areas covered. In the case of properties found within the summit region, the report should also address how any new findings contribute to the description and significance of the historic district. It should also assess any potential impacts observed in the areas surveyed.

In addition to recording newly identified properties, an effort should be made to upgrade and standardize the descriptions and photographic record of previously recorded properties where needed and to verify their locations. This would be particularly important for some properties which were recorded over the last 30 years but have not been documented recently. This includes many of the properties and workshop areas located in the Natural Area Reserve. Even the descriptions of some shrines recorded since 1982 could be improved if they were initially recorded under weather or time constraints. Upgrading descriptions of recently identified properties could be done during the monitoring effort, but documenting and locating those identified many years ago or only briefly should be scheduled with the incremental inventory of previously unsurveyed lands. In general, priority should be given to

Table 6

Management Actions and Plans

Complete Inventory and Documentation of Historic Properties

Action	Purpose	Strategy
Complete survey and inventory of all historic properties within the historic district and other management areas	Complete and more accurate records allow for better informed and effective management decisions Information contributes to interpretation and educational efforts	Develop plan to systematically and incrementally survey areas not previously surveyed Verify locations and standardize documentation of previously described properties when necessary Prepare report after each survey increment Document and evaluate newly identified properties to current standards Add newly documented properties to historic properties catalogue Upgrade descriptions of previously record historic properties in the catalogue when necessary

identifying new properties because knowing the distribution of historic properties is more crucial when dealing with many management issues.

3. Interpretation and Education
The interpretation and educational initiatives described here will be implemented by an interpretation plan that includes four major components. The first component designates those historic properties which may be suited for public access and discusses ways in which visitation can be informative while diminishing the integrity of the properties as little as possible. The second deals with preparation of brochures for distribution at the Visitor Center at Hale Pohaku which provides information on the historic properties found throughout the summit region and in the area surrounding Hale Pohaku. The third component discusses the preparation of displays at the Visitor Center. As plans to renovate or expand the current center have not been finalized, the plan can only discuss appropriate interpretive themes for the displays and display options. Once these decisions are made, displays can be designed to conform with the size or general lay-out of the rest of the Visitor Center. The fourth component consists of summaries or extracts of information on the prehistory and history of Mauna Kea to help staff stationed at the Visitor Center or in the field give informed presentations and to answer many of the routine questions asked by the public.

a. Interpretation of Historic Properties. Subject to consultation and review, three approaches to interpreting and providing access to historic properties in the summit region are being proposed. These interpretive efforts will not include historic properties in the NAR until specific proposals can be coordinated with the NARS Commission and can be implemented within the context of a management plan for the NAR. The levels of interpretation and access proposed include self-guided tours with optional stops at designated properties and vantage points; guided tours to multiple properties and vantage points; and providing only limited and general guidance to those wishing to hike independently in the summit region. In all cases, any signage, literature, or presentations would emphasize appropriate ways of visiting historic properties and warn against altering or damaging historic properties.

Self-Guided Tours. The plan will consider the development of three areas with shrines and four vantage points to accommodate those members of the public wishing to visit historic properties in the Science Reserve. The shrines that appear to be the most appropriate for visitation and interpretive development are in the complex located just East of the summit road between 12,200 and 12,260 ft. in elevation (Site No. 16204). Access to the five shrines in this complex is relatively easy because of their proximity to roads and their being at a lower elevation. A limited parking area could be developed to the side of the existing road to the VLBA where parked vehicles and pedestrians would not interfere with use of the summit road. A trail could be developed from this parking area to the lowest shrine where interpretive signs could lead visitors to the upper shrines in the complex. Their location on a solid, stone ridge is also an advantage because this surface would withstand pedestrian traffic better than areas with loose stones, glacial till, or cinders. Reconstruction of the shrines, mostly returning fallen shrine slabs to their apparent up-right positions, should also be considered in the plan. The plan will include provisions for the detailed recording of the shrines in their present state, surface collection of vulnerable artifacts, and possible test excavations before any reconstruction or site development is undertaken.

Two other areas with shrines may be amenable to this kind of interpretive development although priority should be given to Site No. 16204. A self-guided route could be established to visit five shrines located east of the VLBA observatory (Site No 11077, 11079, 21210, 21211, 21213, 21214). Two of these shrines have flaked material from the adze manufacturing process. This area has the advantage of being near an established access road that could accommodate limited parking and of being at a lower elevation (i.e., 12,200 ft. in elevation) where walking would be slightly easier for those not acclimated to high elevations. If this area is developed, adze material should be recorded and recovered prior to initiating public visitation. Trails to these scattered shrines and signage would also be established. The other shrines potentially amenable to self-guided tours are two (Site No. 16166 and 16167) located on the western slope between the Caltech Submillimeter Observatory and the construction staging area and parking lot. Both are relatively near parking areas which could be improved without expanding already disturbed ground. Disadvantages to developing these properties for visitors is the higher altitude of their location (13,240 ft. in elevation), the uneven terrain that would need to be crossed to reach them, and the relative simplicity of the shrines themselves.

Establishing interpretive signs will also be recommended at four vantage points to give the public information on those landscape features which are historic properties because of their association with traditional and legendary characters and, possibly, an overview of the distribution of known shrines and adze workshops. Two interpretive points would be established on already existing parking lots. Although the positions of these parking lots is not ideal for viewing some of these historic properties, the judicious use of both is preferable to constructing additional parking or pull-off areas and the effect this would have on the historic district. The lower parking area (i.e., at 11,880 ft. in elevation), could be used to point out that portion of the adze quarry which is visible from this lot if the NARS Commission agrees. Some of the geological features, such as the terminal moraine, are well illustrated from this lot and would be an appropriate topic for interpretation as well. Signs at the upper parking lot (i.e., at approximately 12,800 ft. in elevation) would focus on the traditions of Lilinoe and Kukahau`ula as the lot is located between the two cinder cones bearing these names. Some discussion could also be devoted to the diverse and complex cluster of shrines located between the two cinder cones.

The other two vantage points should be on the crest of the summit cones; one interpreting the view of the summit plateau to the east of the summit and the other the plateau to the west. Exact placement of these interpretive signs would be decided in conjunction with UH and the adjacent observatories so that limited parking would be available without obstructing traffic or road maintenance. Interpretive themes could include the known distribution of shrines, suspected routes to the summit region, and the landscape features which contribute to the unique historic district. In preparing the text for these interpretive signs, Hawaii residents should be considered the primary audience. The availability of four-wheel drive vehicles in the local community and the relatively high expense of renting them, makes it likely that Hawaii residents would make up a high percentage of visitors to the summit. Out-of-state visitors may be more likely to arrive with commercial tours.

A seventh historic property, Pu`u Waiau and its lake, is also a good candidate for self-guided tours because of its uniqueness, its significance, and the relatively high number of individuals already visiting the lake. Any consideration of formalizing access to Lake Waiau and providing interpretive signs at the lake would need to be done in conjunction with the NARS Commission and due consideration needs to be given to their primary mandates. Signage would also be useful in making visitors aware of the cultural significance of the lake itself and its waters.

Table 7

Management Actions and Plans

Interpretation and Education

Action	Purpose	Strategy
Prepare interpretive and educational materials for the public about historic properties on Mauna Kea	Educate the public and other users about the prehistory and history of Mauna Kea Encourage the preservation of historic properties on Mauna Kea and their environmental context Inform the public about the restrictions and precautions of visiting the summit region and other management areas	Designate historic properties suitable for public visitation and minimize impact of visitation: Self guided tours Guided tours Independent Hikers Prepare brochures on Mauna Kea's past including with visitor precautions: Develop themes for brochure Develop text, select photographs, and prepare graphics for two brochures Develop conceptual components of display panels, text, and illustrations for expanded or renovated Visitors Center at Hale Pohaku to include: Contents focus on five major topics: Develop context for the presentation of the major topics Objects or replicas in display Compile archaeological and historical background materials to aid staff presentations or interactions with public Outline major themes in more detail Answers to commonly asked questions

Table 7a

Management Actions and Plans

Interpretation and Education: Strategy Details

Public Visitation of Historic Properties	Brochures on Mauna Kea's Past	Conceptual Components of Display
Self guided tours: Proposes three potential areas with shrines for visitation Proposes four vantage points for interpretive signs Guided tours: Proposes three potential tours to areas with shrines Proposes potential tours to Mauna Kea Adze Quarry Independent Hikers: Provide appropriate information to independent hikers to remote areas	Develop themes for brochure: Prehistoric uses (adze manufacture, religious practices, access routes, burial practices, bird catching, travel, resource gathering) Legends and traditions associated with Mauna Kea Chronology of historic-period events and uses of Mauna Kea (early visitors and explorers, cattle hunting, ranching, forest and wildlife management, scientific research) Penalties for disturbing historic properties General precautions to protect the historic district (control debris, prohibit off-road vehicle use) Develop text, select photographs, and prepare graphics for two brochures Simple brochure for casual visitors with moderate interest in the topics (used during visit, single sheet, black and white, easily reproduced) More elaborate brochure for visitors with long-term interest in the topics (kept for future reference or souvenir, larger format, color, higher quality paper)	Display contents focus on five major topics: Adze manufacture at the Mauna Kea Adze Quarry Religious observances demonstrated by shrines Burial practices in remote areas Traditions and legends associated with Mauna Kea Chronology of historic periods and uses Develop context for the presentation of the five major topics: Historic district which integrates the types, distribution, and significance of historic properties Environmental zones, geology and topography of Mauna Kea's upper slopes Objects or replicas in display: Artifacts and stone previous removed from the quarry Artifacts and stone removed from octopus manufacturing area during data recovery Replica of a shrine found in summit region

Guided Tours. Guided tours to some of the more remote shrine complexes may be appropriate if the Office of Mauna Kea Management hires staff who will act as rangers or management specialists. One of their responsibilities could be escorting small to moderate sized groups to three areas which are relatively accessible but not appropriate for interpretive development or high levels of visitation. The level of effort devoted to these tours would be similar to the star-gazing events sponsored by UH at the Visitor Center and the periodic facilities tours conducted by the individual observatories. These guided tours would not cater to companies having commercial use permits to transport visitors to the summit, but to community or school groups requesting tours and to individuals who would be welcome to participate in tours scheduled at specified intervals (e.g., once a month). These tours would also provide the rangers an opportunity to periodically monitor the condition of the shrines and the surrounding landscape.

The most accessible of the three potential areas is the cluster of 11 shrines located between Pu`u Lilinoe and the summit cones (Pu`u Kukahau`ula). In terms of shrine attributes (i.e., number and position of uprights, structural foundations, ground plan or layout), this grouping includes the most diverse examples of complex shrines within a relatively concentrated area. The location of this cluster between the two cinder cones also provides an opportunity to discuss traditions associated with the legendary characters Lilinoe and Kukahau`ula whose names are born by these cinder cones. Visiting this cluster is relatively convenient given its proximity to the summit road and the existing parking lot at 12,800 ft. in elevation which could be used as a tour staging point. Depending on the number of shrines visited in the cluster, the tour could take between two and three hours. Proximity to the summit road is also advantageous for health and safety concerns, including the weather turning bad, visitor straying and becoming disoriented, or those who are overcome by the effects of altitude.

The second tour could visit a single shrine, Site No. 16168, which is an excellent example of a complex shrine and one of the most architecturally elaborate shrines found thus far in the summit region. Located on a flat promontory at the edge of a substantial flow margin, the shrine is composed of the three, discontinuous alignments with a total of 25 standing and fallen slabs. The configuration of these alignments and modifications to the base outcrop create the distinct impression of a court. In some respects it is the shrine that most closely resembles those recorded on Necker Island. An added attraction of this particular shrine is the commanding and aesthetically pleasing view from the shrine on a clear day. This expansive vista can include the Hamakua Coast, the Waimea Plains, the Kohala Mountains, and Haleakala on Maui. The shrine can be accessed from the road leading to the lowest observatory platform of the Smithsonian Submillimeter Array. Tours would have to be coordinated with staff of the Submillimeter Array to make sure that parking or the timing of the tour did not interfere with their operations. The tour could take one and half to two hours. Prospective participants should be warned that the walk is moderately arduous and all above 13,000 feet in elevation.

The third tour, the most arduous and remote of the tours, would encompass the scattered shines located to the west of Pu`u Mahoe. Many of the shrines within this relatively small area are good representative examples of the various shrine forms and display the range of shrine attributes found within the summit region. This includes the simplest shrine form which consists of a single upright propped by several stones; a relatively common form created by an alignment of three upright slabs, and a much more complex arrangement in which multiple alignments of uprights form a semi-enclosed, court-like area. Flexibility is one of the advantages of this tour as the number of shrines visited and the distances covered could be tailored to the particular wishes or abilities of the participants. A convenient grouping of shrines for the tour would include Sites 16176, 16178, 16179, 16180, 16184, 16185, 21201, and 21202. Another advantage of this more remote tour is that it allows, to a greater degree, visitors to experience the isolation, quit, and natural setting of the shrines. All participants should be warned that the hike, particularly the return to access road, can be fatiguing as these shrines all lie between 12,400 and 13, 000 feet in elevation. Access would be from the jeep road that runs along the northern base of the summit cones at approximately 13,200 feet in elevation. The tour could take about four hours.

Consideration should also be given to conducting tours to the Mauna Kea Adze Quarry because supervised visits to this impressive and highly significant historic property would be preferable to self-guided tours or individuals wandering independently through the site. Of particular concern is the removal of artifacts from the quarry workshops or disturbance to the mounds of flaked material and rockshelter deposits. Before such tours are planned or recommended in the preservation plan, the NARS Commission and staff would need to be consulted. If conducted, these tours would preferably conform with an historic preservation plan prepared for the NAR.

Independent Hikers. Given that the Science Reserve and the Natural Area Reserve are public lands, individuals who want to hike or independently explore the open, undeveloped areas of the summit region often feel they have a right to do so. The level of guidance provided these individuals should, however, be seriously considered. Providing individuals with some level of information on the nature and distribution of shrines within the Science Reserve could either put the shrines at greater risk or reduce this risk. This information could serve as an incentive for individuals to intentionally visit a greater number of shrines or to search out those in the more remote areas of the Science Reserve. Increased visitation could, in turn, increase the vulnerability of the shrines to disturbance. If properly presented, however, this same information could make hikers aware of the shrines which they might not have recognized otherwise and could have damaged in ignorance. Particular consideration should be given to aiding native Hawaiians requesting information for independent hikes.

b. Brochure. The exact content of the brochure will not be prepared until the synthesis of archaeological and historical information gathered for the preservation plan has been completed. The main topics addressed in the text of the brochure will include the major prehistoric and historic activities known to have occurred on the mountain; legends and traditions associated with the Mauna Kea; and a chronology of what brought people to the mountain during the historic period (i.e., 1823 to present). For the prehistoric period, focus will be on adze manufacture, religious practices as represented by the shrines, access routes, and burial practices. The Hawaii Island Burial Council and other concerned native Hawaiians would be asked to review the discussion on burials. The collective significance of the historic properties representing these uses, as expressed in the designation of the summit as an historic district, would be noted. Also mentioned would be known uses of the mid-elevation slopes where Hale Pohaku is located. These include bird catching, travel from one side of the island to the other, and the use of resources needed to carry out these activities (water sources, bird distributions, wood). Some of the historic properties located near the mid-elevation facilities could illustrate activities that occurred at these elevations. For legends and traditions, the text would discuss the major characters Poliahu, Lilinoe and Kukahau`ula and traditions alluding to

Lake Waiau. The chronology of historic periods uses would begin with the ascent of the mountain by early visitors and explorers; use of the lower slopes for cattle hunting and later sheep and cattle ranching; efforts to manage the mountain's forests and wildlife; and scientific research.

The number and distribution of graphics or photographs appearing in the brochure will depend largely on the size, lay-out, and printing specifications chosen for the brochure. In general at least one photograph or drawing of the adze quarry, a shrine, the lake, and a cinder cone associated with a traditional character should illustrate these significant historic properties. A map of the summit region best conveys the high number and wide-spread distribution of shrines throughout the summit region without providing sufficient detail to allow visitors to walk directly to the shrines. This or another map could depict the historic district and other historic properties which contribute to the significance of the district. The location of known and suspected burial sites would not be shown. If the proposed historic properties and vantage points have been developed for self-guided tours by the time the brochure is produced, a map should be included to guide visitors to these interpretive sites.

Given that so much of what can be included in a brochure in terms of topics and illustrations will depend on the size and format of the brochure, the quality of paper used, and printing specifications (number color separations, etc.), consideration should probably be given to producing two brochures. One brochure could be produced quickly and cheaply in black and white and another, more expensive brochure could be printed in color, on higher quality paper, and in a larger format to accommodate more text. The cheaper brochure would be for visitors who have only a causal interest in the mountain's past and will probably throw it away once it serves its purpose as a guide. The other, more expensive brochure, would be for those who are more interested in the information presented and are more inclined to keep the brochure for future reference or as a souvenir.

Portions of the brochure would warn visitors against damaging or altering historic properties and removing artifacts. The penalties for disturbing historic properties on state land will be cited (Chapter 6E-11, a $10,000 fine for each offense). The public would be cautioned about the need to control and remove any debris created during visits and reminded that use of vehicles off of established roads is prohibited. The effects of altitude and the dangers of unpredictable weather (i.e., high winds, snow, or thick mists) would be mentioned briefly as this topic is generally covered in more detail by UH in other informational materials prepared for the public.

c. Displays. As noted earlier, the Master Plan proposes expanding and renovating the Visitor Center so only the conceptual components of the displays, general interpretive themes, and display options can be addressed until these expansion plans are finalized. If expansion occurs, then the selection of specific text, illustrations and objects for the displays on the prehistory and history of Mauna Kea should be coordinated with the other displays panned and the lay-out of exhibit space. If these plans do not materialize, then the lay-out and content of the display should be adapted to the existing space.

Most of the themes and illustrations proposed for the brochure would form the core presentation of the display. Panels and text could focus on four major themes of Mauna Kea's cultural past: adze manufacturing at the Mauna Kea Adze Quarry (i.e., extraction of basalt, reduction of material, etc.); religious observances as illustrated by the distribution of the shrines throughout the historic district; use of inland, remote regions for burial; and traditions and legends associated with Mauna Kea. At least two panels should be devoted to creating a context for these activities. The first would describe the historic district as a means of integrating all the significant properties found in the summit region and should include a map showing the distribution of these properties within the context of the landscape. The second would portray and describe the different environmental and topographic zones of the mountain's upper slopes that provide a context for discussing the resources that drew native Hawaiians to the mountain's slopes or sustained them while they were there. Some of the historic properties found in the vicinity of Hale Pohaku could be addressed within this context. A chronology of historic-period landuse and notable events could also draw on this environmental and topographic context. As with the brochure, historic-period themes would include ascents of the mountain by visitors and explorers; cattle hunting or ranching and sheep rearing, efforts to manage the mountain's forests and wildlife; and scientific research.

Although the displays would primarily be composed of text, photographs, maps, and other illustrations, two displays which include materials should be considered. In discussing adze manufacturing, artifacts and stone already removed from the quarry for various reasons could be displayed to illustrate the different implements and steps needed to take the fine-grained basalt extracted from the quarry and reduce it to the various forms of roughed-out adzes. A similar display could address the manufacture of octopus lure sinkers in the vicinity of Hale Pohaku and their use in fishing. For the use of shrines, a replica of a shrine could be constructed outside the Visitor Center for those who are unable to visit a real shrine, for lack of a four-wheel drive vehicle or health concerns.

d. <u>Informational Material</u>. As part of the preservation plan, informational materials will be compiled to aid those giving presentations at the Visitor Center or guided tours of the Science Reserve and/or NAR. These materials will primarily outline information about the history and prehistory of Mauna Kea in more detail than would be available in the brochures or in displays. Also emphasized would be answers to some of the questions most commonly asked during site visits. The format of these materials should allow guides or rangers sufficient flexibility to adapt the information to different kinds of presentations and assist them in becoming better informed in general. The themes developed in the outline would include both archaeological topics as well as historic-period uses of Mauna Kea and would essentially expand on topics raised in the brochure or display. These materials could also be used by those giving tours of the individual observatories should they want to augment their presentation with information about past uses of the mountain.

4. <u>Burial Protection and Inadvertent Discovery Plan</u>
A burial protection plan will be prepared for known or suspected burial sites located in areas that are not being developed or actively used [See Section I-B(4) for burial plans related to project planning and construction work]. The plan will be developed in consultation with the Hawaii Island Burial Council and other interested native Hawaiians. At present, taking specific actions to protect these sites (i.e., constructed barriers, markers, signs) could be counter-productive. Such measures tend to call attention to features that would otherwise be overlooked. There is currently no indication that known or potential burial sites are being actively disturbed or that any particular activities are causing such disturbances, but this could only be established with greater certainly through routine monitoring. An exception would be the possible burials on the rim of Pu`u Waiau as the lake is visited by hikers more than any other area in the summit region. Despite this high rate of visitation, the potential burial mounds show no sign of on-going disturbance and anonymity may be the be best form

Table 8

Management Actions and Plans

Burial Protection and Inadvertent Discovery Plan

Action	Purpose	Strategy
Adopt measures to protect burial sites in all management areas (within a non-development context) in consultation with Hawaii Island Burial Council	Protect known or possible burial sites from disturbance and degradation Determine appropriate treatment for inadvertently exposed human remains (non-development context)	Prepare plan to protect known burial sites: Anonymity strong protection Use of barriers, markers, or warnings only if needed Monitor burial sites and adjacent areas for signs of visitation or disturbance Prepare plan for inadvertently exposed human remains (e.g., by natural processes): Comply with administrative rule §13-300-40 Provide guidance on potential burial treatment plan scenarios: Stabilize exposed human remains Relocate if stabilization is not feasible Consider temporary repository in summit region until consultation or reburial is completed Designate protected reburial areas if appropriate Document inadvertent burial sites and reburial sites for inclusion in historic property catalogue to ensure long-term protection and monitoring Establish policies on confidentiality for burial site information

of protection. An important protective measure would be ensuring that enforcement or management personnel working in the Science Reserve pay particular attention to any signs that people may be visiting known or suspected burial areas.

Given the known presence of burials in the summit region and at lower elevations, it is possible that human remains could become exposed by natural processes (e.g., erosion). The historic preservation plan will include provisions for dealing with inadvertent burials found in these circumstances in accordance with §13-300-40 and will provide guidance on the preparation of an inadvertent burial treatment plan for these situations. As with other burial matters, the plan should be reviewed by the Hawaii Island Burial Council and members of the native Hawaiian community. The plan will emphasize the stabilization of exposed burial sites so that they can remain in place and be protected from further disturbance. If stabilization is not feasible, the burial would be relocated in accordance with a burial treatment plan prepared in consultation with the Hawaii Island Burial Council and other native Hawaiians requesting to be consulted in these matters. For all inadvertent discoveries that need to be removed for their protection before reburial occurs, the plan may propose finding a temporary repository in the summit region so that the remains need not be removed from the mountain while waiting for reburial. The plan could also consider designating reburial areas that would be more feasible to monitor and protect over time and identifying those individuals or groups wanting to take responsibility for the care of these remains.

All inadvertent burial sites and reburial sites should be recorded and their exact location plotted so they can be included in the on-going monitoring program and protected. This information should be added to the catalogue of known historic properties within lands administered by UH or DLNR and maps showing these additional locations should be updated for use by land managers or enforcement personnel. Policies on confidentiality established for all burial site records would apply to these documents. Records of human remains exposed where there are no surface indications of a burial (i.e., mounds, platforms, in-filled cracks) are particularly important because they would indicate the presence of burials in areas that were not previously known. These areas or type of areas could then be afforded greater attention in monitoring efforts. Some remains in the more remote areas may have been exposed for many years before being discovered as is indicated by surveyors' accounts which mention seeing eroding burials in cinder cones.

Guidelines should be established to address the issue of confidentiality. A balance needs to be found between restricting information on the precise location of burial sites and having this information readily available for those with management responsibilities.

5. General Management Issues

Several long-term management issues are addressed here individually because they are not associated with any one user group or specific type of historic properties. Instead, they are created by or can influence all the major uses (i.e., public uses, commercial operations, use of the observatories, etc.) of the summit region, the summit road, or the areas surrounding Hale Pohaku. These include approaches to control the distribution of debris, prohibitions on the use of off-road vehicles, the monitoring of public access, and enforcing the various restrictions or regulations that exist or may become adopted.

a. Debris Removal, Monitoring and Prevention. The wide-spread distribution of debris over the summit region has been recognized as a problem for a long time. During the archaeological surveys conducted for this preservation plan, it was clear that some areas within the summit region are more vulnerable to debris accumulations than others and that debris is generated by the full range of activities taking place on the mountain. Construction work, routine activities by observatory personnel, and uses by the public, particularly snow-related ones, all appear to contribute to the wide-spread and sometimes concentrated distribution of debris.

Debris can potentially affect historic properties in three ways. First, it could physically damage or deface individual properties such as shrines or burials. During the 1995 and 1997 surveys of the summit region, no instances were noted of such damage to individual properties other than debris lying on the slopes of the summit cinder cones. Second, debris can affect the visual integrity of the historic district and individual landscape features within the district. This potential effect is particularly high given the open and exposed landscape of the summit region. Third, systematic efforts to remove debris could, if not done appropriately, affect historic properties. Most vulnerable would be the shrines and the slopes of the summit cones. Individuals participating in the clean-up could inadvertently damage or alter a shrine if they were unaware of its significance or if collection points for the temporary stock-piling and removal of debris are placed too close to shrines or shrine complexes.

A debris removal, monitoring and prevention plan will be developed to define steps that can be taken to avoid or reduce the initial creation and spread of debris and to remove debris that will inevitably escape and accumulate despite the best intentions. Some of the steps needed to minimize the chance of materials being carried away by high winds may already be practiced by UH, the individual observatories, and contractors. These or other appropriate measures will be included in the plan in order to recognize their importance in terms of historic preservation and as a means to ensure their inclusion in future agreements or in permits. For the public, the plan will address educational efforts to raise awareness of the problem and recommend that unobtrusive trash receptacles be placed where visitors are most likely to congregate. To avoid potential adverse effects on historic properties during debris clean-up efforts, all those participating should be briefed sufficiently to recognize shrines and instructed to exercise caution when collecting debris near them. Preferably the locations of all collection points will be selected prior to the effort and will be placed at sufficient distances from any shrines. This would ensure the avoidance of shrines and the effective spacing of collection points. Efforts to remove debris from the slopes of the summit *pu`u* should be designed to avoid permanent or temporary scarring of the slopes. Hopefully the need for large-scale clean-ups will decrease as preventative efforts increase and much of the debris which has accumulated over many years is removed.

b. Off-Road Vehicle Use. Historic properties and the district as a whole can be affected directly and indirectly by the use of vehicles off of established roads. Direct damage can be caused by vehicles running over or into historic properties. Most vulnerable to this kind of damage are relatively obscure flake scatters produced by adze manufacturing and cinder cones which can be scarred by vehicle tracks. Shrines are less vulnerable to these direct impacts given their frequent location on stone outcrops or outcrop ridges which are often inaccessible to vehicles or are avoided in cross-country travel. Vehicle tracks can also scar the landscape within the historic district as well as the cinders cones. While some scars may be obscured by natural forces through time, others could remain visible for long periods, particularly if repeated use occurs, and could be enhanced by erosional processes. More importantly, visible tracks tend to encourage others to follow the same route if

Table 9

Management Actions and Plans

General Management Issues

Action	Purpose	Strategy
Adopt measures that address issues affecting all major user groups on Mauna Kea and historic properties in all management areas	Minimize and mitigate the effects of debris on historic properties and the landscape	Prepare guidelines to remove debris and reduce its initial distribution
	Prevent or deter the use of vehicles off of established roads	Continue to prohibit the use of vehicles off of established roads and strengthen measures to deter off-road use
	Minimize the impact of unrestricted public access on historic properties along the summit road and the summit region	Institute measures to minimize the potential effects of unrestricted public access on historic properties and the historic district through registering visitors, distributing information on the protection of historic properties, and monitoring public uses
	Improve enforcement of laws, regulations, and restrictions that protect historic properties and deter violations	Institute measures to increase the effectiveness of enforcing and deterring infractions by maintaining a sufficient staff presence and compiling all laws, regulations, and policies needing enforcement

Table 9a

Management Actions and Plans

General Management Policies: Strategy Details

Guidelines to remove debris and reduce its distribution	Take steps to minimize debris escaping from observatories, during maintenance work, and from construction sites Inform public and commercial users of the impact of debris Install and maintain unobtrusive trash receptacles where users congregate Monitor the distribution of debris Conduct systematic clean-ups to remove debris without disturbing historic properties by: Informing clean-up participants of historic properties and restrictions Designating debris collection and pick points which avoid historic properties
Prohibit and deter use of vehicles off-road	Retain and enforce current prohibitions Adopt language used in NARS administrative rules in rules or management controls Establish measures to prevent or deter vehicles from leaving established roads and designated parking areas Maintain current guardrails and boulder barriers Avoid or minimize visual intrusions on landscape if new guardrails or barriers are installed Designate parking areas by unobtrusive signs, temporary signs when needed, or on maps distributed to public users Inform public and commercial users and UH staff of these restrictions Devise mitigation measures to obscure off-road tracks created by unauthorized or authorized vehicles
Measures to minimize effects of unrestricted public access	Monitor public use through a registration process Provide public users with information on historic properties and restrictions that protect historic properties and the historic district Monitor the effects of public use on historic properties so that controls or restrictions can be revised when necessary Maintain an adequate level of staff presence to deter violations and encourage adherence to restrictions Direct users to historic properties or vantage points designed to accommodate visitation or to guided tours
Measures to effectively enforce or deter infractions	Hire sufficient staff with enforcement or management authority to patrol the three management areas and portions of the NARS Train staff to document the intentional alteration of historic properties to federal standards Maintain and update the catalogue of historic properties and their current condition for comparative purposes Monitor the condition of historic properties to identify patterns in the alteration of historic properties Integrate all regulations, restrictions, and polices in a single document to aid management staff

only out of curiosity. Off-road vehicles have an indirect affect on historic properties because they allow individuals to visit a greater number of historic properties and more distant parts of the Science Reserve with greater ease during a single outing. This increase in accessibility to otherwise relatively remote properties can, in theory, raise the probability that historic properties or parts of the historic district could be altered or damaged.

The 1995 Revised Management Plan prohibits the use of off-road vehicles by the general public and commercial operators. The types of off-road vehicles specified as being subject to this prohibition include motorcycles, dune buggies, snowmobiles, and 4-wheel drive passenger vehicles, van, and trucks. Exceptions are allowed for emergency rescue and medical reasons. The administrative rule for the Natural Area Reserve prohibits the operation of all motorized and unmotorized land vehicles within a NAR except on roads or trails specifically designated for this purpose. It also prohibits the use of "air conveyance of any shape or form" in the NAR. The NARS Commission can issue special use permits to allow otherwise prohibited activities for purposes such as research, education, and management. For historic preservation purposes, we would prefer that the stronger of the two conditions be applied to the entire Science Reserve in addition to the NAR and that similar provisions be included to deal with exceptions such as emergencies or special requests that would then be subject to review by the appropriate agencies. The terminology used for off-road vehicles in the NARS Commission rule is also preferable because it is broad enough not only to include the range of vehicle types in use today, but also those that have not been developed yet or have yet to become popular. In addition to keeping vehicles on designated roads or trails, the historic preservation plan will also address measures to restrict vehicles to designated parking areas such as those that are formalized and paved or those that are unpaved but marked for this purpose. The latter could include previously disturbed turning areas or stretches of road shoulders that have been previously disturbed and could accommodate parking safely. In all cases, these restriction would apply to public and commercial activities.

The plan will consider mitigation measures to prevent or deter off-road vehicle use and to obscure tracks or damage caused by authorized and unauthorized vehicles. Currently restrictions against off-road vehicle use are encouraged or enforced by signage and guardrails or boulder alignments that keep vehicles from departing the main road where exits are possible or have been used in the past. The proposed Master Plan recommends that guardrails be installed in potentially hazardous stretches of the summit road after a road safety study assesses where they are needed. We would prefer that physical barriers, including guardrails or boulder alignments, be used sparingly as they are a visual intrusion on the landscape although safety is still a primary consideration. Boulder barriers could be installed in areas that are identified as problematic only after monitoring suggests a need for them in particular places. Even these should be installed in a way that minimizes their visibility. Signs should also be used with constraint and be designed to certain specifications so that they do not distract from the landscape. Low markers, instead of tall or reflecting signs, could be used to delineate unpaved parking areas or stretches along the road where parking is permitted. Preferably, all areas in which vehicle use or parking is restricted or allowed should be well illustrated in information distributed to all visitors and commercial operators. If presented effectively, this information could help reduce the need for distracting signs and markers. To restore areas that have been marred by vehicle tracks, experiments may be needed to determine which methods will best obscure the scars in differing slopes and substrate types. Those areas in which this has been attempted should be reexamined to see how effective these efforts were.

c. Public Access. From the narrow perspective of preserving historic properties, the more access to the summit region is controlled and restricted, the less likely it is that historic properties will be damaged or destroyed. Preservation alone, however, is not the overriding or exclusive mandate of the historic preservation plan which must also consider native Hawaiian access and public education as major objectives. When all three objectives are considered, options that emphasize the monitoring of access instead of restricting it are preferred. This does not include the exceptions of restricting access for snow clearance, for health and safety reasons, during heavy visitor usage periods, or for night-time observatory use (i.e., access restricted to one half hour before sunrise and after sunset). The proposed Mater Plan commits to establishing guidelines for registering visitors to the summit region and providing an orientation for visitors.

Many of the potential affects of uncontrolled access on historic properties can be reduced or minimized by providing users with information on historic properties; monitoring the condition of historic properties; having some level of staff or ranger presence in the area as a deterrent; enforcing the laws or regulations when needed; directing visitors to historic properties suitable for visitation; or informing them of the guided tours. Asking that all visitors register before going beyond Hale Pohaku would provide the opportunity to supply the public with the appropriate guidance and warnings.

d. Enforcement. In terms of enforcing of historic preservation laws and protecting historic properties, the importance of having a greater staff presence in the summit region, either in the role of enforcers or managers, can not be over emphasized. While it may be preferable to have individuals with full enforcement powers available, the presence of rangers or management specialists alone can significantly deter actions that disturb historic properties or alter the landscape. Rangers or management specialist who are not official enforcement personnel should be trained in standard procedures for documenting potential violations. In particular, they should receive training in recording damage to historic properties such as that given National Park rangers who need to document damage or vandalism to standards required when enforcing the Archaeological Resources Protection Act on federal lands.

Three documents or programs generated by the preservation plan should make enforcement efforts more effective. The first is a catalogue of all known historic properties and their locations in the Science Reserve which can serve as baseline documentation against which any suspected alteration or damage can be compared. Second, the monitoring plan will routinely up-date this comparative documentation and identify patterns of disturbance and those particular areas or properties that are most vulnerable to intentional disturbance. Enforcement efforts can then be focused in these areas. Third, an outline of the applicable laws and regulations will be compiled for ready use by management staff. Adopting administrative rules specific to the Science Reserve, as recommended in the Legislative Auditor's report, could help simplify the overall enforcement effort in that all the required procedures, prohibitions, and penalties applicable to all resources and uses on the mountain would be available in one document.

B. Management of Public Use

In addressing the affects of public uses on historic properties within the UH leased areas and the NAR, the historic preservation plan will follow the general categories of use discussed in the 1995 Revised Management Plan adopted by the Board of Land and Natural Resources and UH. This includes a fundamental distinction between public uses which are generally considered recreational in nature and commercial uses which encompass any organized activity conducted on a fee-for-service basis. Public uses are largely unrestricted although the 1995 Revised Management Plan specifies a number of controls which can be enforced to manage these public uses. These controls are in addition to restrictions or procedures mandated by state laws and regulations. Commercial users must obtain permits for their operations and abide by a number of permit conditions which control and restrict certain types of activities during commercial operations.

Under the 1995 Revised Management Plan, DLNR assumed primary responsibility for managing and enforcing both commercial and public uses of the Science Reserve and other lands leased by UH (i.e., excluding facilities or areas under sub-lease agreements). Specifically, the Land Division of DLNR is charged with issuing and monitoring commercial permits while the Division of Conservation and Resources Enforcement (DOCARE) of DLNR is responsible for enforcing permit conditions or other violations. UH is charged only with assisting in these management and enforcement efforts, primarily through monitoring uses and reporting infractions. The proposed Master Plan suggests having UH assume responsibly for all commercial and non-commercial public uses of the Science Reserve. Public activities occurring within the NAR remain under the jurisdiction of the Natural Area Reserve Commission which also calls upon DOCARE if enforcement action is needed. Commercial uses within the NAR are prohibited without a NARS Special Use Permit and specific kinds of non-commercial activities also require Special Use Permits. Permits issued include general restrictions as well as specific conditions to prevent or minimize potential impacts by a proposed activity.

The following discussion addresses only those public and commercial activities known to occur on UH controlled lands and in the NAR which have the potential to affect historic properties. The general approach adopted to deal with the potential affects of these on-going uses is similar to that adopted for on-going or routine maintenance activities in that it involves identifying those areas in which public and commercial activities are most likely to occur; determining the presence or likelihood of historic properties in these areas; assessing the potential of these activities to affect historic properties in these areas; and proposing measures to prevent or mitigate any of these potential adverse affects. Essential to the effectiveness of this part of the plan is a program to systematically monitor these uses, to effectively inform users of any controls or restrictions imposed to protect historic properties, and to enforce restrictions when necessary. Monitoring would allow the potentially affected areas to be identified more realistically in the future and the defined areas to be revised if patterns of use change through time.

1. <u>Recreational Use by the Public</u>
   The treatment of public, non-commercial uses focuses on four major kinds of activities, most of which can be undertaken by individuals or groups. The first is snow-related activities which occur intermittently, usually seasonally, when sufficient snow falls on the mountain. The second kind encompasses activities associated with visitors who are primarily interested in seeing and experiencing the mountain region and summit. This includes activities associated with learning about the natural and cultural history of the mountain, enjoying vistas possible from higher elevations, or seeing the telescopes independently of tours sponsored by the Mauna Kea Support Services or individual observatories. The third is hunting which is allowed under 1995 Revised Management Plan if coordinated with UH and in the NAR only as part of a coordinated plan to reduce and control animal numbers. The fourth is non-commercial tours organized by Mauna Kea Support Services or individual observatories in which the primary objective is to tour facilities or view the stars through optical telescopes.

   a. <u>Snow-Related Activities</u>. Snow-related activities occurring in the summit region range from the simplest form of merely experiencing snow to the more technical sports such as down-hill skiing on preferred slopes. These activities can include snow-play, snow-boarding, sledding, and cross-country skiing. The frequency, intensity, and distribution of these activities will always depend on the depth of snow accumulations, how long the snow cover lasts, and how far down the mountain slope the cover extends. These conditions can draw large numbers of people for relatively short periods (i.e., one or two days, a weekend, etc.) or cause only moderate increases in the routine number of visitors to the summit region. Despite this variability, most of these activities probably take place in relatively predictable

Table 10

Long-Term Management of Historic Properties - Public Uses

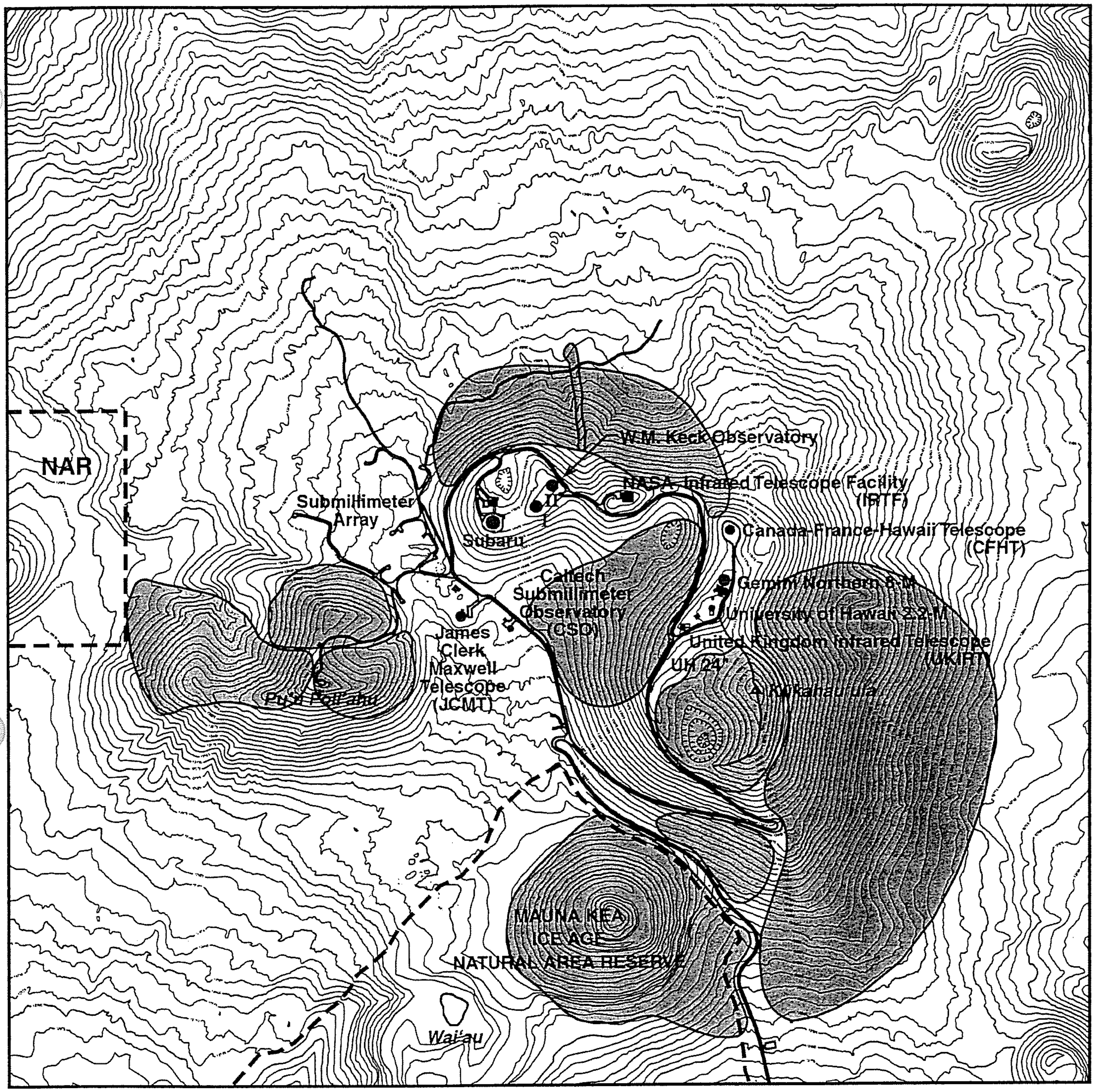
Snow Related Activities

General Characteristics	Examples of Activities	Potential Effects on Historic Properties and District	Mitigation Measures
Use is intermittent, usually seasonal, when sufficient snow falls Occurs where: Snow accumulates to sufficient depths Terrain and slopes are amenable to winter sports Areas are accessible by road or near parking Intensity of use: Large number of user for short periods Moderate increase in routine visitor numbers for short periods	Experiencing snow and winter conditions Snow play Snow-boarding Sledding Down-hill skiing Cross-country skiing	Scaring or eroding cinder cones during skiing, sledding or snow-boarding Inadvertent damage to shrines or flake scatters during cross-country skiing, snow-play, or snow-boarding Inadvertent damage to cinder cones, shrines, or flake scatters during emergency rescues Creating debris (clothing, beverage containers, Styrofoam board fragment, cardboard) Need for rest room facilities Use of vehicles off-roads (caused by limited parking, wanting to reach snow banks or covered slopes)	Confine down-hill skiing and sledding to cinder slopes with a protective layer of snow Monitor long-term effects of snow-related activities on cinder cones Designate areas where specific snow-related activities can occur Inform users of designated areas through maps, temporary signs, or directions given by rangers Inform users of rest room facilities and permanent trash receptacle locations Increase ranger presence during high intensity use periods Limit number of visitors or duration of visits during high intensity use periods Install temporary trash receptacles in areas of high usage Perform debris clean-up sweeps in high use areas at end of winter season Inform users of designated parking areas (also with temporary signs if needed UH staff reviews emergency plans when winter season begins

areas (Fig. 6). For down-hill skiing, the favored runs are well known to be particular slopes on Pu`u Poliahu, Pu`u Hau Kea, and the summit cones where established roads also allow a degree of vehicle access at the beginning and end of the runs. For other types of snow-related activities, factors such as proximity to access roads, convenient parking areas, and appropriate slopes for snow-boarding and sledding will influence where these activities are most likely to occur.

Most of the snow-related activities have the potential to directly affect historic properties. As we believe the cluster of summit cones (i.e., Pu`u Kukahau`ula) is an historic property, skiing on the slopes of this *pu`u* could adversely affect this historic property. For example, visibly scarring of the *pu`u* could occur if skiing-related actions take place on portions of the cinder cone which are not covered with a sufficient depth of snow to protect the cinder cone. If this is the case, skiers could be asked to confine their activities (i.e., walking, skiing) to slopes that are covered with a protective layer of snow. Long-term monitoring of the cinder cone slopes should be able to identify the magnitude of these or any other affects. Although we do not consider all cinder cones to be historic properties, similar constraints should be applied to them as they are encompassed by the historic district and contribute to the setting and integrity of the district as a whole. UH staff and other frequent users of the mountain will be asked to help identify areas most likely to be affected by the other types of snow-related activities. With this information, the plan can designate areas in which specific kinds of snow-related activities can and can not occur based, at least in part, on the known presence or absence of historic properties. Individuals could be shown which areas are appropriate and inappropriate in brochures, by rangers patrolling these areas during times of heavy snow cover, and possibly by temporary signs.

In general, the indirect effects of snow-related activities on the historic district are similar to those resulting from other recreational uses except that their occasional intensity can dramatically increase their effect. These activities all increase the amounts of debris generated, the need for rest room facilities, potential off-road vehicle use, and the likelihood of emergency rescues. In general, those mitigation measures recommended under General Management Issues and Policies [Section II-B(5)] apply although some additional steps may be needed to accommodate the intensity of use. During periods of heavy usage, the presence of rangers or resource managers patrolling areas should be increased and consideration given to controlling



Source: 1983 Mauna Kea Science Reserve Complex Development Plan, Dr. Jerry Johnson, 1998

Ski Areas

25' Contour Intervals

Natural Area Reserve

0' 750' 1500' 3000' NORTH

Existing Ski Areas

Figure 6 Commonly Used Ski Areas

the number of visitors allowed access to the summit region at a given time. The length of the visits could also be limited to allow access to more individuals within these constraints.

Snow-related activities create the same kinds of debris as other public uses (hats, food and beverage containers, pieces of plastic, etc.) with some notable exceptions. They appear to be primarily responsible for the fragments of Styrofoam or fiberglass boards and cardboard sheets that are scattered over parts of the Science Reserve. Efforts to control debris, such as informing users of the problem and providing trash receptacles, should be intensified during periods of heavy snow. Temporary trash receptacles could be placed in areas where snow conditions are particularly favorable or use is high. This would be in addition to permanently installed receptacles. Once the snow cover has melted or when the winter season appears over, specific clean-up sweeps could be conducted in high use areas. The proposal in the draft Master Plan to construct permanent rest room facilities in a previously disturbed, level area between the summit cones and Pu`u Poliahu, would be particularly helpful in reducing the affects snow-related activities on the historic district. The presence of this facility and its location should be made clear to all users.

Several factors increase the probability of off-road vehicle use, including parking, during periods of heavy snow. Some individuals may be enticed to reach more remote areas where snow cover or slopes are amenable to snow-boarding. Greater competition for limited parking areas could also compel users to venture off of established roads or parking areas. These problems could be reduced if patrols by rangers were increased during these periods and if information distributed to the public makes it clear that off-road use is prohibited. If off-road parking becomes problematic in specific areas, temporary warning signs could be installed.

The frequency of emergency rescues clearly increases during periods of heavy snow given the potential danger inherent in snow-related activities and the high number of users. Accidents and the need for rescues might be reduced if users are better informed, areas appropriate for snow-related activities are specifically designated, and rangers or management staff direct users to areas where the snow is thickest and sledding or snow boarding are the least dangerous (e.g., relatively free of exposed rocks). More importantly, procedures recommended in this plan [Section I-A(3)] to avoid damaging historic properties during emergency actions should be followed and the necessary materials made readily available when heavy snow falls in case they are needed by rescue crews.

Neither the NARS regulations nor its 1997 management policies specifically address snow related activities. The slopes of Pu`u Hau Kea are defined in the Master Plan as one of the preferred skiing and snow play areas and, depending of the extent and depth of particular snowfalls, other areas could be used as well. Skiing and snow play are not specifically mentioned as a permitted use (§13-209-3) and could be considered a prohibited use if they result in the damage or disturbance of geological features such as the cinder cones. If it were seen that skiing and snow play are disturbing these areas, the 1997 management policies state that public access may be "controlled, regulated, or prohibited in order to manage the impacts of public use of sensitive resources" (1997:5). A more specific policy on these uses should be developed with the NARS staff so that the monitoring, management and control of these uses during periods of heavy snow fall can be integrated with that of the Science Reserve.

b. <u>Sightseeing, Hiking, and Educational Pursuits</u>. General sightseeing and hiking, whether for experiencing the summit region or educational purposes, could have a greater effect on historic properties than other kinds of public uses because individuals or groups tend to have the time, mobility, and inclination to wander from established roads and trails and to encounter historic properties intentionally or inadvertently. In reality, however, relatively few visitors seem to wander far from established roads and trails or even from their private, four-wheel drive vehicles given the effects of altitude, cold temperatures, or windy conditions. Once at the summit, visitors generally stop at various vantage points for the view. Some will drive to the summit of Pu`u Poliahu on the rough, existing dirt road. Those inclined to hike tend to follow the well-worn path to the actual summit peak, the former dirt road to Lake Waiau, or the Humu`ula trail which cuts through the NAR from Hale Pohaku to Lake Waiau. Some wanting to see the Mauna Kea Adze Quarry and knowing its location will hike cross-county from the summit road to one or two of the workshop areas that are closest to the road.

The most likely, direct effects sightseers or hikers could have on historic properties would be the alteration of shrines, the removal of artifacts or materials from the

Table 11

Long-Term Management of Historic Properties - Public Uses

Sightseeing, Hiking and Educational Pursuits

General Characteristics	Examples of Activities	Potential Effects on Historic Properties and District	Mitigation Measures
Use occurs all year but higher during summer months or when weather is good Users generally stay near vehicles and on established roads and trails Low numbers of individuals or groups leave established roads or trails to climb cinder cones or visit areas of interest Occasional and unpredictable use of more remote areas	Non-Hawaii residents sightseeing in rented vehicles Sightseeing by Hawaii residents Day-hikers Excursions by school groups Individuals or groups interested in natural history	Scaring or eroding cinder cones by walking or running down slopes Inadvertent alteration of shrines, adze quarry features, or burial sites by visitors Inadvertent damage to cinder cones, shrines or adze quarry features during emergency rescues Removal of artifacts from the Mauna Kea Adze Quarry Contamination of Lake Waiau by visitors Intentional vandalism of historic properties Defacing landscape features	Control visits to historic properties by developing interpretive vantage points and self-guided and guided tours Inform visitors to avoid disturbing historic properties and of penalties in brochures or orientations Register all visitors to summit region to so that information on historic properties can be distributed Limit size of groups visiting off-road or remote areas through permitting process Enforce Special Use Permits issued for groups visiting the NAR Propose areas and routes for self-guided or guided natural history tours Establish new trails or formalize existing trails only if needed Inform visitors of need to control debris and personal belongings in high winds Inform users of locations of trash receptacles, rest rooms, and parking areas Control the number of visitors or the duration of visits if needed

Mauna Kea Adze Quarry, the disturbance of burial sites, or the scarring of cinder cone slopes. Those properties closest to access routes or visible from a distance are the most likely to be visited and are thus the most vulnerable. Creating self-guided tours and regular guided tours will hopefully reduce these potential impacts by focusing visitation on particular properties which can accommodate visitors or by having a guide present to monitor visitor actions. This would also reduce the frequency of visitors wandering independently and thus decreases the chance of historic properties being damaged inadvertently. As damage to historic properties by visitors is primarily done inadvertently or in ignorance, providing visitors with adequate information on how to recognize historic properties and on their appropriate treatment should also reduce these effects. This could be accomplished through brochures and orientations coupled with requirements that all entering the summit region must register. Registration provides the opportunity to distribute this information to all visitors and increases the likelihood of adherence to warnings and instructions.

A requirement that groups greater than a specified size obtain a permit or special permission to visit off-road areas of the Science Reserve should be considered because it allows conditions to be placed on group visits that are tailored to the particular areas being visited or the size of the group. This would be important for groups visiting for educational purposes because they are more likely to seek historic properties. A similar policy can already be implemented for the NAR. The NARS 1997 management polices state that all organized educational trips require a Special Use Permit which allows specific restrictions to be placed on the group's size and what areas will be visited. Currently, groups with more than 15 members are required to obtain a permit to visit the Mauna Kea Ice Age NAR.

For groups wanting to view multiple aspects of the mountains natural history, suggested tour routes could be developed to accommodate groups of various sizes, interests and abilities. This allows greater control over where groups go, particularly in remote or potentially sensitive areas, and what they do without diminishing their educational experience or a need for flexibility. If the routes of natural history tours are standardized to some degree, then it would be easier to provide group leaders with information on how to recognize and avoid historic properties located along or near those specific routes. Some group visits could become guided tours led by rangers or management staff which would further help reduce potential effects on historic properties. This is consistent with the 1997 NARS management policies which direct Reserve Management Plans to identify areas appropriate for educational activities and field trips.

For recreational hiking, the 1995 Management Plan for the Science Reserve restricts hikers to existing roads and tails although this restriction does not appear to have been enforced or well publicized. The proposed Master Plan does not address this restriction, but proposes to eventually establish hiking trails though sections of the Science Reserve, particularly along routes that were traveled during the historic period. Hiking is permitted in the NAR although the 1997 management policies allow public assess, which presumably includes hiking, to be controlled or prohibit such if it could impact sensitive resources. This issue needs to be reconsidered and some consensus reached after all potentially interested parties have been consulted and the legality of enforcing any restrictions are addressed. Although extensive, independent hiking should be discouraged for those not prepared for the dangers of hiking at high elevations, it could be difficult to prohibit realistically. As part of the interpretive effort, we have proposed that those wishing to hike independently to visit shrines, particularly native Hawaiians, be provided sufficient information to visit these historic properties and to treat them appropriately. We prefer this alternative to establishing a network of hiking trails because trails themselves, no matter how well designed and constructed, are a visual intrusion on the landscape and thus affect the integrity of the historic district. We would, however, favor the creation of formalized trails if the monitoring program determines that multiple paths or tracks are being created because of repeated visitation to specific areas and that formalizing these routes would help reduce the overall impact of hiking on the historic district. The affects of heavy foot traffic are already evident in the worn paths leading to the summit peak and to Lake Waiau and on the road leading to the top of Pu`u Poliahu. Consideration should be given to formalizing these access routes for hikers and providing appropriate interpretative information about these landscape features. The creation of any new, formalized trails or substantial alteration of an existing route would be subject to review by the Historic Preservation Division.

The indirect effects of sight-seers and hikers are essentially the same as snow-related users in that they can generate debris, create a need for rest room facilities, could be tempted to drive vehicles off of existing roads, and could require emergency rescues. Although less intense than snow-related activities, effects caused by hikers and sightseers could be more widespread and less predictable as some hikers could reach infrequently visited areas farther from existing roads. These effects would, in general, be reduced if mitigation measures discussed in the section on General Management Issues and Policies are implemented. Specifically, information given to sightseers or hikers should note areas where parking is permitted and trash receptacles and rest rooms are located. Some arrangements for parking should be formalized near the head of any formalized or well established trails such as those leading to the summit, Lake Waiau, and Pu`u Poliahu. In general, restricting the total number of visitors allowed in the summit region at a given time and visitation to specified hours would also, indirectly, reduce access to historic properties and thus the probability of them being altered. Currently, access to the summit region is primarily restricted to daylight hours and visitor numbers can be controlled should demand for access be exceptionally high.

c. Extreme Sports. Management proposals for the summit region and the summit access road must now consider the potential effects of what are loosely defined as extreme sports. Their recent rise in prominence can be attributed to the growing popularity of such sports and to technological advances in sporting equipment which have made these sports possible and affordable. Their potential impacts are addressed in the draft Master Plan, but not the 1995 Management Plan. The Master Plan defines extreme sports "as recreational activities that seek dangerous and unusual thrills" and gives down-hill cycling and hang gliding as examples of extreme sports that have occurred in the summit region. The unique settings and extreme conditions of summit regions such as Mauna Kea provide the kinds of conditions that can attract thrill-seekers. The status of this use is summarized in the draft Master Plan as not being categorically prohibited. The draft plan recommends that each extreme sport be evaluated on a case by case basis and that some may be prohibited or require permits.

Not all activities considered extreme sports are likely to have a direct effect on historic properties. Those which are confined to existing roads, such as down-high cycling, are highly unlikely to damage historic properties. Any activities, however, involving the use of motorized or unmotorized vehicles off of existing roads should be explicitly prohibited. This could include mountain bikes, all terrain vehicles, or motor cycles when used in an extreme manner. As with all off-road vehicle use, these vehicles can scar and damage the landscape which is an integral part of historic

Table 12

Long-Term Management of Historic Properties - Public Uses

Extreme Sports

General Characteristics	Examples of Activities	Potential Effects on Historic Properties and District	Mitigation Measures
Recreational activities by those seeking dangerous or unusual thrills Can occur on established roads or in remote areas Can increase need for emergency rescues Does not occur frequently Most are prohibited in the NAR	Down-hill cycling Hang gliding	Scaring and eroding cinder cones Scaring or damaging the landscape Inadvertent damage to shrines or adze flake scatters during activity Inadvertent damage to shrines or adze flake scatters during emergency rescues Creating debris	Establish permitting process to include these conditions: Clean-up any debris created by activity Specific measures to protect historic properties Submit an emergency plan prior to event which avoids damage to historic properties and the district SHPD reviews all permit applications Prohibit activities involving motorized and unmotorized vehicles off-road Prohibit activities in the remote parts of the Science Reserve Enforce NARS regulations when activity is a prohibited use Inform visitors of that permits requirements and prohibitions apply to extreme sports before they enter the summit region

district. Any activity that takes participants in the more remote areas of the Science Reserve should also be prohibited and is inconsistent with the concept of the Natural/Cultural Preservation Area proposed by the Master Plan. These sports could include hang gliding and the extreme use of other vehicle types. Not only can these activities damage historic properties, but they raise the probability of emergency rescues given their inherent danger. The emergency rescues themselves can mar the landscape or inadvertently damage historic properties given the speed and haste with which they must take place.

The preservation plan supports the recommendation that extreme sports be subject to a permit and review process. With the exception of those confined to existing roads, all applications should be reviewed by the Historic Preservation Division. The permitting process would provide a mechanism by which potential impacts on historic properties can be assessed and avoided. All applications should clearly define the area in which the activities will take place so that the potential to effects on historic properties in this area can be assessed. Permit conditions should also address some of the indirect effects of this recreational use. For example, permit conditions can stipulate that applicants are responsible for cleaning up any debris generated by the sports activity, particularly if this debris includes pieces of their equipment. Applicants could be required to submit an emergency rescue plan before the activity takes place to ensure that historic properties are avoided. The requirement to obtain a permit for these sports should be made clear to all those visiting the summit region. Information given in hand-outs or during orientations should give examples of activities that are considered extreme sports to reduce the chance of any misunderstandings.

d. Hunting. According to the 1995 Management Plan, hunting is currently allowed within the Science Reserve during daylight hours although it must be coordinated with the UH and is still subject to DLNR rules, regulations and policies related to hunting. Requests are apparently infrequent as there are few game animals or birds at the higher elevations. As a policy objective of the NARS commission is to reduce non-native animals to their lowest possible levels, public hunting is only used as a measure to control the number of animals in a reserve when practical. The 1997 NARS management policies list public hunting as only one of the ways to control non-native animals in the reserve. A summary of areas that have been or are most likely to be used for hunting will be compiled for the final plan and when completed,

Table 13

Long-Term Management of Historic Properties - Public Uses

Hunting

General Characteristics	Examples of Activities	Potential Effects on Historic Properties and District	Mitigation Measures
Allowed during daytime hours in the Science Reserve Occurs rarely as most game located at lower elevations Subject to applicable DLNR rules and regulations governing hunting Coordination with UH required if in the Science Reserve Prohibited in the NAR unless part of a sanctioned effort to reduce animal numbers	Rifle hunting for game birds, pigs, goats, and mouflon sheep Archery hunting for goats and mouflon sheep	Inadvertent alteration of shrines, flake scatters, or burial sites Ammunition striking shrines Off-road vehicle use to access game Debris left in areas hunted	Prepare description and map of most likely hunting areas and assess potential effects on historic properties Provide hunters with information on historic properties and the need to avoid them Inform hunters of designated parking areas and prohibitions against off-road vehicle use Ask hunters to remove all debris created while hunting Monitor long-term effects of hunting on historic properties and the district

the potential of hunting activities affecting historic properties can be better assessed. In several respects, the potential effects of hunting on individual historic properties are similar to those of hikers in that damage would probably be inadvertent because individuals do not recognize features as historic properties. Particular to hunting, however, is the possibility that historic properties could be damaged by ammunition that misses its mark or is deflected. Hunters may also be tempted to use off-road vehicles to reach hunting areas that are at a distance from human activity and thus more likely to have unsuspecting game.

The potential effects of hunting can probably be reduced or prevented in two ways. First, those granted permission to hunt in the Science Reserve should be provided an information sheet that describes the kinds of historic properties they might encounter in particular areas; warns against disturbing these properties; notes restrictions against driving off established roads, designates areas in which hunters can park; and asks that debris be controlled. Second, if long-term monitoring indicates that hunters are adversely affecting historic properties in particular areas, then additional steps can be taken to prevent this damage. One solution may be to designate the areas immediately surrounding these historic properties as being off-limits to hunters. This is more likely to occur, if at all, in areas with higher concentrations of historic properties.

e. Astronomical Observatories. Currently the public has several, non-commercial opportunities to tour astronomical facilities on Mauna Kea or to participate in star-gazing activities independently or in organized groups. The 1995 Management Plan permits individuals to use the grounds of the Visitor Information Station at Hale Pohaku for independent star-gazing and, if permission is granted by UH, they may also use areas within the summit region for this purpose. UH and the individual observatories operating on the summit are permitted to conduct tours of the astronomical facilities and to hold star-gazing, groups sessions at Hale Pohaku. They are also permitted to convene other educational meetings at Hale Pohaku. The Keck Observatory has a visitors gallery open to the public during day-light hours. Recently UH has been conducting tours to the summit observatories twice a week and star-gazing sessions at Hale Pohaku four times a week.

None of these activities is likely to affect historic properties directly given that they take place in existing facilities and on previously disturbed ground surfaces at the

Table 14

Long-Term Management of Historic Properties - Public Uses

Astronomical Observations

General Characteristics	**Examples of Activities**	**Potential Effects on Historic Properties and District**	**Mitigation Measures**
Public tours of astronomy facilities conducted by UH and individual observatories Nighttime stargazing at the Visitor Center or near summit observatories Educational events at the Visitor Center Activities almost always occur in previously disturbed or developed areas Number of visitors can be high for special events (meteor showers, eclipses) Existing facilities provide rest rooms and trash receptacles	Daytime public tours of the Keck Observatory School field trips to Hale Pohaku or observatories UH sponsored stargazing programs at Hale Pohaku four times a week Amateur astronomers independently observe from Hale Pohaku grounds	Low potential effects because activities confined to previously altered areas Parking off of previously disturbed surfaces could alter landscape or historic properties near Hale Pohaku when user numbers are high Debris escaping from users could have a visual effect on the historic district Increase usage of Mauna Kea by introducing public to the mountain	Confine all activities to previously disturbed areas Restrict parking to designate parking areas that have been previously altered Warn participants to secure clothing, beverage containers and other personal items in high winds and point out trash receptacle locations Include overview of visitor policies and allowed uses in presentations for potential return visitors

summit and at Hale Pohaku. As with all other on-going activities, amateur astronomers and UH sponsored tours should be confined to previously disturbed ground surfaces as delineated in the historic preservation plan. This includes not only the tour or star-gazing activities themselves, but all parking for these activities should be accommodated on previously disturbed surfaces. This is particularly important when specific events (e.g., meter showers, eclipses, etc.) can attract large numbers of participants. Activities taking place on the summit cones, which we consider to be a historic property, should be conducted in a manner that does not further alter the current condition and integrity of the summit cones.

The indirect effects of these public uses are already reduced by the presence of rubbish receptacles and rest room facilities at Hale Pohaku and the summit observatories. Participants should be warned to keep litter or pieces of clothing from being carried away by high winds. When conducting group tours and stargazing sessions, presentations should include a brief overview of visitor policies and allowed activities in the summit region for those who may return to visit the mountain independently. In many cases, these tours may be the first introduction many have to Mauna Kea and some may want to return.

2. Permitted Commercial Uses

The 1995 Revised Management Plan returned to DLNR administrative responsibility for all commercial activities that were not directly related to astronomy facilities. UH retained, as exceptions, the right to operate concessions and to contract shuttle services to the summit from Hale Pohaku. The DLNR mandate to manage and enforce commercial uses includes issuing permits; setting and collecting of fees; limiting the number of permits issued or operators receiving permits as needed, and enforcing permit conditions. Commercial uses were defined as any organized activity operated on a fee-for-service basis such as tours conducted for snow-related activities, hiking, sight-seeing, or daytime visits to observatories. Organized events, such as snow-related sports meets, also require a permit even if no fee is charged for participation in the event. A maximum of 14 commercial tour operators can be issued revocable, year-to-year permits to conduct tours on Mauna Kea. Permits for other commercial activities or organized events are to be issued on a case-by-case basis. The draft Master Plan recommends that these permitting and enforcement responsibilities be administrated by the a newly-created management authority instead of DLNR.

Table 15

Long-Term Management of Historic Properties - Public Uses

Permitted Commercial Uses

General Characteristics	Examples of Activities	Potential Effects on Historic Properties and District	Mitigation Measures
Organized activities operated on a fee-for-service basis Currently administered by DLNR Operators must obtain permit, are subject to fees, and must abide by permit conditions Number of commercial operator permits is limited Frequency of tours and number of participants are limited Case-by-Case permits issued for commercial activities or events not run by commercial operators Permit conditions include provisions addressing historic preservation concerns UH can operate concessions and contract shuttle service to the summit from Hale Pohaku	Commercial Operators: Sightseeing tours to Hale Pohaku and the summit with paid guide Skiing, snow-boarding, or cross-country skiing tours Stargazing tour to Hale Pohaku Commercial Events Ski or snow-boarding meets Viewing special astronomical events at Hale Pohaku	Scaring or eroding of cinder cones by walking, running, skiing, or snow-boarding down cinder slopes Altering of shrines, lithic scatters, or burial sites by hikers leaving established roads or trails Altering of shrines or lithic scatters by cross-country skiers or snow-boarders leaving frequented areas Damage to cinder cones, shrines or flake scatters during emergency rescues Visual impact of debris on the historic district Need for rest room facilities Landscape scared by vehicles when transporting skiers	Retain commercial permitting process which provides mechanism to: Inform operators and clients of historic preservation restrictions and laws Enforce permit conditions, regulations or laws Revoke permits if operators or clients knowingly damage historic properties Restrict operators to areas and intended uses described in their applications Control the number and frequency of users Require vehicles to park in designated areas Prohibit use of vehicles off-road Require measures to reduce debris and remove that created by their activities Direct operators to provide temporary toilet facilities when needed Require emergency plans which avoid historic properties Restrict access to the adze quarry until a management plan is developed Control visits to historic properties by creating vantage points with interpretative signs and self-guided and guided tours to selected properties SHPD reviews all permits case-by-case until classes of commercial activities having no effect on historic properties can be defined Monitor and assess the effects of commercial activities and adjust controls or restrictions accordingly Ask operators to participate in clean-ups if appropriate Distribute information on the location of rest rooms and parking areas to all operators

Table 15a

Long-Term Management of Historic Properties - Public Uses

Commercial Uses - Specific Activities

General Characteristics	Mitigation Measures
Snow-Related Activities Tours use relatively predicable areas despite variable snow falls	For snow-related commercial activities: Retain restrictions that snow-related activities on cinder cones occur only in areas with sufficiently deep protective layers of snow Identify staging areas for snow-related activities
Sightseeing Tours: Most clients remain near vehicles and on established roads or trails Low numbers of clients leave trails or roads to climb cinder cones or visit areas of interest	For sightseers and hikers: Focus use on existing trails through visitor information, marking trail heads or showing trails on maps Formalize trails if monitoring indicates modifications are needed SHPD reviews any modifications to trails Commercial tours require a permit to hike to remote areas Require permits for commercial groups over a specified sizes that visit historic properties not designated for self-guided tours or areas illustrating Mauna Kea's natural history SHPD reviews permits for commercial tours to historic properties not designated for self-guided tours or to areas illustrating Mauna Kea's natural history
	For star-gazing at Hale Pohaku: Confine activities to existing facilities and previously altered surfaces Designate parking areas and enforce parking controls during periods of high use
Film Industry Activities: Requires a permit from Film Branch (DBEDT) except for news coverage and filming astronomical activities Permit applications are reviewed by DLNR and UH on a case-by-case basis	For film industry activities Require permit for all commercial film activities which include conditions to avoid or protect historic properties and the district SHPD reviews all permit applications on a case-by-case basis unless all activities are restricted to previously disturbed areas Include standard permit conditions addressing debris, parking, off-road vehicle use, and emergency precautions

In contrast to other public uses, the commercial permitting process itself provides a mechanism for informing users of historic preservation issues and for more clearly enforcing violations of regulations or permit conditions. The current restrictions and conditions are set out in the 1995 Revised Management Plan and signed permit agreements. The latter primarily repeats the basic conditions set out in the 1995 Revised Management Plan although the language is often expanded to clarify some of the conditions. The agreement also includes other standard conditions placed on most state lease or permit agreements such as those covering issues of liability and hazardous materials. Another document, an application submitted to UH, requires commercial operators to describe their intended uses and provide a map of where these activities will take place.

The intent of the historic preservation plan is to strengthen the permit process and conditions regardless of which agency eventually oversees commercial uses. The process should retain something similar to the three document types currently used if historic properties and the historic district are to be protected. One document should set out the basic conditions and restrictions under which commercial uses are to be regulated. This function is currently served by 1995 Revised Management Plan which may be superseded by administrative rules. The second is the signed permit or entry agreement which insures that the applicant is fully aware of and accepts the restrictions and responsibilities set out in the agreement. The third is the application form which should require clear descriptions of the scope of an applicant's intended uses and the areas to be used. This will not only help managers assess which areas are being used most frequently, but it binds the applicants to designated areas which are either free of historic properties or can be visited with specified precautions. These applications should also help managers identify more quickly when users, either commercial or public, are not in appropriate areas. To help commercial operators serve their clients more effectively, the process for changing or amending these applications should be relatively simple although still subject to appropriate review. In addition to these documents, an informational sheet should be prepared and distributed to commercial users which discusses the various restrictions and provides some background on the mountain's past. These could be similar to the guidelines now distributed to commercial operators on driving conditions and emergency procedures. The planned brochures may provide the desired information about the mountain's history and pre-history.

A number of existing conditions placed on commercial use permits already addresses actions that can effect historic properties or the historic district as a whole. Any regulations developed should retain the stipulation that a commercial use permit will be suspended if a commercial operator or his/ her clients have knowingly damaged any historic properties. They should also be informed of penalties authorized under Chapter 6E-11 for damage caused to historic properties or burial sites on state lands. Background checks on applicants should be conducted to see if any have been cited for disturbing or damaging historic properties. General provisions which allow the number of users and the frequency of use to be limited should also be retained as it provides a means of controlling the overall impact of visitor use on historic properties and the historic district. The on-going monitoring program proposed in this historic preservation plan should help assess whether the intensity of commercial uses, particularly when combined with other kinds of uses, needs to be adjusted or adjusted only in particular locations. Other conditions which apply to multiple kinds of commercial uses should be retained and, in some cases, strengthened because they address issues such as parking, off-road vehicle use, rest room facilities, debris, and emergencies which can affect historic properties or the historic district.

The 1995 Revised Management Plan restricts parking for commercial operators to specific areas if they are instructed to do so. It names four parking areas in the summit region (i.e., two visitor parking lots, the paved shoulders of the summit access road, areas near the observatories, and an unpaved area near the batch plant) and three at Hale Pohaku (i.e., 23 stalls next to the VIS, an unpaved parking lot near the Construction Camp, and the lower lot of the Mid-Level Facility) although it does not say that parking is confined to these areas. At Hale Pohaku, the number of vehicles allowed to park at the VIS and on the adjacent roadway at any one time is determined by UH. The permit agreement specifies that parking is restricted to areas where parking is indicated by signs although, to our knowledge, signs have not been systematically installed for this purpose. To clarify where commercial vehicles can park, a map should be prepared delineating and describing areas in the summit region and at Hale Pohaku where commercial vehicles are allowed to park. Distinctions could also be made between primary parking areas and secondary areas to be used if visitor numbers are particularly high. The map should reduce the need for extensive signage which can be visually intrusive. The designated parking areas would, in part, be based on the maps being prepared to depict previously disturbed ground surfaces which are the basis for determining if on-going activities have the potential to affect historic properties [Section I-A(1)]. This would be similar to the map being recommended for public users. Off-road vehicle use is clearly prohibited in the 1995 Revised Management Plan, but as suggested in Section II-5(b), the wording of this prohibition could be strengthened by adopting the broader wording used in the NARS administrative rules. This wording should be repeated in the signed permit agreement.

The issue of toilet facilities is addressed in the Revised Management Plan by noting that the rest room facilities at the VIS are available for commercial users and by saying that commercial operators are to provide, operate, and maintain pre-positioned portable toilets above the VIS if required. In the permit agreement, this obligation to provide portable toilets is assigned to an association of commercial operators and, if toilets are required, their number and locations are to be determined by the association, DLNR, and UH. Neither document describes which set of circumstances would "require" portable toilets. Some of these conditions will not be needed if a permanent rest room facility is constructed in the summit region as has been proposed in the draft Master Plan. Until that time or if other circumstances require portable toilets, the circumstances in which toilets may be required should be defined more clearly in the administrative rules and appropriate locations designated in advance. These locations should be shown on a map and should be those which have been previously disturbed and can accommodate some parking. When possible, the toilets should be positioned to minimize their visibility. Given that we consider the summit cluster a historic property, toilet facilities for commercial uses should not be placed on this cluster of cones unless there is a compelling reason to do so.

In the Revised Management Plan and the permit agreement, commercial operators are required to pick up and remove any rubbish generated by their activities. Food and drink containers in particular must be disposed of properly if operators provide refreshments or a meal during the tour. While this adequately considers intentionally created rubbish, it does not address the possibility of rubbish or personal belongings being carried away in windy conditions. A general provision should be added to the permit agreement asking commercial operators to take all necessary precautions to prevent debris or personal belongings from being accidentally carried away by high winds and to warn clients to be cautious in these situations. The accidental distribution of some debris is probably inevitable despite the best intentions and precautions. If this proves to be the case and commercial operations appear to be contributing to the problem, their staff should be asked to participate in organized clean-ups of the effected areas or contribute to the clean-up effort in some manner. The monitoring plan recommended by the historic preservation plan should help assess the degree to which commercial activities are contributing to debris accumulations in general or in particular areas.

Provisions of the Revised Management Plan and the permit agreement primarily address emergency situations by focusing on the need for operators to have appropriate emergency and rescue supplies or equipment available, to have individuals with first aid or medical training present, and to be well versed in the lines of communication should public medical or rescue units be needed. The permit agreement, however, also asks that the association of commercial uses develop an emergency plan that anticipates the full range of emergency scenarios and describes how these scenarios will be handled. Given the concern that emergency rescue efforts could inadvertently damage historic properties, the emergency plan should specified emergency routes for each scenario to insure that no historic properties are along or near these routes. Stipulations should include measures which prevent scarring or rutting of the cinder cones, particularly the cluster of cones forming the summit which is considered a historic property. This emergency plan should be integrated with that prepared for all on-going activities [Section I-A(3)] which includes provisions to make maps of historic properties readily available and specifies contingency plans should rescue and emergency operations need to take place beyond the areas of expected commercial use.

a. Snow-Related Commercial Activities. The 1995 Revised Management Plan characterizes the know commercial or organized snow-related activities as being downhill skiing, snow play and sledding tours, cross-country skiing tours, and meets, races or events organized for these kinds of activities. Services provided for downhill skiing and cross-country skiing tours or events usually include transportation from anticipated drop-off and pick-up points. Participants in all these activities can be accompanied by guides or event leaders and, in the case of downhill skiing, ski instructors are sometimes present.

   Two conditions included in the 1995 Revised Management Plan have implications for the protection of historic properties. The first states that these snow-related activities shall only take place when there is sufficient snow for a particular activity. This stipulation can, potentially, protect the cinder cones in the summit region which are either part of a historic property or contribute to the environmental setting of the historic district. The depth and extent of snow coverage can provides a protective layer on the steep cinder slopes during these snow-related activities. If the snow is not sufficiently deep or its distribution patchy, these activities could cause scarring or accelerate erosion of the cinder slopes. If possible, the permitting process should attempt to define what "sufficient snow" is for specific kinds of activities. As has been suggested for those participating in non-commercial, snow-related activities, participants should be advised to remain on the snow covered sections of the cinder slopes as much as possible.

The second condition is that suitable staging areas be identified in the permit applications of those conducting tours or organizing events. This condition also states that these staging areas shall not be located near any archaeological sites. This conditions should be reworded to require applicants not only to identify the staging areas, but to delineate areas where the sporting activities are most likely to take place. This should not be too difficult as the favored areas for these sports are relatively well known and routinely used despite considerable variations in snow falls. They generally coincide with appropriate slopes and places where transportation can be used to drop-off and pick-up participants. Once these are submitted, it can be determined which areas contain known historic properties and what measures should be taken to avoid these properties. With the summit cluster of cones being considered a historic property, it is impossible for these snow-related activities to avoid all historic properties completely although, as stated above, steps can be taken to avoid damaging the cinder cones. Maps being prepared to show areas where non-commercial snow-related activities should be allowed could be used as a guide for these applications and for assessing the potential of each application to effect historic properties.

b. <u>Commercial Tours.</u> This category groups most of the non-snow related activities for which commercial tours are offered or anticipated. This includes hiking tours; simple sight-seeing with a picnic or photography stops; daytime tours of the observatories; or star-gazing tours at Hale Pohaku. Although extreme sports are not mentioned, they would fall in this category if commercial operators conduct or facilitate the sport. Tours are generally conducted by a paid guide and entail commercially provided transportation. The most commonly conducted tours take visitors to the summit after a stop at Hale Pohaku. Time at the summit is spent viewing the landscape from preferred vantage points, taking a tour of an observatory when arranged, and dropping-off and picking up those who wish to take short hikes to the true summit or to Lake Waiau. Some tours drive visitors to the top of Pu`u Poliahu. The stop at Hale Pohaku can include time viewing the VIS displays and a short hike to the top of Pu`u Kalepeamoa along a path established and becoming more prominent with usage. Transporting visitors to Hale Pohaku at night is apparently growing increasingly more popular. A specific tour can be designed to focus on any one or several aspects of the routine tours depending on the individual interests of clients or groups. School groups and others with an interest in the natural or cultural history of the mountain or astronomy also rely on commercial vendors for transportation. Under the 1995 Revised Management Plan, UH was given the right to "operate concessions and sell astronomy-related items" at the VIS and other UH facilities within their leased lands. They also retain the right to contract for shuttle service to take visitors to the summit for unspecified activities and events.

As with non-commercial public uses, the probability of routine tours directly effecting historic properties is relatively low because a majority of the clients do not stray far from the vehicles due to altitude and weather conditions. Those going for short hikes generally do not wander from existing paths to the summit or to Lake Waiau and are limited by the tour's time constraints. This is also true of short hikes taken to the summit of Pu`u Kalepeamoa at Hale Pohaku. Exceptions could be those hikers who may leave established routes, particularly if they are looking for short-cuts. This could contribute to the deterioration of cinder cone slopes or create multiple, unsightly paths. An example may be those visitors on commercial tours who climb to the top of Pu`u Hau Kea and then slide or run down the cone's steep slopes. If visitors on commercial tours were to hike well beyond the frequented areas, they would be more likely to access areas with historic properties. Most vulnerable would be those properties located near roads or visible from a distance. This could include some shrines, portions of the Mauna Kea Adze Quarry, and several potential burial sites.

The approach to minimizing the potential effects of commercial activities parallels those proposed for public users. Adequately informing the operators, guides, and clients that historic properties are located in the summit region and at Hale Pohaku and stressing the need to prevent their alteration should reduce the chance of historic properties being inadvertently damaged. This can be accomplished by distributing information sheets on historic properties to all operators and making brochures available to their clients. Establishing self-guided tours to selected historic properties [Section II-A(3-a)] should focus visitor attention on historic properties prepared to accommodate visitation and foot traffic. This would reduce the probability of tour participants wanting to wander and accidentally damaging historic properties or defacing the landscape. Allowing those on commercial tours to participate in guided tours conducted under the control and guidance of a management specialist [Section II-A(3-a)] would also focus visitor use. All historic properties visited by commercial tours should be monitored to assess the cumulative impacts of public and commercial visitation. If impacts appear to be too great, then the number commercial users and their frequency should be reduced.

To minimize the impacts of those taking short hikes, the frequented routes to the summit peak, to Lake Waiau, and to the top of Pu`u Kalepeamoa should be more formalized. This would focus use on already established paths which lead to attractions clearly preferred by visitors. Formalizing the trails could include little more than marking the trails on visitor information materials (i.e., maps, brochures, displays at the VIS) and more clearly designating the trail head. For example, unobtrusive signs could be installed indicting the route's distance and destination. Structural modifications to the trails, such as curbing or footholds, need not be added unless the monitoring program suggests that trail use is creating conditions requiring these modifications. Any substantial alteration of an existing route would be subject to review by SHPD. Hikers should be asked to stay on the established routes in information given them in visitor materials or by commercial operators. As some members of the community have asked that the road to the top of Pu`u Poliahu be closed for cultural, environmental, and practical reasons, the existing unpaved road could be restricted to hikers. This would create another opportunity for hikers without opening a previously undisturbed or infrequently visited area. This could be particularly important for photographers searching different perspectives of the summit region. Participants in commercial tours should not be allowed to hike to distant parts of the Science Reserve without prior permission of the agency managing the reserve or being accompanied by a management specialist. Guidelines should be developed with SHPD on which kinds of requests can and cannot be granted without SHPD review and comment.

Tour groups visiting with the goal of learning about the mountain's cultural or natural past are more likely to wander from established routes to see features or areas of interest and, if unguided or ill-informed, could unknowingly damage historic properties. These groups should be encouraged to follow the same procedures as those not using commercial services [Section II-A(3)]. If the size of the group exceeds a specific number, for example 15, a permit should be required and permit conditions tailored to the areas being visited and the visit's intent. All permit conditions should include measures to protect historic properties. If the groups are interested in cultural history, they should be encouraged to visit those properties designated for visitation or participate in one of the proposed tours led by rangers. As suggested earlier [Section II-B(b)], routes should be developed for groups interested in multiple aspects of the mountain's natural and cultural history. This would help control where groups go and group leaders could be given information on how to recognize and avoid historic properties located along or near the chosen routes.

Tours conducted for stargazing at Hale Pohaku are unlikely to effect historic properties if activities are confined to facilities designated for this purpose and parking is controlled. If the visits include short walks with flash-lights, the routes taken should be confined to those used during the daylight hours. Presumably activities conducted by UH that require contracting shuttle services or involve concessions would be confined to existing facilities and would thus not directly affects historic properties. If UH sponsored commercial activities are to take place beyond existing facilities, then they should be subject to the same conditions and restriction concerning historic properties as other commercial users. Those participating in extreme sports who utilize commercial services or those commercial operators sponsoring an extreme sports event should be subject to the same review and permit procedures established for non-commercial participants [Section II-B(c)].

Commercial activities within the NAR are prohibited unless a Special Use permit is obtained. Applications will be considered only if these activities do not impact the resources of a NAR or do not impinge on public use of the area. Public use is given priority over commercial uses should access or the level use need to be controlled or limited. The 1997 management policies for the NARS program set out the following five criteria used when evaluating commercial use permits: activities cannot be conducted elsewhere; they are consistent with the protective and educational purposes of the NARS program; they do not degrade the reserve's resources; groups do not exceed the maximum number recommended for that reserve; the operator has adequate liability coverage; and the activity must have an educational component approved by the Department. The interface, however, between issuance of commercial use permits by Land Division and the Special Use permit approved by the NARS commission remain somewhat ambiguous. Commercial operators with a Special Use permit cannot reach the most commonly visited places within the NARS without entering or parking in the Science Reserve and some current holders of commercial use permits from the Land Division now allow clients hike into the NAR (e.g., to Lake Waiau, down the Humu`ula Trail) without obtaining a Special Use permit. Hopefully, the attempt of this historic preservation plan to integrate aspects of the long-term management and monitoring of historic properties in the Science Reserve and the NAR will help to resolve of these ambiguities.

A condition on the current commercial use permit states that there shall be no tours to the Mauna Kea Adze Quarry until a management plan is developed by NARS, the UH, and SHPD. It is not clear whether the management plan referred to in this condition is that being prepared for the Science Reserve or one developed specially for the NAR. Despite attempts of the historic preservation plan to address some of the long-term management issues of the NAR, it does not address public visits to the adze quarry in sufficient detail to warrant removing this condition from commercial permits. Once management responsibilities for the Science Reserve and other UH management areas are officially assigned, the issue should be reexamined, hopefully within the context of a management plan for the NAR. This particular permit condition concerning visits to the Adze Quarry is ambiguous because it does not address private groups that visit the quarry with the appropriate NARS permits but contract commercial operators for transportation. Also in question are those commercial tour operators who provide transportation for clients hiking down the Humu`ula Trail. This trail passed through what is considered the Mauna Kea Adze Quarry and past one of the quarry's prominent shelter caves. Technically, however, if hikers remain on the trail, they do not pose a direct threat to any of the quarry's features.

c. Film Industry Activities. The 1995 Revised Management Plan does not require a permit for commercial uses involving still photography, filming for television, or moving pictures, but instead requires the applicant to obtain permission from the Film Branch of the State Department of Business, Economic Development and Tourism. Review of this application is on a case-by-case basis and concurrence must be obtained from DLNR and UH. News coverage and filming astronomical activities are excluded from this process. The proposed Master Plan recommends that commercial film projects require a special permit. These special permits or comparable application process should continue to be reviewed and granted on a case-by-case basis. The potential effects of these uses on historic properties could vary greatly with the areas used during production, the scale of equipment needed for the shoot, and the actions of subjects being photographed. All applications should be reviewed by SHPD unless all activities involved in the production take place in previously disturbed areas as defined when the impact of on-going activities are assessed [Section I-A (1)]. Permit conditions should include standard provisions concerning parking, the containment and removal of debris, off-road vehicle use, and emergency precautions that apply to all commercial users.

The 1997 management polices adopted by the NARS commission state that commercial film activities require a Special Use permit in addition to a film permit obtained through the Film Branch of the State Department of Business, Economic Development and Tourism. Staff also recommended a number of permit conditions for the Mauna Kea Ice Age NAR in particular which include, for example, limiting crew size and prohibiting participants from climbing cinder cones.

3. Research

The research activities addressed here include those conducted to collect data, systematically make observations, or evaluate the status of resources within the context of research or educational objectives. These activities can range from relatively low-impact efforts, such as those in which researchers hike to specific areas to record information, to more intrusive efforts such as setting up instruments to record data over time. Not included are activities associated with astronomical research which are discussed in another section (Section I) or educational efforts that generally consist of groups or individuals wanting to view natural or cultural features of interest [Section II-B (1-b) and II-B (2-b)]. As a category, research was not directly addressed in the

Table 16

Long-Term Management of Historic Properties - Public Use

Research

General Characteristics	Examples of Activities	Potential Affects on Historic Properties and District	Mitigation Measures
Data collection, observations, and resource evaluation with research or educational objectives May require work in remote areas away from established roads or commonly visited areas Subject to State Conservation District Use regulations in all four management areas and may require a permit Subject to NARS rules if conducted within the NAR and may require a Special Use Permit Conservation District Use or Special Use applications reviewed by SHPD for potential effects on historic properties Permits can include conditions to avoid effects on historic properties Compliance with federal historic preservation laws required if research is federally funded or conducted by a federal agency Frequency of permit requests is low	Record distribution of flora or fauna Collect geology samples Survey to map geological units Record distribution of historic properties Install instruments to record climatic conditions	Low probability of effects if research involves only observations Higher probability of effects if research involves collecting samples or installing instruments Inadvertent alteration of shrines, adze quarry features, or burial sites by researchers Alteration of the landscape by installing equipment or instruments Visual intrusion by installed equipment or instruments on the historic district	Prepare guidelines for which kinds research projects require permits Prepare guidelines for appropriate and enforceable research permit conditions Raise awareness that research may require a permit Provide researchers information on historic properties and warn them against the alteration of historic properties whether their research requires a permit or not Provide researchers with information given visitors on debris, prohibitions on off- road vehicle use, and emergency procedures During visitor registration process inquire if research will be conducted

1995 Revised Management Plan and, in the proposed Master Plan, it is briefly mentioned within the broader category of education and research.

Research activities taking place in the Science Reserve or at Hale Pohaku are currently regulated through the State Conservation District Use permitting process administered by DLNR. Under the Conservation District Use regulations, data collection is a permitted use in these two areas because they are classified as Resource Subzones of the Conservation District. The level of permit required for data collection primarily depends on the degree of ground disturbing activities involved in the research (§13-5-22 and 24). If data collection does not involve any form of "land use," a permit is not required. As the definition of "land use" in this context includes the alteration or removal of materials or natural resources (§13-5-2), any research that involves collecting materials or resources would require a permit. Research involving incidental ground disturbance, such as that required to install equipment, requires a departmental permit while data collection that causes more than incidental ground disturbance requires DLNR Board approval.

Research conducted within the NAR usually requires a Special Use permit approved by the NARS commission and issued by the DLNR Board. The uses permitted must also be consistent with Conservation District Use regulations. The administrative rule for the NARS program allows Special Use permits to be issued for otherwise prohibited uses if these activities are conducted for the purposes of research (§13-209-4 and 5). Examples of prohibited uses which may be allowed for research include the removal or disturbance of any plant or animal life, of geological features, and of historical or prehistoric remains. According to the 1997 management policies for the NARS, favorable consideration is given an application if the project contributes to knowledge applicable to the goals and objectives of the NARS, if the resources collected cannot be obtained elsewhere, and if collection will not severely deplete or damage the integrity of the resource. Conditions can be placed on Special Use permits which are appropriate to the resources found in a particular NAR or are tailored to the proposed research.

Applications for research in the Science Reserve and the NAR that need department or board approval are usually circulated to the various DLNR divisions for review and concerns raised are included in the permit as conditions. More specifically, SHPD must be given the opportunity to review and comment on any research involving the disturbance of historic properties or the removal of any archaeological materials.

The application of these regulations to particular research activities should be clarified through guidelines prepared in consultation with the staffs of NARS and the Land Division which administers Conservation District permits. The guidelines would help illustrate, through examples, which kinds of research activities are considered a "land use," which cause "incidental ground disturbance," and which constitute "ground disturbance" when these criteria are applied by Land Division staff. For the NAR, examples should clarify which kinds of research activities would and would not require a Special Use permit given current interpretations of "prohibited activities." This would not only help expedite the application process, but would help rangers or management specialists identify which individuals should have obtained permits if they are noticed working off of established roads or when they register to enter the summit region. If administrative rules are adopted to manage the Science Reserve, provisions should be considered to require a level of scrutiny or disclosure that is not now always applied to research projects under the Conservation District administrative rule.

For research projects requiring permits, SHPD should continue to review applications on a case-by-case basis and projects should not begin until written concurrence has been obtained from SHPD (Chapter 6E). The staffs of the Land Division, NARS, and SHPD need to continue to coordinate the review of these applications if they are to be effective. They should also ensure that the appropriate conditions are included in the permits issued. To help expedite the review process, the guidelines proposed to help clarify which kinds of research activities need permits could also recommend standard conditions to be placed on most Conservation District or Special Use permits issued for the summit region. These standard conditions should address the protection of historic properties and the potential impact of debris, off-road vehicle use, and emergency rescues on the historic district. Permit conditions for projects proposing to install equipment temporarily should require removal of all equipment within a specified time period after the project's completion. If equipment is to be installed on a more permanent basis or over longer periods of time, then the visual impact of any equipment on the historic district should be considered and mitigated when possible. Activities needed to maintain such equipment over time should also be addressed.

Despite existing regulations, some researchers are not aware of them or that their projects could be subject to regulation. Even the best-intended researcher, particularly those in the natural or physical sciences which can involve collecting, could inadvertently disturb historic properties out of ignorance. Raising awareness of these requirements would help reduce the potential effects of these projects on historic properties because the permit application process provides a mechanism to inform researchers of historic properties that could be affected by their actions. It also provides managers with recourse if permit conditions are not followed. Applicants should also be made aware that research funded with federal monies, such as the National Science Foundation, or conducted by federal agencies are also subject to the Section 106 review process (NHPA). The probability that projects could affect historic properties is relatively high given the number of known historic properties in the summit region, the proposal to consider it a historic district, and the designation of the Mauna Kea Adze Quarry as a National Historic Landmark. Those seeking information on conducting research should be encouraged to contact SHPD or the management staff of the proposed Office of Mauna Kea Management to discuss what measures could be taken to avoid potential effects on historic properties or the historic district before they submit their applications. This would reduce the time needed for application review and approval.

Those research projects not requiring permits would probably be those that simply involve hiking to specific locations to make and record observations. Even if no permit is required, researchers should be encouraged to meet with appropriate staff prior to conducting their research so that they can be fully informed of the kinds of historic properties in the areas they intend to work and the need to avoid disturbing these properties. Other precautions would be similar to those given recreational users or hikers wishing to independently visit the more remote areas [Section II-A (3)]. The need to control and remove debris, to prohibit the use of off-road vehicles, and to consider emergency procedures should be emphasized. If all public users will be required to register before going up the summit road, the registration process can inquire if individuals will be conducting research. If they are and a permit is not needed for the intended activity, then they should be briefed at that time on the nature and distribution of historic properties in their areas of interest and of all the appropriate precautions.

4. Cultural Practices and Access

Policies

Members of the Hawaiian community and representatives of native Hawaiian organizations, including the Office of Hawaiian Affairs, shall be approached to take the lead in making recommendations and setting policies regarding access and cultural practices on Mauna Kea.

A Kupuna Advisory Committee composed of individuals knowledgeable about Hawaiian cultural practices shall be formed. It is to advise the Mauna Kea Advisory Board on cultural matters. This Advisory Board, in turn, shall set policy for the proposed Office of Mauna Kea Management which is responsible for implementing policies concerning cultural practices. To assure due consideration be given to cultural practices, the Mauna Kea Advisory Board shall include a member of the Kupuna Advisory Committee.

Current Context

The 1995 Revised Management Plan identified cultural practices as a permitted use but stated that such activities must be otherwise consistent with the plan's provisions and must not involve physical impacts. The Plan also restricted practices to daylight hours unless permission was obtained from DLNR and UH.

Cultural practices and visitation are not restricted in the NAR unless they involve prohibited activities or the disturbance of historic properties. Practices that involve the gathering of resources or the disturbance of geological features or historical properties require a Special Use Permit. The 1997 Management Policies for the NARS specifically address the issue of Native Hawaiian gathering rights and the collecting of resources for traditional Hawaiian cultural purposes. The policies reaffirm such activities are permitted only if a Special Use Permit is obtained and that the claimed use is consistent with other applicable laws. Appendix D of the Management Policies outlines criteria to evaluate whether Special Use applications should be recommended or denied. For traditional religious access and practices, a permit would be recommended if the activity cannot be conducted elsewhere; will be consistent with the protective and educational purposes of NARS; does not degrade the natural resources of the Reserves; and will not be used for commercial purposes.

In a recent example, the Special Use Permit issued for native Hawaiian gathering on Maui included a number of conditions that controlled the number of gathering trips allowed; the specific kinds of resources that could be taken and in what quantities; who could participate in the allowed trip; and prohibited the use of any of the gathered resources for commercial purposes. Under the current management structure, most permits issued for the Mauna Kea Ice Age Reserve ask the applicant to notify the Mauna Kea Support Services and DOCARE prior to entry to help both agencies monitor permitted and non-permitted use of the area.

Appendix D of the NARS Management Policy also recommends that gathering be limited to native Hawaiians who are residents of the island where the Reserve is located. This recommendation, if adhered to, denies gathering rights to people with strong cultural ties to Mauna Kea who no longer reside on the island of Hawaii. Considering the mobility of people today, this recommendation needs to be re-examined.

The State historic preservation law, Chapter 6E, Hawaii Revised Statutes, does not specifically address native Hawaiian cultural practices or access issues. However, it protects historic properties from alteration or destruction. Destruction or alteration can only occur on State land when authorized by DLNR.

Discussion

The 2000 Master Plan reaffirms that access for traditional and customary practices is to be permitted, as is access to the summit unless construction work poses a danger. The Master Plan suggests Hawaiian cultural and religious practices may be managed or coordinated if they will have a significant impact on the physical landscape or historic properties. If conflicts appear to be unresolvable, native Hawaiian practices and values are to be given priority.

The following sections identify a number of cultural practices which could affect known historic properties. Discussions have already been raised concerning a number of these practices, and the others may be reasonably anticipated. These practices include use of the ancient shrines, visitation of burial sites, procuring stone from the adze quarry, practices associated with Lake Waiau, and contemporary religious worship which could involve construction of new features or structures for cultural purposes. Guidance from the Hawaiian community and the Kupuna Advisory Committee shall be sought to address these issues.

a. Visitation and Use of Ancient Shrines

Policies

Access shall not be denied or unduly restricted for any native Hawaiian wanting to visit the shrines within the summit region.

No restrictions shall be placed on any religious observance that is deemed to be appropriate by the Kupuna Advisory Committee.

A program to regularly monitor the condition of ancient shrines shall be established.

Discussion

Although access to shrines shall not be denied or unduly restricted for any native Hawaiian, these persons should be informed of the same general precautions and prohibitions as are all public users. These would include warnings about the effects of altitude and cold, windy weather conditions as well as the prohibition of off-road vehicle use and the need to control debris.

Ancient shrines usually were constructed for worship by a specific family. It is difficult, with the passage of time, to understand the full intent or consequences of a shrine's particular form and construction. In some instances, components of a religious feature may have been intentionally set aside, hidden, or toppled after the completion of particular ceremonies. In other cases, it might be culturally improper for an individual, not connected to the original builder, to alter or even use the shrine.

Some current cultural practitioners may want to restore or reconstruct ancient shrines according to their needs or beliefs. Practitioners may want to alter shrines by adding components such as more up-rights or features such as a platform or wall to a shrine's foundation. These would be additions in that no physical evidence suggests that more up-rights or more elaborate foundations were ever associated with the shrine. The recent addition of up-rights to some religious sites elsewhere in Hawaii makes this a possibility. The concerns of those wishing to express their religious feelings through the alteration of shrines and of those wanting the shrines to be left as they were last used needs to be discussed within the Hawaiian community and addressed by the Kupuna Advisory Committee.

Another impetus for reconstructing historic properties is for public interpretation and education programs. Reconstruction is a way to return a site to what it may have looked like when it was being actively used. In a reconstructed state, it may better convey the potential mood and setting of past cultural practices. If some shrines are going to be reconstructed, preference might be given to those easily accessible for public visitation. Again, this issue needs to be discussed within the Hawaiian community and addressed by the Kupuna Advisory Committee.

Another form of alteration, one that has already occurred, is the marking of shrine slabs with writing or symbols. The markings were scratched in the surface of the tabular up-rights by those who believed it was done for cultural reasons. This should be distinguished from what would clearly be classified as graffiti which should be prohibited and remedied if possible. It should be noted that none of the shrine up-rights found throughout the summit region appear to have been marked with petroglyphs or other intentional markings. The Hawaiian community and the Kupuna Advisory Committee needs to consider this issue as well.

As with other public uses, shrine disturbing activities are most likely to occur at shrines near access roads which are also the most likely to be visited by the general public and may even be those designated for self guided tours [Section II-A (3)]. Such shrines shall be documented in greater detail so that an exact record exists of the position, number, and arrangement of all up-rights in the shrine. This would allow someone to analyze these configurations with precision in the future despite any recent alterations. Existing plan view maps of the shrines should enable rangers or management specialists to verify, during routine monitoring, whether new components are being added to shrines. The monitoring program shall periodically assess the cumulative effects of visits by cultural practitioners and the public on the most frequently visited shrines. If the effects of heavy usage become apparent and lead to the deterioration or scarring of these areas, measures should be considered to control the frequency and number of commercial or public visitors to particular shrines.

b. Access to Burial Sites.

Policies

Native Hawaiians shall not be restricted from visiting burial sites for cultural reasons.

Any disturbance of a burial site shall be reported immediately to the rangers or SHPD.

Discussion

Although no restriction is placed upon native Hawaiian visitation to burial sites, it would be beneficial to inform the rangers or management specialists of such intentions. This notification will assist the staff on patrol with maintaining security at these sites.

c. Extraction and Collection of Stone from Mauna Kea

Policy

Guidance shall be sought from the Hawaiian community and the Kupuna Advisory Committee to establish direction for the utilization of this resource.

Current Situation

The NARS administrative rule prohibits the extraction of stone from the quarry without a Special Use permit and the existing policies suggest that such a request would be closely scrutinized. The rule prohibits the disturbance of any "geological features" which could be a potential source of usable stone. The other source of stone would be the prehistorically extracted materials that remain within the complex as blocks, partially formed implements, and flakes. As "prehistoric remains," any damage to or disturbance" of these previously worked stones is prohibited. One criterion used to evaluate the appropriateness of issuing a Special Use permit is whether the "activity cannot be conducted elsewhere." This could favor the approval of an application because there are relatively few known quarry complexes of any size in Hawaii and most are located on other islands.

The Science Reserve is classified as a Resource Subzone within the Conservation District. If a suitable source of stone were to be found, a Conservation District Use approved by the DLNR Board and potentially a management plan, would be required for the "extraction of any material or natural resource."

The 1997 management policies state, under the heading of Native Hawaiian Rights, that any disturbance of religious or historic sites is strictly prohibited.

Discussion

One reason for caution in extracting stone from Mauna Kea is that, unlike some plants and animals, the prehistoric record is not a renewable resource. Any removal or extraction of stone within the quarry complex, including unaltered stone and previously worked material, could have an adverse affect on this National Historic Landmark (NHL).

The most probable source for stone today would be the NHL quarry complex and most of the outlying workshop areas. These places were once used in ancient adze manufacture. They are located within the boundary of the NARS. There is a remote possibility that some suitable stone sources lie within the Science Reserve.

Some native Hawaiians have claimed that the extraction and removal of stone from the Mauna Kea Adze Quarry should be considered a native Hawaiian gathering right protected by the State Constitution.

Any protocol developed by the Kupuna Advisory Committee and the Hawaiian community related to the gathering of stones might address: where and how the blocks or reduced materials are considered for removal, these pieces should be chosen so that their removal does not alter the overall appearance or composition of the deposit. All removal locations should be documented.

d. <u>Deposition of Piko and Collection of Water from Lake Waiau</u>

Policies

Guidance shall be sought from the Hawaiian community and the Kupuna Advisory Committee as to the appropriate utilization of this area.

An appropriate procedure shall be developed to address the desire for privacy when conducting activities in this area.

Discussion

Practices and beliefs associated with Lake Waiau include: 1.) the association of waters from Lake Waiau with healing practices and 2.) the depositing of *piko* (umbilical cord) either in the lake or in an appropriately secured place adjacent to the lake.

Given the growing interest in native Hawaiian medicinal practices in recent years, people should be aware that lake waters might be taken in inappropriate quantities or even become a commodity. Considering the cultural significance of the lake, it might be deemed appropriate to protect this resource.

The practice of depositing *piko* at the lake ideally would be done in private. Requests might be made to exclude the public from the vicinity of the lake while any rituals associated with the practice are observed. Such exclusions would allow practitioners to maintain the silence and prevent unexpected disturbances or interference by the curious.

e. <u>Construction of New Religious or Cultural Features</u>

Policy

Guidance shall be sought from the Hawaiian community and Kupuna Advisory Committee with regards to the construction of new religious features and the long-term management of these features. Those constructions not complying with the guidance established by the Hawaiian community and the Kupuna Advisory Committee shall be subject to removal.

Current Context

Whether all new features constructed for religious purposes in the Science Reserve or at Hale Pohaku require a permit is somewhat ambiguous as these kinds of minimal structures and this type of land use are not specifically addressed in the Conservation District regulations.

The 1995 Revised Management Plan for Mauna Kea states that cultural activities are permitted if they do not involve physical impacts. Whether the construction of modest shrines constitutes a physical impact will need to be determined.

Under the NARS regulations, any construction is a prohibited use and requires a Special Use permit. Whether the erection of modest shrines is to be construed as construction remains to be determined.

Discussion

The construction of new features for cultural purposes within the summit region has been an on-going activity. In addition casual visitors have constructed stacked stone piles, apparently in commemoration of their visit. Any policy on the construction of religious or cultural features might consider which kinds of features and locations are appropriate or inappropriate, and whether a review process should be instituted. If new shrines are erected it might be prudent to have a description of the feature and its location recorded so that it can be protected by rangers on patrol and checked as part of the ongoing monitoring program.

f. Offerings and Conducting Ceremonies

Policy

A staff person or a specially designated individual or organization shall be responsible for the culturally appropriate removal of offerings that are made on Mauna Kea.

Discussion

At a number of religious sites and culturally significant places in Hawaii, accumulations of offerings have become obtrusive and distracting to the point that they can have an adverse effect on historic properties. This has been true at *heiau* in State Parks and at places like Kilauea Crater which are open to public. If this practice becomes common on the ancient shrines, at Lake Waiau, at the summit or elsewhere, then policies will probably be needed to deal with these offerings. Organic offerings become a problem as they deteriorate or are dispersed by winds while inorganic offering, such as stones or objects made of modern materials, remain at the site for considerable periods of time unless removed.

Culturally appropriate means of handling the removal of offerings should be devised by the native Hawaiian community and the Kupuna Advisory Committee to apply to all areas within the Science Reserve, the NAR and at Hale Pohaku that could be the focus of observances. Any actions should be coordinated with the NARS commission as it is the hope that the staff hired by the Office of Mauna Kea Management will also monitor specified areas within the NAR and could also be responsible for tending to offering left there as well.

III. Consultation with Native Hawaiian Organizations and Individuals

Policies

Members of the native Hawaiian community and representatives of native Hawaiian organizations shall be consulted on the development of this historic preservation plan before it is finalized. Copies of the draft plan shall be distributed to interested parties and organizations, when the supporting background information is complete. Meetings shall be held to discuss the plan in more detail.

Members of the native Hawaiian community and representatives of native Hawaiian organizations shall be turned to take the lead in making recommendations and setting policies on access and cultural practices on Mauna Kea.

A mechanism shall be developed to assure Native Hawaiians are consulted on individual development projects as discussed in Section I-B(6).

A roster of individuals, families, or organizations that wish to be consulted when individual development projects are proposed shall be maintained by the University of Hawaii.

Discussion

Native Hawaiians may wish to be involved in management decisions and even in management activities, such as the surveys conducted to monitor the condition of historic properties or to complete the inventory. A mechanism needs to be developed to assure groups and individuals have the opportunity to participate. A roster of individuals, families, or organizations that wish to be contacted under specified circumstances should be maintained. This approach could also accommodate those who are concerned about a particular place or area but do not wish to disclose its location or the nature of its significance. They could appear on the roster as wanting to be consulted about any planned activity or issue occurring in the general vicinity and then decide if they wish to act on any concerns they have.

The constitution and role of the proposed Kupuna Advisory Committee in the consultation process will also need to be defined. They might help integrate the diverse concerns raised on a particular issue or development and then help shape these concerns into proposed management policies or actions. They can also serve as a point of contact for those native

Hawaiians who wish to raise a concern but do not want to discuss it with agency staff members. In turn, they can be informing those in the community of issues or actions brought before them at committee meetings. They should not, however, be viewed as a substitute for consultation with native Hawaiians.

IV. COOPERATIVE AGREEMENTS

The UH should incorporate, where appropriate, stipulations or conditions that address preservation and management issues in written agreements it has with user organizations who construct and operate facilities on Mauna Kea. This would better define who is responsible for fulfilling specific management obligations, particularly if historic properties are located within or very near areas covered by sub-leases or actively used by the other party. Some of these stipulations and conditions may be included in the individual land use permits obtained when the observatories or related infrastructure were constructed.

V. REVIEW OF HISTORIC PRESERVATION PLAN

A process shall be established to conduct a review of the historic preservation plan by all the major parties affected by the plan's provisions every three to five years. These parties shall include, at a minimum, representatives of UH and any of the individual observatories wishing to participate, interested members of the native Hawaiian community including the Kupuna Advisory Committee and the Office of Hawaiian Affairs, and staff of the following agencies: the Office of Mauna Kea Management; the Land Division of DLNR who oversee the issuing of Conservation District Use permits; the NARS program who are responsible for managing the Mauna Kea Ice Age Reserve; the State Historic Preservation Division who review projects or actions for their affects on historic properties, and the Division of Forestry and Wildlife of DLNR if issues of hunting or management of the *mamane* forest arise. Other interested parties, such as the commercial tour operators or recreational skiers, should be informed of the review and invited to comment if they choose. The primary intent of the review is to assess the effectiveness of the plan and its implementation, to identify any omissions, and to remove or revise provisions that have proved unrealistic. SHPD would be primarily responsible for making any of the requested amendments or revisions.

Appendix

Management Documents to be Generated by the Historic Preservation Plan

I-A. Current Maintenance Programs and Routine Operations Performed by UH or Observatories:

List of Maintenance Activities and Routine Operations Excluded from Historic Preservation Review and Compliance Process

Map and Descriptions of Altered Ground Surfaces in the Summit, the Road Corridor, and at Hale Pohaku.

List of Maintenance Activities Needing Prior Review and Potential Compliance Measures

Emergency Plan to Avoid or Minimize Damage to Historic Properties during Emergency Activities

I-B. Planned Development and Construction Projects

Guidelines for Preparing Historic Property Treatment Plans for Mauna Kea:
- Interim and Long-Term Preservation Plans
- Monitoring Plans
- Burial Treatment Plans
- Inadvertent Burial Treatment Plan

Map and Descriptions of Showing Areas of High and Low Probably of Historic Properties in the Summit Region, Road Corridor, and at the Mid-Level Facilities

II-A. Management Actions and Plans

Monitoring Plan to Assess the Long-Term Condition of Historic Properties and the Historic District

Plan to Complete the Inventory and Documentation Historic Property within the Management Areas and NARS

Public Interpretation Plan and Products
- Plan for Self-Guided Tours
- Plan for Guided Tours
- Independent Hikers
- Brochure
- Displays
- Information Material

Plan for Debris Removal, Monitoring, and Prevention

Policies for Preventing and Deterring Use of Vehicles Off of Established Roads

Map of Designated or Allowed Parking Areas

II-B. Management of Public Uses

Map of Areas Designated for Commercial and Non-Commercial Snow-Related Activities

Proposed Areas for Natural History Tours

Describe and Compile Map of Potential Hunting Areas within the Science Reserve

Policies on Commercial Tour Visits to Historic Properties Not Designated for Self-Guided Tours

Guidelines for Assessing which Research Projects Require Permits

MAUNA KEA SCIENCE RESERVE
MASTER PLAN

APPENDIX G

Botanical Resources, Hale Pōhaku Mid-Elevation Facilities

Botanical Resources, Mauna Kea Summit, Hawai'i

July, 1999

Mauna Kea Science Reserve Management Recommendations – Botanical Resources

Jan 2000

Char & Associates

MARCH 2000

BOTANICAL RESOURCES

HALE POHAKU MID-ELEVATION FACILITIES

by

Winona P. Char

CHAR & ASSOCIATES
Botanical/Environmental Consultants
Honolulu, Hawai'i

Prepared for: **GROUP 70 INTERNATIONAL, INC.**

July 1999

BOTANICAL RESOURCES
HALE POHAKU MID-ELEVATION FACILITIES

INTRODUCTION

The University of Hawai'i mid-elevation astronomy support facilities are located at the 9,200-foot elevation of Mauna Kea. This intermediate elevation allows scientists, support staff and construction workers a place to acclimatize before continuing on to the summit to work. The mid-level facilities provide sleeping accommodations, offices, eating, and lounge areas (Group 70, Inc. 1979; MCM Planning 1985).

The first botanical study of the Hale Pohaku site was conducted by Gerrish in June 1979 for the permanent facilities as well as the Hale Pohaku State Park. Prior to the new facilities, the University had temporary buildings on a portion of the site. Gerrish also evaluated two alternate sites. The first near the Humu'ula Sheep Station (between 6,000 and 6,800 feet elevation), and, the other, at about the 8,000-foot elevation, east of the Mauna Kea Access Road.

A survey of the areas proposed for the construction camp site and staging areas was made by Char in May 1985. The first area was on relatively flat terrain with scattered clumps of mamane trees; it consisted of parts IA and IB. The other area was located on the slopes adjacent to and above the mid-level facilities' maintenance area. This site was not recommended due to the steep slopes and increased soil erosion hazard. The site was also heavily vegetated and much of the vegetation would have to be removed.

A survey of the dormitory area was made in 1990 by Char for the Japan National Large Telescope (JNLT) project since a new dormitory would be constructed within the existing mid-level facilities to accommodate the JNLT personnel.

DESCRIPTION OF THE BOTANICAL RESOURCES

The following description is drawn largely from the three botanical studies conducted for the facilities and from personal observations. A list of plant species recorded from the site is presented at the end of this report.

The vegetation on the mid-level facilities consists of open-canopied mamane forest; this has also sometimes been referred to as mamane parkland. Mamane (Sophora chrysophylla), a member of the pea family (Fabaceae), has bright yellow clusters of flowers and somewhat woody, knobby seed pods, brown to tan when mature; leaves and young shoots are covered by fine, golden brown hairs. The mamane trees occur in scattered clumps, from 6 to 18 feet tall. Smaller saplings less than 3 feet tall are also common.

Ground cover consists of a mixture of bunch grasses, these form upright tussocks or clumps rather than low, running mats. The most abundant grasses are two native species, Deschampsia nubigena and pili uka (Trisetum glomeratum), and the introduced needlegrass (Stipa cernua). Other grasses and herbaceous species found in this vegetation type include ripgut grass (Bromus diandrus), orchardgrass (Dactylis glomerata), hairy cats-ear (Hypochoeris radicata), afilaria (Erodium cicutarium), sheep sorrel (Rumex acetosella), woolly mullein (Verbascum thapsus), and common groundsel (Senecio vulgaris). The plants tend to be denser under and around the mamane trees where there is more moisture available because of fog drip.

Shrubs of 'aweoweo or 'aheahea (Chenopodium oahuense) are occasional. A few shrubs of pukiawe (Styphelia tameiameiae) and nohoanu (Geranium cuneatum), a native woody geranium with attractive white flowers and silvery leaves, are also found on the site; these plants are usually associated with the more rocky areas. Two native members of the mint family (Lamiaceae), Stenogyne microphylla and ma'ohi'ohi (Stenogyne rugosa), are fairly common and can be observed growing at the base of the mamane trees. Sometimes the long stems of these Stenogyne climb up into the mamane and form dense tangles.

In the open areas between the clumps of mamane trees, ground cover is less dense with bare areas of fine soil or rocky outcroppings prominent. Scattered patches of the introduced California poppy (Eschscholzia californica) are locally common on some open areas, especially near the stone cabins.

A small grove of Eucalyptus trees and saplings is found just above the information station parking lot. A few shrubs of tagasaste (Cystisus palmensis) also occur here.

DISCUSSION

The vegetation on the mid-level facilities has been surveyed at least three times. No threatened and endangered species or species of concern (U.S. Fish and Wildlife Service 1999) were found.

In the last studies conducted for the facilities (Char 1990), it was recommended that efforts should be directed to managing the natural resources on and around the site. This included increasing plantings of native species and removing some of the introduced or alien species such as the California poppy. Increased visitor

traffic would result in more weedy species being brought up to the site. Thus, monitering of the site for new alien species was recommended. It would be easier to remove these plants when their numbers were low.

The recommendations outlined in the 1990 report as well as in the earlier reports are still valid today.

LITERATURE CITED

Char, W.P. (Char & Associates). 1985. Botanical survey for the proposed Temporary Construction Camp Housing at Hale Pohaku, Mauna Kea, island of Hawai'i. Prepared for MCM Planning. June 1985.

Char, W.P. (Char & Associates). 1990. Botanical survey, JNLT and Associated Facilities, Mauna Kea, Hawai'i. Prepared for MCM Planning. September 1990.

Evenhuis, N.L. and S.E. Miller, eds. 1995-1998. Records of the Hawaii Biological Survey. Bishop Museum Occasional Papers Nos. 41-56.

Gerrish, G. 1979. Botanical survey of principal site (Hale Pohaku) and two alternate sites. Prepared for Group 70, Inc. June 1979.

Group 70, Inc. 1979. Hale Pohaku, Hamakua, Mauna Kea, Hawaii, Environmental Impact Statement, Mid-Elevation Facilities Master Plan. Prepared for State of Hawaii, Department of Land and Natural Resources. November 1979.

Lamoureux, C.H. 1988. Draft checklist of Hawaiian pteridophytes, "Kupukupu O Hawai'i Ne'i". Lyon Arboretum, University of Hawai'i, Manoa.

MCM Planning. 1985. Amendment to the Mauna Kea Science Reserve Complex Development Plan, Final Supplemental Environmental Impact Statement for Construction Camp Housing, Hale Pohaku, Hamakua, Hawai'i. Prepared for University of Hawai'i. October 1985.

U.S. Fish and Wildlife Service. 1999. U.S. Fish and Wildlife Service species list, plants. March 23, 1999. Pacific Islands Ecoregion Office, Honolulu, HI.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1990. Manual of the flowering plants of Hawai'i. 2 vols. University of Hawai'i Press and B.P. Bishop Museum Press, Honolulu. B.P. Bishop Museum Special Publication 83.

PLANT SPECIES LIST -- Hale Pohaku Mid-Elevation Facilities

A list of all the vascular plant species recorded from the Hale Pohaku mid-elevation facilities follows. The list is drawn from the three botanical surveys (Gerrish 1979; Char 1985, 1990) which have been made for the construction of the various facilities on the site. The taxonomy and nomenclature of the ferns follow Lamoureux (1988), and Wagner et al. (1990) for the flowering plants (monocots and dicots). Recent name changes for some of the flowering plants are in accordance with those reported in the Hawaii Biological Survey series (Evenhuis and Miller, eds., 1995-1998).

The following information is provided for each species:

1. Scientific name with author citation.
2. Common English and/or Hawaiian name(s), when known.
3. Biogeographic status. The following symbols are used:
   - E = endemic = native only to the Hawaiian Islands.
   - I = indigenous = native to the Hawaiian Islands and also elsewhere.
   - I? = questionably indigenous = data unclear if dispersal by natural or human-related mechanisms, but weight of evidence suggests probably indigenous.
   - X = introduced or alien = all those plants brought to the Hawaiian Islands by humans, intentionally or accidentally, after Western contact, that is, Cook's discovery of the islands in 1778.

Scientific name	Common name	Status
FERNS		
ASPLENIACEAE (Bird's-nest fern family)		
Asplenium adiantum-nigrum L.	'iwa'iwa	I
Asplenium trichomanes L.	'oali'i, 'owali'i	I
SINOPTERIDACEAE (Cliffbrake fern family)		
Pellaea ternifolia (Cav.) Link	kalamoho, lau-kahi	I
GYMNOSPERMS		
PINACEAE (Pine family)		
Pinus sp.		X
FLOWERING PLANTS		
DICOTS		
ASTERACEAE (Daisy family)		
Achillea millefolium L.	common yarrow, milfoil	X
Cirsium vulgare (Savi) Ten.	bull thistle, pua kala	X
Conyza bonariensis (L.) Cronq.	hairy horseweed, ilioha	X
Heterotheca grandiflora Nutt.	telegraph plant	X
Hypochoeris radicata L.	hairy cats-ear, gosmore	X
Pseudognaphalium sandwicensium (Gaud.) A. Anderb.	'ena'ena	E
Senecio vulgaris L.	common groundsel	X
Sonchus oleraceus L.	sowthistle, pualele	X
BRASSICACEAE (Mustard family)		
Lepidium africanum (N.L. Burm.) DC		X
Lepidium bonariense L.		X
CARYOPHYLLACEAE (Pink family)		
Polycarpon tetraphyllum (L.) L.	allseed	X
Silene struthioloides A. Gray		E
CHENOPODIACEAE (Goosefoot family)		
Chenopodium oahuense (Meyen) Aellen	'aweoweo, 'aheahea	E
EPACRIDACEAE (Epacris family)		
Styphelia tameiameiae (Cham. & Schlechtend.) F.v. Muell.	pukiawe, maiele	I

Scientific name	Common name	Status
FABACEAE (Pea family)		
Cytisus palmensis (Christ) Hutch.	tagasate	X
Medicago sativa L.	alfalfa, lucerne, 'alapapa	X
Melilotus indica (L.) All.		X
Melilotus sp.		X
Sophora chrysophylla (Salisb.) Seem.	mamane, mamani	E
Trifolium arvense L.	rabbit-foot clover	X
GERANIACEAE (Geranium family)		
Erodium cicutarium (L.) L'Her.	alfilaria, pin clover	X
Geranium cuneatum ssp. hololeucum (A. Gray) Carlq. & Bissing	nohoanu, hinahina	E
LAMIACEAE (Mint family)		
Stenogyne microphylla Benth.		E
Stenogyne rugosa Benth.	ma'ohi'ohi	E
MALVACEAE (Mallow family)		
Malva parviflora L.	cheese weed	X
MYRTACEAE (Myrtle family)		
Eucalyptus spp.	eucalyptus, gum tree	X
ONAGRACEAE (Evening primrose family)		
Epilobium billardierianum ssp. cinereum (A. Rich.) Raven & Englhorn	willow herb	X
PAPAVERACEAE (Poppy family)		
Eschscholzia californica Cham.	California poppy	X
POLYGONACEAE (Buckwheat family)		
Rumex acetosella L.	sheep sorrel	X
SCROPHULARIACEAE (Figwort family)		
Verbascum thapsus L.	woolly mullein, common mullein	X
Verbascum virgatum Stokes	virgate mullein, wand mullein	X
SOLANACEAE (Night-shade family)		
Solanum americanum Mill.	popolo, glossy night-shade	I?

Scientific name	Common name	Status
MONOCOTS		
CYPERACEAE (Sedge family)		
Carex macloviana ssp. subfusca (W. Boott) T. Koyama		I
IRIDACEAE (Iris family)		
Iris sp.	iris	X
LILIACEAE (Lily family)		
Aloe vera L.	aloe	X
POACEAE (Grass family)		
Agrostis sandwicensis Hillebr.		E
Anthoxanthum odoratum L.	sweet vernalgrass	X
Bromus diandrus Roth	ripgut grass	X
Dactylis glomerata L.	cocksfoot, orchardgrass	X
Deschampsia nubigena Hillebr.		E
Holcus lanatus L.	velvet grass	X
Lolium sp.		X
Poa pratensis L.	Kentucky bluegrass	X
Rytidosperma pilosum (R. Br.) Connor & Edgar	hairy oatgrass	X
Rytidosperma semiannulare (Labill.) Connor & Edgar	wallaby grass	X
Stipa cernua Stebb. & A. Love	needlegrass	X
Trisetum glomeratum (Kunth) Trin.	pili uka, he'upueo, mountain pili	E
Vulpia bromoides (L.) S.F. Gray	brome fescue	X
Vulpia myuros (L.) C.C. Gmelin	rat tail fescue	X

BOTANICAL RESOURCES
MAUNA KEA SUMMIT, HAWAI'I

by

Winona P. Char

CHAR & ASSOCIATES
Botanical Consultants
Honolulu, Hawai'i

Prepared for: **GROUP 70 INTERNATIONAL, INC.**

July 1999

BOTANICAL RESOURCES
MAUNA KEA SUMMIT, HAWAI'I

INTRODUCTION

A summary of the botanical resources found on the Mauna Kea summit above 13,000 feet elevation is presented. The information is drawn largely from the earlier survey by Smith et al. (1982) for the Mauna Kea Science Reserve Complex Development Plan, Final Environmental Impact Statement (Group 70 1983), and from the botanical resources study for the Smithsonian Submillimeter Array site (Char 1992). A reconnaissance-level field survey was also made on the slope beyond the summit ridge and to the northwest of the summit ridge. These are the areas proposed for the Next Generation Large Telescope (NGLT) site and the Optical Interferometer Array site. The field survey was conducted on 21 June 1999; a map of the transect locations is attached.

The information presented in this report will be incorporated into the Mauna Kea Science Reserve Complex Development Plan Update. A description of the habitat and the plant communities found at the summit is provided. The impact of the proposed facilities on the north and northwest slopes as well as around the existing facilities is discussed.

HABITAT AND PLANT COMMUNITIES

The Mauna Kea Science Reserve is characterized by its severe climate with extremes of moisture and temperature and by its rugged landscape, alternating between massive andesite lava flows and large cinder cones of volcanic ash, loose cinder, and other interbedded volcanic material.

The distribution of the plant communities at the summit is driven primarily by substrate type. The cinder cones do not provide suitable habitat for most plants because of their loose, unstable nature and high porosity. The andesite (Hawaiite-mugearite) lava flows consist of dense rock with numerous pits, fissures, small caves, overhangs, and deeply shaded pockets and crevices. These less exposed areas of the flow provide habitat for the lichens and mosses found at the summit. The vascular plants tend to occupy the areas at the base of the rock outcrops where there is an accumulation of soil and somewhat moister conditions. There are numerous deposits of eolian or colluvial material scattered throughout the lava flows in low lying, swale areas. Like the cinder cones, these deposits of loose material provide only a poor to marginal habitat for the plants.

A discussion of the lichen, moss, and vascular plants found at the summit follows. The algae were not inventoried during the earlier survey (Smith et al. 1982) since Lake Waiau was not considered a part of the study area. However, one algae species, Haematococcus sp., was observed on almost all the snow banks investigated during the 1982 survey; this algae stains the snow a blood red.

Lichens

A list of the lichen species identified from the 1982 survey by Smith et al. is presented in Appendix 1 at the end of this report. The list does not include those species which were uncollectable, about 5; these were crustose, rock-colonizing species imbedded deeply in the andesite flows. About half of the lichens identified are endemic to the Hawaiian Islands, that is, they are native only to the Hawaiian Islands.

Lichens can be found throughout the summit area, but reach their highest density and greatest diversity on the north and west facing andesite rocks where they are not exposed to the sun for long periods of time. Some south facing rock faces can also support lichen communities if protected from exposure to the sun.

The lichen community on almost vertical north facing rocks is characterized by an association of _Umbilicaria hawaiiensis_ and _Pseudephebe pubescens_. _Lecanora muralis_ is commonly found under both species. _Candelariella vitellina_ and _Lecidea skottsbergii_ are often associated with these species. These north facing rock faces are often exposed to the prevailing winds. On vertical west facing andesite rocks, the lichen community is a mixed association of _Acarospora depressa_, _Candelariella vitellina_, _Lecanora muralis_, _Lecidea skottsbergii_, _Lecidea vulcanica_, _Physcia dubia_, _Rhizocarpon geographicum_, and _Umbilicaria hawaiiensis_.

The lichen community on south facing rocks is characterized by an association of _Umbilicaria pacifica_ and _Physcia dubia_. _Lecanora muralis_, _Candelariella vitellina_, and _Lecidea skottsbergii_ are common.

The areas within the Mauna Kea Science Reserve with massive andesite lava flows which could provide suitable, potential habitat for the more diverse lichen communities have been identified. The habitat distribution map is based on the U.S. Geological Survey (1998) maps of Mauna Kea lava flows.

The cinder cones and the deposits of eolian or colluvial material on lava flows are species poor. Only the most ubiquitous lichen species occur here. _Lecanora muralis_ is the most abundant lichen and can be found throughout the summit on all substrate types. _Candelariella vitellina_ and _Lecidea skottsbergii_ are found on

small rocks or cobbles scattered throughout the cinder and colluvial material.

Mosses

About 12 species of mosses were inventoried during the 1982 survey (see Appendix 1). The _Grimmia_ sp. material collected may represent 2, or possibly 3, different species. Less than a quarter of the mosses are endemic. All of the mosses are related to members which are temperate in origin.

The mosses are found in the more protected areas such as under rock overhangs and in deeply shaded pockets and crevices on north-northeast facing sides of rocky mounds, as well as south-southwest facing sides of these mounds. The mosses are nearly always associated with small run-off channels where greater moisture is available from snow melt. Small caves and rocky overhangs can harbor pockets of compacted snow for some time, providing much needed moisture.

Mosses occur only on rock mounds and in ash-filled crevices. Mosses were not observed on loose cinders or on the eolian or colluvial fields.

The most frequently observed mosses are the species of _Grimmia_; these form silvery-gray clumps in run-off channels on semi-exposed rock faces. The second most frequently encountered moss is _Pohlia cruda_, a bright green-colored moss associated with the deeply shaded and well protected sites. The other moss species are not common. They occupy habitats somewhat intermediate between the relatively exposed _Grimmia_ habitats and the well protected niches favored by _Pohlia_.

Vascular Plants

Six species of vascular plants are found within the Mauna Kea Science Reserve area (see Appendix 1). The plants tend to be associated with the rocky outcrops, usually at the base of the large outcroppings or among large boulders, where there is an accumulation of soil or ash and moisture. The plants rarely are found on the loose, less stable cinder cone areas.

Two species of fern, Asplenium adiantum-nigrum (common name 'iwa'iwa) and Cystopteris douglasii, are known from the summit. Asplenium is found in well protected areas at the base of rock outcrops or tucked in among the large boulders. The Mauna Kea Cystopteris douglasii is unusual in that it prefers to grow in open, exposed areas on weathered rock facing the tradewinds. Other members of this genus grow in more protected situations. The Mauna Kea Cystopteris douglasii also differs from its East Maui relatives in its narrower, linear fronds. The Mauna Kea taxon may represent a new variety or, perhaps, a new species of Cystopteris, but more studies are needed (D. Palmer, pers. comm.). Cystopteris douglasii is considered a species of concern by the U.S. Fish and Wildlife Service (1999).

Two members of the grass family (Poaceae) are found at the summit. Agrostis sandwicensis is the more commonly encountered of the two grasses, where it is sparingly distributed among boulders on loose substrate or at the base of rocky outcroppings. Trisetum glomeratum (common names pili uka, he'upueo, mountain pili) is similar to Agrostis in appearance. It forms erect, dense clumps but has fewer flower spikes. It is uncommon at the summit.

The Agrostis, Trisetum, and Cystopteris are endemic. The Asplenium is indigenous, that is, it is native to the Hawaiian Islands and also elsewhere. The other two species found at the summit are

introduced, common, weedy, temperate species; these are Hypochaeris radicata (hairy cat's ear or gosmore) and Taraxacum officale (common dandelion).

DISCUSSION AND RECOMMENDATIONS

The areas with andesite lava flows and large rock outcrops provide habitat for a number of lichen and moss species as well as a few vascular plants. Less than a quarter of the mosses are endemic. The mosses are widely dispersed over the summit area in crevices and deeply shaded pockets on rocky mounds. The 1982 study by Smith et al. concluded that any proposed construction above 13,000 feet would not endanger any of the moss species or their entire habitat.

While the lichens are found throughout the summit area, there are areas where lichen diversity and numbers are high. Approximately half of the lichen species identified are endemic; some such as the Umbilicaria and Pseudephebe pubescens are unique to Mauna Kea. Smith et al. (1982) identified two areas of high lichenological interest. The first is the slope of Pu'u Wekiu cinder cone below the switchback where there are numerous large rocks. The second region encompassed their Intensively Studied Areas 2,3, and 4; this is the site proposed for the NGLT, Optical Interferometer, and Submillimeter Array (SMA) expansion on the northwest slope.

Five of the six vascular plants are widespread throughout the islands. The Agrostis, Trisetum, and Cystopteris are endemic. Agrostis and Trisetum are also common at lower elevations on Mauna Kea, and they also occur on Mauna Loa and Maui. Cystopteris douglasii is known only from high elevation areas on East Maui (Haleakala) and Hawai'i where it is rare. It is considered a species of concern by the U.S. Fish and Wildlife Service (1999). Species of concern are plants for which there is a need for more biological and/or taxonomic information to determine if a particular species might require conservation actions. Species of concern do not receive legal protection under the Federal and State Endangered Species laws. Use of the term does not mean that the species will eventually be listed as threatened or endangered. There are a number of morphological and habitat differences which separate the Mauna Kea _Cystopteris_ from other _Cystopteris douglasii_ populations. The Mauna Kea population may represent a new taxon, but further studies are needed.

Given the information above, the following recommendations are made concerning the botanical resources and the different types of facility development projects proposed.

Expansion of Existing Facilities

The addition of four to six outriggers on the existing W.M. Keck Observatory site is not expected to have an impact on the botanical resources as the site is located on a cinder cone. Cinder substrate provides poor habitat for plants at the summit.

Expansion of the existing Smithsonian SMA may impact some of the lichen colonies. It is recommended that a site survey be conducted prior to any construction to locate areas with high lichen concentrations and to recommend suggestions for placement of the pads and antennae as well as roads. A survey similar to that conducted for the existing SMA (Char 1992) should be made. For the 1992 study, the presence of _Umbilicaria_ was used as an indicator for high lichen densities and diversity; the three _Umbilicaria_ species are major components of the lichen communities identified by Smith _et al_. (1982). In addition to being associated with rich lichen concentrations, the relatively large _Umbilicaria_ thalli are easily identified in the field.

Redeveloped Facility Site

This would involve replacement or upgrading of facilities at existing sites such as U.H. 2.2-m., CFHT, UKIRT and IRTF. No impacts to the botanical resources are anticipated as these existing sites are already disturbed and are located on areas with cinder substrate.

Expansion Areas: North and Northwest Slopes

The north slope beyond the summit ridge is proposed for Conventional Optical/IR. An existing unimproved dirt roadway will be used to access the site and should minimize site disturbance. THis proposed expansion area is located primarily on a very weathered lava flow with large fields of eolian or colluvial deposits. The fields of loose ash/ colluvial deposits make up about 60 to 70% of the surface while rock mounds or outcrops occupy about 30 to 40% of the surface. Fairly large colonies of lichens were observed on the more exposed ends of the rock outcrops during our reconnaissance survey in June. Three patches of _Cystopteris douglasii_ were found along our transect 5.

The northwest slope of the summit ridge is proposed for the NGLT and Optical Interferometer Array site, as well as the SMA expansion area which was discussed earlier. Rock outcrops cover about 50 to 60% of the surface, while ash or colluvial material occupies about 40 to 50% of the somewhat younger lava flow. Large and fairly diverse colonies of lichen were found scattered throughout the rocky outcroppings on north and west faces during our field studies.

It is recommended that structures and roadways be placed on the ash or colluvial fields which are found at both locations. These fields occupy the low lying areas among the rock outcroppings.

Areas with rock outcrops should be avoided. Structures should not be placed where they would block tradewind flow to any nearby colonies of lichens or Cystopteris. It is recommended that the roadways be paved to prevent excessive dust dispersal onto nearby lichen colonies or Cystopteris ferns. A survey similar to that conducted for the existing Smithsonian SMA (Char 1992) should be made to map areas of high lichen concentrations.

The impact on the botanical resources is expected to be minimal if the recommendations above are followed.

LITERATURE CITED

Char, W.P. (Char & Associates). 1992. Botanical resources, Smithsonian Radio Telemetry Facility, Mauna Kea, island of Hawai'i. Prepared for MCM Planning. September 1992.

Group 70. 1983. Mauna Kea Science Reserve Complex Development Plan, Final Environmental Impact Statement, Mauna Kea, Hamakua, Hawaii. Prepared for Research Corporation of the University of Hawaii. January 1983.

Smith, C.W., W.J. Hoe, and P.J. O'Conner (Bishop Museum). 1982. Botanical survey of the Mauna Kea summit above 13,000 feet. Prepared for Group 70. October 1982.

U.S. Fish and Wildlife Service. 1999. U.S. Fish and Wildlife Service species list, plants. March 23, 1999. Pacific Islands Ecoregion Office, Honolulu, HI.

U.S. Geological Survey. 1998. Geology and petrology of Mauna Kea Volcano, Hawaii - A study of postshield volcanism. U.S. Geological Survey Professional Paper 1557.

APPENDIX 1. List of species recorded from Mauna Kea summit, Hawai'i (from Smith et al. 1982).

Scientific name	*Status	Abundance
NON-VASCULAR PLANTS		
LICHENS		
Acarospora depressa Magn. apud Malme	I	Uncommon
Acarospora pyrenuloides Magn.	E	Rare
Acarospora sp.	I?	Single
Bacidia sp.	I?	Single
Caloplaca lithophila Magn.	E	Occasional
Candelariella insidiata Magn.	E	Single
Candelariella vitellina (Ehrh.) Muell.-Arg.	I	Abundant
Lecanora muralis (Schreb.) Rabh.	I	Abundant
Lecidea skottsbergii Magn.	E	Common
Lecidea vulcanica Zahlbr.	E	Uncommon
Lepraria sp. (white)	I?	Common
Lepraria sp. (green)	I?	Common
Physcia dubia (Hoffm.) Lett.	I	Common
Placopsis sp. (?)	I	Single
Pseudephebe pubescens (L.) Choisn.	I	Locally common
Rhizocarpon geographicum var. hawaiiensis Raes.	E	Locally common
Rinodina cf. cacuminum (Th.f.) Malme	I	Single
Rinodina interrupta Magn. (?)	E	Single
Umbilicaria hawaiiensis Magn.	E	Common
Umbilicaria magnussonii Llano	E	Common
Umbilicaria pacifica Magn.	E	Uncommon
MOSSES		
Amphidium tortuosum (Hornsch.) Robins.	I	Occasional
Andreaea acutifolia Hook.f. & Wils.	I	Occasional
Bryum caespiticium Hedw.	I	Uncommon
Bryum hawaiicum Hoe	E	Uncommon
Grimmia apocarpa var. pulvinata (Hedw.) Jones	I	Occasional
Grimmia cf. pilifera P. Beauv.	I	Uncommon
Grimmia sp.	I?	Occasional
Pohlia cruda (Hedw.) Lindb.	I	Common
Pohlia cf. mauiensis (Broth. ex Bartr.) Schultze-Motel	E	Uncommon

Scientific name	*Status	Abundance
Tortella humilis (Hedw.) Jenn.	I	Uncommon
Zygodon tetragonostomus A. Br.	I	Uncommon
VASCULAR PLANTS		
FERNS		
Asplenium adiantum-nigrum L.	I	Uncommon
Cystopteris douglasii Hooker	E	Rare
DICOTS		
Hypochaeris radicata L.	X	Uncommon
Taraxacum officinale Weber	X	Uncommon
MONOCOTS		
Agrostis sandwicensis Hillebr.	E	Common
Trisetum glomeratum (Kunth) Trin.	E	Uncommon

*Status

E = endemic = native only to the Hawaiian Islands.
I = indigenous = native to the Hawaiian Islands and also elsewhere.
X = introduced or alien = all those plants brought to the Hawaiian Islands by humans, intentionally or accidentally, after Western contact, that is, Cook's discovery of the islands in 1778.

CHAR & ASSOCIATES
Botanical/Environmental Consultants
4471 Puu Panini Ave.
Honolulu, Hawaii 96816
(808) 734-7828

January 2000

MAUNA KEA SCIENCE RESERVE

MANAGEMENT RECOMMENDATIONS -- BOTANICAL RESOURCES

Management recommendations to preserve and protect the botanical resources on the Mauna Kea Science Reserve complex are proposed. The recommendations are presented in two sections. The Hale Pohaku mid-elevation facilities' recommendations are drawn largely from the earlier studies by Gerrish (1979) and Char (1985, 1990), while the summit area recommendations are taken primarily from Smith _et al_. (1982) and Char (1992).

At present, there is no one plan which provides for the management, conservation, and protection of the natural resources on the summit area science reserve and Hale Pohaku. It is recommended that the new Office of Mauna Kea Management prepare a comprehensive Natural Resources Management Plan (NRMP) in the near future. The NRMP will provide guidance in protecting and enhancing the habitat of native plants and animals. The management recommendations presented in this paper should be included in the future NRMP.

HALE POHAKU MID-ELEVATION FACILITIES

The mid-elevation facilities are found within an open-canopied mamane forest. Whenever possible, the buildings have been sited so that they occupy the open areas between the clumps of mamane trees. Attempts have been made at transplanting trees, but the survival rate has been low.

Mamane (_Sophora chrysophylla_), a member of the pea family with large, bright yellow clusters of flowers and knobby seed pods, occurs in scattered clumps, from 6 to 18 feet tall. A few shrubs of 'aweoweo (_Chenopodium oahuense_), nohoanu (_Geranium cuneatum_), and pukiawe (_Styphelia tameiameiae_) are also found on the site. Ground cover consists of a mixture of bunch grasses and smaller herbaceous species, some of them weedy, annuals. Two native bunch grasses which are abundant here are _Deschampsia nubigena_ and pili uka (_Trisetum glomeratum_). Two members of the mint family, _Stenogyne microphylla_ and ma'ohi'ohi (_S. rugosa_), are fairly common growing at the base of the mamane trees.

No threatened and endangered species or species of concern (U.S. Fish and Wildlife Service 1999) have been found on the site. However, the Mamane Subalpine Dry Forest plant community in which the facilities are located is considered rare on a global level and vulnerable to various threats, especially invasion and competition from alien plant species (Hawai'i Heritage Program 1994).

Management Recommendations

Monitering for and removal of alien plants: The chances for an accidental introduction of a weedy species onto the site will increase with more visitor traffic. Seeds of weedy plants can be transported on clothing, shoes, or on vehicles. The area around the mid-elevation facilities should be monitered on a regular basis, every six months to a year, and any introduced species not already found on the site (refer to plant list in Char 1999) should be noted and the plant(s) removed.

A plan to remove the California poppy (_Eschscholzia californica_) is presently being studied. Eventually, the _Eucalyptus_ planting found just above the visitor's center will need to be removed.

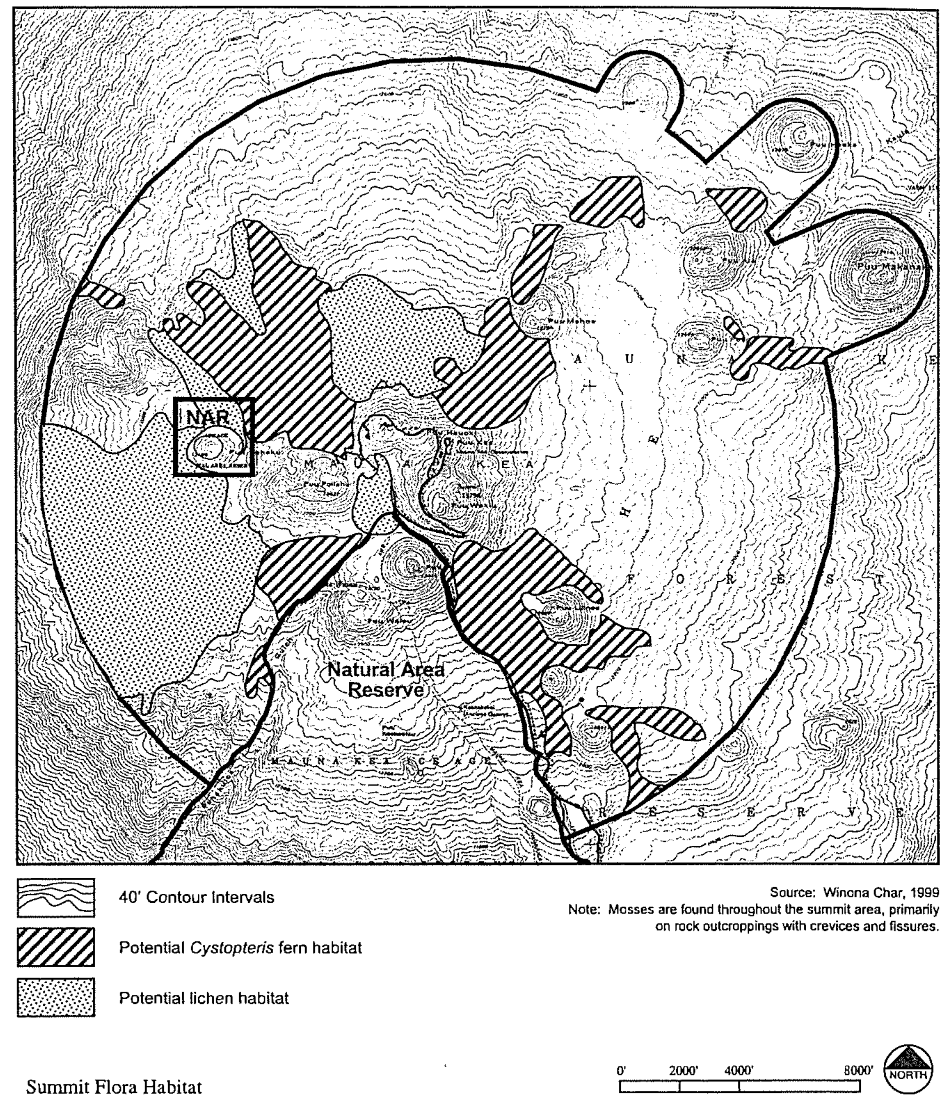
The stand of trees is heavily used by alien bird species (Kjargaard 1985, 1990).

Use of native plants for landscaping: Only those native species associated with the mamane plant community should be used. Propagation material should be collected from plants in the immediate area. Some replanting of mamane has been undertaken at the mid-elevation facility (MCM Planning 1985). Plantings of mamane as well as other species such as the nohoanu and pili uka should be increased. More vegetation on the site would help control soil erosion as well as soften the visual impact of the facilities on the surrounding areas.

Education program: An education program should be developed to acquaint all visitors to the site as well as facilities' personnel and astronomers with the environmental sensitivity of the area, and the importance of not disturbing the vegetation and native bird resources. People generally tend to comply with the rules if they understand the reasons for them. Topics could include effects of fire on native ecosystems, trampling and off-road vehicle impacts, alien plant invasions, etc.

MAUNA KEA SUMMIT

Substrate type is the driving force behind the distribution of the plant resources on the summit area. The cinder cones do not provide suitable habitat because of their loose, unstable nature and high porosity. The andesite lava flows have numerous pits, fissures, small caves, overhangs and deeply shaded pockets and crevices which provide a somewhat more protected, less exposed site for lichens and mosses. The vascular plants tend to occupy the areas at the base of rock outcrops where there is soil and somewhat moister conditions. The eolian or colluvial material



Source: Wincna Char, 1999
Note: Mosses are found throughout the summit area, primarily on rock outcroppings with crevices and fissures.

Summit Flora Habitat

Mauna Kea Science Reserve
Master Plan Update

which form somewhat extensive fields throughout the lava flows in low lying, swale areas provide poor to marginal habitat for the plants; like the cinder cones, this material is highly porous and loose.

Twelve moss species, 25 lichen species, and six vascular plant species have been inventoried on the summit area. All of the mosses are related to members which are temperate in origin and are widely disbursed over the summit. About half of the lichens are endemic (i.e. native only to the Hawaiian Islands) with some such as the Umbilicaria and Pseudephebe pubescens found only on Mauna Kea. Two areas of high lichenological interest were identified by Smith et al. (1982). The first on the slopes of Pu'u Wekiu where there are large boulders, and, the second on parts of the proposed expansion area on the northwest slope.

Five of the six vascular plants are widespread throughout the Hawaiian Islands. The sixth species, Cystopteris douglasii, is known only from high elevation areas on Haleakala (Maui) and Hawai'i. It is considered a species of concern (U.S. Fish and Wildlife Service 1999). There are morphological and habitat differences which separate the Mauna Kea Cystopteris fern from the other populations; the Mauna Kea population may represent a new species, but more studies are needed. Three patches of Cystopteris fern were found on the north slope during the limited reconnaissance survey for the Master Plan (Char 1999).

Management Recommendations

Placement of facilities: Rocky outcrops which contain high lichen concentrations and the Cystopteris should be avoided. Structures and roadways should be placed on the ash or colluvial fields found among the large rocky outcroppings. A survey method similar to the one conducted for the existing SMA (Char 1992)

should be used. Structures should not be placed where they would block the tradewind flow or sunlight to the lichen colonies or fern.

Reducing dust: Roadways should be paved to prevent excessive dust dispersal onto the nearby lichen colonies or ferns. Off-road vehicle use by the public should be strictly enforced.

References

Char, W.P. (Char & Associates). 1985. Botanical survey for the proposed Temporary Construction Camp Housing at Hale Pohaku, Mauna Kea, island of Hawai'i. Prepared for MCM Planning. June 1985.

Char, W.P. (Char & Associates). 1990. Botanical survey, JNLT and Associated Facilities, Mauna Kea, Hawai'i. Prepared for MCM Planning. September 1990.

Char, W.P. (Char & Associates). 1992. Botanical resources, Smithsonian Radio Telemetry Facility, Mauna Kea, island of Hawai'i. Prepared for MCM Planning. September 1992.

Char, W.P. (Char & Associates). 1999. Botanical resources, Hale Pohaku Mid-elevation Facilities. Prepared for Group 70 International, Inc. July 1999.

Gerrish, G. 1979. Botanical survey of principal site (Hale Pohaku) and two alternate sites. Prepared for Group 70, Inc. June 1979.

Hawai'i Heritage Program, The Nature Conservancy of Hawai'i. 1994. Summary listing of Hawaiian Natural Communities. February 1994.

Kjargaard, M.S. 1985. Avian survey of the Hale Pohaku area. Prepared for MCM Plannning. July 1985.

Kjargaard, M.S. 1990. Summary and literature review of fauna and ornithological survey for support facility sites, Japan National Large Telescope (JNLT), Hale Pohaku, Mauna Kea, Hawai'i. Prepared for MCM Planning. September 1990.

MCM Planning. 1985. Amendment to the Mauna Kea Science Reserve Complex Development Plan, Final Supplemental Environmental Impact Statement for Construction Camp Housing, Hale Pohaku, Hamakua, Hawai'i. Prepared for University of Hawai'i. October 1985.

Smith, C.W., W.J. Hoe, and P.J. O'Conner (Bishop Museum). 1982. Botanical survey of the Mauna Kea summit above 13,000 feet. Prepared for Group 70, Inc. October 1982.

U.S. Fish and Wildlife Service. 1999. U.S. Fish and Wildlife Service species list, plants. March 23, 1999. Pacific Islands Ecoregion Office, Honolulu, HI.

MAUNA KEA SCIENCE RESERVE
MASTER PLAN

APPENDIX H

Mauna Kea Science Reserve
Geological Resources Management Plan

Geohazards Consultants International, Inc.
J. Lockwood

January 2000

MARCH 2000

GCI

GEOHAZARDS CONSULTANTS INTERNATIONAL, INC.

Appraisal of hazards - reduction of risk

Mauna Kea Science Reserve

GEOLOGICAL RESOURCES MANAGEMENT PLAN

Prepared for Group 70 International, Inc

Honolulu, Hawaii

AMERICAN INSTITUTE OF PROFESSIONAL GEOLOGISTS
CERTIFICATE NUMBER 9806
AIPG
JOHN P. LOCKWOOD
CERTIFIED PROFESSIONAL GEOLOGIST

January, 2000

P.O. BOX 479 • VOLCANO, HAWAII 96785 • USA
TEL: (808) 967-8579 • FAX: (808) 967-8525 • email: geohaz@aloha.net

EXECUTIVE SUMMARY

- Many geologic features and structures found within the Mauna Kea Science Reserve are unique in Hawaii and some are rare elsewhere on Earth. Because of the remoteness of the Mauna Kea summit area and the lack of vegetation, these features are generally well-preserved and have great value as esthetic and as educational resources.

- The volcanic cinder cones of the Mauna Kea summit area are some of the most pristine in Hawaii since similar cones at lower elevations have been severely degraded by human activities

- Mauna Kea is the world's best example of a glaciated oceanic tropical volcano, and preserves the only glacial deposits and glacial features found in Hawaii.

- The interaction of molten lava and glacial ice during the Ice Ages has formed unique geologic features that are well-preserved in some areas and are amongst the world's best examples of these rare structures.

- The best samples of lava/ice interaction structures are found along the southern boundary of the Astronomy Precinct on steep slopes unsuitable for construction; they deserve protection from future development.

- Most of the unique geologic features on Mauna Kea are durable and are not subject to degradation by human visitors. They are well-suited for educational interpretation and can serve to familiarize visitors with the unique geological processes that have shaped this beautiful mountain

FIGURES

Figure 1. Generalized map of the Mauna Kea Science Reserve, showing the locations of geologically unique features.

Figure 2. Aerial view of the Mauna Kea summit from east, showing typical cinder cones. Pu'u Poepoe is on the left; Pu'u Ala on the lower right; Pu'u Mahoe in the right background includes several individual cones. The light colored material surrounding these cones consists of glacial *till* – loose rock material eroded and carried from the Mauna Kea's summit during the Ice Ages.

Figure 3. Aerial view towards Mauna Kea summit from the southwest. Pu'u Waiau and Lake Waiau are on the lower right and Pu'u Hau Kea is in the middle background. The prominent hawaiite lava flow has partially buried Pu'u Waiau was derived from Pu'u Hau Kea, and was erupted beneath glacial ice. Fine-grained lavas from the steep water-cooled margin of this flow was quarried in this area by Hawaiian tool makers. The light-colored ash beds forming the lower slope of Pu'u Wekiu indicate probable explosive interaction of lava fountains and ice water during early phases of this eruption.

Figure 4. Large lava bomb on the upper east flank of Pu'u Wekiu. Such bombs were erupted in semi-molten states from many of Mauna Kea's cinder cones and were typically shaped into elongate forms during their flights before impact.

Figure 5. Large pit crater on Mauna Kea's south flank, south of Pu'u Koko'olau. This crater was filled with ice and overridden by glaciers during the Ice Ages.

Figure 6. Glacially polished rock surface within the Astronomy Precinct. Note the scratch marks ("glacial striations") on this surface, formed as rocks in the overlying glacier scraped against bedrock as ice flowed downslope.

Figure 7. "Glacial erratic" resting on glacially polished rock outcrop within the Astronomy Precinct. Such boulders, flattened on lower surfaces, were left perched on bedrock outcrops as enclosing ice melted away at the end of the Ice Ages.

Figure 8. Aerial view of Mauna Kea's summit from the northwest showing the flat expanse of the Astronomy Precinct Submillimeter Array site on the left and snow-covered Pu'u Poliahu on the right. The steep cliff bounding the Astronomy Precinct is the margin of a lava flow erupted beneath glacial ice and quenched by contact with meltwater. This lava flow edge preserves many unique lava features indicative of lava/ice contact processes.

Figure 9. Large pillow-like structure preserved in the lava flow margin north of Pu'u Poliahu. This structure formed as molten lava flowed into subglacial icewater and quickly quenched on all sides. The pillow overlies fragmentary material formed by the explosive interaction of lava and water.

Figure 10. Gas spiracles exposed in the lava flow margin north of Pu'u Poliahu. Such features form when lava overrides water and pipes of superheated steam ascend upward into molten rock from below. The spiracle walls are lined with volcanic glass.

Figure 11. "Self-sorted stone stripes" developed on the lower south slopes of Pu'u Poliahu. These uncommon soil features consist of alternating bands of fine and coarse rock fragments, and apparently form by freeze/thaw processes that concentrate fine material on ridges and coarse material in grooves.

Mauna Kea Science Reserve

GEOLOGICAL RESOURCES MANAGEMENT PLAN

INTRODUCTION

An understanding of the geology of Mauna Kea is arguably the most essential, basic requirement for an understanding of the environment of this great volcano. The nature of the rocks and soils upon which the animals, plants, and humans reside is also an essential ingredient of ecosystem analysis. Mauna Kea is of course unique because of its animals, plants, and human activities, but it is also unique because of the extraordinary geologic processes that have operated on this volcano in the past. Many geologic features found on Mauna Kea are rare elsewhere on Earth and are absolutely unique in Hawaii.

In early December, 1999, Geohazards Consultants International, Inc. was asked to prepare a report on the geologic resources of the Mauna Kea summit area and to offer suggestions for their management and interpretation. The following report is relatively brief, but sources for further reading about the geology of Mauna Kea are given in the "References Cited" Section.

GENERAL GEOLOGIC HISTORY OF MAUNA KEA

Mauna Kea Volcano was born on the Pacific Ocean floor on the south flank of the older Kohala Volcano about 750,000 years ago, and may have emerged above sea level about 400,000 years ago (Moore and Clague, 1992). These oldest lavas of Mauna Kea probably formed a shield volcano like Mauna Loa, but these have been buried by younger "postshield" flows and later submerged below sea-level. The oldest lavas now exposed on Mauna Kea are found low on the Hamakua flanks and are about 240,000 years old (Frey and others, 1990; Wolfe and others, 1997).

The oldest exposed lavas of Mauna Kea are of basaltic composition and are termed the "Hamakua Volcanics" by Wolfe and others (1997) and earlier workers. Most of these basalts are exposed on the lower flanks of the volcano below about 3,000 ft. elevation, although important outcrops of the Hamakua Volcanics are also found as kipuka within the southern part of the Mauna Kea Ice Age Natural Area Reserve. The composition of lavas erupted on Mauna Kea changed abruptly about 65,000 years ago, and the older basalts were largely buried by more alkalic lavas termed the "Laupahoehoe Volcanics". Lava flows and cinder cones of the Laupahoehoe Volcanics underlie the entire summit area of Mauna Kea - except for the small basalt kipuka mentioned above.

As the highest volcano in Hawaii, Mauna Kea has likely been repeatedly covered by montane glaciers during the past few hundred thousand years, although the oldest glacial deposits preserved are only about 150,000 years old (Wolfe and others, 1997). Glaciers may have also formed on high volcanoes such as Haleakala and Mauna Loa during the Ice Ages, but if so any record of this has been buried by younger lava flows. Mauna Kea is the world's only known example of a glaciated tropical oceanic volcano, and preserves some of the best records of sub-glacial volcanism on Earth. The last glaciers on Mauna Kea melted away before about AD 7000 (Porter, 1979a).

GEOLOGIC RESOURCES

A. The Lavas:

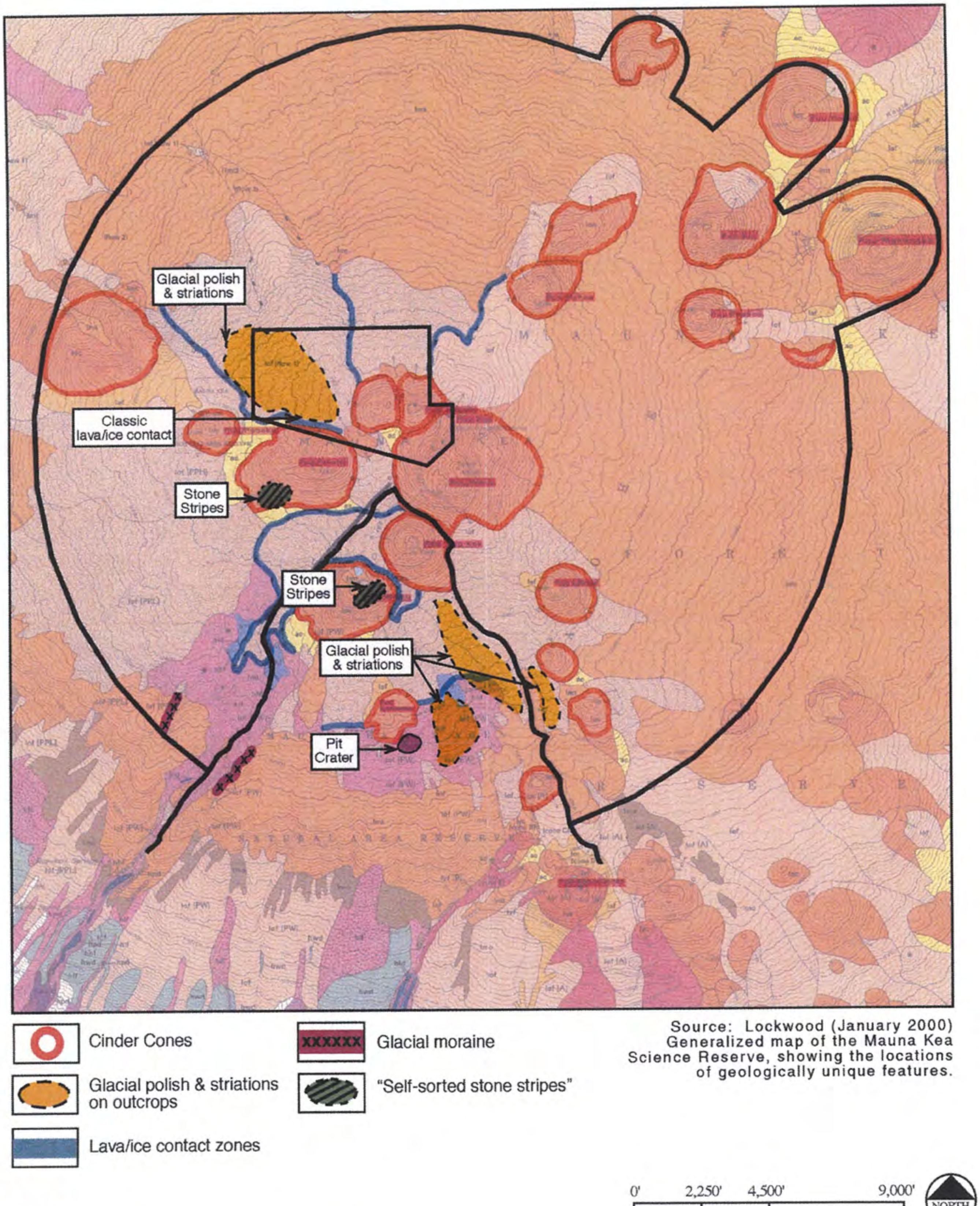
1. Hawaiites: "Hawaiites" are a type of lava characterized by higher amounts of alkalic elements and more soda-rich plagioclase than in the typical basalts that make up the bulk of most Hawaiian volcanoes (Washington, 1923). They are typically erupted during late stages of Hawaiian volcano evolution, and are also found as young lavas at other oceanic volcanoes.

2. Basalts: The bulk of the Mauna Kea edifice consists of basaltic lava flows, but most of these are covered by later alkalic lava flows and tephra of the Laupahoehoe Volcanics (Wolfe and others, 1997). Although these older basalts are widely exposed on lower flanks of Mauna Kea, they are rare on the upper slopes of the volcano, and within the Mauna Kea Science Reserve are found in only two kipuka south and southwest of Pu'u Waiau (Fig. 1). These basalts consist of glacially eroded lava flows and minor scoria associated with probable source vents. Internal structures within these basalt flows suggest that some of them may have formed beneath glacial ice (Wolfe and others, 1997).

B. Geologic Features

1. Cinder Cones: Mauna Kea's late stage, postshield eruptive activity was characterized by the formation of hundreds of large cinder cones all across the volcano's summit and flanks. Porter (1972) counted more than 300 of these cinder cones, which formed during both the basaltic Hamakua eruptions and the younger alkalic Laupahoehoe eruptions. These latter cinder cones form all of the prominent pu'u visible on Mauna Kea's summit and upper flanks. Wolfe and others (1997) mapped a total of 23 cinder cones within the area of the Mauna Kea Science Reserve, including three within the Mauna Kea Ice Age Natural Area Reserve; Porter (1979c) shows 25.

Nearly all of the lower elevation cinder cones of Mauna Kea have been badly degraded by human impacts, including military bombing operations within the Pohakuloa Training Area, widespread quarrying operations for road and golf course construction, and the grazing of introduced feral ungulates. The cinder cones of Mauna Kea's summit area and upper flanks have, however, largely been spared human modification and represent some of the most pristine and well-preserved such cones anywhere in Hawaii. Of the 20 + cinder cones within the Mauna Kea Science Reserve only five show human modification (road constructed on Pu'u Poliahu, grading for observatory sites on Pu'u Kea, Pu'u Hauoki, and the unnamed cone immediately west of Pu'u Hauoki, and the road construction on the south and west slopes of Pu'u Wekiu).



Source: Lockwood (January 2000) Generalized map of the Mauna Kea Science Reserve, showing the locations of geologically unique features.

The remaining cones of the summit area are untouched by human activity, and although most of them have been slightly modified by glacial erosion, they are spectacular and well preserved (Figs. 2, 3), and are largely unstudied to date. Well-formed, well-preserved volcanic bombs of various shapes and sizes (Fig. 4) litter the summits and flanks of many of the cinder cones, and some of these bombs contain inclusions ("xenoliths") of coarse-grained volcanic rock fragments carried to the surface from deeper layers within Mauna Kea.

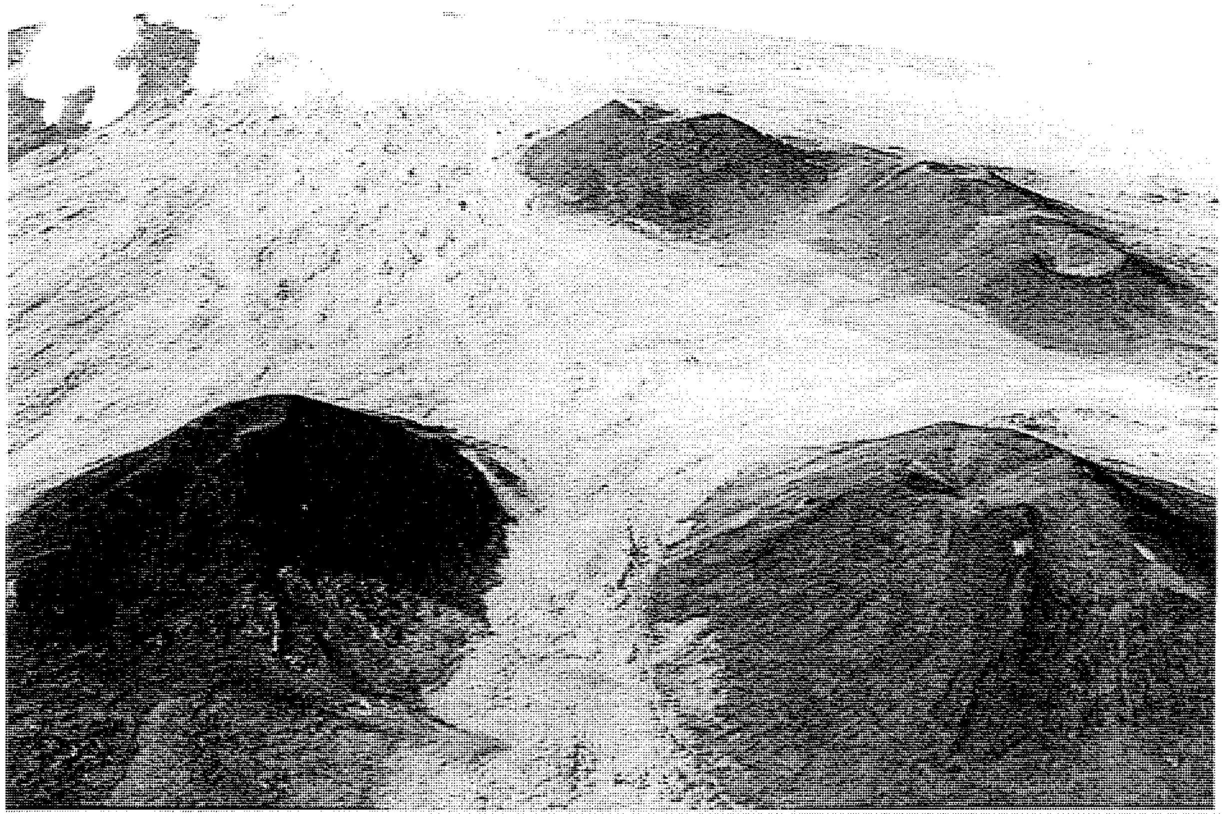
2. Pit Crater: Pit craters are uncommon on Mauna Kea, and one of the few is located within the Mauna Kea Ice Age Natural Area south of Pu'u Koko'olau (Fig. 5). This pit crater was overridden by the Makanaka glacier, but as it was filled with ice at the time, it was spared filling by glacial rock material being transported downslope above it.

3. Glacial Features: Mauna Kea has been repeatedly glaciated over the past several hundred thousand years (Porter, 1979b), but evidence of the earlier glacial episodes becomes more fragmentary with time, as glacial deposits are buried by younger lavas and glacial deposits. The youngest Mauna Kea glacier, termed the Makanaka by Wentworth and Powers (1941) completely covered the Mauna Kea summit area with ice up to 400' thick (Porter, 1979a). The area of the Mauna Kea Science Reserve was completely covered by this glacier from about 40,000 to 10,000 years ago, with the exception of a few high cinder cones that projected above the ice as "nunataks" (glacial kipuka). The area covered by the maximum extent of the Makanaka glacier was determined by Porter (1979a) to be 70.5 km^2 (27 mi^2) with a volume of about five km^3 (1.2 mi^3). The following features and rock deposits provide irrefutable evidence for this period when ice ruled Mauna Kea's summit:

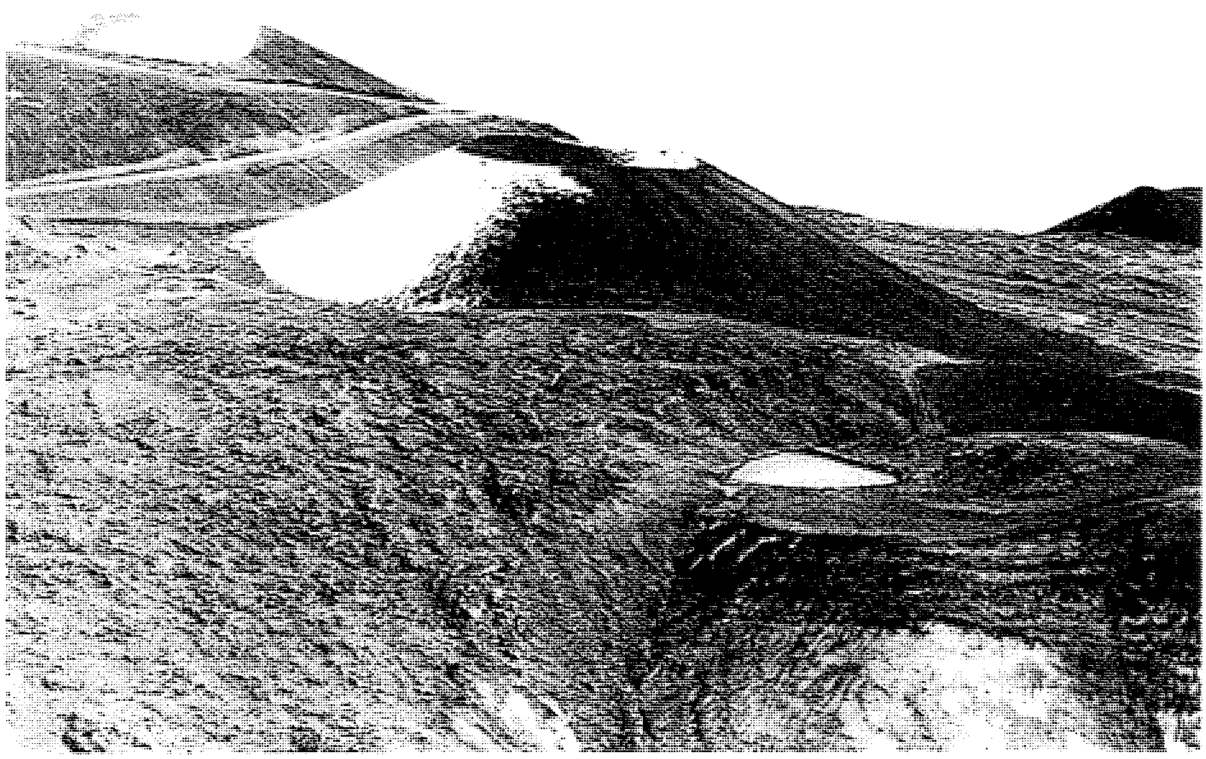
(a) Glacially polished rock surfaces: Glacially polished lava outcrops are found throughout the Mauna Kea Science Reserve and Mauna Kea Ice Age Natural Area Reserve. Especially well-preserved examples of glacial polish and related features (bedrock striations, glacial "erratics", and "chatter marks") are found along both sides of the summit access road between 12,000 and 12,800' elevation (Fig. 1) and on the lava flow underlying the "Astronomy Precinct" north of Pu'u Poliahu (Figs. 6, 7).

(b) Lava/ice contact zones: Volcanic eruptions occurred repeatedly during the periods that the Mauna Kea summit area was covered with glaciers, and excellent examples of lava/ice contact deposits are well preserved within the Mauna Kea Science Reserve. Although similar lava/ice deposits are found in a few high-latitude volcanic areas elsewhere on Earth, Mauna Kea preserves the only such deposits in the tropics.

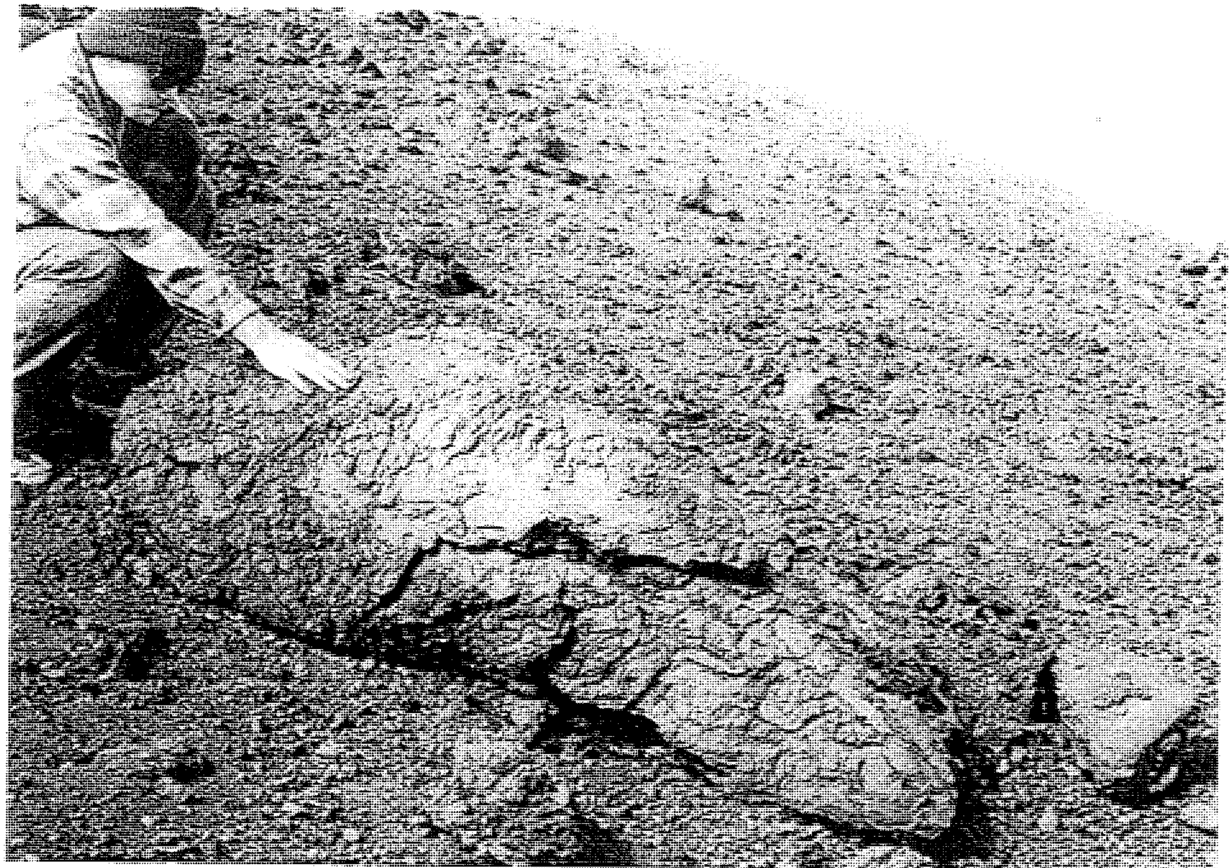
Sub-glacial volcanic eruptions on Mauna Kea caused melting of adjacent and overlying ice, and the quenching of molten lava in pools of melted ice water formed structures very similar to those formed in submarine environments. These include steepened, fine-grained flow margins, pillow lavas, gas spiracles, and hyaloclastic (fragmentary glass) deposits. Lava flows in most cases traveled downslope in melt caves at the bases of glacial ice, and may not have been evident at the surface. The ice directly above eruptive vents was commonly melted to the surface, however, and spectacular eruptive activity must have typified these eruptions as steam

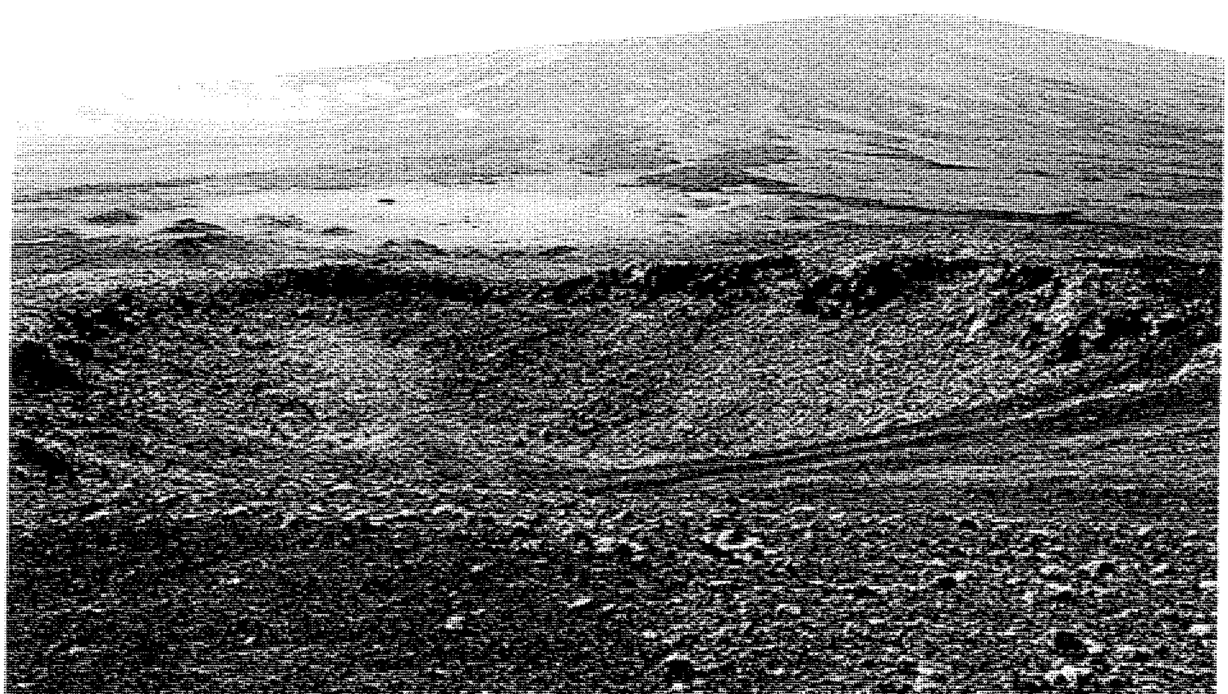


Aerial view of the Mauna Kea summit from east, showing typical cinder cones. Figure 2



Aerial view towards Mauna Kea summit from the southwest. Figure 3


Large lava bomb on the upper east flank of Pu'u Wekiu. Figure 4


Large pit crater on Mauna Kea's south flank, south of Pu'u Koko'olau. Figure 5

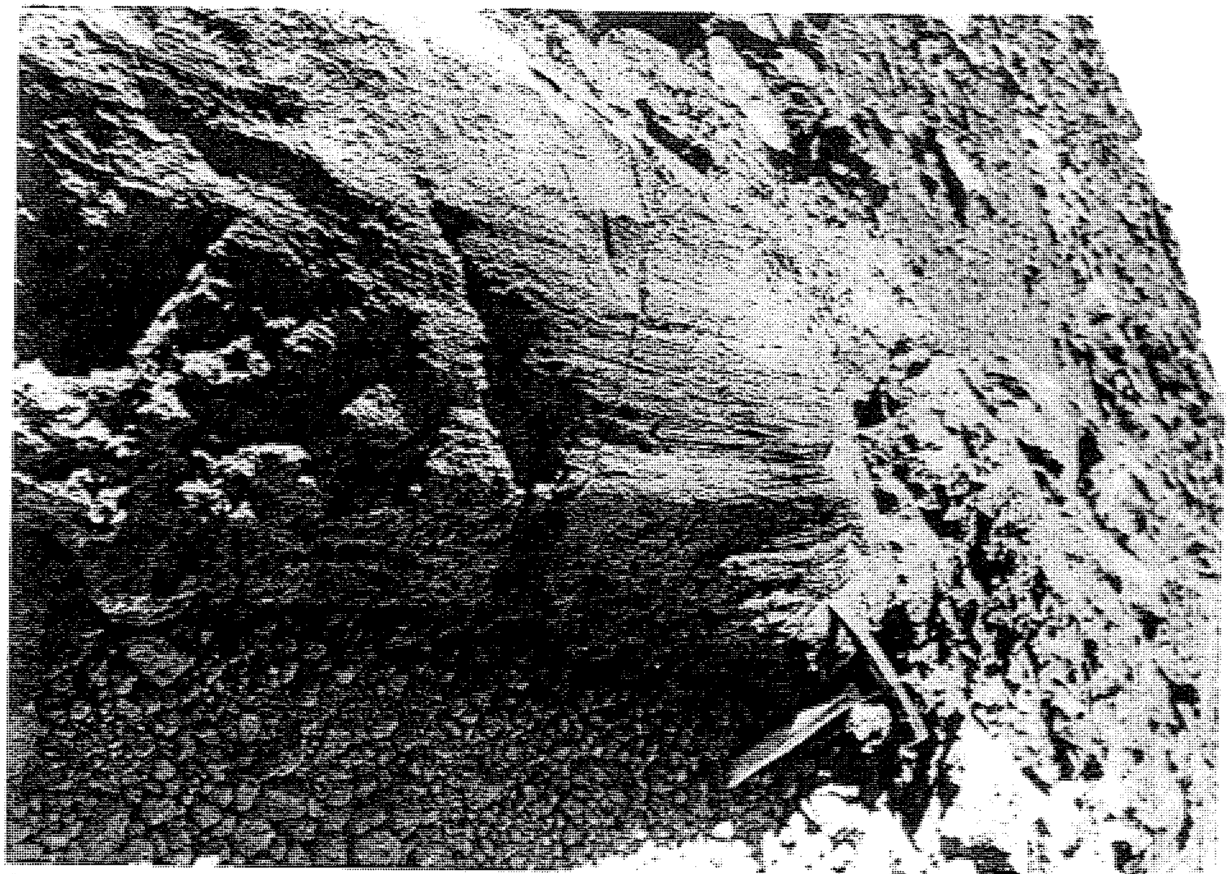

Glacially polished rock surface.

Figure 6

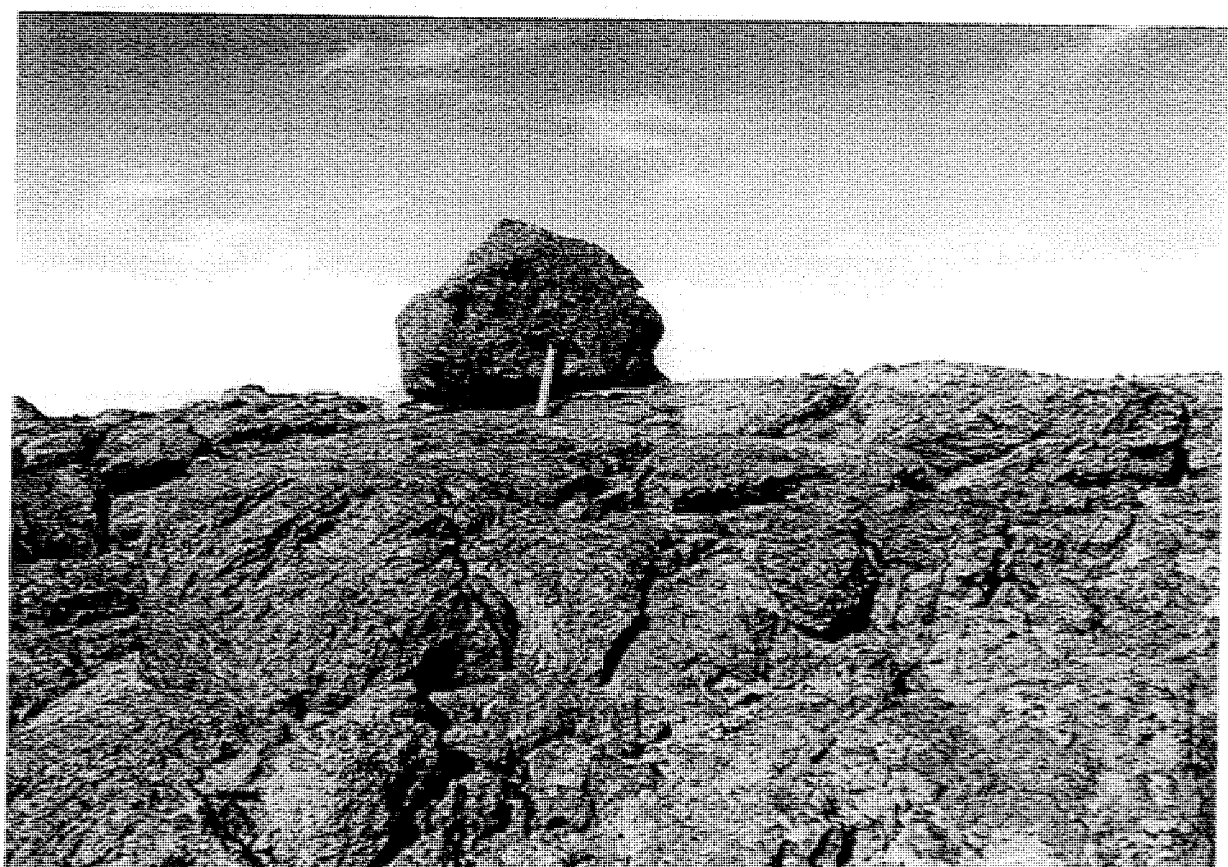

"Glacial erratic" resting on glacially polished rock outcrop.

Figure 7

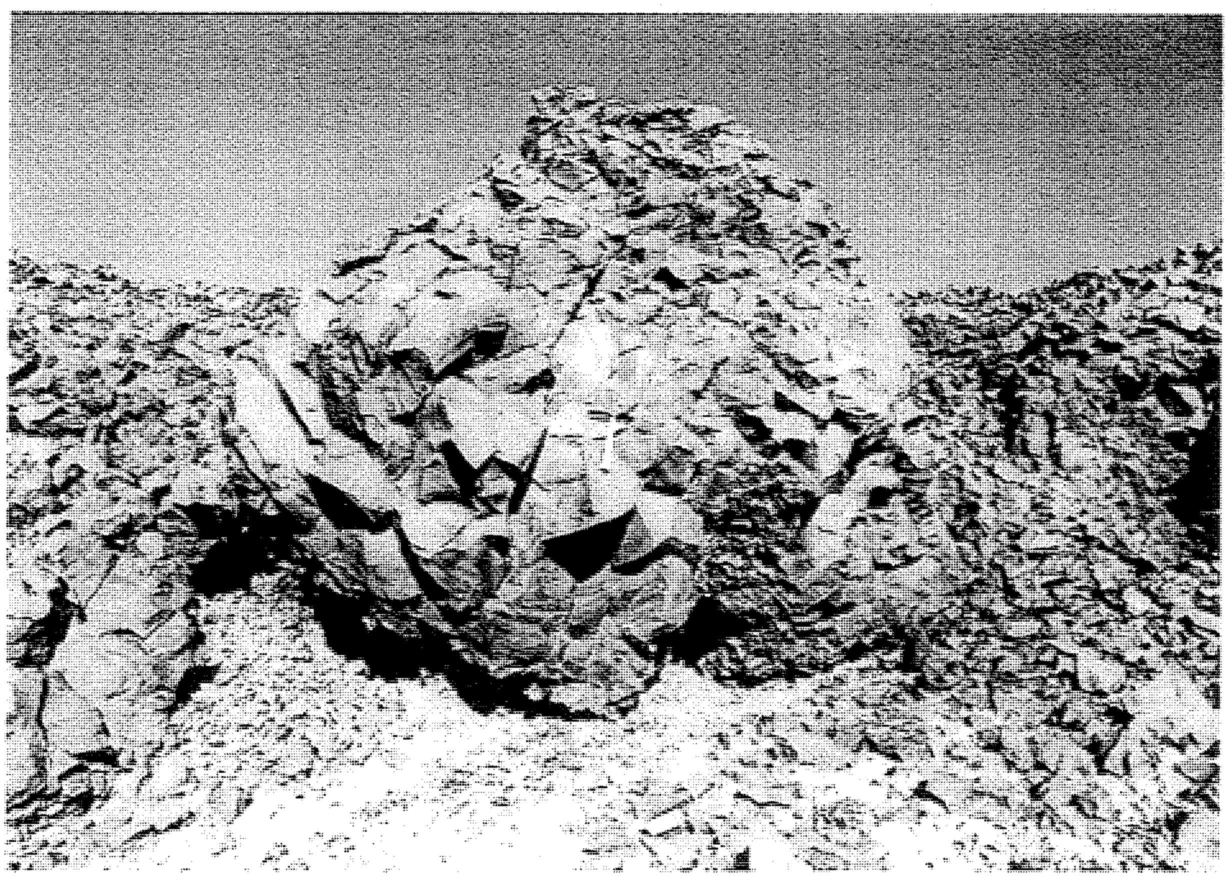
explosions and fiery lava fountains burst through these lakes to the surface. This activity is well-documented by the occurrence of bedded hyaloclastite ash (quenched glass fragments, typically well-indurated and altered to yellow secondary minerals) on the lower flanks of Pu'u Poliahu and Pu'u Waiau. It is probable that similar hyaloclastite forms the cores of all Mauna Kea's summit area cones, but these deposits have been buried by later cinders and lava bombs as erupted materials built cones above the tops of glaciers and the effects of water diminished.

The generalized locations of lava flow/ice contact margins are shown on Fig. 1. These steep flow margins are characterized by very fine-grained, quickly cooled lava, and include the sources of all the adze-making quarries on Mauna Kea (Fig. 3). Most of these contact margins are modified by later glacial erosion, which removed most original structures. The best examples of lava flow/ice contact relations on Mauna Kea are preserved north and northwest of Pu'u Poliahu (Fig. 8), on the southern margin of the Astronomy Precinct (group 70 International, 1999). Large pillow-like structures here (Fig. 9) were formed as molten lava quenched against meltwater at sub-glacial flow margins. Spiracles (gas chimneys) formed where molten lava was penetrated by ascending steam (Fig. 10). These features are also well illustrated by Porter (1987).

(c) <u>Glacial till and moraines:</u> Glaciers erode vast quantities of rock from their upper reaches and transport this material downslope. Most of this eroded debris is deposited at the bases of the glaciers as broad expanses of *till* that blanket much of Mauna Kea's summit above 11,000. Glacial till forms the entire eastern flank of Mauna Kea from 11,000' to the base of Pu'u Wekiu (Fig. 2). Glacial *moraines* form at the margins of glaciers and are well-preserved along Pohakuloa Gulch, at the western boundary of the Mauna Kea Ice Age Natural Area Reserve.

(d) "<u>Self-sorted stone stripes</u>": These distinctive markings have also been referred to as "self-sorting sands" (Group 70 International, 1999) and consist of geometrically regular alterations of stones and fine-grained ash in linear rivulets on gentle slopes of certain fine-grained Mauna Kea cinder cones (Fig. 11) . They are especially well-developed on the inner rim of Pu'u Waiau within the Mauna Kea Ice Age Natural Area, and on the lower southwestern slopes of Pu'u Poliahu (Fig. 1). These puzzling features form by the alternate freezing and thawing of "needle-ice", and occur in many parts of the world on unvegetated hillslopes subject to frequent freeze-thaw events (Werner and Hallet, 1993).

Aerial view of Mauna Kea's summit from the northwest. Figure 8



Large pillow-like structure preserved in the lava flow margin north of Pu'u Poliahu. Figure 9

Gas spiracles exposed in the lava flow margin north of Pu‘u Poliahu　　Figure 10

“Self-sorted stone stripes” developed on the lower south slopes of Pu‘u Poliahu　　Figure 11

MANAGEMENT CONSIDERATIONS

A. Resources within the Astronomy Precinct.

1. Glacial features. The Astronomy Precinct includes well-preserved glacial features over much of its area, including glacially polished and striated lava surfaces, "chatter marks", and glacial erratics. Well-preserved examples of such features are also found in many other areas of the Mauna Kea Science Reserve and Mauna Kea Ice Age Natural Area Reserve (Fig. 1) and are extremely common in alpine areas throughout the world wherever glacial ice has moved across hard bedrock. Within the Astronomy Precinct these features are largely restricted to high-standing rock outcrops , and it is suggested that access roadways and construction sites be located on lower-standing areas wherever feasible to avoid destruction of the glacially-polished rock surfaces.

2. Sub-glacial lava/ice contact features. The steep cliffs at the southern and western boundaries of the Astronomy Precinct north of Pu'u Poliahu represent the margins of a lava flow that was erupted beneath Mauna Kea's summit glacier about 30-40,000 years ago (Wolfe and others, 1997, Plate 3). As this flow moved downslope beneath a thick cover of ice, it was surrounded by an envelope of melted icewater that separated molten lava from ice. In this fiery contact zone unique lava structures formed that represented the effects of rapid cooling and conversion of water to steam. After the eruption ceased and the lava flow cooled, continued movement of the glacier eroded this contact zone and destroyed many features, but the structures that remain (Figs. 9. 10) are some of the best examples of lava/ice interaction found anywhere in the world.

These areas are very steep, consist of loose and unstable rock, and are likely not suitable for any construction purposes. They are presently included within the boundaries of the Astronomy Precinct as depicted on Fig. IX-13, but should be protected from any future construction activities. Great care should be taken so as not to discard debris over these cliffs during future construction on the flat-lying areas above. These lava/ice contact features are easily accessible by a trail leading along the north slope of Pu'u Poliahu and have excellent potential as teaching resources for the public or for others interested in the unique interactions between fire and ice that have characterized Mauna Kea's geologic past.

B. Resources within the Natural/Cultural Preservation Area.

1. Cinder Cones. The cinder cones of Mauna Kea's summit region are some of the best preserved such features in Hawaii, in large part owing to their remoteness from human activities. These cones are visually attractive in their pristine state, preserve excellent examples of pyroclastic structures such as lava bombs, and should be protected from future construction modification, as is stated in the Mauna Kea Science Reserve Master Plan (Group 70 International, 1999). The slopes and rims of these cones are constructed of loose, friable materials, however, and excessive visitations by humans could cause degradation over time simply by the action of foot traffic on cinder slopes. Because of their remoteness, however, most

of them are rarely visited by humans and such traffic is not a significant problem. In fact the traffic impact of feral sheep and goats may be more significant than that of humans.

The slopes of most of these cones are littered by lava bombs (Fig. 4) of various shapes and sizes. These bombs are fragile and can be destroyed by the common "recreational process" of rock-rolling or removed by collectors. Visitors intending to climb Mauna Kea's cinder cones should be asked not to engage in such practices and to refrain from sliding down cinder slopes. If visitor traffic to these cones ever increased significantly, the marking of formal trails up cinder cone slopes should be considered to limit degradation.

2. Pit Craters. The one pit crater found in the summit area is located within the Mauna Kea Ice Age Natural Area (Fig. 5) and is rarely visited. This feature is large, however, and is not susceptible to damage from human impact. A good view of this pit crater is available from the slope above, near the large adze quarry east of Pu'u Koko'olau. Visitors to this quarry and adjacent adze workshops could be made aware of this unique feature through signage or visitor literature.

3. Glacial Features. Glacial features are widely distributed throughout the Natural/Cultural Preservation Area and Mauna Kea Ice Age Natural Area Reserve. Most of these features (glacially polished rock surfaces, lava/ice contact zones, and glacial till and moraine deposits) are robust and not subject to degradation by human visitation and require no special protection from casual visitors. The "self-sorted stone stripes" found within the NAR and on the south slope of Pu'u Poliahu are fragile, however, and could be easily damaged by human footsteps; visitors should be asked not to walk directly across the slopes where they are found. These unique soil textures are likely re-generated by repeated freeze/thaw cycles, and may be self-healing over time.

The glacial features of Mauna Kea are unique in Hawaii and are important for public education and appreciation. They are not widely known to Mauna Kea visitors, and the most appropriate management tool for their preservation and utilization as educational resources is public awareness. Brochures to describe these unique features and public exhibits to document their locations and modes of origin will allow Hawaii residents and visitors to realize their importance to the environment of Mauna Kea.

VOLCANIC HAZARDS

Mauna Kea has not erupted within the period of Hawaii's human occupancy (the last eruption occurred about 4,400 years ago), and the volcano is considered to be "dormant" by volcanologists . It is almost certain that Mauna Kea will erupt again, however, although no studies have ever been made of eruption probabilities. The statistical probabilities for future eruptions must be based on the past history, assuming that the long-term record of the recent past will also characterize the near future.

Wolfe and others (1997) mapped a total of 12 post-glacial eruptive vents on Mauna Kea; the youngest on the south flank erupted between 4,000 and 5,000 years ago. Although none of these younger vents are found within the Mauna Kea Science Reserve, they occur near Hale Pohaku and along the Summit Access Road above 11,000 ft. elevation. The fact that these 12 eruptions have occurred within the past 10,000 years or so suggests a "recurrence interval" of somewhat less than 1,000 years. Mauna Kea's post-glacial eruptions have been episodic rather than periodic, however, with a particular concentration of eruptive activity between 4,400-5,600 years ago. The 1,000 year recurrence interval of the past 10,000 years does not thus indicate that an eruption is "overdue", but does reinforce the likelihood that eruptions will occur sporadically in the future. Future eruptions will be similar to those of Mauna Kea's past, and marked by the formation of high cinder cones and sluggish lava flows that will mostly impact the lower flanks of the volcano. Eruptions of this type will almost certainly be preceded by substantial premonitory activity, which will likely give years of advance warning. No "volcanic earthquakes" of the sort that will precede Mauna Kea's next eruption have ever been detected beneath the volcano, and it can be safely assumed that no eruption is likely in the humanly near future.

REFERENCES CITED

Frey, F.A., Wise, W.S., Garcia, M.O, West, H., Kwon, S.T., and Kennedy, A., 1990, Evolution of Mauna Kea Volcano, Hawaii - petrologic and geochemical constraints on postshield volcanism: Journal of Geophysical Research, v. 95, p. 1271-1300.

Group 70 International, 1999, Mauna Kea Science Reserve Master Plan, Draft #4: Unpublished report to the University of Hawaii Board of Regents, November, 1999,

Moore, J.G., and Clague, D.A., 1992, Volcano growth and evolution of the Island of Hawaii: Geological Society of America Bulletin, v. 104, p. 1471-1484.

Porter, S.C., 1972, Distribution, morphology, and size frequency of cinder cones on Mauna Kea Volcano, Hawaii: Geological Society of America Bulletin, v. 83, p. 3607-3612.

Porter, S.C., 1979b, Quaternary stratigraphy and chronology of Mauna Kea, Hawaii - a 380,000 year record of mid-Pacific volcanism and ice-cap glaciation: Geological Society of America Bulletin, Pt. 2, v. 90, p. 908-1093.

Porter, S.C., 1979c, Geologic map of Mauna Kea volcano, Hawaii: Geological Society of America, Map and Chart Series MC-30, Scale 1:57,000.

Porter, S.C., 1987, Pleistocene subglacial eruptions on Mauna Kea, in Decker, R. W., Wright, T.L., and Stauffer, P.H. (Eds.), Volcanism in Hawaii: U.S. Geological Survey Professional Paper 1350, p. 587-598.

Washington, H.S., 1923, Petrology of the Hawaiian Islands; 1, Kohala and Mauna Kea, Hawaii: American Journal of Science, ser. 5, v.5, p. 465-502.

Wentworth, C.K. and Powers, W.E., 1941, Multiple glaciation of Mauna Kea, Hawaii: Geological Society of America Bulletin, v. 52, p. 1193-1218.

Werner, B.T. and Hallet, B., 1993, Numerical simulation of self-organized stone stripes: Nature, v. 361, p. 142-145.

Wolfe, E.W., Wise, W.S., and Dalrymple, G.B., 1997, The geology and petrology of Mauna Kea Volcano, Hawaii – a study of postshield volcanism: U.S. Geological Survey Professional Paper 1557, 129 pp.

ACKNOWLEDGMENTS

I am particularly indebted to Professor Steven Porter of the Quaternary Research Center of the University of Washington for a great deal of background information used in this Report. He has studied Mauna Kea for over thirty years, and gave freely of his knowledge of this volcano, including his personal insights into features and specific localities that were particularly unique. Ed Wolfe and Bill Wise also know the geology of Mauna Kea well, and shared information on localities of interest

APPENDICES

A. Suggested revisions to existing sections of Draft #4 --- Pages IV-1, -2

Mauna Kea Science Reserve Master Plan Draft #4
Natural Environment Page IV - 1

NATURAL ENVIRONMENT

Geologic History

The Hawaiian Archipelago, extending 2,200 miles across the Pacific Ocean, was built almost entirely by volcanic activity. The oldest of the volcanoes are in the northwest and the youngest extend to the southeast. Each island is the top of an enormous volcano that grew from the sea floor to above sea-level, modified by stream and wave erosion and by minor amounts of organic reef growth.

Mauna Kea formed as a shield volcano that was later modified by neatly formed cinder cones and associated blocky lava flows. It is a dormant postshield stage volcano that last erupted about 4,500 years ago; and hence cannot yet be labeled as extinct. The oldest exposed lava flows on Mauna Kea are approximately 250,000 years old. The mountain's latest volcanic activity was characterized by explosive eruptions that produced widespread ash deposits. (Clague in Atlas of Hawaii , 1998).

The dome of Mauna Kea measures 30 miles across and is studded with cinder cones in a pattern indicating that the volcano was built over rifts extending eastward, southward, and westward. The volcanic rocks of Mauna Kea are divided into two series. The older Hamakua series is made up chiefly of primitive olivine basalts and forms the bulk of the mountain. The overlying Laupahoehoe volcanic series predominantly consists of andesine andesites ("hawaiites") and forms a thin veneer over the upper part of the mountain. The Laupahoehoe series is the thickest at the Mauna Kea summit where it has filled in the summit caldera. This volcanic series is characterized by both short and long a'a flows and bulky cinder cones. (Stearns, 1966).

During the last glaciation of the Pleistocene epoch, an ice cap covered approximately 27 square miles of the summit area of Mauna Kea (Porter, 1979). The tops of several of the mountain's cinder cones peaked stood above the ice cap, which had an average thickness of 200 feet and a maximum thickness of 350 feet in places. Within the limits of this glacier, which reached down to the 11,000 and even the 10,500-foot elevation, many areas were scraped bare of ash and cinder. (Macdonald and Abbott, 1970). The scouring action of the glacier is documented today by the common occurrence of glacially polished rock outcrops in the summit area and by glacial till deposits and classic terminal moraines such as those of Pohakuloa Gulch. In other parts of the summit plateau, over steepened sides of *pu'u* and large areas of glacial till indicate the extent of the glacier. Areas of buried ground ice in the craters of two of the summit cinder cones show that permafrost exists near the summit where the mean annual temperature is below freezing . Cycles of freezing and thawing continue today, creating ever-changing patterns of rock fragments. These fragments of various coarseness are constantly moving, sorted into stripes and polygons .

Mauna Kea, seemingly quiet and still, is never at rest.

During this period, volcanic eruptions continued to take place beneath the ice cap, forming several subglacial lava flows. Margins of these lava flows cooled quickly against ice meltwater, creating uniquely hard, dense rock in many places. Thousands of years later, this fine-grained, dense rock was sought after by Hawaiians who used it to craft adzes.

The landscape that exists today was formed by volcanic and glacial activity and is a unique environment for insects, spiders, lichens, ferns, and mosses. Rocky outcrops, loose cinder, and smooth lava flows make up habitats that combine with the snowfall and wind patterns of the summit area to support various forms of plant and animal life.

Among the many natural features found on Mauna Kea, the small alpine lake, Wai'au , is unique and revered. Wai'au is a nearly circular pond, 300 feet in diameter, situated on the summit platform of Mauna Kea at an altitude of approximately 13,020 feet. It is the highest lake within the boundaries of the Pacific Ocean basin and one of the highest lakes in the United States. The southern rim of the depression containing the lake is the rim of a subglacially-formed cinder cone, Pu'u Wai'au. The water of the lake, a maximum of 10 feet deep, is derived entirely from precipitation and runoff from the edges of the basin. (Stearns and Macdonald, 1946)

B. Suggested revisions to existing sections of Draft #4 --- Page IX-8:

[NOTE: I suspect this section may be changed to reflect inclusion of our "Geologic Resources Management Plan" and associated figures elsewhere in this document. I shall nonetheless make suggested changes here to indicate additions and factual corrections to this section if it is retained in some form... (jpl)]

GIS Mapping of Natural and Cultural Resources

Unique Surface Geology. There are numerous unique areas of surface geology within the Science Reserve, including cinder cones, glacially scoured rock surfaces, glacial moraines, rock structures formed by sub-glacial eruptions, texturally sorted soils, and an alpine lake. Outcrops of uniquely fine-grained, dense lava found along sub-glacial vents and lava/ice contacts within the Mauna Kea Ice Age Natural Area Reserve and adjacent areas were extensively used as quarries (Keanakako'i) for ancient Hawaiians to obtain adze materials. The distribution of these features is shown in Fig 1. These areas are included in the GIS as unique geological resource areas, and will be protected from disturbance by development and intensive recreational activities. Slopes in excess of 20 percent are shown in Figure IX-7.

MAUNA KEA SCIENCE RESERVE
MASTER PLAN

APPENDIX I

1999 Mauna Kea Science Reserve and Hale Pōhaku Complex Development Plan Update: Oral History and Consultation Study, and Archival Literature Research. Ahupua'a of – Ka'ohe (Hāmākua District) and Humu'ula (Hilo District), Island of Hawai'i (various TMK)

Kepā Maly

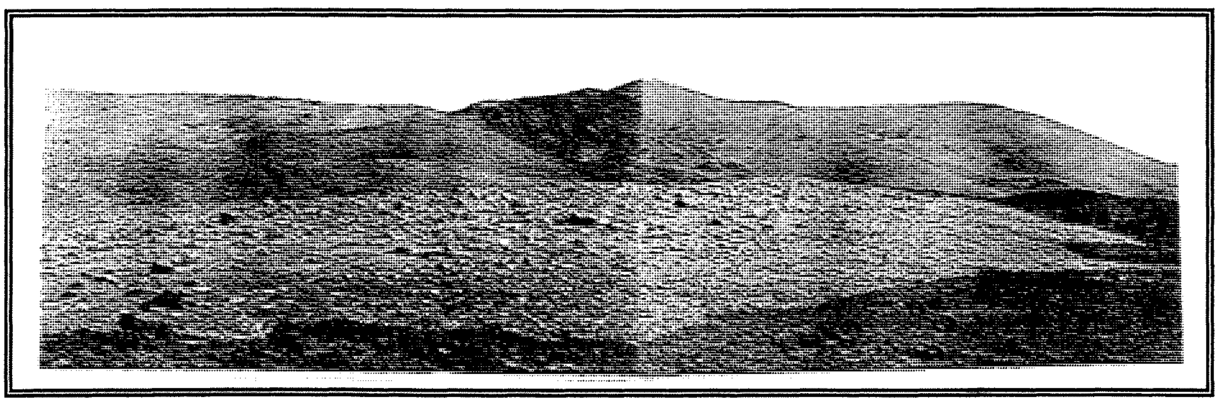
February, 1999

MARCH 2000

MAUNA KEA SCIENCE RESERVE AND HALE PŌHAKU COMPLEX DEVELOPMENT PLAN UPDATE:

ORAL HISTORY AND CONSULTATION STUDY, AND ARCHIVAL LITERATURE RESEARCH

Ahupua'a of – Ka'ohe (Hāmākua District) and Humu'ula (Hilo District), Island of Hawai'i



Mauna Kea Summit Region:
"Panorama showing lateral moraine in contrast with unglaciated a-a surface compound summit cone of Mauna Kea in background."
(C.J. Krabel Collection; 1922 - Bernice Pauahi Bishop Museum Negative No. 14985 – A)

Kumu Pono Associates

Historical & Archival Documentary Research · Oral History Studies · Partnerships in Cultural Resources Management · Developing Preservation Plans and Interpretive Programs

Report HiMK21 (020199)

MAUNA KEA SCIENCE RESERVE AND HALE PŌHAKU COMPLEX DEVELOPMENT PLAN UPDATE:

ORAL HISTORY AND CONSULTATION STUDY, AND ARCHIVAL LITERATURE RESEARCH

Ahupua'a of – Ka'ohe (Hāmākua District) and Humu'ula (Hilo District), Island of Hawai'i (various TMK)

BY

Kepā Maly • Cultural Resources Specialist

PREPARED FOR

Group 70 International
925 Bethel Street, Fifth Floor
Honolulu, Hawai'i 96813-4307

February 1, 1999

Kumu Pono Associates
Kepā Maly, Consultant
Historical & Archival Documentary Research · Oral History Studies · Partnerships in Cultural Resources Management • Developing Preservation Plans and Interpretive Programs

554 Keonaona St. · Hilo, Hawai'i 96720 · (ph./fax) 808.981.0196 · (e-mail) kepa@interpac.net

EXECUTIVE SUMMARY

At the request of Group 70 International, cultural resources specialist, Kepā Maly (*Kumu Pono Associates*), conducted oral historical interviews and developed an overview of archival and historical literature in conjunction with the update of the Complex Development Plan of the Mauna Kea Science Reserve and Hale Pōhaku for the University of Hawai'i (UH). The primary UH study area is situated in the *ahupua'a* (land divisions) of Ka'ohe (Hāmākua District) and Humu'ula (Hilo District), on the island of Hawai'i; and encompasses the summit region of Mauna Kea. This study was conducted to help document some of the traditions and practices associated with Mauna Kea, and to identify some of the significant features of the landscape, including natural and man-made cultural resources on Mauna Kea so that they can be protected, preserved, and appropriately managed in the future.

The work conducted as a part of this study was developed and performed in consultation with the Department of Land and Natural Resources-State Historic Preservation Division, native Hawaiian organizations and community members, and the consulting firm of Paul H. Rosendahl, Ph.D., Inc. (PHRI), a sub-consultant to Group 70 International for the master plan update project.

Mauna Kea is one of the most significant land features of the Hawaiian Archipelago. Because of its prominence on the landscape of Hawai'i Island, Mauna Kea has been and continues to be viewed from afar by many people who attribute spiritual and cultural values to the mountain. Thus, Mauna Kea's place in the culture and history of the Hawaiian people is significant, and extends beyond physical sites or particular features which have been previously identified in archaeological site studies. The present study area contains approximately 11,000 acres and includes a portion of the southern flank of the mountain, and the entire summit region (the zone at approximately the 11,500 foot elevation and higher) of Mauna Kea.

Oral History Interviews and Consultation

In the period between September 25th to December 21st, 1998, Maly (the author) conducted a total of fifteen tape recorded and supplemental oral history interviews with twenty-two participants. The interviews were transcribed and returned to each of the interviewees and follow up discussions were conducted to review each of the typed draft-transcripts. The latter process resulted in the recording of additional narratives with several interviewees. Following completion of the interview process, all of the participants in the tape recorded oral history interviews gave their written permission for inclusion of portions of their transcripts in this study (*Appendix A*). Additionally three historic interviews (recorded between 1956 to 1967) were translated from Hawaiian to English by the author and transcribed. With those interviews, representing three primary interviewees, the total number of interviewees represented in this study is twenty-five.

Also, during the process of preparing for, and conducting the formal recorded interviews, the author spoke with more than 100 individuals who were known to him, or were identified as: (*1*) having knowledge about Mauna Kea; (*2*) knowing someone who could be a potential interviewee; or (*3*) who represented Native Hawaiian organizations (i.e. *Hui Mālama i nā Kūpuna o Hawai'i Nei*, the Island of Hawai'i Council of Hawaiian Civic Clubs, and the Office of Hawaiian Affairs) with interest in Mauna Kea. Several of those contacts resulted in the recording of informal documentation regarding Mauna Kea, or generated written responses as formal communications. Notes written up during some of those conversations, which add information to the historical record of Mauna Kea, are cited as personal communications in *Appendix B*. The notes paraphrase key points from individual conversations, but were not reviewed by the individuals identified. Thus, they represent informal communications which could be followed up on at a later date as a part of further work to be undertaken on Mauna Kea. The formal letter communications are also reproduced from the original transmittals in their entirety in *Appendix B*.

It is also noted here that several potential participants in the interview or consultation process were unavailable or did not wish to participate in the formal oral history interview study. All but one of those individuals were identified when they spoke at one or more of three formal public hearings held by the Mauna Kea Advisory Committee (MKAC) on August 31st, September 1st and 3rd, 1998. By agreement with hearing participants, the hearings were recorded on tape. Those tapes were transcribed by Group 70 International (with final transcript preparation by this author), but because of technical difficulties, not all of the testimonies were recorded. Portions of the testimonies made by individuals who did not participate in the oral history program, but which include cultural-historical narratives are cited verbatim in *Appendix C* as they provide readers with further information on issues and concerns raised about Mauna Kea.

Documentary Research

In the period between August 1996 and May 1998, the author conducted and reported on the findings of detailed archival research for the Mauna Kea study area (Maly, published May 1998). As a result, the present scope of work for this study focused on oral history interviews, limited archival research, and development of an overview of several recent studies which provide important historical documentation on Mauna Kea (reported in *Appendix D* of this study). Archival documentation was researched in the collections of the Hawai'i State Archives, Land Management and Survey Divisions, and Bureau of Conveyances; collections of the Bernice Pauahi Bishop Museum and Hawaiian Historical Society; and the University of Hawaii-Hilo Campus, Mo'okini Library. Also, while the scope of work for this study did not include conducting a detailed review of previous archaeological work performed on Mauna Kea, the author did review several key studies. Archaeologists with the Department of Land and Natural Resources-State Historic Preservation Division and the consulting firm of Paul H. Rosendahl, Ph.D., Inc. (PHRI) are preparing reports on past and present archaeological studies on Mauna Kea.

Overview of Research and Primary Recommendations made by Interviewees and Consultation Participants

The archival literature and oral historical accounts cited in this study provide resource managers, UH planners, DLNR-SHPD, consultants, and members of the community with several forms of information. They include: (*1*) historical accounts of practices on, and travel to Mauna Kea, as experienced by elder native Hawaiians and others with personal knowledge—learned from elders or through actual travel upon the mountain; an overview of the pre-history and early historic period of Mauna Kea; (*2*) through the recollections and stories of the interviewees—some of whom trace their connection to Mauna Kea back to the 19th century—readers gain an overview of their sentiments regarding the impacts attributed to the present uses of Mauna Kea and proposed further development of observatory facilities on Mauna Kea; and (*3*) an overview of the pre-history and early historic period of Mauna Kea.

In regards to item # 2 referenced above, sixteen of the interviewees expressed the opinion that the proposed development of additional observatory complexes on Mauna Kea was inappropriate. Two of the interviewees expressed hesitancy at further development–based on a deep respect for Mauna Kea. One interviewee felt that the benefits of the work done by the observatories far out weighed other concerns, and that the research conducted on Mauna Kea provided important knowledge to all mankind.

All individuals spoken with as a part of the consultation and information collection process felt that further development of observatories on Mauna Kea was inappropriate. All participants in the study shared a common love for the mountain and encouraged that any activity on Mauna Kea be done in a way that is respectful of the past and the natural resources, and that all activities need to be monitored to ensure protection of the resources.

Study Organization

As noted above, this study presents readers with the findings of two phases of work — (*1*) oral historical interviews and consultation records (in this volume); and (*2*) documentation recorded in archival and historical literature (*Appendix D*). Because this project represents the first detailed oral history program for Mauna Kea — focusing on the area extending from the *piko* (summit) to the *kula* (flat lands) surrounding Mauna Kea — the oral history and consultation records are presented in the main body of the document. In the area of archival-historical literature, there has been more extensive work conducted and reported, thus, the overview of that documentation is presented following the interview and consultation records.

CONTENTS

APPENDICES

INTRODUCTION

BACKGROUND

At the request of Group 70 International, cultural resources specialist, Kepā Maly (*Kumu Pono Associates*), conducted a two phased study in conjunction with the preparation the Complex Development Plan update of the Mauna Kea Science Reserve and Hale Pōhaku for the University of Hawai'i (UH). The primary UH study area is situated in the *ahupua'a* (land divisions) of Ka'ohe (Hāmākua District) and Humu'ula (Hilo District), on the island of Hawai'i (TMK Overview Sheets: 3-8-01 & 4-4-15); in the summit region of Mauna Kea (*Figure 1*). This study was conducted in two primary phases. One phase of the study entailed conducting a detailed oral history interview and consultation program. The other phase of work included a limited review and preparation of an overview of archival and historical literature. The work conducted as a part of this study was developed and performed in consultation with the Department of Land and Natural Resources-State Historic Preservation Division (DLNR-SHPD); native Hawaiian organizations and community members; the Mauna Kea Advisory Committee; and the archaeological consulting firm of Paul H. Rosendahl, Ph.D., Inc. (PHRI).

Overall, this study was conducted to help document some of the traditions and practices associated with Mauna Kea, and to identify some of the significant cultural features of the landscape and other resources on Mauna Kea so that they can be protected, preserved, and appropriately managed in the future. Additionally, the interview component of the study specifically elicited recommendations from interviewees regarding present and future uses of Mauna Kea. As a result, the oral history interviews cited in this study provide readers with detailed documentation about Mauna Kea and an introduction to some of the people who have been a part of the mountain's history. This study also provides those interested in conducting further research and interviews with leads to contacts and resources for undertaking such work.

Importantly, the information cited herein, presents the UH, Department of Land and Natural Resources-State Historic Preservation Division, native Hawaiians, and community organizations with historical information that will be helpful in the creation of a partnership by which to continue learning about Mauna Kea and developing a comprehensive integrated resources management program for Mauna Kea's varied resources (development of such a partnership is one of the interviewee recommendations discussed at end of this study).

Project Setting: A Cultural Landscape

Mauna Kea is the focal point of a number of native Hawaiian traditions, beliefs, customs, and practices. With its summit peak reaching 13,796 feet above sea level, Mauna Kea is one of the most significant land features of the Hawaiian Archipelago. In the summit region of Mauna Kea—an area extending from around the 10,000 foot elevation to the summit peak, including a plateau-like feature above the 11,500 foot elevation—and on its slopes extending down to an area once covered in dense forest growth (approximately the 9,000 foot elevation), are many *pu'u* (hills) and other natural features. A number of the place names recorded for this mountain landscape are associated with Hawaiian gods. Other place names are descriptive of natural features and resources, or document events that occurred on the mountain.

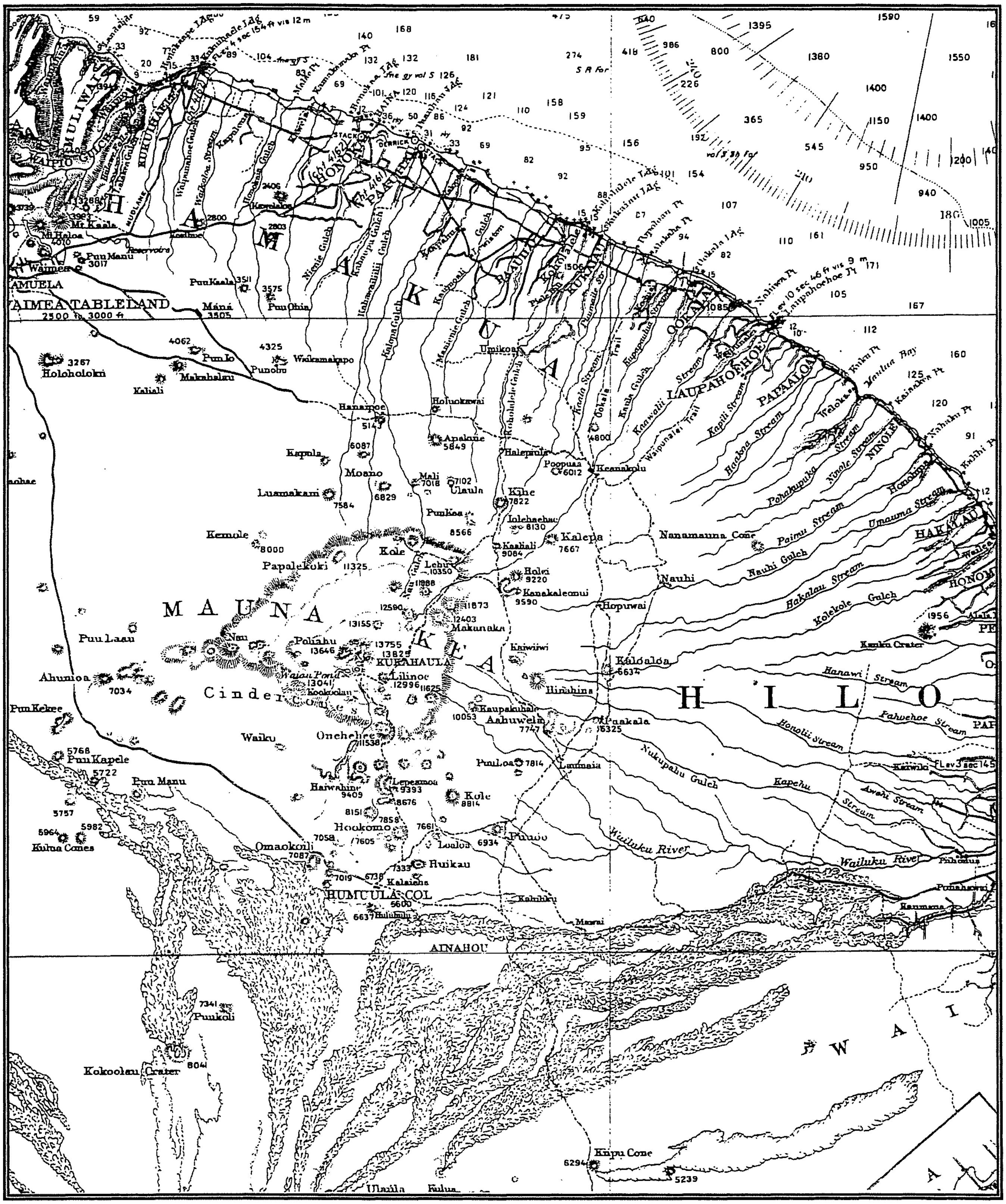


Figure 1. Mauna Kea, Island of Hawai'i (with Districts of Hilo, Hāmākua and Kohala)
Portion of U.S. Army Map – surveys up to 1932; in collection of DLNR-DOFAW

Perhaps as a result of its prominence, isolation, and extreme environmental conditions, Mauna Kea's place in the culture and history of the Hawaiian people is significant. This "cultural significance" extends beyond a physical setting, sites or particular features which have been previously identified in archaeological site studies. Mauna Kea is a prominent feature on the cultural landscape of Hawai'i which has been and continues to be, viewed from afar, and to which spiritual and cultural significance is attributed.

Archaeological surveys (see DLNR-SHPD and PHRI documentation cited in the Master Plan) have recorded a number of significant cultural sites in the summit region of Mauna Kea. Department of Land and Natural Resources-State Historic Preservation Division (DLNR-SHPD) archaeologists note that nearly all of the identified sites are shrines, burials, or are associated with adze manufacture practices. This "cultural landscape" has been determined to be eligible for the National and State Register of Historic Places, under multiple criteria, including cultural significance to the native Hawaiian people (cf. letter of D. Hibbard to R. Evans, September 12, 1991). As a result, archaeologists with DLNR-SHPD have referred the summit region of Mauna Kea as a "ritual landscape," with all of the individual parts contributing to the integrity of the whole summit region (pers comm. P. McCoy and H. McEldowney; Group 70 meeting of September 10, 1998).

The present study area contains approximately 11,000 acres. It includes a portion of the southern flank (Hale Pōhaku vicinity) of the mountain and the entire summit region—the zone at approximately the 11,500 foot elevation and higher—of Mauna Kea. Documentation found in native traditions, historic accounts, and oral history interviews (cited in this study), and the presence of cultural features on the ground all speak to the uniqueness of, and significance of Mauna Kea. Yet, while there is much that has been recorded, there is more that remains unanswered. Thus, it is in this light, that wise use of, and care for Mauna Kea takes on a greater urgency in these times of change. A number of participants in the oral history and consultation phases of this study, recommend that the DLNR and University form a partnership with knowledgeable individuals descended from families with generations of experience on Mauna Kea and others, who can help protect and interpret the landscape that is Mauna Kea.

Overview: Study Guidelines and Presentation

The oral historical and archival research conducted for this study was performed in a manner consistent with Federal and State laws and guidelines for such studies. Among the referenced laws and guidelines were the National Historic Preservation Act (NHPA) of 1966, as amended in 1992; the Advisory Council on Historic Preservation's "*Guidelines for Consideration of Traditional Cultural Values in Historic Preservation Review*" (ACHP 1985); National Register Bulletin 38, "*Guidelines for Evaluating and Documenting Traditional Cultural Properties*" (Parker and King 1990); the Hawai'i State Historic Preservation Statute (Chapter 6E), which affords protection to historic sites, including traditional cultural properties of ongoing cultural significance; the criteria, standards, and guidelines currently utilized by the Department of Land and Natural Resources-State Historic Preservation Division (DLNR-SHPD) for the evaluation and documentation of cultural sites (cf. Title 13, Sub-Title 13:274-4,5,6; 275:6 – Dec. 12, 1996); and guidelines for cultural impact assessment studies, adopted by the Office of Environmental Quality Control (November 1997).

While the scope of work for this study did not include conducting a detailed review of, and writing a summary of previous archaeological work performed on Mauna Kea, the author met with state and project archaeologists on several occasions. The author also reviewed several primary archaeological studies as a part of the research. Archaeologists with the Department of Land and Natural Resources-State Historic Preservation Division, who have been working on Mauna Kea for more than 15 years, and the consulting firm of Paul H. Rosendahl, Ph.D., Inc. (PHRI) present detailed documentation on past and present archaeological studies on Mauna Kea. *It is further noted that information collected as a part of this study will be, taken into consideration by the archaeologists in determining recommendations for site protection, interpretation, and treatment* (see reports prepared by DLNR-SHPD and PHRI as a part of the present Master Plan project).

In summary, this study presents readers with information collected from two primary resources — oral historical and consultation narratives, and archival literature. Cited documentation has been recorded over and period of more than 170 years, and covers many centuries of traditions. It will be seen that there is continuity and a number of similarities shared between both forms of documentation. The continuity in the written and oral historical accounts, suggests that there is time-depth in many aspects of the cultural knowledge expressed and practiced by members of the present generation.

Oral History Interviews and Consultation Records of the Mauna Kea Study

Oral history interviews for the Mauna Kea study were conducted between September 25th–December 21st, 1998. Maly (the author) conducted a total of fifteen tape recorded and supplemental oral history interviews with twenty-two participants. The interviews were transcribed and returned to each of the interviewees and follow up discussions were conducted in review each of the typed draft-transcripts. The latter process resulted in the recording of additional narratives with several interviewees. Following completion of the interview process, all of the participants in the tape recorded oral history interviews gave their written permission for inclusion of portions of their transcripts in this study (*Appendix A*). Additionally three historic interviews (recorded between 1956 to 1967) were translated from Hawaiian to English by the author and transcribed. Those interviews were located in the collection of the Bernice Pauahi Bishop Museum and personal collection of Larry Kauanoe Lindsey Kimura, Chairman of the Hawaiian Studies Department, University of Hawai'i-Hilo. With those interviews, representing three primary interviewees, the total number of interviewees represented in this study is twenty-five.

Also, as a part of the present study, more than 100 individuals and representatives of native Hawaiian organizations were contacted, told about the present study, and invited to provide input into development of the study and its report of findings[1]. Narratives recorded as a part of the interview program and references from the consultation process are presented in the following section of the study. The detailed communications of the consultation program are cited in *Appendices B & C*. During the interviews and other communications, several historic maps were referenced, and when appropriate, the general locations of sites referenced were

[1] Also, for several years, the author has been speaking with various individuals about the history of Mauna Kea, and selected references from those communications are cited in the consultation records as well.

marked on the maps. That information was in turn compiled on one map, which is cited as *Figure 2*, an annotated interview map at the end of this study.

Archival Research

The primary sources of archival literature were five previously published studies, which in-turn cited primary sources of historical documentation. One of the most recent studies that included detailed historical documentation recorded by native Hawaiian authors and historic documentation compiled in the late 1800s and early 1900s, was researched and written by the author of the present study (Maly, published May 1998). Titled "*Mauna Kea – Kuahiwi Ku Ha'o i ka Mālie: A Report on Archival and Historical Documentary Research; Ahupua'a of Humu'ula and Ka'ohe, Districts of Hilo and Hāmākua, Island of Hawai'i*," the study was conducted at the request of Lehua Lopez, President of the Native Lands Institute. That work was conducted primarily in the period from August 1996 to March 1997, with supplemental information added through final publication in May 1998. As a result of having undertaken that study, the author has compiled and referenced a significant collection of archival literature on Mauna Kea[2].

An overview of the archival and historical documentary research is reported in *Appendix D*. In preparing *Appendix D*, I have not attempted to rewrite all that has been previously reported in literature on Mauna Kea. Instead, I have cited verbatim and annotated excerpts of the original documentation. The original studies (McEldowney and McCoy 1982; Cordy 1994; Kanahele and Kanahele 1997; Langlas {draft–February 1997}; and Maly 1998) provide readers with a foundational understanding of various facets of the history and cultural significance of Mauna Kea. The full reports should be referenced for a complete record of their archival resources.

Finally, as a part of this work, I have conducted further limited archival research, in follow up to leads revealed during the oral history interview phase of the study. That research was conducted between October 5th and November 24th, 1998, in the collections of the Hawai'i State Archives, Bishop Museum, Bureau of Conveyances, and Land Management Division.

[2] Primary repositories of documentation cited in the study was found in the collections of the Hawai'i State Archives, Land Management and Survey Divisions, and Bureau of Conveyances; collections of the Bernice Pauahi Bishop Museum and Hawaiian Historical Society; and the University of Hawaii-Hilo Campus, Mo'okini Library.

MAUNA KEA ORAL HISTORY INTERVIEWS AND CONSULTATION PROGRAM (SEPTEMBER – DECEMBER 1998)

Study Background

This section of the study presents readers with the following information: (*1*) an overview of how the Mauna Kea Oral History Study was designed and undertaken; (*2*) an overview of the interviewee-released accounts recorded through interviews and consultation; (*3*) communications received from Native Hawaiian organizations and individuals regarding Mauna Kea; and (*4*) an overview of primary recommendations made by interviewees and others who participated in the consultation process. As noted in the release of interview record forms (at the end of each interview — *Appendix A*), the transcripts in this study may supersede the recorded narratives. This is the result of the review process—when interviewees may make corrections or additions to their transcripts, and/or also ask that certain sensitive family information be removed from the public record.

Oral history interviews help to demonstrate how certain knowledge is handed down through time, from generation to generation. Often, because the experiences conveyed are personal, the narratives are richer and more animated than those that are typically found in reports that are purely academic or archival in nature. Thus, through the process of conducting oral history interviews things are learned that are at times overlooked in other forms of studies. Also, with the passing of time, knowledge and personal recollections undergo changes. Sometimes, that which was once important is forgotten, or assigned a lesser value. So today, when individuals—particularly those from outside the culture which originally assigned the cultural values—evaluate things such as resources, cultural practices, and history, their importance is diminished. Thus, oral historical narratives provide both present and future generations with an opportunity to understand the cultural attachment—relationship—shared between people and their natural and cultural environments.

Readers are asked to keep in mind that while this component of the study records a depth of cultural and historical knowledge of Mauna Kea and vicinity, the documentation is incomplete. In the process of conducting oral history interviews and consultation, it is impossible to record all the knowledge or information that the interviewees possess. Thus, the records provide readers with only glimpses into the stories being told, and of the lives of the interview participants. The author/interviewer has made every effort to accurately relay the recollections, thoughts and recommendations of the people who shared their personal histories in this study.

As would be expected, participants in oral history interviews sometimes have different recollections of history, or for the same location or events of a particular period. There are a number of reasons that differences are recorded in oral history interviews, among them are that:

(1) recollections result from varying values assigned to an area or occurrences during an interviewees formative years;

(2) they reflect localized or familial interpretations of the particular history being conveyed;

(3) with the passing of many years, sometimes that which was heard from

elders during one's childhood 70 or more years ago, may transform into that which the interviewee recalls having actually experienced;

(4) in some cases it can be the result of the introduction of information into traditions that is of more recent historical origin; and

(5) some aspects of an interviewee's recollections may be shaped by a broader world view. In the face of continual change to one's cultural and natural landscapes, there can evolve a sense of urgency in caring for what has been.

In general, it will be seen that the few differences of history and recollections in the cited interviews are minor. If anything, they help direct us to questions which may be answered through additional research, or in some cases, pose questions which may never be answered. Diversity in the stories told, should be seen as something that will enhance interpretation, preservation, and long-term management programs on Mauna Kea.

The author also notes here that reconciliation of information among informants is inappropriate within the interview process and is inconsistent with the purpose of oral historical research. *The main objective of the oral history interview process is to record the ideas and sentiments personally held by the interviewees as accurately and respectfully as possible, without judgement.* Adhering to these standards ensures both the quality and quantity of information obtained from individual interviewees, and facilitates the recording of information that will be of benefit to present and future generations. The oral history process also has another value to contemporary issues. It provides a means of initiating a meaningful dialogue and partnership with local communities by communicating on the basis, and in a form that is respectful of cultural values and perspectives of individuals representative of their community.

Development of the Oral History–Consultation Program

While conducting, and writing the previously mentioned archival literature study on Mauna Kea (Maly, published May 1998), the author also prepared a general list of names of potential interviewees who might be contacted as a part of an oral history study. During that period, Dr. Langlas of the University of Hawai'i-Hilo Campus, was contracted to conduct the Saddle Road Realignment study (Langlas draft – February 1997). At that time, Dr. Langlas and this author discussed potential interviewees—several of whom were interviewed by Langlas—and that list was revisited with Dr. Langlas in August of 1998. In the 1996-1997 period, and subsequently as a part of the present study, I elicited further recommendations of interviewee candidates from the Mauna Kea Advisory Committee (MKAC), DLNR-SHPD, Lehua Lopez (Native Lands Institute), Mililani Trask (*Kia'āina – Ka Lāhui Hawai'i*), and *kūpuna* and families known to myself.

During the 1996-1997 period, and leading up to the present work, I also prepared—in consultation with members of Hawaiian organizations and community members—a basic questionnaire format which could be used to develop the oral history interview discussions. Between August 31st to September 4th, 1998, that questionnaire was reviewed by staff of Group 70 International and DLNR-SHPD, and was modified in conjunction with their recommendations. *Figure 3* is the Mauna Kea Oral History Study List of General Questions, that was used to set the framework for conducting the interviews. The question outline was

Mauna Kea Oral History Interviews — List of Topics

Overview

The Mauna Kea oral history study is being conducted in conjunction with the development of the Mauna Kea Complex Development Plan, Master Plan and EIS being prepared by the State of Hawaii and University of Hawaii. During the oral history interviews, I hope to identify significant places, sites, features, or resources on Mauna Kea so that they can be avoided, preserved, or appropriately managed in the future. In the interviews, I also hope to document:

(1) how was Mauna Kea being used during your life time and in the lifetimes of your grandparents;

(2) cultural perceptions of Mauna Kea as seen from a distance; and

(3) how historic properties and cultural resources found on Mauna Kea should be treated.

For Discussion:

✓ Family background (self and elders).
✓ How did you become familiar with sites, history, and/or practices associated with Mauna Kea.

Reference Interview Map No. 1 (HTS Plat 613) and Map No. 2 (Island of Hawai'i, 1928)

✓ What activities took you to Mauna Kea — cultural and/or religious practices; resources collection; ranching; forestry; hunting; recreation… other?
✓ Besides your family, do you know of other families (individuals) who traveled to Mauna Kea, and participated in activities on the mountain?
✓ How did you go to Mauna Kea — what trails were used, and approached from where?
✓ What are the significant sites and features that your have you learned about on Mauna Kea?

Place Names: Pu'u Kūkahau'ula; Pu'u Poli'ahu; Pu'u Lilinoe; Waiau; Keanakāko'i/ Kaluakāko'i; Ka-wai-hū-a-Kāne; Pōhakuloa; Houpo-o-Kāne; Pu'u Lepeamoa; Hale Pōhaku; Keonehe'ehe'e; Mākanaka; Pu'u Papa; One o Wakiu; Kamakahālau; Pu'u-o-kihe; Pu'u Kālepa; Ahuopo'opua'a… others.

✓ How would you describe Mauna Kea — what regions or areas do you use to define Mauna Kea? Where did you view Mauna Kea from, and did you hear stories of Mauna Kea when viewed from afar — it's place in the cultural and natural landscape and relationship to other Hawaiian places?
✓ Do you know of cultural sites / historic properties on Mauna Kea (for example – shrines, *ilina*, adze quarries, habitation shelters) — can you describe them and their locations?

There are a number of *kūahu* or altar like features, many with upright stones on Mauna Kea, that encircle the summit region; there are also a number of *ahu* that encircle Lake Waiau. Did you hear about any of these sites, and what they were used for?

Did you ever hear about the methods of internment on the *pu'u* and slopes of Mauna Kea?

✓ What do you think about the use of cultural-historic sites on Mauna Kea? Should they be protected as is? Should native Hawaiian practitioners continue using the sites, thus changing them from how they were left by the early Hawaiian visitors to Mauna Kea?
✓ What do you feel about the telescopes on Mauna Kea; and further development of telescope facilities on Mauna Kea?
✓ What steps would you recommend be taken to protect the summit area and cultural sites on Mauna Kea?

HiMk21-OHQ.doc2
(group70-SHPD – September 4, 1998)

Figure 3. Mauna Kea Oral History Study List of General Questions

forwarded to some of the interviewees at their request prior to the interview, and was referenced during all of the interviews.

Additionally during the process of preparing for, and conducting the formal recorded interviews, the author spoke with more than 100 individuals who were known to him, or who were: (*1*) identified as having knowledge about Mauna Kea; (*2*) knew some one who should be contacted as a potential interviewee; or (*3*) who represented a Native Hawaiian organizations (i.e. *Hui Mālama i nā Kūpuna o Hawai'i Nei*, the Office of Hawaiian Affairs {as mandated in the NHPA and NAGPRA}, and the Island of Hawai'i Council of Hawaiian Civic Clubs). Several of the contacts referenced above resulted in the informal recording of documentation regarding Mauna Kea, or generated written responses as formal communications from individuals and Native Hawaiian organizations. Notes written during some of those conversations, which add information to the historical record of Mauna Kea, are cited in *Appendix B*. The expanded notes summarize the discussion and paraphrase key points from individual conversations. Because the expanded notes were not reviewed by the individuals, they do not represent formal documentation, but provide an overview of selected information and may provide guidance for further work in the future. The formal letter communications received in response to inquiries are also reproduced from the original transmittals in their entirety, in *Appendix B*.

In accordance with Federal and State guidelines, one additional inquiry and request for public participation was made as a part of this study. An announcement and inquiry for assistance was developed in consultation with DLNR-SHPD and the Mauna Kea Advisory Committee, and was published in three local newspapers (*Figure 4*). During the first two weeks of September, an advertisement and articles regarding the Mauna Kea study were published in The Hawaii Tribune Herald and West Hawaii Today. That advertisement was also published in the October 1998 issue of the newspaper of the Office of Hawaiian Affairs, "*Ka Wai Ola o OHA*." One call was generated as a result of the advertisement, and that call did not result in the recording of an interview.

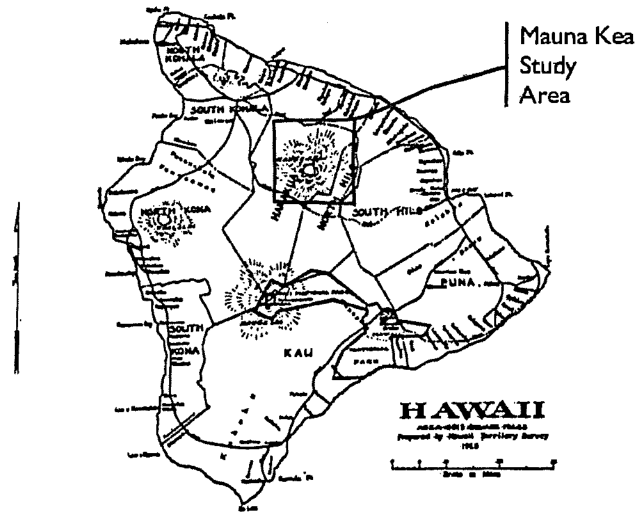
In selecting interviewees, the author followed several standard criteria for selection of who might be most knowledgeable about the study area. Among the criteria were:

a. The interviewee's genealogical ties to early residents of lands within or adjoining the study area. In this case, because of the remoteness of the study area, an individual's descent from families who traveled to, and/or worked the Mauna Kea region, either as a part of on-going native practices and customs, or historic period land management and ranching operations;
b. Age. The older the informant, the greater the likelihood that the individual had had personal communications or first-hand experiences with even older, now deceased Hawaiians and area residents;
c. An individuals' identity in the community as being someone possessing specific knowledge of lore or historical wisdom pertaining to the lands, families, practices, and land use and subsistence activities in the study area; and
d. Recommendations from Native Hawaiian organizations.

It is also noted here, that several potential participants in the interview or consultation process were unavailable, or did not wish to participate in the formal oral history interview study. All but one of those individuals were identified when they spoke at one or more of three formal public hearings held by the Mauna Kea Advisory Committee on August 31st, September 1st and 3rd, 1998. By agreement with hearing participants, the hearings were recorded on tape. Those tapes were transcribed by Group 70 International (with final transcript preparation by this author), but because of technical difficulties, not all of the testimonies were recorded. Portions of the testimonies made by individuals who did not participate in the oral history program, but which include cultural and historical information are cited verbatim in *Appendix C* as they provide readers with further information on issues raised about Mauna Kea.

Please Kōkua – Oral Historical Information Sought For Mauna Kea on the Island of Hawai'i

The University of Hawaii is updating its 1983 Master Plan of the Mauna Kea Science Reserve and Hale Pohaku–lands situated within the *ahupua'a* of Ka'ohe, Hāmākua District; and Humu'ula, Hilo District, on the island of Hawai'i (see map below). Cultural Resources Specialist, Kepā Maly (*Kumu Pono Associates*), of Hilo, will be conducting archival-historical research and an oral history study to help in the development of the Master Plan.



The goal of the oral history study is to identify culturally significant sites and native practices associated with Mauna Kea, and formulate recommendations for the protection of cultural resources on Mauna Kea. If you, or someone you know, is knowledgeable about the history, traditional sites, native practices, and cultural resources of Mauna Kea, or if you are knowledgeable about historic land use on Mauna Kea, please contact Kepā Maly at (808) 981-0196, or by mail at 554 Keonaona St., Hilo, HI 96720.

Figure 4. Public Notice of Undertaking of Oral History Study and Request for Input

Interview Methodology

As noted in the preceding section of this study, a general list of interview topics (*Figure 3*) was developed in consultation with staff of DLNR-SHPD, Group 70 International, the University of Hawai'i's Mauna Kea Advisory Committee (MKAC), and various members of the Hawaiian community. That form was used during all of the interviews and, at the request of some interviewees, was forwarded to them prior to conducting their individual interviews.

Also, in the process of initiating contact with potential interviewees and introducing them to the oral history study, each individual was told about the nature of the study—the kinds of information being sought. Everyone was told that the study was being conducted as a part of the Mauna Kea Science Reserve Complex Development Plan Update and EIS. When the interviewees indicated their willingness to participate in a formal interview arrangements were made to meet and conduct the interview.

During the interviews several maps were referenced to identify, when appropriate, mark various locations being discussed. The maps included Register Maps 1641, 1718, 2785; the USGS Quad – Lake Waiau (1926); the HTS Survey – Island of Hawai'i (1928); and HTS Plat 613. *Figure 2* (at the end of this study) is an annotated map, identifying the approximate locations of sites referenced during the interviews. During each of the interviews clean copies of the maps were used, so that the interviewees would be able to mark locations they discussed, based on their own memory of historic sites and features.

The taped interviews were recorded on a Sony TCS-580V cassette recorder, using TDK D90 High Output standard cassette tapes. The interviews were transcribed and returned to the interviewees and follow up discussions were conducted to review the draft-typed transcripts of each interview. The latter process resulted in the recording of additional narratives with several interviewees. Following completion of the interview process, all of the participants in the tape recorded oral history interviews gave their written permission for inclusion of portions of their transcripts in this study.

The primary goals of the oral history study were to record —

(1) traditional and historic knowledge—as handed down through families—about the summit region of Mauna Kea;

(2) information pertaining to land-use, traditional sites, religious and cultural practices, traditional values;

(3) historic events in the lives of native Hawaiians and other individuals who share first-hand experiences on Mauna Kea (resulting from generations of cultural affiliation with the landscape and mountain resources; or are the result of extensive personal travel upon, or work upon the mountain); and

(4) community views regarding activities, including development of observatories on Mauna Kea.

As a result of the follow up interview transcript review process, the final released interviews supercede the original tape recorded interview. Because of the personal and sensitive nature of certain information recorded on tape, some of the interviewees withheld release of the interview tapes. Several interviewees also placed restrictions on the curation of the interview records. The releases provide specific requirements as to the release of tapes and records (*Appendix A*).

Upon completion of the agency review process, all interview participants and several consultation participants are to receive full copies of this study in order to help perpetuate the history in their respective families (cf. K. Maly and F. Oda, August 19 & 26, 1998:#6). Released interview records and other documentation will be curated in the Hawaiian Collection of the University of Hawai'i-Hilo Mo'okini Library.

Overview of Information Recorded Through Interviews and Consultation

The "summit region" study area contains approximately 11,000 acres, including a portion of the southern flank of the mountain (a roadway and the Hale Pōhaku facilities), and the entire summit region (the zone at approximately the 11,500 foot elevation and higher) of Mauna

Kea. The specific tasks of the oral history study sought to focus on sites and resources in the summit region of Mauna Kea. In conducting the study, limited—yet important—site-specific information for the summit was recorded. This fact is not surprising, and can be attributed in-part to the remoteness, environmental conditions, and nature of the Mauna Kea summit region. Also, by the time of undertaking this study, nearly all of the elders (i.e., the parent and grandparent generations of the interviewees—who were born in the period between 1850 to 1900) who traveled to Mauna Kea with their own elders had passed away. In reading the interviews, it will be seen that a significant portion of the information recorded for Mauna Kea focuses on the mountain as a whole feature in the cultural and natural landscape, rather than focusing on specific regions or zones. This attachment to the mountain landscape is rooted in antiquity and remains important in the lives of native Hawaiians today, who attribute spiritual and cultural values to Mauna Kea. It will also be seen that non-Hawaiians assign spiritual significance to Mauna Kea.

The following overview provides readers with summaries of the primary information recorded about several of the resources on Mauna Kea, considered to be significant by interview- and consultation-participants. The site, resource, cultural significance, and documentation on practices has been separated into several general categories below. These categories provide readers with immediate access to key points raised by interviewees and consultation participants. Each of the primary topic categories are also divided into two sub-categories—information recorded in a formal interview, and information recorded in consultation. Please note that while the information below provides readers with an overview of the cultural-historical information that was recorded as a part of this study, the full interview transcripts (*Appendix A*), and consultation records (in *Appendices B & C*), should be read for further details and to understand the context in which the information was discussed. Additionally, at the end of *Appendix A*, readers will find an "*Index to Selected Subjects Discussed in Oral History Interviews.*" The index will help readers access various areas of interest raised in the interviews.

Table 1. Interviewee Background

Previously Recorded Interviews:

Name of Interviewee	*Ethnicity*	*Year Born*	*Birth Place*	*Male (M) Female (F)*	*Place of Residence*	*Comments*
Kaleohano Kalili	Hawaiian	ca. 1884	n/a	M	Honolulu	1956 participant in Bishop Museum interview.
James Kahalelaumāmane Lindsey	Hawaiian	1882	Waimea Hawai'i	M	Waimea	1966 participant in family interview.
Kalani Ka'apuni Phillips	Hawaiian	1902	Waimea Hawai'i	F	Waimea	1967 participant in family interview.

Interviews of 1998:

Name of Interviewee	*Ethnicity*	*Year Born*	*Birth Place*	*Male (M) Female (F)*	*Place of Residence*	*Comments*
Toshi Imoto	Japanese	1928	Pu'u 'Ō'ō	M	Pāpa'ikou	Retired Cowboy.
John Ah San	Chinese-Portuguese	1907	Laupāhoehoe	M	Laupāhoehoe	Retired Mauna Kea Forestry employee.
Coco Hind	Part Hawaiian	1923	Honolulu (Raised in Waimea)	F	Hōlualoa	Descendant of Hawaiian ranching family.

Table 1. Interviewee Background (continued)

Name of Interviewee	*Ethnicity*	*Year Born*	*Birth Place*	*Male (M) Female (F)*	*Place of Residence*	*Comments*
Teddy Bell	Part Hawaiian	1923	Waimea	M	Waimea	Retired Cowboy and Construction worker.
Sonny Kaniho	Part Hawaiian	1922	Kawaihae uka	M	Waimea	Retired Cowboy.
Daniel Kaniho Sr.	Part Hawaiian	1932	Waimea	M	Waimea	Retired Cowboy.
Judge Martin Pence	Caucasian	1904	Kansas	M	Honolulu	Federal Judge; Mauna Kea Hunter.
Pete L'Orange	Part Hawaiian	1933	Waipahu	M	Waimea	Retired Parker Ranch/Humu'ula Manager; Land Use Planner.
Alika Lancaster	Part Hawaiian	1930	Hilo	M	Keaukaha	Mason; Hawai'i Loa Descendant; Hawaiian practitioner.
Anita (Kamaka'ala-Poli'ahu) Lancaster	Part Hawaiian	1942	Moloka'i	F	Keaukaha	Poli'ahu-Hawai'i Loa descendant.
Tita Spielman	Part Hawaiian	1924	Waiākea	F	'Ōuli	Parker-Low family descendant.
J.K. Spielman	Part Hawaiian	1959	Honolulu	M	'Ōuli	Son of Tita Spielman; fisherman.
Hannah Kihalani Springer	Part Hawaiian	1952	Kona	F	Ka'ūpūlehu	Hawaiian Practitioner; historian; OHA Trustee.
Albert Kahiwahiwaokalani Haa Sr.	Hawaiian	1930	Kapoho	M	Waiākea	Retired from Military and State Corrections program; Hawaiian ranching family with ties to Mauna Kea.
Albert K. Haa Jr.	Part Hawaiian	1953	Honolulu	M	Waiākea	Son of A. Haa Sr.; Hawaiian Practitioner.
Lloyd Case	Part Hawaiian	1949	Waimea	M	Waimea	Construction worker; Hawaiian practitioner; and subsistence hunter.
Pualani Kanaka'ole-Kanahele	Hawaiian	1937	Hilo	F	Pana'ewa	Hawaiian Educator, cultural practitioner; Ho'opa'a Kumu Hula.
Irene Lindsey-Fergerstrom & Romona Fergerstrom-Kalalau and family members	Part Hawaiian	1932 1960	Waimea	F F	Waimea	Descendants of families with generations of practice on Mauna Kea.

Heiau (Ceremonial Sites) and Spiritual Significance

In Hawaiian culture, natural and cultural resources are one and the same. Native traditions describe the formation of the Hawaiian Islands and the presence of life on and around them, in the context of genealogical accounts. All forms of the natural environment, from the skies and mountain peaks, to the watered valleys and plains, and to the shore line and ocean depths were the embodiments of Hawaiian gods and deities. One Hawaiian genealogical account, records that Wākea (the expanse of the sky) and Papa-hānau-moku (Papa—Earth-mother who gave birth to the islands)—also called Haumea-nui-hānau-wā-wā (Great Haumea—Woman-earth born time and time again)—and various gods and creative forces of nature, gave birth to the islands. Hawai'i, the largest of the islands, was the first-born of these island children. As the Hawaiian genealogical account continues, we find that these same god-beings, or creative forces of nature who gave birth to the islands, were also the parents of the first man (Hāloa), and from this ancestor, all Hawaiian people are descended (cf. David Malo 1951:3; Beckwith 1970; Pukui and Korn 1973).

In some genealogical chants, Mauna Kea is referred to as "Ka Mauna a Kea" (Wākea's Mountain), and it is likened to the first-born of the island of Hawai'i (Pukui and Korn 1973). A *mele hānau* (birth chant) for Kauikeaouli (Kamehameha III) describes Mauna Kea in this genealogical context:

O hānau ka mauna a Kea,	*Born of Kea was the mountain,*
'Ōpu'u a'e ka mauna a Kea.	*The mountain of Kea budded forth.*
'O Wākea ke kāne, 'o Papa,	*Wākea was the husband, Papa*
'o Walinu'u ka wahine.	*Walinu'u was the wife.*
Hānau Ho'ohoku he wahine,	*Born was Ho'ohoku, a daughter,*
Hānau Hāloa he ali'i,	*Born was Hāloa, a chief,*
Hānau ka mauna, he keiki mauna na Kea...	*Born was the mountain, a mountain-son of Kea...*
(Pukui and Korn 1973:13-28)	

In Hawaiian practice, elders are revered —they are the connection to one's past—and they are looked to for spiritual guidance (Interview with Tita and JK Spielman; Pua Kanahele pers comm. Dec. 1, 1998 and interview Dec. 11, 1998; and Handy and Pukui 1977). In this case, Mauna Kea, the landscape itself is a sacred ancestor.

In regards to specific features, native traditions such as the Boundary Commission Testimonies collected as early as 1873; field survey work conducted by W.D. Alexander and party in 1892; and an archaeological survey (Hudson ms. 1930), provide specific documentation of worship or sites of worship on Mauna Kea, including the presence of *heiau* in the summit region (see historical documentation in *Appendix D*). Also, a 1926 photograph in the collection of Bishop Museum (No. CP 14969) shows Willie Kaniho sitting on what appears to be a stone platform on the summit plateau of Mauna Kea (see interview with Sonny and Daniel Kaniho). Detailed documentation of the "ritual landscape" of Mauna Kea as recorded in archaeological surveys is documented in studies presently being prepared by the State Historic Preservation Division (DLNR-SHPD).

Interview participants

- None of the interviewees recalled hearing the names of *heiau* or other ceremonial sites on Mauna Kea.

- Lloyd Case, and Irene Lindsey-Fergerstrom (with Romona Fergerstrom-Kalalau and relatives of the Lindsey-Kealamakia line) do describe various *kūahu* (altar) and platform features with upright stones that archaeologists have identified around the 10,000 foot elevation, and in other areas of Mauna Kea. The other interviewees did not recall seeing the features.
- Most had never heard any *kūpuna* or old timers speak of specific *heiau* on the Mauna Kea.
- Johnny Ah San, Toshi Imoto, Daniel Kaniho Sr., Tita Spielman, and Lloyd Case all stated they had seen a stone *ahu* or platform on the summit peak of Mauna Kea (still visible from ca. 1947 to 1969).

  Based on family history, Lloyd Case specifically associates the platform with navigational practices.
- Theodore Bell Sr., recalls seeing a stone *ahu* or mound at Waiau, in the vicinity of the Humu'ula-Mauna Kea Trail. In his youth, a bottle with the names of visitors to Mauna Kea was set on the stone mound.
- Alika Lancaster (as a participant), Albert K. Haa Sr. (and Jr.), and Lloyd Case (being told by elders) share accounts learned from elders of individuals going to the summit region of Mauna Kea to offer prayers.
- Members of the Haa family specifically describe the work of their *kupuna*, Ioane, on Mauna Kea as being work of *Akua*. He retreated to Mauna Kea to worship in secrecy (in the old way), because to do so publicly was *kapu.*
- Alika and Anita Lancaster, and Lloyd Case describe the practice of gathering water from Waiau, which was used for ceremonial and healing practices.
- Alika Lancaster describes Mauna Kea as a sanctuary in ancient times. The area above the forest line was so sacred that once in the upper region, your enemies could not pursue you.
- Other interviewees feel that it is likely that worship occurred on Mauna Kea.
- All interviewees attributed spirituality and healing qualities to being on Mauna Kea; and several stated that they still go to Mauna Kea for prayer and restoration.

  Pua Kanaka'ole-Kanahele provides readers with detailed narratives of the spiritual significance of Mauna Kea, the Mountain of Wākea in Hawaiian traditions of creation. She observes that Mauna Kea is considered to be *kupuna* (elder), the first born, and is held in high esteem. In native traditions, Mauna Kea is identified as "*Ka mauna a Wākea*" (The Mountain of Wākea–traditional god and father of Hawai'i–who's name is also written "Kea"). There are many *mele ali'i* (chiefly chants) that identify Mauna Kea as foremost in the genealogies of the *ali'i*. Mauna Kea is the source of a high sense of spirituality. It is the *'aha ho'owili mo'o* (genealogical cord that ties earth to the heavens). (MKAC meeting Dec. 1, 1998 and interview of December 11, 1998)
- Alika Lancaster and Hannah Kihalani Springer described their on-going

customs of travel to Mauna Kea to worship and pray.

Consultation Records (see Appendices B & C)

- Many individuals who were contacted about Mauna Kea report being told by their elders that worship occurred on Mauna Kea—with practices occurring at specific sites and other areas as the spirit moved them.
- Emma Kauhi, Pua Kanaka'ole-Kanahele, Larry Kauanoe Kimura, and Leina'ala Teves, all described Mauna Kea as a sacred and spiritual place.
- Kealoha Pisciotta, Maile Akimseu, Leina'ala McCord, Ed Stevens, Reynolds Kamakawiwo'ole, and Kaliko Kanaele offer personal knowledge of *ahu* (altars) and the on-going practices of worship on Mauna Kea, including worship at specific sites or features.

Trails and Access

In the period leading up to the mid 1800s, travel to Mauna Kea was done on foot, along a system of trails that crossed the mountain. By the later nineteenth and early twentieth centuries, those trails were often traveled on horseback, and while fewer of the trails were used, travel still generally occurred on traditional trails. The trails of Mauna Kea are unique features that linked communities and cultural and natural resources together. To reach the summit, people departed the near-shore and plains lands, and traveled the mountain slopes to the summit region. Thus, the signature or evidence of visitation and site use from pre-contact and through the historic periods, has been recorded across the mountain. Family traditions pertaining to journeys on the mountain trails, and knowledge of Mauna Kea—handed down by elders—are still retained as important family history today. A number of the interview participants still travel to Mauna Kea for spiritual well-being and recreational opportunities.

Interview Participants

- Interviews with James K. Lindsey, Johnny Ah San, Theodore Bell, Sonny and Daniel Kaniho, Alika and Anita Lancaster, Albert K. Haa Sr. (and Jr.), Lloyd Case, and Irene Lindsey-Fergerstrom (with Romona Fergerstrom-Kalalau and relatives of the Lindsey-Kealamakia line) provide descriptions of trail systems that approach the summit of Mauna Kea from all sides of the mountain. Several of these trails were still traveled by the interviewees in their youth, or were described by their elders who still used the trails through the 1930s. Two of the trails, the Makahālau-Kemole-Waiau Trail, Waiki'i-Pu'u Lā'au-Waiau Trail (see interviews with Kahalelaumāmane Lindsey and Theodore Bell Sr.) are generally unknown to most people today. Another important trail described in the interviews is the Laupāhoehoe-Waipunalei-Keanakolu Trail to the summit of Mauna Kea (see the interview with Johnny Ah San).
- Of particular interest to the history of trail use is the fact that many of the trails converge at Waiau (reference interviews cited above). The trails ascend the slopes of Mauna Kea from nearly all the major, and many smaller *ahupua'a* which lie upon Mauna Kea. Testimonies gathered by the Commission on Boundaries from native informants in the 1870s (see excerpts in *Appendix D*), describe *ahupua'a*-specific rights of use and collection of resources on the summit and slope regions of Mauna Kea.

However, the number of trails leading up the mountain indicate that people from various regions of the island had reasons to visit Mauna Kea as well.

- Irene Lindsey-Fergerstrom (with Romona Fergerstrom-Kalalau and relatives of the Lindsey-Kealamakia line, including elders recorded in 1966 & 1967) share family traditions of travel along the trails of Mauna Kea. They also shared accounts of a visit made by Queen Emma to Mauna Kea in ca. 1881. The Queen was led by William Seymour Lindsey, and as a result of his help to her, the Queen named one of the Lindsey children "Ka-hale-lau-māmane" (The house made of *māmane* leaves.) The name commemorates an event that occurred on the ascent to Mauna Kea.
- Albert K. Haa Sr. (and Jr.), Alika and Anita Lancaster, and Lloyd Case, shared information that their elders traveled the Mauna Kea trails to worship in the summit region and gather water from Waiau. The water was used for healing and ceremonial practices.
- Theodore Bell, Sonny and Daniel Kaniho, Tita Spielman (with JK), Albert K. Haa Sr. (and Jr.), and Alika Lancaster, provide information they learned from their elders about travel to Mauna Kea to procure stone for adze making, which occurred in ancient times.

  Johnny Ah San also recalls information about the practice as he learned of it from old native informants.
- Toshi Imoto, Tita Spielman (with JK), Daniel Kaniho, Johnny Ah San, and Lloyd Case provide information about the use of the Mauna Kea-Humu'ula Trail (later the Mauna Kea Road) for the purpose of taking individuals ash remains to the summit of Mauna Kea for release.
- Martin Pence, Johnny Ah San, Sonny and Daniel Kaniho, Theodore Bell, Toshi Imoto, Albert K. Haa Sr. (and Jr.), Alika Lancaster, Pete L'Orange, and Lloyd Case provide detailed discussion of their own use of trails on Mauna Kea. Use was primarily associated with Territorial Forestry operations, ranching, hunting, and recreational activities.
- Access – many of the interviewees express various concerns about access to Mauna Kea. Most believe that the rights of access by native Hawaiians must be protected. But several interviewees express concerns about unmonitored and uninformed access. Nearly all interviewees believe that everyone who visits Mauna Kea needs to have information that can help them be responsible for their actions on Mauna Kea. See interviews with Tita Spielman (with JK), Albert K. Haa Sr. (and Jr.), Pete L'Orange, Hannah Kihalani Springer, Lloyd Case, Pua Kanaka'ole-Kanahele and members of the Lindsey family.

Consultation Records (see Appendices B & C)

- William Akau, a Kawaihae native, learned from his elders of the traditional use of a Mauna Kea trail. The trail was situated on the north-western slope of the mountain, and reached by individuals from other islands, who landed their canoes in the Kīholo vicinity and went to Mauna Kea to gather adze making stones from the summit region.

- John Hale and Gabriel Kealoha, native residents of the Puna District, learned from their elders that families of Puna traveled to the upland *koa* forests on Mauna Kea and made canoes there. They then returned to the shore with the canoes, and traveled back to Puna by sea.
- Ed Stevens describes the use of trails (ʻUmikoa and Waipunalei) by priests traveling to Mauna Kea for ceremonies.
- Maile Akimseu testified that her *kūpuna* walked the trails on Mauna Kea (noting that part of her genealogy ties back to ʻUmi-a-Līloa; with whom the ʻUmikoa-Mauna Kea Trail is associated).

Burial Practices and Sites

All of the interviewees who were asked about their feelings of the treatment of *ilina* (burial sites), expressed their desire that *ilina* be protected in place. While none of the interviewees reported knowing of specific locations of burials in the immediate area of the Mauna Kea summit, many spoke of *ilina* in cinder cones, and other natural features in the region extending from about the 12,000 to 7,000 foot elevation. The presence of burials on Mauna Kea, ranging from the summit region to the forest zone was recorded as early as 1873 in testimonies before the Boundary Commission, with subsequent documentation in the 1880s and 1890s by surveyors and historic visitors (see historical documentation in *Appendix D*). Knowledge of the occurrence of burials on Mauna Kea has been handed down through present times.

Interview Participants

- Alika and Anita Lancaster, Sonny and Daniel Kaniho, Albert K. Haa Sr. (and Jr.), Lloyd Case, and Irene Lindsey-Fergerstrom (with Romona Fergerstrom-Kalalau and relatives of the Lindsey-Kealamakia line) shared their understanding that the individuals buried on Mauna Kea were of an elite class, and considered sacred.
- Alika Lancaster further records learning from his elders that all the high mountain *puʻu* contain *ilina* (burials).
- Johnny Ah San, Sonny and Daniel Kaniho, Alika Lancaster, and Lloyd Case share first hand knowledge of the presence of *ilina* at several of the *puʻu* on Mauna Kea, including but not limited to—Mākanaka, Kaupō, Puʻu Loa, Kanakaleonui, Keanakolu, Puʻu Kihe, Puʻu Kālepa, Puʻu Mali, and Kemole.

  A Bishop Museum Photograph (No. CP 14970) discussed in the interviews with Sonny and Daniel Kaniho, and Johnny Ah San, shows Lester Bryan and Willie Kaniho sitting outside of a small cave identified as a burial site by H. Gregory (BPBM Field Notes and Photograph; July 24, 1926)
- Albert K. Haa Sr. (and Jr.), and Pete L'Orange have heard of the presence of *ilina* on Mauna Kea from elders.

  Albert K. Haa Sr. (with his son), expressed the thought that his great grandmother (the wife of Ioane) was buried somewhere on Mauna Kea.
- Tita Spielman (with JK), Toshi Imoto, Johnny Ah San, Sonny and Daniel Kaniho, Theodore Bell, and Lloyd Case stated that since 1954 several

family members or close friends of theirs have had their cremated remains taken to the summit of Mauna Kea for release.

The ashes of Tita Ruddle-Spielman's grandfather (Eben Low) and her mother and father (Annabelle and Albert Ruddle), were taken to the summit of Mauna Kea to be released. Tita (with JK) stated that until a few years ago she was going to have her ashes taken there as well. But because of the amount of development on the summit, Tita changed her plans and so notified her children.

While cremation of remains is not a traditional Hawaiian practice, the practice of taking loved one's remains to special landscapes—considered to be the realm of the gods—is an ancient Hawaiian custom. Today, the burial of family remains at a place such as one of the *pu'u* of Mauna Kea may not feasible. Yet the depth of and on-going cultural attachment to landscape remains strong. Thus, the traditional practice of interment in special landscapes has been adapted to allow for its continuation (see also the interview with Pua Kanaka'ole-Kanahele for further discussion on the cultural significance of this practice).

- Johnny Ah San and Theodore Bell have it written in their wills that upon their passing away their ashes are to be taken to Kalua Kauka and Pu'u Nānā (respectively), on the slopes of Mauna Kea.
- All interviewees who were asked (16 out of 19) specifically stated that burial remains should be protected in place, and that present activities in the vicinity of the sites should be relocated, or if in the future tense, planned actions should be relocated.
- Both Teddy Bell and Alika Lancaster worked on the original road and telescope pads in the mid 1960s, early 1970s. They stated that during that time, they did not see, or hear of burial sites being disturbed as a part of construction activities.

Consultation Records (see Appendices B & C)

- Leina'ala McCord, Maile Akimseu, Ed Stevens, Iopa Maunakea, and Kealoha Pisciotta recounted hearing from elders that the individuals buried atop Mauna Kea were sacred personages, possibly even the progenitors of the Hawaiian race.
- Iopa Maunakea's *kūpuna* taught him that the reason people were buried atop Mauna Kea was because they desired to be close to *Akua* (God).
- Maile Akimseu, Leina'ala McCord and Kealoha Pisciotta stated that the burials sites and individuals in them were so sacred, that to speak of them outside of family members could mean death.
- Maile Akimseu, Kealoha Pisciotta, and Luana Adams report that they have heard of burial sites being destroyed in the summit region as a part of observatory development.

Waiau

Waiau is one of the significant features on Mauna Kea that also has an important role in the traditions of the mountain. Of particular importance in traditions and some of the oral history interviews are accounts that associate the water of Waiau with the god Kāne and documentation that the water is important to the on-going practices of native healers and practitioners (see historical documentation in *Appendix D* for further details).

Interview Participants

- Irene Lindsey-Fergerstrom (with Romona Fergerstrom-Kalalau and relatives of the Lindsey-Kealamakia line, including elder family members recorded in 1966 & 1967) recorded that in ca. 1881, Dowager Queen Emma ascended Mauna Kea on a journey of spiritual and physical well-being. On that visit, one of the Queen's primary desires was to swim across the waters of Waiau, which she did with the help of William Seymour Lindsey and Waiau Lima who accompanied her on the journey.

  Traditions passed down through descendents of the Lindsey family also describe that it has been the custom of their family to take the *piko* (umbilical cords) of children born in the family to Waiau and the summit peak of Mauna Kea (see interviews with the above family members and consultation records with Larry Kauanoe Kimura).
- Pua Kanaka'ole-Kanahele described the waters of Waiau as the most spiritually and culturally significant in all the islands.
- Alika and Anita Lancaster and Lloyd Case stated that their elders regularly traveled to Waiau to collect water to be used for healing purposes. Lloyd Case also describes customs associated with collection of water from Waiau to be used for healing purposes.
- Johnny Ah San, Theodore Bell, Tita Spielman (with JK), Toshi Imoto, Sonny and Daniel Kaniho, Coco Hind, Alika Lancaster provide descriptions of visits to Waiau in the period between 1932 to 1954.
- Theodore Bell, Toshi Imoto, and Tita Spielman (with JK) describe specific features in the vicinity of Waiau.

  Theodore Bell recalled that in his youth, there was an *ahu* near Waiau, close to the Mauna Kea-Humu'ula Trail, in which a glass bottle was kept. In that bottle were placed papers on which the names of visitors to Mauna Kea were kept.

  Toshi Imoto and Tita Spielman describe a memorial plaque which was set in place on ca. January 16, 1954, commemorating the life of Eben Low and his love for Mauna Kea.

Consultation Records

- Larry Kauanoe Kimura and Pua Kanaka'ole-Kanahele learned that the waters of Waiau are perhaps the most sacred in all Hawai'i. The water was (and still is) collected for use in ceremonies and for healing. Kimura also stated that it is the custom of his mother's family (descendants of Kaluna Lindsey) to have taken the *piko* (umbilical cords) of newborn children to be placed in Waiau. (MKAC meeting Dec. 1, 1998)
- Barbara (Ka'apuni) Phillips-Robertson (daughter of Kalani Ka'apuni-Phillips, interviewed by Kimura in 1967), noted that her mother discussed

> the custom of taking *piko* to Waiau on Mauna Kea. Her mother described it as a unique custom of the people of Waimea–there was (and remains) a strong connection between the native families of Waimea and Mauna Kea (pers comm. December 22, 1998).

As noted above, Hawaiian members of the Lindsey family have a tradition of taking the *piko* of their children to Waiau and the summit of Mauna Kea. This custom was first brought to the author's attention in 1997, by aunty Emma Kauhi (a native of Kapa'ahu, Puna), who provided the author with a historical account about Waiau, published as a part of a special insert of the Hawaii Tribune Herald. Titled "*Mauna Kea (Past, Present and Future)*" (January 27, 1980), one of the articles was authored by Pat McCoy (now of the DLNR-SHPD), who wrote that "there are reports of certain families depositing the umbilical cord (*piko*) of newborn babies in Lake Waiau at the 13,020 foot elevation" (McCoy in the Hawaii Tribune Herald, 1980:B-3). Aunty Emma found the reference very interesting, but had not personally heard of the practice (pers comm.).

On November 24, 1998, the author located a 1956 Bishop Museum interview recorded in Hawaiian by Kaleohano Kalili. Kalili documented that in the old days, people used to take "*piko*" (umbilical cords) of newborn children to a "*punawai*" (spring) on Mauna Kea; he also observed that the people who did this were worshippers of Pele (Bishop Museum audio recording, April 21, 1956 – HAW 60.1). The author subsequently translated and transcribed the Kalili interview, and learned that members of Kalili's parent to great grandparent generation had lived on the island of Hawai'i (at the time of the interview, Kalili was residing on O'ahu), and many of the *piko* of various generations of the family had been taken to Mauna Kea. Also, while Kalili did not specifically name Waiau as the *punawai*, he did note that it was situated near the top of Mauna Kea (see interview transcript in *Appendix A*).

During several of the interviews, or in follow up discussions with several of the participants in this oral history study (i.e., Toshi Imoto, Johnny Ah San, Tita Spielman, Sonny and Daniel Kaniho, Albert Haa Sr., Alika Lancaster, and Irene Lindsey-Fergerstrom et al.), interviewees were asked if they had heard of the practice. None of the interviewees except for the Lindsey descendants had. Irene Lindsey Fergerstrom and her family have continued the customs of taking children's *piko* to the summit of Mauna Kea to the present-day. The *piko* of *mo'opuna* (grandchildren) of Mrs. Fergerstrom have been taken to Mauna Kea within the last ten years.

Others interviewees who had not heard of the practice of taking *piko* to Mauna Kea all felt that it was likely to have occurred, and they shared similar stories from their own families of the custom at various localities. The interviewees suggested that Lake Waiau was a likely location of such a practice as well. When asked about Kaleohano Kalili, none of the interviewees had personal knowledge of him (he was not known as a Waimea or Hilo vicinity native).

On December 1st, 1998 (following initial write up of this study), the author was given an opportunity to review his findings with members of the MKAC and the special panel that provided committee members with an overview of Hawaiian spirituality. In regards to the custom of *piko* being taken to Mauna Kea and Waiau, Larry K. Kimura noted that in his immediate family, this practice was still discussed and possibly occurring. His own *piko*, and that of other siblings was to have been taken to Waiau by his mother (pers comm. Dec. 1, 1998). At the December 1st, MKAC meeting, Larry Kimura also provided the author with audio copies of two recorded interviews he had conducted with elder family members in the 1960s. The interviews recorded the family's traditions of William Lindsey's having guided dowager Queen Emma and her party to Mauna Kea and Waiau in ca. 1881. As recorded in the interview with James Kahalelaumāmane Lindsey, his name, given at the request of Queen Emma, is still carried by family members, and commemorates the journey.

Keanakāko'i (or Kaluakāko'i) – Adze Quarries

In 1964, the Mauna Kea Adze Quarry was placed on the National Register of Historic Places and designated a National Historic Landmark. It is the largest prehistoric quarry in the world, extending at lease seven miles across the summit region of Mauna Kea. Many sites, including, but not limited to shrines, habitation features, and burials are associated with the adze quarries. In the period from the 1860s through the 1880s, Ka-lua-kā-ko'i (The adze making pit – quarry) was recorded as a name for the quarries, with a specific named location identified near the Mauna Kea-Humu'ula Trail. By the 1890s, and subsequently through modern times, the name has been written as Ke-ana-kā-ko'i (The adze making cave). Traditions and historical accounts describe the protocols and customs associated with the collection of stone and manufacture of adze, which was still practiced through the early 1800s–stone adze eventually gave way to metal tools. Many of the interview participants traveled to Mauna Kea in the 1930s to 1940s with their elders, and the adze quarries were pointed out to them as being one of the significant cultural features on Mauna Kea.

Interview Participants

- Johnny Ah San, Theodore Bell, Sonny and Daniel Kaniho, Coco Hind, Alika Lancaster, Tita Spielman, Lloyd Case, and Irene Lindsey-Fergerstrom (with Romona Fergerstrom-Kalalau and relatives of the Lindsey-Kealamakia line) all traveled to Mauna Kea with members of their family and visited the adze quarries. On those visits, they heard short accounts of the process of making adze on Mauna Kea, and the value of the stone to the ancient Hawaiians.
- Alika Lancaster describes customs associated with collection of stone for adze making as learned from his elders.
- Other interviewees also visited the quarries in the company of friends.
- Johnny Ah San, Albert K. Haa Sr. (and Jr.), Hannah Kihalani Springer, Lloyd Case, and Pua Kanahele specifically express concerns about the impacts of collectors on the traditional quarry sites, and discuss possible protocols for on-going practices.

Consultation Records (Appendix B)

- As noted above, under the heading of "*Trails and Access*," as a child, William Akau heard his elders talking about visits made by people from other islands to Hawai'i. In ancient times, canoes would land in the Kīholo vicinity, and people walked the trails along the gentle slopes of Mauna Loa-Mauna Kea to the summit to harvest and shape stone. Mr. Akau knows the location of a stone just inland from the shore of Kīholo, that was reportedly used as a polishing stone for adze brought from Mauna Kea.

Landscape

There is an ancient Hawaiian saying "*Mauna Kea kuahiwi ku ha'o i ka mālie*" (Mauna Kea is the astonishing mountain that stands in the calm) (Pukui 1983: No. 2147), that suggests that Mauna Kea is a source of awe and inspiration for the Hawaiian people. Mauna Kea figures in a number of traditional accounts, and many of its place names are directly attributed to the interaction of gods with the land and people. The discussion under the heading of "*Heiau (Ceremonial Sites) and Spiritual Significance*," provides readers with an introduction to native Hawaiian beliefs surrounding the birth of the islands, and the prominence of Mauna Kea in Hawaiian genealogies—the mountain is a respected elder, a spiritual connection to one's gods. Thus, landscape can be interpreted as a significant facet of a Hawaiian's identity. Also, the discussions above, under the heading of Waiau, add further insight into the relationship of land to cultural practices, customs, and beliefs.

There are people today who tie the name Mauna Kea to that of the Wākea, the forefather of the Hawaiian race and liken the mountain to one of his body forms (see the historical documentation in *Appendix D* for further details). Native families also retain names such as Maunakea, Poli'ahu, Lilinoe, and Waiau, which in some cases are directly tied to the mountain landscape. All of the interview participants, regardless of cultural affiliation, expressed deeply rooted sentiments about seeing Mauna Kea. Everyone spoke of their sense of spiritual well-being in either viewing, or being on Mauna Kea. And a number of the interviewees affectionately refer to Mauna Kea as "my mountain."

During the interviews, several interviewees lamented that their parents or grandparents had passed away before an interview process was undertaken. The families recounted that their elders knew the names of every *pu'u*, the trails, various sites and features, and traditions of Mauna Kea. But because of the remoteness of the summit region and historic changes in native Hawaiian land tenure and practices associated with resource usage, the interviewees noted that their primary experiences in the summit region of Mauna Kea came from infrequent visits made with elders, or later on their own. Thus, only limited site specific documentation of summit sites and place names was recorded. As a result of historic ranching, forestry, and hunting activities much of the information recorded as a part of the present oral history study pertains to the elevations below the summit and into the forest zone.

Interview Participants

- All interviewees expressed a spiritual connection to Mauna Kea when viewing it from afar, or walking upon it.
- Pua Kanaka'ole-Kanahele describes the summit region of Mauna Kea as a "sacred landscape." Indeed for some people it was so sacred, that there was no desire to even walk upon it. Mauna Kea – the Mountain of Wākea and first born of Hawai'i, is *kupuna* (an elder or ancestor). Just seeing Mauna Kea from afar provided Hawaiians with a sense of well-being and security. Pua states that seeing Mauna Kea today with construction upon it is hurtful and shameful.

  Pua Kanahele further explained, that one did not need to physically touch the mountain to benefit from this spiritual connection. Simply looking at Mauna Kea from afar, seeing it standing there reaching to the heavens, gave the Hawaiian spiritual strength. She also stated that today, each time she looks at Mauna Kea with the observatories built upon it she feels pain, and cannot look at it because she is ashamed that she did nothing to stop the desecration of Mauna Kea.

- Anita (Kamaka'ala) Lancaster, a descendant of the Poli'ahu line; and Lloyd Case, also tied to the Poli'ahu line associate their lineage with features of the Mauna Kea landscape. Likewise, Alika and Anita Lancaster trace their genealogies through the line of Hawai'i Loa—in some accounts, named as the original settler of Hawai'i and progenitor of the Hawaiian race (see *Appendix E* for an overview of the Hawai'i Loa traditions). The Lancasters and many other native Hawaiians associate a number of the natural and cultural features on the landscape of Mauna Kea with their ancestor's activities and as repositories of their remains.
- People from the eastern side of the island describe Mauna Kea's beauty at sunrise and value the changing of the mountain's colors. Likewise, people from the northwestern side of the island describe the mountain's beauty and changing colors as lit in the sunset.
- Tita Spielman recalled that an elder fisherman and relative of hers, always instructed her when they were out fishing from Keawaiki, to watch a *pu'u* on the upper slopes of Mauna Kea for signs of shifting clouds (thought to be Ahumoa). When the clouds moved onto the *pu'u*, it was time to return to the shore as the winds would rise and the ocean become rough.
- Johnny Ah San, Martin Pence, Theodore Bell, Sonny and Daniel Kaniho, Tita Spielman (with JK), and Lloyd Case describe changes in vegetation on Mauna Kea in the period between 1930 to the present day.
- Theodore Bell, Tita Spielman (with JK), Sonny and Danny Kaniho, Toshi Imoto, Albert K. Haa Sr. and Jr., Alika and Anita Lancaster, Coco Hind, Hannah Kihalani Springer, Lloyd Case, Pua Kanaka'ole-Kanahele, and Irene Lindsey-Fergerstrom (with Romona Fergerstrom-Kalalau and relatives of the Lindsey-Kealamakia line) all express the sentiments that the observatories are painful to see on the landscape of the summit.
- Albert K. Haa Sr. (and Jr.) specifically describe the landscape of Mauna Kea as belonging to *Akua* (God).

Consultation Records (see Appendices B & C)

- Hannah Akau-Bowman, Sister Thelma Parrish, Wm. Billy Paris, Katherine Kahe'e, Martha Lancaster, and Marjorie Kaholo-Kailianu (in personal communications prior to undertaking the present study); and Maile Akimseu, Luika Pereira, Arthur Mahi, Leina'ala McCord, Kealoha Pisciotta, Abe and Reynolds Kamakawiwo'ole, Ed Stevens, and Iopa Maunakea attribute sacredness and healing qualities to Mauna Kea.
- As noted above, in the section under the heading of "*Heiau (other Ceremonial Sites) and Spiritual Significance*," Emma Kauhi, Pua Kanaka'ole-Kanahele, Larry Kauanoe Kimura, and Leina'ala Teves, ascribe spiritual-cultural significance to the landscape of Mauna Kea (MKAC meeting of Dec. 1, 1998).

Larry K. Kimura also noted that it was the tradition of the old agricultural families of the Waimea-Kohala region (and still practiced today among ranchers and others), to discern the nature of the upcoming growing season by the amount of snow fall seen upon Mauna Kea. Viewing heavy snow fall on the mountain prior to what we now call the New Year, indicated that there would be good rainfall in the coming season. The rains would in turn bring life to the crops in the spring. (MKAC meeting Dec. 1, 1998)

- Leina'ala McCord stated her line descended from Poli'ahu; and Ed Stevens and Kealoha Pisciotta trace their lines through the Hawai'i Loa genealogy and thus state that they share a familial relationship with named features of the Mauna Kea landscape (see interviews with Alika and Anita Lancaster and Pualani Kanaka'ole Kanahele, and *Appendix E* for an over view of the Hawai'i Loa traditions).
- Some of the individuals cited in the above paragraphs likened natural phenomena such as cloud formations to omens of coming events or natures way of lamenting the passing of an individual of high rank.
- All of the individuals cited above, express strong sentiments about the impacts of observatory development on the landscape of Mauna Kea.

Development

Sixteen of the interviewees expressed the opinion that the proposed development of additional observatory complexes on Mauna Kea was inappropriate and not acceptable. Two of the interviewees expressed hesitancy at further development–based on a deep respect for Mauna Kea. One interviewee felt that the benefits of the work done by the observatories far out weighed other concerns, and that the research conducted on Mauna Kea provided important knowledge to all mankind.

Thus, nearly all the interviewees and all others who participated in the consultation process (*Appendices B and C*) called for a moratorium on any further development on the summit of Mauna Kea. In *Appendix B*, it will be noted that on November 14th, 1998, the Association of Hawaiian Civic Clubs (AHCC) voted in support of and passed the Hawai'i Island Caucus' Resolution No. 98-16, calling for a moratorium on further construction on Mauna Kea (*Appendix B*).

On October 27th, 1998, Mililani B. Trask, Kia'āina of *Ka Lāhui Hawai'i* submitted a packet of documentation to Kenneth Mortimer, President, University of Hawaii, the Mauna Kea Advisory Committee (and other organizations), which included communications from several agencies, public organizations, and individuals documenting both cultural and natural resources on Mauna Kea (see communications in materials present by Group 70 International). The communication set forth nine recommendations regarding protection and use of Mauna Kea. Recommendation # 5 observed that "future development of astronomy on Mauna Kea should not occur." (Trask to Mortimer et al. Oct. 27, 1998:9 # 5)

As a part of the work undertaken as a part of this study, a letter was sent to *Hui Mālama i Nā Kūpuna o Hawai'i Nei* on October 6th, 1998 (*Appendix B*). While no answer was received, Pua Kanaka'ole Kanahele, one of the founding members of this nationally recognized Native

Hawaiian organization did participate in the oral history interview program (see also *Appendix D* for an overview of historical information compiled by Pualani Kanahele regarding Mauna Kea). Also, on October 6th and November 18th, 1998, letters were sent to the Office of Hawaiian Affairs (OHA)—with telephone conversations in between—requesting that OHA consider submitting comments to this study (*Appendix B*). While no answer was received, it is noted that Trustee Springer participated in the interview program (as a *kama'āina* – native practitioner), and that Mililani Trask (recently elected as a Trustee of OHA) has for years, taken an active role in the issues on Mauna Kea.

CULTURAL ATTACHMENT – CULTURAL PROPERTIES AND PRACTICES IN THE LIVES OF HAWAIIAN PRACTITIONERS

"*Cultural Attachment*[3]" embodies the tangible and intangible values of a culture. It is how a people identify with and personify the environment (both natural and manmade) around them. Cultural attachment is demonstrated in the intimate relationship (developed over generations of experiences) that people of a particular culture share with their landscape—for example, the geographic features, natural phenomena and resources, and traditional sites etc., that make up their surroundings. This attachment to environment bears direct relationship to the beliefs, practices, cultural evolution, and identity of a people. In Hawai'i, cultural attachment is manifest in the very core of Hawaiian spirituality and attachment to landscape. The creative forces of nature which gave birth to the islands (e.g., Hawai'i), mountains (e.g., Mauna Kea) and all forms of nature, also gave birth to *nā kānaka* (the people), thus in Hawaiian tradition, island and humankind share the same genealogy (see page 14 above for further discussion of this genealogical connection).

Cultural Assessment

In considering projects that will modify a cultural landscape, government agencies, land managers, and the public are provided a series of Federal and state laws and guidelines (cited on page 3 in this study) that set forth criteria for identifying cultural values, properties and resources, and for assessing the impacts of actions on the same. The Advisory Council on Historic Preservation (ACHP 1985) provides the following definition of *cultural value*:

> ...the contribution made by an historic property to an ongoing society or cultural system. A traditional cultural value is a value that has historical depth… (ACHP 1985:3)

The ACHP guidelines also note that "[a] property need not have been in consistent use since antiquity by a cultural system in order to have traditional cultural value..." (ACHP 1985:7)

The National Register Bulletin 38 "*Guidelines for Evaluating and Documenting Traditional Cultural Properties*" (Parker and King 1990), provides agencies with further guidance for assessing the importance of traditional cultural beliefs or practices (or cultural attachment) while assessing cultural resources and proposed actions that will affect their integrity. In defining "*traditional cultural properties*," the National Register explains:

> "Traditional" in this context refers to those beliefs, customs, and practices of a living community of people that have been passed down through the generations, usually orally or through practice. The traditional cultural significance of a historic property, then, is significance derived from the role the property plays in a community's historically rooted beliefs, customs, and practices...
>
> ...A traditional cultural property, then, can be defined generally as one that is eligible for inclusion on the National Register because of its association with

[3] "Cultural Attachment: Assessment of Impacts to Living Culture" (James Kent, September 1995).

> cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community (Parker and King 1990:1).

As described in interviews of the present Mauna Kea oral history study, readers learn that sometimes a traditional cultural property may not have physical boundaries which are easily understood, valued, or defined, yet the property continues to be valued in the Hawaiian cultural system. In "Protecting Traditional Cultural Properties Through the Section 106 Process," Sebastian (CRM Volume 16 - 1993) discussed the importance of oral history in determining and evaluating the historical importance of traditional cultural properties:

> Although many traditional cultural properties have physical manifestations that anyone walking across the surface of the earth can see, others do not have this kind of visibility, and more important, the meaning, the historical importance of most traditional cultural properties can only be evaluated in terms of the oral histories of the community (Sebastian 1993, CRM – Vol. 16:22)

By way of claims made, and information shared in the Mauna Kea oral history interviews and consultation program, it is possible to develop assessment categories which may be used to evaluate the impacts of observatories and development on Mauna Kea. Generally described, these categories would include:

(1) *Traditional Cultural Property* claims which are within the purview of Federal and state historic preservation review processes;

(2) *Traditional and Customary Cultural Practice* claims which are within the purview of Article XII, Section 7, of the Hawaii State Constitution; and

(3) *Contemporary Cultural Practice* claims. These claims, while perhaps not within the purview of traditional cultural properties or traditional and customary cultural practices as defined by agencies, do relate to current practices and beliefs of cultural practitioners.

In the section of this study titled "*Overview of Information Recorded Through Interviews and Consultation*" readers were provided with a narrative overview of the primary documentation pertaining to sites, cultural landscape, and practices described during interviews and consultation. *Tables 2a, 2b, & 2c* presents that information in a format that assigns the claims to one or more of the three categories described above. In reading the overview and interviews, it will be seen that at times, there is no fine line between certain customs, practices, and beliefs. For example, one interviewee may discuss going to a traditional site to offer prayers as taught by his or her elders, and may offer prayers that are to native gods and Christian in manner. Other interviewees describe the significance of ancient burial sites and the sanctity of Mauna Kea as a place for burial, and continue the practice through cremation, which is not an ancient Hawaiian practice. These intermixings and variations in traditional and contemporary practices are to be expected, and are a result of the significant impacts of foreign cultures and values on the native Hawaiians over the last 180 years.

Table 2a. Traditional Cultural Properties

Property	*Source of Identification*	*Comments*
Ka Mauna a Wākea or Mauna Kea, also referred to as "*Ka piko kaulana o ka 'āina*" (The famous summit or center of the land).	Historical literature.	See *Appendix D*.
	Oral history interviews with all Hawaiian interviewees (particularly – J.K. Lindsey, K.K. Phillips, A. & A. Lancaster, A.K. Haa Sr. & Jr., L. Case, and P. Kanahele).	Generally described as the mountain region from approximately the 6,000 foot elevation to summit. Described as a sacred landscape that is a physical and spiritual connection between one's ancestors, history, and the heavens.
	Consultation records of: Association of Hawaiian Civic Clubs (AHCC), Ed Stevens, Iopa Maunakea, L. McCord, K. Pisciotta, L.K. Kimura, E. Kauhi, L. Teves, and B. Robertson.	Many of the *pu'u* (hills) and other topographic features on Mauna Kea are named for Hawaiian gods and deities. Also, many of the *pu'u*, particularly those of the upper region, are believed to be burial sites of *ali'i* and other important ancestors.
	Interviews with Tita & JK Spielman, H.K. Springer, A.K. Haa Sr. (& Jr.), C. Hind, L. Case, and P. Kanahele; and consultation *Appendices B & C*.	<u>Viewplain</u>: The upper mountain region is described as a sacred landscape; for some interviewees ascending the mountain and viewing its features is important, for other families, the mountain is so scared that there is no desire to ascend it, but seeing it from afar–feeling its presence–is sufficient.
	Oral history interview with Lloyd Case.	Mountain landscape in <u>navigational traditions</u>: Hawaiian Navigational It is noted that while none of the archival-historical literature cited has made specific references to sites or features on Mauna Kea that were recorded as being associated with navigational practices and customs, the gods and deities associated with Mauna Kea have celestial body forms and some were evoked for navigational practices.
	Consultation records of K. Pisciotta and L. McCord.	Ms. Pisciotta was invited to provide the interviewer with a report she has prepared on the navigational-practices—to be included as an appendix under her name with the present study—but at the time of this writing, the report has not been received. (It is likely that Rubellite Kawena Johnson, Clay Bertlemann and Nainoa Thompson could provide the University with additional documentation on native practices and lore of Hawaiian navigation.)

Table 2a. Traditional Cultural Properties (continued)

Property	Source of Identification	Comments
Pu'u Kūkahau'ula – the summit peak of Mauna Kea.	Historical literature. Oral history interviews with all interviewees (particularly–I. Lindsey-Fergerstrom et al., A.K. Haa Sr., A. & A. Lancaster, L. Case, Tita Spielman et al., and P. Kanahele). Consultation records of: Ed Stevens, Iopa Mauna-kea, L. McCord, and K. Pisciotta.	See *Appendix D*. Generational repository of: *piko* (umbilical cords of children); ashes of individuals with strong attachment to Mauna Kea; and locations of an *ahu* (possibly more than one over time) associated with navigational practices and historic surveys.
Pu'u Poli'ahu	Historical literature. Oral history interviews with all Hawaiian inter-viewees (particularly – A. & A. Lancaster, L. Case, and P. Kanahele). Consultation records of: Ed Stevens, L. McCord, K. Pisciotta, and AHCC.	See *Appendix D*. As an important cultural-geographic feature, and for its association with the Hawaiian goddess and ancestress of some interviewees.
Pu'u Lilinoe	Historical literature and oral history interviews with all Hawaiian inter-viewees (particularly – A. & A. Lancaster, A.K. Haa Sr., and P. Kanahele). Consultation records of: Ed Stevens, L. McCord, K. Pisciotta, and AHCC.	See *Appendix D*. As an important cultural-geographic feature, and for its association with the Hawaiian goddess and ancestress of some interviewees.
Waiau	Historical literature. Oral history interviews with all Hawaiian inter-viewees (particularly – K. Kalili, J.K. Lindsey, K.K. Phillips, A. & A. Lancaster, A.K. Haa Sr., L. Case, P. Kanahele, and I. Lindsey Fergerstrom et al.). Consultation records of: Ed Stevens, L. McCord, K. Pisciotta, L.K. Kimura, B. Robertson, and AHCC.	See *Appendix D*. As an important cultural-geographic feature – a repository of *piko* of children; and a source of sacred water used for ceremonial and healing practices.

Table 2a. Traditional Cultural Properties (continued)

Property	*Source of Identification*	*Comments*
Pu'u Mākanaka and Kaupō vicinity.	Historical literature. Oral history interviews – particularly J. Ah San, S. & D. Kaniho, and P. L'Orange.	See *Appendix D*. Particularly noted as burial sites.
Trails — • Kūka'iau-'Umikoa to Mauna Kea Trail. There are also other trails which are potential Traditional Cultural Properties; documentation was recorded for the following trails:	Historical literature. Oral history interviews: particularly – J. Ah San, T. Imoto, S. & D. Kaniho, T. Bell Sr., A. Lancaster, A.K. Haa Sr. (& Jr.), M. Pence, L. Case, I. Lindsey Fergerstrom et al., and A.K. Haa Sr. (& Jr.).	See *Appendix D*. Trail generally known to all interviewees, and remains in use by some who travel to Mauna Kea in present times. A portion of the trail which connects with the lower Mānā-Laumai'a Trail (around the base of Mauna Kea) was also known as "Ioane's Trail" (Ioane was the great grandfather of A.K. Haa Sr.)
• Humu'ula to Mauna Kea Trail.	Oral history interviews: particularly – J. Ah San, T. Imoto, S. & D. Kaniho, T. Bell Sr., A. Lancaster, M. Pence, and P. L'Orange.	Trail generally known and traveled on by all individuals who went to Mauna Kea prior to opening of the summit road alignment in the 1960s.
• Laupāhoehoe-Waipunalei-Kanakaleonui to Mauna Kea Trail.	Oral history interviews: particularly – J. Ah San, & L. Case.	Trail generally known to individuals who traveled to Mauna Kea up to ca. 1930.
• Makahālau-Kemole to Waiau Trail. & • Waiki'i-Pu'u Lā'au to Waiau Trail.	Oral history interviews with: J.K. Lindsey, T. Bell Sr, and L. Case. Oral history interviews with: J.K. Lindsey, and Teddy Bell Sr.	These two trails are not generally known to most people who have traveled to the summit region of Mauna Kea. The two elder interviewees last traveled on them in the 1930s, Lloyd Case still travels the trails. In the interviews, it was also noted that most of the trails rising to the summit of Mauna Kea converge in the vicinity of Waiau, with a trail then rising to the summit peak.
— • 10,000 ft. elevation trail/road around Mauna Kea.	Oral history interviews with: I. Lindsey Fergerstrom et al., and L. Case	Of particular interest to this trail/road feature at approximately the 10,000 ft. elevation are references to: (1) stone platforms and uprights that mark the contour of the trail (Mrs. Fergerstrom et al., associate them with the work on the alignment–there are burials and other features near by which they have personally seen); and (2) the walled enclosures in the region above Pu'u Lā'au.

Table 2b. Traditional and Customary Cultural Practices

Practice	Source of Identification	Comments
Prayer and ritual observances	Historical literature. Oral history interviews with – A. & A. Lancaster, A.K. Haa Sr. (& Jr.), H.K. Springer, P. Kanahele, I. Lindsey-Fergerstrom et al., Consultation records of: Ed Stevens, Iopa Maunakea, L. McCord, K. Pisciotta, L.K. Kimura, E. Kauhi, and AHCC.	See *Appendix D*. Several interviewees discuss past practices as learned from their elders, and others document that such observances remain important to their Hawaiian spirituality.
Collection of water from Waiau for ritual purposes	Historical literature. Oral history interviews with A & A Lancaster, A.K. Haa Sr. (& Jr.), L. Case, and P. Kanahele.	See *Appendix D*. Described as the most sacred of Kāne's waters in all the Hawaiian Islands.
Depositing of *piko* (umbilical cords) at Waiau and the summit peaks of Mauna Kea.	Oral history interviews with – K. Kalili, I. Lindsey-Fergerstrom et al., and P. Kanahele. Consultation records of – L.K. Kimura, and B. Robertson.	Members of the Lindsey-Fergerstrom family describe the practice as on-going. Barbara (Ka'apuni) Robertson, was told be her elders that it was a custom that was unique to people of the Waimea region, who shared a particularly close affinity with Mauna Kea.
Burial Practices: • Interment of remains –	Historical literature. Oral history interviews with – J. Ah San, T. Imoto, S. & D. Kaniho, A. Lancaster, A.K. Haa Sr. (& Jr.), L. Case, I. Lindsey-Fergerstrom et al. Consultation records of: Ed Stevens, Iopa Maunakea, L. McCord, K. Pisciotta, and AHCC.	(see *Appendix D*) Describing specific knowledge of ancient burial sites, and belief that burials occurring in the upper elevations are those of *ali'i* and other sacred personages – the ancestors of some interviewees.
• Releasing of ashes at the summit and other locations on Mauna Kea.	Oral history interviews with – T. Imoto, J. Ah San, T. Bell Sr., S. & D. Kaniho, Tita & JK Spielman, and P. Kanahele.	Described as a continuation of the traditional practice of taking loved ones remains to Mauna Kea.

Table 2c. Contemporary Cultural Practices

Practice	*Source of Identification*	*Comments*
Prayer and ritual observances – including construction of new *kūahu* (altars) as a part of ceremonial observances.	Consultation records of: K. Pisciotta and L. McCord.	See *Appendix C.*
Keanakāko'i – This complex of adze quarries, shrines and numerous associated features is already a property listed on the National Register of Historic Places.	Historical literature. Oral history interviews with all interviewees (particularly – J. Ah San, A. Lancaster, A.K. Haa Sr., H.K. Springer, P. Kanahele and I. Lindsey-Fergerstrom et al.). Consultation records of Wm. Akau.	See *Appendix D.* All interviewees had knowledge of the adze quarries and various caves associated with the practice of collection of stones for adzes, (only I. Fergerstrom et al.,–the result of years of traveling on Mauna Kea with Harry Fergerstrom who worked for the Territorial/State Forestry Div.) had knowledge of the platforms and uprights. None of the other interviewees could recall hearing of, or seeing the shrines in the vicinity of the quarry sites. There is also on-going contemporary practice of collection of stone from adze quarry sites for various purposes. While present-day collection of stone from traditional quarry sites compromises the integrity of the cultural resources, the practice is claimed as a traditional right. This is one of the important management issues which cultural practitioners, the Department of Land and Natural Resources, and the University will need to address. The interviews with J. Ah San, L. Case, H.K. Springer, and P. Kanahele include introductory discussions on protocols for collection of adze stones.
Subsistence and recreational hunting.	Oral history interviews with J. Ah San, and T. Imoto, M. Pence, S. &. K. Kaniho, T. Bell Sr., I. Lindsey-Fergerstrom et al., and L. Case.	Described as important to the well-being of practitioner families, and important in maintaining a balance in an already disturbed environment on Mauna Kea.

Further assessment of the status and significance of cultural properties and practices—in conformance with Federal and State criteria—will occur under the guidance of DLNR-SHPD. That assessment will be based upon archaeological work undertaken by staff of the State Historic Preservation Division, and will be developed when the information becomes available. At that time, the findings and recommendations cited in this study will be taken into consideration for development of a historic properties–site preservation plan for Mauna Kea (pers comm. J. Overton – Group 70 International; Jan. 26, 1999).

OVERVIEW OF RECOMMENDATIONS MADE BY INTERVIEWEES AND CONSULTATION PARTICIPANTS

Below, readers are presented with summaries of the key recommendations of interview and consultation participants, paraphrased by the author from the original documentation. The full released transcripts and consultation records should be read to understand the significance and context of the recommendations.

- All but one interview-consultation participant stated that they would prefer no further development of observatories on Mauna Kea. A few others expressed reservations about further development, but did not rule out the possibility. High visibility of observatory features and impacts on *pu'u* were raised as issues by many interviewees.

  [Note: the scope of work for this study focused on current and any proposed observatory development on Mauna Kea, neither interviewees or consultant participants were asked about any other forms of development on Mauna Kea.]

- Protection of the landscape and view planes (e.g. *pu'u* to *pu'u* and cultural resources) needs to be addressed.
- The general consensus of all other participants—often voiced with deep emotion—was that the State of Hawai'i – UH should be thankful for what they have been able to use, and they should use what they have wisely.
- Before trying to establish guidelines for native Hawaiian use and practices on Mauna Kea, the State-University and other facilities users of Mauna Kea must establish and adhere to their own guidelines and requirements for use of Mauna Kea.
- When addressing the varied resources in the summit of the Mauna Kea, the State-University and other agencies and users must look beyond the summit. In a traditional Hawaiian context, Mauna Kea is comprised of two major land units that extent from sea level, through the mountainous region and on to the summit of Mauna Loa. Mauna Kea is Hawai'i—there would be no Hawai'i had Mauna Kea not first been born. What occurs on the summit of Mauna Kea, filters down to, and has an impact on what is below.

  The native system of *ahupua'a* management (which may be likened to an integrated resources management planning approach) needs to be incorporated into planning for any future activities on Mauna Kea.

- Complete work and studies that were required as a part of the original master plan, and keep commitments.

  Protocols for the collection of cultural data, data analysis, and any resulting recommendation should be stated, including recommendations will be implemented. Sampling of sites should be limited and plans developed in consultation with knowledgeable cultural practitioners.

- Use of existing facilities and infrastructure needs to be monitored to ensure that further damage (e.g. impacts to *pu'u*, viewplains, cultural sites and practices, and geological resources) to the cultural-natural landscapes does not occur.
- A plan for access to, and use of traditional sites and resources (e.g., Keanakāko'i) needs to be formulated in consultation with native practitioners and families who share generational ties to Mauna Kea, and who still practice their culture and religion on Mauna Kea.
- The State of Hawai'i, University of Hawai'i-Institute for Astronomy, and other sub-lessees and users of the Mauna Kea facilities and resources should form a sustainable partnership[4] with community members.

  Key participants in this partnership should include knowledgeable native Hawaiian families who share generational ties to Mauna Kea, and other individuals known to be knowledgeable about Mauna Kea's various resources.

  Such a partnership should have more than an "advisory role," and would focus on formulating culturally sensitive management guidelines and protocols for users of Mauna Kea. Partnership programs could also implement further literature research and oral history documentation for Mauna Kea; develop site preservation and resource monitoring plans; and design educational-interpretive programs for Mauna Kea.
- Restore documented traditional Hawaiian place names to appropriate features and use.
- Develop a plan for the restoration of the natural environment on Mauna Kea. For many interviewees, this includes maintaining hunting populations of introduced herbivores which can help keep alien plant species under check.
- Seek out and speak with members of the Hawaiian community who have generational ties to Mauna Kea, prior to undertaking any new projects. Then take their beliefs, practices, feelings, and recommendations into account in reaching management decisions.

---

[4] Models for such partnerships can be found in the State's curatorship programs coordinated through the DLNR-State Parks and Historic Preservation Divisions. Also, the author prepared a detailed community partnership program for the Department of Defense-Marine Corps Base Hawaii at Mōkapu, which explores a wide variety of stewardship programs and sets forth options for program development and operations (Maly 1997). During the MKAC meeting of Dec. 1st, 1998, it was also suggested that the Kaho'olawe Commission Plan could provide a good foundation for development of a Mauna Kea plan.

REFERENCES CITED

ACHP (Advisory Council on Historic Preservation)
1985 Guidelines for Consideration of Traditional Cultural Values in Historic Preservation Review. Washington, D.C.: Advisory Council on Historic Preservation. (Draft report, August)

Beckwith, M.
1970 *Hawaiian Mythology*. Honolulu: University of Hawaii Press.

Cordy, R.
1994 *A Regional Synthesis of Hāmākua District Island of Hawai'i*. Historic Preservation Division Department of Land and Natural Resources. State of Hawaii.

DLNR (Department of Land and Natural Resources)
1996 Hawaii Administrative Rules, Title 13, Department of Land and Natural Resources, Subtitle 13, State Historic Preservation Division Rules, Chapter 276:7, Consultation with individuals knowledgeable about the project area's history; & Chapter 277, Rules Governing Minimal Requirements for Archaeological Site Preservation and Development (Draft, December 12, 1996).

Hudson, A.E.
Ms. 1932 Archaeology of East Hawaii. Ms., B.P. Bishop Museum.

Kanahele, P.K., and E. L.H. Kanahele
1997 A Hawaiian Cultural Assessment of the Proposes Saddle Road Alignments. Project A-AD-6 (1). Hilo, Hawai'i.

Langlas, C. Ph.D., et al.
draft 1997 Draft Environmental Impact Statement – Saddle Road (State Route 200) Mamalahoa Highway (State Route 190) to Milepost 6. County of Hawaii, State of Hawaii, FHWA Project No. A-AD-6(1). Technical Appendices- Volume IV Archaeological, Historic and Traditional Cultural Assessment. Prepared for U.S. Dept. of Transportation FHWA-Central Federal Lands Highway Decision and Hawaii Dept. of Transportation. Paul H. Rosendahl, Ph.D., Inc., (Report No. 1522-022897). Hilo, Hawaii.

Malo, D.
1951 Hawaiian Antiquities. Honolulu, B.P. Bishop Museum.

Maly, K.
1998 "*Mauna Kea Kuahiwi Ku Ha'o i ka Mālie*" A Report on Archival and Historical Documentary Research; Ahupua'a of Humu'ula and Ka'ohe, Districts of Hilo and Hāmākua, Island of Hawai'i. Prepared for Native Lands Institute. Hilo, Hawai'i (published May 1998).

McCoy, P.
1982 Report 2. Archaeological Reconnaissance Survey. In Cultural Resources Reconnaissance of the Mauna Kea Summit Region, H. McEldowney & P. McCoy. Bishop Museum ms. 110192. (Prepared for Group 70 International)

McEldowney, H.
1982 Report 1. Ethnographic Background of the Mauna Kea Summit Region. In Cultural Resources Reconnaissance of the Mauna Kea Summit Region, H. McEldowney & P. McCoy. Bishop Museum ms. 110192. (Prepared for Group 70 International)

OEQC (Office of Environmental Quality Control, State of Hawai'i)
1997 Guidelines for Assessing Cultural Impacts. Adopted by the Environmental Council; November 17, 1997.

Parker, P.L., and T.F. King
1990 Guidelines for Evaluating and Documenting Traditional Cultural Properties. *National Register Bulletin* 38. U.S. Department of the Interior, National Park Service, Washington D.C.

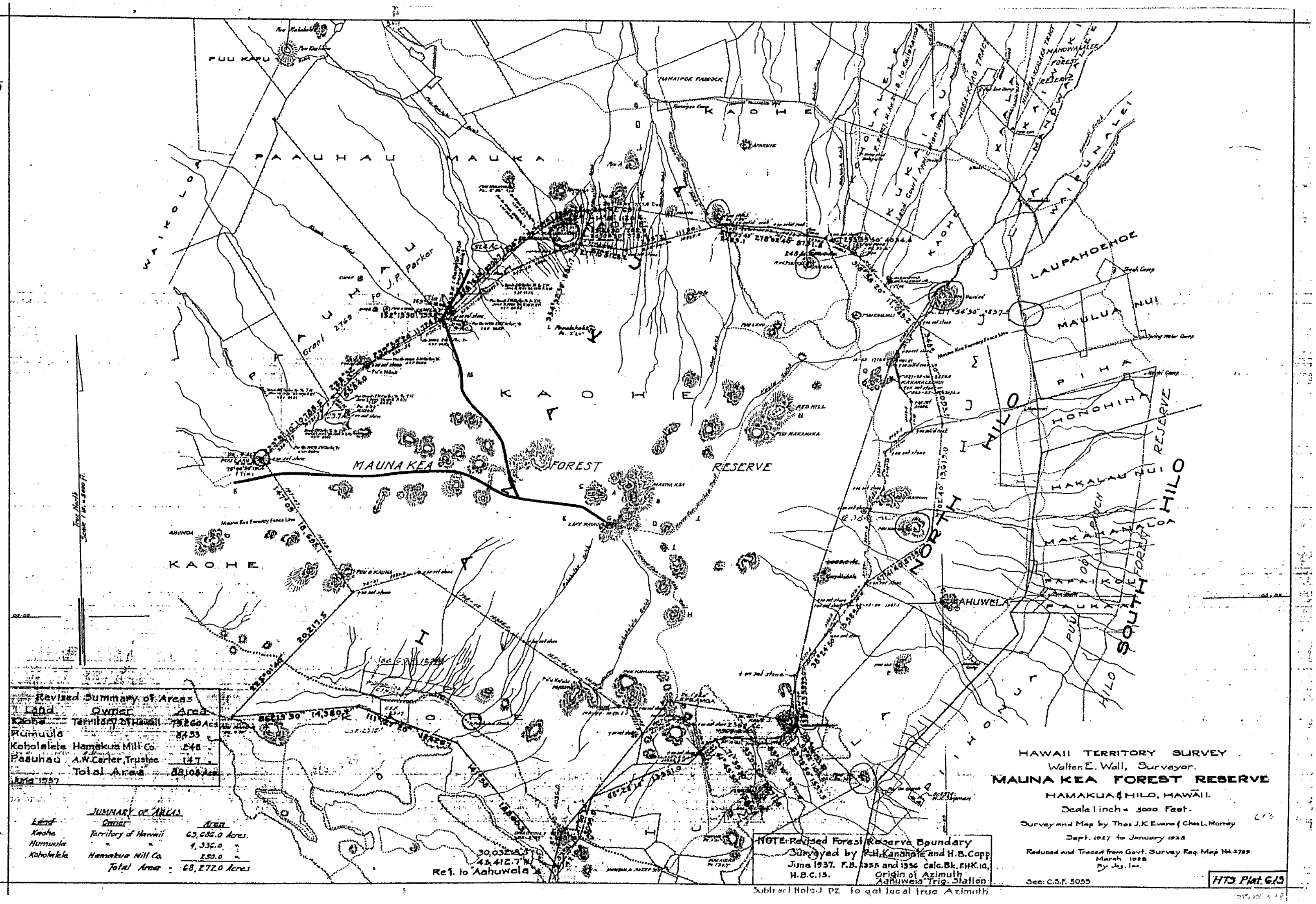
Pukui, M.K.
1983 *Olelo Noeau.* B.P. Bishop Museum Special Publication 71. Bishop Museum Press, Honolulu.

Pukui, M.K., and A.L. Korn
1973 The Echo of Our Song. Chants and Poems of the Hawaiians. Honolulu: University Press of Hawaii.

Sebastian, L.
1993 Protecting Traditional Cultural Properties Through the Section 106 Process. CRM Vol. 16:22-26 (Special Issue)..

Figure 1. HTS Plat 613; March 1928 (State Survey Division) Annotated as Interview Map Showing Approximate Locations of Selected Sites Referenced During Oral History Interviews

Kumu Pono Associates Report No. HiMK-21 (020199)



Key to Sites Identified on Map
(Source – Mauna Kea Oral History Interviews):

A – Mauna Kea. "Ka Mauna a Wākea" (the Mountain of Wākea); "Ka piko kaulana o ka 'āina" (The famous summit of the island); a sacred landscape[1].

B – Pu'u Kūkahau'ula. The summit peak, a sacred landscape. Site of an ahu, repository of piko, and site where ashes of deceased are released.

C – Pu'u Poli'ahu. A sacred landscape.

D – Pu'u Līlinoe. A sacred landscape.

E – Waiau. A sacred landscape, source of water used for ceremonial and healing rituals, and repository of piko.

F – Site of an old ahu or cairn on which a bottle was placed, and in which papers with the names of early visitors to Mauna Kea were placed.

G – Memorial plaque commemorating the life of Eben Low (placed in January 1954 – later removed by unknown individuals).

H – Mauna Kea-Humu'ula Trail.

I – Mauna Kea-'Umikoa Trail.

J – Keanakāko'i (Kaleakāko'i). A specific adze quarry site, and area extending several miles with associated quarries, caves and platform features.

K – Waiki'i-Waiau Trail (shown at approximate route).

L – Pōpōlohilohi. A sacred Landscape.

M – Mahukona-Kemole-Waiau Trail (shown at approximate route).

N – Pu'u Mākanaka and Kaupō. A sacred landscape.

O – Pu'u Kanakaleonui. A sacred landscape.

P – Pu'u Loa. A sacred landscape.

Other pu'u and natural features circled on map.

[1] Sacred landscape indicates that a location is associated with one or more attributes, for example: (1) a Hawaiian god or goddess; (2) prayer and/or ritual observances; (3) traditional practices; and/or (4) interment of remains.

APPENDIX A NOT INCLUDED (800+ PAGES OF TRANSCRIPTS) AVAILABLE UPON REQUEST

APPENDIX A: MAUNA KEA ORAL HISTORY INTERVIEW TRANSCRIPTS AND RELEASE OF INTERVIEW TRANSCRIPTS

(with an Index to Selected Subjects Discussed in the Oral History Interviews)

MAUNA KEA SCIENCE RESERVE AND HALE PŌHAKU COMPLEX DEVELOPMENT PLAN UPDATE:

ORAL HISTORY AND CONSULTATION STUDY, AND ARCHIVAL LITERATURE RESEARCH

Ahupua'a of – Ka'ohe (Hāmākua District) and Humu'ula (Hilo District), Island of Hawai'i

Kumu Pono Associates

Historical & Archival Documentary Research · Oral History Studies · Partnerships in Cultural Resources Management · Developing Preservation Plans and Interpretive Programs

APPENDICES — B, C, D, & E

MAUNA KEA SCIENCE RESERVE AND HALE PŌHAKU COMPLEX DEVELOPMENT PLAN UPDATE:

ORAL HISTORY AND CONSULTATION STUDY, AND ARCHIVAL LITERATURE RESEARCH

Ahupuaʻa of – Kaʻohe (Hāmākua District) and Humuʻula (Hilo District), Island of Hawaiʻi

Kumu Pono Associates

Historical & Archival Documentary Research · Oral History Studies · Partnerships in Cultural Resources Management · Developing Preservation Plans and Interpretive Programs

APPENDIX B: MAUNA KEA ORAL HISTORY STUDY AND CONSULTATION – CONTACT LOG

MAUNA KEA SCIENCE RESERVE AND HALE PŌHAKU COMPLEX DEVELOPMENT PLAN UPDATE:

ORAL HISTORY AND CONSULTATION STUDY, AND ARCHIVAL LITERATURE RESEARCH

Ahupuaʻa of – Kaʻohe (Hāmākua District) and Humuʻula (Hilo District), Island of Hawaiʻi

Kumu Pono Associates

Historical & Archival Documentary Research · Oral History Studies · Partnerships in Cultural Resources Management · Developing Preservation Plans and Interpretive Programs

MAUNA KEA SCIENCE RESERVE AND HALE PŌHAKU COMPLEX DEVELOPMENT PLAN UPDATE:

ORAL HISTORY AND CONSULTATION STUDY, AND ARCHIVAL LITERATURE RESEARCH

Ahupua'a of – Ka'ohe (Hāmākua District) and Humu'ula (Hilo District), Island of Hawai'i (various TMK)

BY

Kepā Maly • Cultural Resources Specialist

PREPARED FOR

Group 70 International
925 Bethel Street, Fifth Floor
Honolulu, Hawai'i 96813-4307

February 1, 1999

Kumu Pono Associates
Kepā Maly, Consultant
Historical & Archival Documentary Research · Oral History Studies · Partnerships in Cultural Resources Management · Developing Preservation Plans and Interpretive Programs

554 Keonaona St. · Hilo, Hawai'i 96720 · (ph./fax) 808.981.0196 · (e-mail) kepa@interpac.net

APPENDIX B: MAUNA KEA ORAL HISTORY STUDY AND CONSULTATION CONTACT LOG

During the process of preparing for, and conducting the formal recorded interviews documented in this study, the author spoke with more than 100 individuals who were known to him, or were identified as: (1) having knowledge about Mauna Kea; (2) knowing some one who could be a potential interviewee; or (3) who represented Native Hawaiian organizations (i.e. *Hui Mālama i nā Kūpuna o Hawai'i Nei*, the Island of Hawai'i Council of Hawaiian Civic Clubs, and the Office of Hawaiian Affairs). Several of those contacts resulted in the recording of informal documentation regarding Mauna Kea, or generated written responses as formal communications. Notes written up during some of those conversations, which add information to the historical record of Mauna Kea, are cited here as personal communications. The notes paraphrase key points from the conversations, but were not reviewed by the individuals speaking. Thus, they represent informal communications which could be followed up on at a later date as a part of further work to be undertaken by UH-IfA and/or DLNR-SHPD. The formal letter communications are reproduced from the original transmittals in their entirety (chronologically) in this appendix.

While conducting literature research on Mauna Kea between 1996 to early 1998, the author also spoke with several *kūpuna* who shared a few comments on Mauna Kea. Excerpts of those comments are included here as well.

Name	Date	Location	Comments
P. McCoy H. McEldowney	8/31/98	Letter	Asking DLNR-SHPD for input on OH program and suggestions on questions to be asked.
Ed Stevens	9/3/98	Hilo MKAC meeting	Hawai'i Loa descendant (expresses knowledge of cultural practices and resources, and *ilina*). Resides in Kona. Known his family for 25 years, he wants to talk.
Maile Akimseu	9/3/98	Hilo MKAC meeting	Hawai'i Loa affiliation as with Ed Stevens; and member of Ka Lāhui Kūpuna Council. Resides in Hilo.
Nāmāhana Kino, Ms. McCord, or Leina'ala McCord	9/3/98	Hilo MKAC meeting	Spoke at all three MKAC community hearings. Discusses personal knowledge of the sacred worshipping places (shrines, *pu'u*, and caves), burial sites of the progenitors of the Hawaiian people (the Hawai'i Loa genealogy), and great spiritual significance of Mauna Kea to the Hawaiian people. I approached Mrs. McCord and introduced myself, and she thanked me for coming to speak with her. She had seen the Mauna Kea oral history study announcement but explained that other than what she had said above, she could not speak to me about Mauna Kea. "It is too sacred. Like Kealoha said, 'to reveal these things, and the places of our ancestor's burials is death to those who speak it.' I'm not ready to die yet. I can only speak of these things to someone of my line."

Name	Date	Location	Comments
Leina'ala McCord (continued)	9/3/98		She mentioned that she had spoken briefly with Charles Langlas, but, "I only told him surface things and said nothing to him about the sacred things." She apologized, and said "I feel you have a good heart, but I cannot talk to you about Mauna Kea." She also mentioned that she "represented 150 *kūpuna*–of the Hawai'i Loa and Poli'ahu lines–perhaps one of them may be willing to speak with you..."
L. Kimura re: Kaoru Sunada	9/3/98	Hilo MKAC meeting	At the suggestion of Larry Kimura. Mr. Sunada called Larry in response to the MKAC advertisement. Mr. Sunada's father worked on the mountain in the 1920s-1930s with a silver sword project (perhaps with L. W. Bryan, Territorial Forester). Phone 959-8225.
Pat McCoy	9/4/98	Telecomm.	Requesting comments on letter of Aug. 31st. and discuss approach of OH program. 3:55 p.m. unsigned/undated fax from DLNR-SHPD replying to letter of Aug. 31st.
D. Hibbard, H. McEldowney, P. McCoy	9/5/98	Letter	Letter responding to DLNR-SHPD fax letter of 9/4/98. (cc. w/attachment to J.O./Grp 70)
J. Overton, C. Ruotola, F. Oda, P. McCoy, H. McEldowney, B. Rechtman	9/10/98	Honolulu Meeting	Review current status of: (1) DLNR-SHPD archaeological survey work on Mauna Kea (see handout); and (2) approach to OH program (referring to ltrs. of 8/31, 9/4, & 9/5. P. McCoy describes the summit plateau as a "Ritual landscape – nearly all of the sites/features are shrines and burials, or associated with adze collection. DLNR's position (at the time of the meeting) is that the entire summit plateau would be placed within a historic district, with all sites being contributing members to the single district." DLNR-SHPD has no comprehensive maps; is interested in questions on: trails and access; cairns around Waiau; knowledge of burials and how to be treated. Noted that following the 9/3 community meeting, I spoke with several individuals (see above entries for date), noting specifically that L. McCord indicated that she could not speak with me about Mauna Kea. In discussion with Holly & Pat – The first priority for interviews should be those that have first-hand experience with their *kūpuna* on the mountain...

Name	Date	Location	Comments
Bucky Leslie President – Kona Hawaiian Civic Club	9/11/98	Telecomm.	Called him regarding the 9/12 Mauna Kea site visit (ref'd. in telecomm. with C. Langlas). He will mention to Kona & Waimea HCC members and participants that I am conducting the OH study and get names of anyone suggested as a possible interviewee. (Mable Tolentino is the WHCC president.)
Bucky Leslie	9/14/98	Meeting in Kona	At meeting regarding Ka'ūpūlehu, Bucky confirmed that he had information to discuss regarding the 9/12 site visit; we will talk the week of 9/21.
Bucky Leslie	9/21/98	Telecomm.	KHCC has prepared a resolution for the Hawaiian Civic Clubs recommendations regarding Mauna Kea. A copy of that resolution will be forwarded to me to be included in the study as consultation. I will also be asked to attend the HCC Conference in October to hear about the clubs position and meet with participants. The 9/12/98 Mauna Kea trip went well. Reynolds Kamakawiwo'ole provided the most detailed narrative regarding the importance of protecting Mauna Kea. He will be at the HCC conference
Papa Auwae (via Stephanie)	9/21/98	Tele-msg.	Spoke with Stephanie (at Tutu's House). Told her; "I am conducting the oral history study for Mauna Kea, doing interviews with *kūpuna*. I spoke with Papa Auwae on Moloka'i (Nov. 20, 1996) and he said that he wanted to speak with me about Mauna Kea." Stephanie said she would pass the message on and my number.
Kaoru Sunada	9/21/98	Tele-comm.	Mr. Sunada was born at Pāpa'ikou in 1912. During his youth, his father was involved in silversword protection projects on Mauna Kea. At that time, the elder Sunada would catch the train from Pāpa'ikou to Hilo, and then ride a car up to the 5 mile camp-Kaūmana. From there he and his gang would walk up to Pu'u 'Ō'ō and on to the head of the Wailuku River. Because of his father's trips to Mauna Kea, and his stories about the silverswords, Kaoru Sunada became very interested in the plant and the history of botany on Mauna Kea. Kaoru made his first trip to Mauna Kea in 1932. He recalled that at that time there were perhaps 40,000 sheep on Mauna Kea, and when he went to the silversword area at around the 9-10,000 foot elevation (an area on the cliffs between Kanakaleonui and the Wailuku river head – Pu'u Hinahina), the sheep were having a significant impact on the plants.

Name	Date	Location	Comments
Kaoru Sunada (continued)	9/21/98		Kaoru Sunada became very interested in working to protect the "beautiful" Mauna Kea Silverswords. His interest in the silver swords has been a life-long passion, and has taken him to the Mauna Loa, Haleakalā, and Pu'u'eke silversword habitats as well. During his career, Mr. Sunada worked for the Territorial Forestry Division, and later in his life he volunteered in silversword propagation projects with State and Federal agencies Mr. Sunada's interest is not solely biological. During the conversation, he also recounted historical narratives from the journals of Goodrich, Macrae (noting that Macrae ascended Mauna Kea via a Laupāhoehoe trail route), Douglas, and his own work with Degner, Rock, Neal and others regarding the silverswords and landscape of Mauna Kea. Mr. Sunada feels strongly that there is a need to protect the native habitats of Mauna Kea. He also noted that he was one of the early people to work towards game control on the mountain. He observed "The native plants have a right to be there. They were there first, and we must work to protect them." The work of Mr. Sunada's father—and others of the period—with the Territorial Forestry Division is written up in the annual reports. Mr. Kaoru Sunada has written articles himself about the Mauna Kea Silversword. He did not feel that he had much information about cultural or historic sites.
Ed Stevens	9/23/98	Telecomm.	Ed has been going to MK every year since 1961. While he did not know about the shrines that were around the mountain at the time, he was drawn to Waiau and the adze quarries, and the significance of Mauna Kea in Hawaiian history and on the landscape. Ed, Alika Lancaster, and Reynolds Kamakawiwo-'ole were on Mauna Kea on 9/21, and they have begun planning their approach to how they will work towards protection of the mountain. Ed feels strongly that it is important to share some of the history and significance of the mountain so that other people can understand its importance. Ed will speak with Alika and Reynolds and once they are ready, he will make arrangements to meet for an interview.

Name	Date	Location	Comments
Ed Stevens (continued)			Ed will send me a copy of a letter he's written, compiled from his testimony at the MKAC hearings regarding making the history known, and sent to the newspapers. I will send him a copy of the study I prepared.
Henry Auwae	9/24/98	Letter	Hand delivered a letter to Papa Auwae at Tutu's House (Parker Ranch Shopping Center); given to Susan Maddox (Tutu's House coordinator). She said she would be seeing Papa Auwae on Fri. 9/25/98.
Ed Stevens	9/25/98	Letter (in)	Received copy of letter sent to newspaper editors, regarding Mauna Kea. (see letter at end of this appendix)
Ed Stevens	9/28/98	Letter (out)	Received his letter, and pursuant to telecomm. Of last week, forwarded copy of Mauna Kea report (Maly 1997). Also forwarded copy of general oral history questionnaire outline, and request to meet with A. Lancaster and he for interview.
Haunani for: Henry Auwae	9/28/98	Telecomm. 4:10 p.m.	Haunani received my 9/21 message for Papa Auwae. Haunani had not gotten the letter of 9/24, from S. Maddox (Tutu's House), was on her way there this p.m. Haunani asked the following questions and I responded: <u>Why is the work being done</u>? To ensure that culturally sensitive sites, features, and landscape are given better dare, and to elicit recommendations regarding the future use Of Mauna Kea. <u>Who doing the interview</u>? Myself. <u>For whom</u>? the DLNR & UH, as a part of the Mauna Kea Master Plan update. <u>Where would interviews be reposited</u>? First, each of the interview participants would receive full copies of all work; then the University, and other agencies involved with the master plan development would receive copies. <u>Do you work for the University or DLNR</u>? No. <u>Will you sign a statement assuming responsibility for interview documentation that is released with out permission</u>? Yes. My practice is that the interview is completely confidential, no one sees it until the interviewee has given permission for it's release. Example – say a one hour interview is done, and 25 to 30 pages of transcript are prepared, and the interviewee wishes to only release a few of those pages, or perhaps only a few specific paragraphs, that is what will be reported.

Name	Date	Location	Comments
Henry Auwae (continued)	9/28/98		Haunani explained that Papa Auwae had participated in other interviews, and some of the information had been misused, thus he is hesitant to participate in the process. She said that Papa Auwae and his assistant are busy (off-island), and that it would probably be one or two weeks before I hear back from anyone. Haunani also told me that she was only the first line of individuals with whom I would need to speak, before meeting with Papa Auwae.
Kealoha Pesciotta	9/29/98	Brief meeting (KTA)	Kealoha will prep a paper regarding her research on Hawaiian astronomy; and her practices on Mauna Kea, and call me to discuss as a formal part of the consultation process.
Ed Stevens	10/1/98	Telecomm.	Received the Mauna Kea study I sent him. Has begun reading it and feels that I have covered many of the cultural concerns which he has expressed. Will complete read through and is planning to meet with A. Lancaster and R. Kamakawiwo'ole, to finalize arrangements for our meeting. Asked for about two weeks to prep arrangements.
John Hansen	10/1/98	Telecomm.	(Is 84 now.) He and Violet did limited work on Mauna Kea; he thinks that Bill Bonk may have some records, as he was a part of the crew. After Violet passed away, John gave all of her papers to BPBM, and he suggests that there may be something of interest in the records. In regards to burials on Mauna Kea, John new that a number of people had their ashes taken to the summit region, Eben Low and others, among them, he thinks that Bill (Lester) Bryan's ashes were also scattered up there. I mentioned to John that I had just been with Johnny Ah San and that I would see him tomorrow , he suggested that I ask him about Bill Bryan and guy he took around the Mauna Kea Trails who may have written a booklet and included a number of photos. Give *aloha* to Johnny A. (done 10/2) In speaking about his recollections of their time on Mauna Kea, and his daily view of it from his home near Kīlauea, Mr. Hansen commented: "To see all those white domes up there, it makes me think that they were careless in their development."

Name	Date	Location	Comments
Dr. Craig Severance	10/3/98	Meeting	Discussed UH-H artifact collection and archaeological records. He has gone through the entire collection, and does not believe that the Eben Low plaque is in the UHH collection; nor does UHH have any records of burial remains or funerary items for Mauna Kea. Wm. Bonk kept all his field notes (try to call). Violet Hansen's notes were all turned over to BPBM. Craig will check curatorial register for any Mauna Kea references.
Wm. Bonk	10/4/98	Telecomm.	He worked two projects on Mauna Kea. The first was under contract to Bishop Museum in 1955 – for a survey of the Waiau-Adze Quarry vicinity. At that time, they recorded a number of sites, including shrines, habitation caves, and quarry sites. During that time, he did speak with Chester Wentworth about Mauna Kea, but the work did not include any interviews. Mr. Bonk had not heard of Eben Low's ashes being placed at the summit of Mauna Kea, and he never saw a plaque at Waiau, commemorating E. Low. The second project was during the 1980s, when he conducted a survey for the power line. The survey area extended from the 6000 to 9500 ft. elevation. Excavations revealed quite a number of fish bones, charcoal and mollusks. During that survey he made field surveys running up the power line route and for a proposed rest site (the site he surveyed wasn't used). The survey identified a number of camp sites. When asked about burial sites or funerary items – Pōhakuloa or Waiau to Summit region–Mr. Bonk said he never heard of any remains being located. When Mr. Bonk went with Violet Hansen, it was to a petroglyph cave on the plain, five or six miles in, on Kona side of the Saddle Road. The cave was in the PTA live fire range, and they were escorted by a range sergeant.
Ulu Garmon	10/4/98	Tele-msg.	Please call if you can re: follow-up to our discussions last year, about Mauna Kea OH, and possible interviewees.
Jim Juvik	10/5/98	Tele-msg.	In follow up to our meeting of Aug. 25th. Please call to discuss Mauna Kea—progress of interview contact and research.

Name	Date	Location	Comments
Ed Stevens	10/6/98	Telecomm.	His Mauna Kea Shrines letter was published in the H. Advertiser. He has not met with Alika Lancaster yet to discuss our possible interview.
Lynn Lee	10/6/98	Letter	Requesting input from Office of Hawaiian Affairs regarding cultural matters and oral history documentation.
Kūnani Nihipali	10/6/98	Letter	Requesting input from Hui Mālama i nā Kūpuna o Hawai'i nei, regarding cultural matters and oral history documentation.
Jim Juvik	10/7/98	Tele-msg.	A.M. call a-machine not on; p.m. msg – please call regarding Mauna Kea work.
B. Rechtman	10/7/98	Telecomm. (in)	OH update, and asked if I had heard of an organization called "I". Haleakalā Hew Len spoke with Bob on a flight to Honolulu, having seen a Waiau photo that Bob was looking at. H. Hew Len subsequently wrote a letter, expressing interest in Waiau and Mauna Kea, and his group's beliefs regarding the mountain. I gave Bob a copy of the public notice and asked him to forward it to Mr. Hew Len with an invitation to write up a statement and/or call me to discuss further.
Mililani Trask	10/7/98	Meeting (at Concept Printing)	Regarding OH program – I mentioned to her: (1) L. McCord had told me that she could not speak with me regarding Mauna Kea; (2) and Kealoha P. and I had spoken, and that I asked her to put her *mana'o* in writing so that I could in include it in the study. Mililani felt that the best I can do, is to invite participation.
Wm. Akau	10/8/98	Meeting (Kawaihae)	During a previous interview with Mr. Akau, he shared that his elders had told him that people from other islands landed their canoes in the Kīholo vicinity, and traveled to Mauna Kea to collect adze making material. Mr. Akau, confirmed that he had learned of this practice, and specifically mentioned travelers from Maui landing at Kīholo. They traveled the trails from the sea to the mountain, traveling along the gentle sloping contours of the land. Collected stone was also apparently worked at Kīholo. Mr. Akau had been told that there was a large grinding and polishing stone near the shore where adzes were finished. When asked his opinion about the present uses of Mauna Kea and possible cultural concerns, he noted that he "Was not *kama'āina* to that area, and really did not know much about the mountain."

Name	Date	Location	Comments
Lorna Akima	10/8/98	Meeting (Pu'u Koholā)	Hawai'i Island Hawaiian Civic Clubs meeting will be held on Oct. 17th at 9 a.m.; Ka'ū.
Jeff Overton	10/9/98	e-mail	OH program communications.
Jim Juvick	10/9/98	e-mail	Request for communication regarding his Mauna Kea documentary resources
Lynn Lee	10/12/98	Meeting (Honolulu)	Reviewed letter request of Oct. 6th, (Maly to Lee) for comments from OHA regarding cultural matters, oral history, and future of Mauna Kea.
J. Overton	10/12/98	Meeting (Honolulu)	Reviewed OH program status; noting that final schedules of interviews and releases are dependent upon interviewee schedules. Reviewed general consensus of interviewees to-date, similar as that of individuals who testified at 3 public hearings.
Ulu Kanaka'ole-Garmon	10/15/98	Telecomm.	Tentative arrangements for interview on 10/21/98 in p.m. Will do what she can to help.
Bucky Leslie	10/16/98	(above meeting)	Hawai'i Island Hawaiian Civic Clubs meeting on 10/17/98 set; meet in Ka'ū at 9:00 a.m.
Island of Hawai'i Council of Hawaiian Civic Clubs	10/17/98	Meeting with 50 HCC members (Ka'ū)	Presented an overview of the Mauna Kea oral history study; gave members copies of the general questionnaire and public notice. Requested input regarding Mauna Kea . The HCC Board and convention delegates gave me a draft copy of AHCC Resolution 98-16 regarding Mauna Kea; and will forward the final to me (following the Nov. 14th, convention on Kaua'i; see pages 32-33 in this Appendix), as their formal statement regarding management and protection of Mauna Kea. The AHCC resolution which will be forwarded to the State Legislature, also calls for moratorium on any further construction on Mauna Kea. Members felt that the individuals who I'd interviewed or contacted to date were among the most qualified. <u>Arthur Mahi</u> (retired from the Army and a contractor; and Hawaiian practitioner – member of KHCC) wants to discuss Mauna Kea – He traveled to the mountain with his grandfather in the 1930s – early 1940s for ceremonial practices; and later, he worked on the road construction. I will call him to make arrangements. <u>Luika Pereira</u> (an elementary school teacher and member Ka'ū HCC) shared an account of an experience she'd had about four years ago in relation to Mauna Kea:

Name	Date	Location	Comments
Island of Hawai'i Council of Hawaiian Civic Clubs	10/19/98	(continued)	She was with a group of Scouts at Pōhakuloa; one evening the moon rose over the mountain, and she watched the moon rise. She then heard a voice call out to her "Look up." Looking around, there was no one around, and she thought she'd been hearing things. The voice called to her again, and once again no one was around. The third time, the voice commanded her "Look up!" She then looked to the summit region of Mauna Kea and saw a line of warriors on the horizon. They ranged in age from young, to parents, and kahiko (ancient ones); they were dressed in all kinds of ancient attire, and armed for war. The voice then told her, "Tell them they stand upon sacred ground. You must tell them, though they don't see us, we are always here, above, below and on all sides. This is sacred ground and they must respect it." Luika feels strongly that Mauna needs to be protected from further development. <u>Ruby Keana'āina McDonald</u> (OHA Liaison-Kona Office and KHCC member). Gave me a copy of her Aug. 1st, 1998 memo to regarding the Mauna Kea Field trip set for Aug. 29th (took place 9/12). Asks several questions of members; similar to those developed in present OH questionnaire.
J. Overton	10/20/98	Telecomm.	OH program update; review interview schedule and upcoming contacts.
Ulu Kanaka'ole Garmon	10/21/98	Tele-msgs.	In follow up to conversation of 10/15; must not have returned from Honolulu. Two messages left –depending on her schedule, Thursday or Friday can work out; please call.
J. Overton	10/21/98	Telecomm. (in)	Project update from Grp. 70. Also updated him on recent calls and interview progress.
Ulu Garmon	10/28/98	Meeting	Interview rescheduled for Nov. 3, at 2 p.m., at Laehala (gave her a copy of the general questions).
Iopa Maunakea	10/29/98	Tele-msg. (x2)	Iopa M. was at DOFAW meeting last night, got number; message with wife this a.m. working on Mauna Kea OH, would like to speak with Iopa to discuss family name. She will ask him to call me. (Has been out all day)
Jeff Overton	10/29/98	e-mail (in)	Request for update on project etc. (see file).
Jeff Overton	10/3098	Fax and letter (out)	Reply to above – noted present Grp. 70/KPA status.
Jeff Overton	11/2/98	Telecomm. (out)	Reviewed status of communication sent 10/30/98. No change –will need to push deadline back.

Name	Date	Location	Comments
Iopa Maunakea	11/2/98	Telecomm. (in)	Returned call – overview of present project and one recently completed for Puna, including area once owned by his family (KPA Report HiPu15). Iopa shared that his kupuna (Katherine Maunkea) had told him that there is a family connection with their name and Mauna Kea; it is a name that has been handed down from generation to generation. *Kupuna* also told him that there are very important people buried on top of Mauna Kea, and that one of the reasons they were buried there was so that they could be closer to *Akua* (God). Iopa said that he would like to meet, is concerned about past impacts of development on Mauna Kea. Wants to get a sense of the kind of work that I do, and will get a sense as to whether or not he can share some of the mo'olelo. I will send him a copy of the HiPu15 report as it includes references to his family in Puna (done 11/3/98).
Ulu Garmon	11/3/98	Telecomm. (in)	Cannot get back from Waimea today, please call Thursday (11/5) in morning to see about meeting that day.
Henry Auwae (Susan Maddox)	11/4/98	Msg. At Tutu's House	Met Susan at Tutu's House. Gave her my card and asked her to please forward it and my request to meet with Papa Auwae regarding the Mauna Kea oral history study. Susan said the Papa Auwae had received the other messages, he has been very busy. He is presently in seclusion, preparing for a healing seminar, and won't be available until Monday Nov. 9th. Susan asked about the school of the study, and I told her that I was working on a deadline for interviews through the end of November. She said she would pass the card and message to Haunani.
Ulu Garmon	11/5/98	Telecomm.	Tentative arrangements made to meet Fri. Nov. 6th in afternoon, or definite time set for Tues. Nov. 10th, 9 a.m.
Ulu Garmon	11/6/98	Telecomm. (in)	Called to say that she could not make the time presently to speak about Mauna Kea. Inquired of my knowledge about the Nā Ala Hele program in Puna, noting that there are some very important and personal issues for her in Puna. She suggested that I look at Pua's Mauna Kea report (I noted that it was one of the documents I would be referencing). I asked her if she thought I might try to at least touch bases with Pua, and she gave me phone numbers to do so.
Pua Kanahele	11/6/98	Tele-msg.	Spoke with Hōkūlani at E.K.F. left message asking if Pua might call me regarding the Mauna Kea Oral History Study.

Name	Date	Location	Comments
J. Overton	11/6/98	Tele-msg.'s (out and in)	Re: Update on their accounting and project work. Jeff said he'd been working on all week, and the B. McLaren had processed paper work. Action should be taken by next week.
Virginia Goldstein	11/9/98	Meeting	Reviewed her work with Violet Hansen – no burials identified in summit region during those limited surveys. Virginia noted that an architect in the late 1970s (Woolsey), had designed environmentally sensitive road and pad approaches for the Mauna Kea summit region; those plans were set aside for the existing infrastructure. Virginia also noted, how as a child, Mauna Kea was always a significant and spiritual feature on the landscape. She described the rosy tones of the sun on the mountain, and she observed the mountain from her family home on a daily basis. I shared with her the place name Pu'u Kūkahau'ula and what it described; also shared with her an overview of interviewee and DLNR-SHPD (9/10) comments on Mauna Kea. In regards to the occurrence of individuals having their ashes taken to Mauna Kea, Virginia noted that it is her plan to go to Mauna Kea as well. Virginia suggested that Donn Carlsmith and Libert Landgraf were both knowledgeable about some of the history and sites on the mountain.
J. Overton	11/10/98	e-mail (out) Telecomm. (in)	Re: status of project and need for project participant meetings. Jeff will forward documentation to me (*Ka Lāhui* packet received 11/12/98). MKAC proposing a elder advisory committee made up of P. Bacon, L. Teves, E. Kauhi, and P. Kanahele to help committee understand depth of cultural documentation. Possible MKAC meeting date of Dec. 1st, and 8th. Jeff will check to see if I can be given time to do update and inquire for feed back. Try one more communication with OHA and Hui to see if either has any input at this time. Grp.70/KPA issues still not resolved.
Pua Kanahele	11/10/98	Telecomm. – Fax.	Letter-fax and questionnaire overview forwarded with request to call regarding study.

Name	Date	Location	Comments
Jeff Overton	11/16/98	Telecomm. (msg.)	MKAC meeting set for Dec. 1st, I am to provide overview of OH program and can ask for recommendations. P. Bacon et al., expected to participate as well. Additional Grp. 70/KPA matter to be taken care of.
Lenningrad Elarionoff	11/17/98	Meeting	County Councilman elect-Kohala; cousin of Kaniho's. Spoke to him about study and individuals interviewed to date, asked him contact me if he thought of any possible individuals who might be contacted as part of OH study.
Winona Matsuzaki	11/18/98	Telecomm. (in-out)	Winona works under Sebastian Allut, new director of Land and Natural Resources at OHA. She heard of and requested a copy of the Mauna Kea (Maly). She will forward letter request for comments on Mauna Kea OH program to director. (Packet mailed express with two copies of study and Oct. 6th letter to Lynn Lee.)
Lehua Lopez (Henry Auwae)	11/18/98	Telecomm. (in)	Lehua received word from one of Papa Auwae's *haumāna* – He is so upset with the treatment of his oral history work on the saddle road and its release prior to his approval, that he will not participate in any further interviews.
Jeff Overton	11/18/98	Telecomm. (msg.)	Returned call left message; confirmed that I would be available for MKAC meeting of Dec. 1st.
Jeff Overton	11/19/98	Telecomm. (in)	Returned call – confirmed Dec. 1st meeting, 4 p.m. at UH-H. Prep overview of OH documentation and interview participants. Jeff also wants to set up meeting between Grp 70/PHRI & I to formulate plan for PHRI's work. I provided update of OH status. Prep review copies of released interviews and get to Jeff.
J. Overton C. Ruotola F. Oda	11/24/98	Meeting at Group 70	Discussed OH program status – thirteen interviews completed, one more (I believe to be an important one) scheduled for Dec. 5th; overview of study presentation of key resource documentation and recommendations brought up in interviews. Group 70 would like to see overview of above ASAP. I am expected at the Dec. 1st, MKAC meeting, to provide overview of above. It is not necessary to provide written documentation. Jeff was unable to facilitate completion of previously submitted cycle.
Pila Wilson (MKAC)	11/25/98 11/26/98	e-mail (in/out)	Requesting that I present overview of OH findings to MKAC on Dec. 1st. Responded that I am prepared to do so.
Maile Akimseu	11/27/98	Telecomm. (in)	In follow up to Sept. 3rd MKAC Hearing; called to say *aloha* and inquire about the status of the oral history work. Their Hawai'i Loa group has conducted several meetings and sites visits to Mauna Kea (more scheduled).

Name	Date	Location	Comments
Maile Akimseu (continued)			She asked if I had been able to speak with Alika Lancaster and Ed Stevens (yes to both). Ed is the group's historian and has been gathering a lot of information. Aunty Maile suggested that Sam Ka'ai be brought over to walk on Mauna Kea and describe the landscape in a cultural context as he sees and feels it should be—he can sense and feel the *pōhaku*…
J. Overton	11/30/98	Letter-fax-email	Project update draft Grp70-Overvw.doc, excerpted from larger study forwarded for internal review; and month of Nov. 98 work completed documentation.
MKAC Meeting Panel participants: Emma Kauhi, Leina'ala Teves Pua Kanahele Larry Kimura	12/1/98	Meeting UH-H	Panel – *kūpuna*/cultural practitioners discussion on Hawaiian spirituality (excerpts): Looking at, being on, and touching the *piko* of Mauna Kea is awe inspiring; no words can describe the feelings that one experiences. Mauna Kea and Mauna Loa are both considered to be kupuna; the first born, and are held in high esteem. Mauna Kea is identified in tradition as "*Ka Mauna a Wākea.*" Mauna Kea is the source of a high sense of spirituality. Mauna Kea is like the *'aha ho'owili mo'o* (the genealogical cord) that ties earth to the heavens; and the water of Waiau is perhaps the most sacred of any water in the islands. *Piko* is both umbilical and summit – Mauna Kea is the *piko*, the center of spirituality; referred to by LK's uncle (J. Lindsey) as "*Ka pika kaulana o ka 'āina.*" Lindsey family has tradition of taking *piko* to Waiau. Larry gave me tape of interviews he conducted with J. Lindsey and Kalani Phillips (listen to and can reference). In response to a committee question regarding identifying "authentic" native customs and sites, and establishing controls for use, Pua Kanahele responded: Before trying to establish guidelines for native Hawaiian use and practices on Mauna Kea, the State-University and other facilities users of Mauna Kea must establish, and adhere to their own guidelines and requirements for use of Mauna Kea.

Name	Date	Location	Comments
MKAC (continued)	12/1/98		The special panel also commented that when addressing the varied resources in the summit of the Mauna Kea, the State-University and other agencies and users must look beyond the summit. In a traditional Hawaiian context, Mauna Kea is comprised of two major land units that extent from sea level, through the mountainous region and on to the summit of Mauna Loa. Mauna Kea is Hawai'i—there would be no Hawai'i had Mauna Kea not first risen. What occurs on the summit of Mauna Kea, filters down to, and has an impact on what is below. The native system of *ahupua'a* management (an integrated resources management approach) needs to be incorporated into planning for any future activities on Mauna Kea. Following panel, I provided group with overview of all interviews to-date; noting many similarities in interviewee's cultural and historical documentation to that just discussed by panel; and cited a few of the recommendations made by interviewees.
Pat McCoy			Said it sounded like the oral history program had brought to light some interesting historical documentation. Noting the "Rawhide Ben" petroglyph is in the adze quarry area, and that there are also several other names. Pat also noted that the remains of the ahu-feature on the top of the Mauna Kea peak is still visible though it has been impacted. He is uncertain of it's function, noting there is one slab, similar to a feature near Waiau, thought to contain a burial. DLNR-SHPD work is incomplete, several months behind; MOA between SHPD and UH-IfA near finished, so that they will be able to hire some one to cover work. As shared with MKAC, I told Pat that there was only limited site-specific documentation of features in the summit region, with broader documentation of the mountain on a whole, and for the lower slopes. He noted that that is what he would have expected. In MKAC and our discussion about the nature of sites on the summit plateau, he observed that the area was primarily a ritual landscape, and that is how he and Holly Mc., are approaching their work.

Name	Date	Location	Comments
MKAC (continued) J. Juvik			Apologized – hasn't been avoiding my calls, has been too busy; will try to make time to call and get together.
Pua Kanahele	12/1/98		Following panel, I spoke with Pua about my letter and request for her to consider participating in OH process; Pua agreed and said to call next week for day and time.
Hannah K. Springer			We can do a review and release over phone, call her office to make arrangements.
Leimana Damate	12/2/98	Telecomm. (out)	Association of Hawaiian Civic Clubs Resolution regarding Mauna Kea passed and is available. Call Arthur Hoke in Hilo for original copy.
Arthur Hoke	12/2/98	Telecomm. (out)	The Association of Hawaiian Civic Clubs resolution regarding Mauna Kea will be e-mailed to me for incorporation into the study. (Received Dec. 18th, 1998; see pages 32-33 below.)
Christine Ruotola	12/2/98	Fax (in)	Requesting photos for Grp 70's use in plan.
Christine Ruotola J. Overton	12/3/98	E-mail (out/in/out)	Advising her to check with UH-IfA and discussing my requests for review and discussion of work and time frame. (see file) Grp. 70 still looking for Dec. turn in (see letter file).
Romona Kalalau	12/3/98	Telecomm.	We're still set for Saturday – no word on uncle's funeral yet, if those arrangements are made for 12/5, we'll need to reschedule. Romona will call me to confirm a time and location.
H. Kihalani Springer	12/4/98	Meeting	Reviewed general comments on Mauna Kea OH interview and approach to larger study – how to take data collected and incorporate recommendations into planning process (cf. interview). Hannah will finish review and high light specific recommendations to be brought forward.
Pua Kanahele (w/ Hōkūlani)	12/8/98	Telecomm. (out)	Interview set for 4 p.m. Friday Dec. 11th.
Bob Rechtman J. Overton	12/7/98	Telecomm. (in)	Reviewed 12/3/98 draft report; discussed points for possible modification (cleaning up of language). Reviewed with J. Overton; I will get revised copy to Bob R. for Grp.70/PHRI /DLNR-SHPD meeting on Dec. 8th.
Bob Rechtman	12/8/98	Meeting	Gave him report draft of Dec. 8, 1998 – first portion of study, up to OH; for distribution to Grp. 70 – and possibly DLNR-SHPD.

Name	Date	Location	Comments
B. Ka'imiloa Chrisman	12/8-9/98	Telecomm. (in/out)	Has hunted and traveled much of Mauna Kea, spoken with a number of old-timers, and researched a great deal of the literature. Primary points of discussion included the following areas: * Manu Gay traveled with aunty Edith Kanaka'ole to a number of *wahi pana* on Hawai'i – speaks of the grave site of Poli'ahu; which he described. Manu should be contacted to discuss what he and aunty spoke of. * Has researched adze making and visited many of the Mauna Kea sites, noting shrines associated with features. * In vicinity of Pu'u Nanaha (portion of Skyline Road) located two caves-looking towards Waimea side. Caves show some signs of temporary habitation with charcoal and *'ua'u* remains. In one of the caves, the *'ua'u* bones showed signs of having been cleaned as a part of a meal (the ends had been chewed up) (confirmed in 1998 site visit with Jon Giffin and DLNR-SHPD archaeologist [P. McCoy?]). A third cave is in area, but situated on an old pāhoehoe flow (also contains bird bones). Also at the c. 9,000 foot elevation where the terrain levels off into a flat cindery zone is the old trail and stone corral area–thought to be from sheep ranching days. * Has noted an interesting system of *'auwai* that form at the upper elevations of 'Auwaiakekea – and that feed through the La'au lease paddock at c. 7,000 ft., and feed *'auwai* to an old field system at Waiki'i. He posits that there was once more water coming off of the mountain–and more regularly–than presently see. * Knows of 9 stone mound burials atop Ahumoa; was there fairly recently with archaeologists. * Not too long ago, was on Mauna Kea and met Alan Kusonoki (works with Smithsonian), who was out in the field near an adze workshop. A. Kusonoki showed him photographs he had taken of the remains of a sheep/mouflon in a small cave. Kusonoki told him that the remains had recently been reported as being human by certain individuals.

Name	Date	Location	Comments
B. Ka'imiloa Chrisman	12/8-9/98 continued)		* In response to questions of historical events raised in interviews, had seen no references to: Queen Emma's trip to Mauna Kea; Piko being taken to Mauna Kea; had seen no burials in summit; had not heard of a Russian presence on Mauna Kea – did note historical accounts of individuals living in vicinity of Douglas' Pit. * Feel that on all levels, respectful visitation to and use of Mauna Kea is critical.
Pete L'Orange	12/9/98	Telecomm. (out)	Reviewed his thoughts on care and use of Mauna Kea; with recommendation of an advisory panel to help address cultural resources.
B. Rechtman	12/9/98	Telecomm. (out)	Meeting with DLNR-SHPD/Grp 70 was interesting. Grp. 70 did not distribute OH Rpt. draft. DLNR-SHPD discussed traditoinal cultural properties what might qualify and what might not qualify (e.g., cremation, yes; prayers to non-traditional gods, no)…
Christine Ruotola	12/10/98	Telecomm. (out)	Review project and report status; repeated request for review and finalization of prefinal before broad release. P. Kanahele interview set for 12/11, and Lindsey-Fergerstrom set of 12/19. I anticipate have everything completed and released shortly after that. Would like to complete this phase of the study and then focus on limited synthesis in Jan. 99…
Pua Kanaka'ole Kanahele	12/11/98	EKF Office	Recorded interview conducted; following and expanding up general discussion of Dec. 1st, 1998 at MKAC.
Christine Ruotola	12/11/98	E-mail (in)	They will conduct review, set up time to discuss analysis with B. Rechtman, and anticipate DLNR-SHP Review by end of month.
Pua Kanaka'ole-Kanahele	12/12/98	Office delivery	Transcript completed and packet delivered to office with letter and release form.
H. Kihalani Springer	12/14/98	Meeting at Pu'u Wa'awa'a	Has completed review, and is making additions/clarifications to documentation.
J. Overton	12/15/98	Hilo	Brief review of OH project status; suggested that we meet with PHRI/Grp. 70 to review documentation and identify appropriate manner for them to incorporate findings into larger project documents and plans. Agreed
Pua Kanaka'ole-Kanahele	12/15/98	Telecomm. (out)	Has begin review of transcript. Call next week to check.
Arthur Hoke	12/18/98	Telecomm. and e-mail (in)	Received formal communication regarding Assc. Of Hawaiian Civic Club – Mauna Kea Resolution No. 98-16. To be included in consultation records.

Name	Date	Location	Comments
Irene Fergerstrom & Romona	12/19/98	Interview	Recorded interview completed. Recorded on-going family practice of *piko* being taken to Mauna Kea – in this case, at the instruction of her grandmother, *piko* taken to the summit of Mauna Kea… Feel strongly that further development should not occur.
Irene Fergerstrom & Romona	12/21/98	Mail & Delivery	Draft interview transcript mailed to Mrs. Fergerstrom, hand delivered to Romona.
Eva Lindsey-Kealamakia & Moses Kealamakia Romona Kalalau	12/21/98	Telecomm. (out)	Reviewed information on naming of Kahalelaumāne and *piko* traditions. Will incorporate notes into Dec. 19th interview transcript.
Barbara Phillips-Robertson	12/21/98	Telecomm, (out)	Daughter of Kalani Ka'apuni Phillips (1967 interview participant). Meet Dec. 22nd, at her office.
Barbara Robertson	12/22/98	Meeting	Discussed her family history – on mother's side, descended from families with generations of residency in the Waiaka-Waimea and Pu'u Anahulu vicinity. Mrs. Robertson was born in 1936 at Waiki'i. She traveled much of the Mauna Kea region with her mother and father (father was also a surveyor for the Parker Ranch lands). Mrs. Robertson grew up with the *mo'olelo* recorded in the 1967 interview with her mother. She also shared that her mother discussed the custom of taking *piko* to Waiau on Mauna Kea. Her mother described it as a unique custom of the people of Waimea–there was (and remains) a strong connection between the native families of Waimea and Mauna Kea. Mrs. Robertson noted that while her mother shared these cherished *mo'olelo* with her, her grandfather, John Ka'apuni, had become a Christian, and the family did not continue some of the old practices. (with tears rising to her eyes) Mrs. Robertson expressed deep love for Mauna Kea and Mauna Loa – they were places that her grandfather Ka'apuni always traveled, and that her mother loved. When she travels on the mountains, or looks at them from afar, she noted that she feels the presence of her grandfather *mā*. Mrs. Robertson suggested that the surveyor Jimmy Murray (son of James Murray who her father worked with on the Parker lands), could be a good contact for Mauna Kea and the Parker lands.

Name	Date	Location	Comments
Barbara Robertson		(continued)	Mrs. Robertson is the principle of an elementary school on Hawai'i; when asked her thoughts about development of observatories on Mauna Kea, Mrs. Robertson noted: "I understand the requirements of the location and the need to learn and gather knowledge, it is worthwhile. But, what they have now on Mauna Kea is enough."
K. Chrisman	12/22/98	Telecomm. (in)	Shared copy of "*Mauna Kea Kuahiwi ku Ha'o*…" with R. Kamakawiwo'ole at the solstice observance on Dec. 21st. About 75 people participated in the observances, including Na Koa, Royal Order of Kamehameha, *Hālau o Kekuhi*, and Vicky Holt-Takamine *mā*. There were on-the-hour observances and recounting of the *Kumu Lipo*.
H. Kihalani Springer	1/8/99	Tele-msg.s (out)	Review completed and released with revisions.
H. Kihalani Springer	1/9/99	Mail	Input revisions and forwarded revised interview to Kihalani.
Bob Rechtman	1/6/99	Telecomm. (in)	Awaiting final word on PHRI's SOW for the Mauna Kea assessment study. Understands that DLNR-SHPD & Grp 70 are still trying to finalize their plan for P. McCoy's schedule of completion.
B. Rechtman	1/13/99	Telecomm. (in)	Met with J. Overton in Hilo yesterday, still trying to finalize SOW.
Group 70	1/12/99	Letter	Project status.
J. Overton	1/13/99	Telecomm. (in)	Got letter — I reviewed current status of OH program and report preparation. Explained approach to appendices, with body of document being about 40 pages. Upon receipt of final releases, I will be ready to turn over study – less historical synthesis. Grp. 70 hoping to be able to finalize next steps to take in PHRI's development of traditional cultural properties assessment. Grp. 70 hopes to have the draft EIS out by end of April. My work is the only one near completion at the present time. JO asked for assistance in the PHRI review process… (see additional notes) E-mailed current draft to J. Overton, and delivered hardcopy to B. Rechtman for internal review.
J. Overton Bob Rechtman	1/19/99	Meeting & Conference call	Reviewed Jan. 13, 1999 draft of report. Minor modification; add text and table of claims of TCPs, Traditional Practices, and Contemporary Practices.
J. Overton	1/22/99	Mail (in)	Received review comments on Dec. 8th, 1998 version of report from Group 70 – minor corrections and clarifications incorporated into body of report.

Name	*Date*	*Location*	*Comments*
Pua Kanahele	1/24/99	Meeting	Reviewed and released oral history interview transcript of Dec. 11th.
B. Rechtman J. Overton, P. Rosendahl	1/26/99	Meeting	Reviewed OH report Tables 2a-c and preparation for agency review. JO and BR will coordinate review schedules for Development of PHRI's synthesis of documentation with DLNR's archaeology and preservation/management plan.
Romona Kalalau	1/26/99	Telecomm (out)	Reviewed transcript, made requested changes, verbal release given; signed release will be picked up this weekend.
B. Rechtman	1/27/99	Telecomm. (out)	Discussed TCP tables – organization completed.

KUMU PONO ASSOCIATES
Kepā Maly, Consultant · 554 Keonaona St. · Hilo, Hawai'i 96720
(ph/fax call first) 808. 981.0196 · (pager) 808.327.7189 · (e-mail) kepa@interpac.net

September 24, 1998

Mr. Henry Auwae
c/o Tutu's House
Parker Ranch Shopping Center

E kupuna Auwae — Aloha mai kāua,

Pehea 'oe? Maika'i paha? O Kepā ko'u inoa, a ua hālāwai mua kāua ma kekāhi wahi like 'ole. O ka manawa hope a kāua i hālāwai aku ai, aia ma Moloka'i, a ua kama'ilio wau me 'oe e pili ana Mauna Kea, kēlā kuahiwi ku ha'o i ka mālie.

O ka'u papa hana i kēia manawa, o ka 'imi mo'olelo kūpuna e pili ana kēlā mauna, a me ka mana'o a nā kūpuna no ka pono o kēlā kuahiwi. Maopopo wau, ua pa'a hana 'oe, akā inā hiki kāua ke hālāwai i ka manawa ku pono, e hiki iā kāua ke kūkā kama'ilio (ma ka lipine ho'okani paha) e pili ana kou mana'o a me kou aloha no Mauna Kea.

Eia ma loko o kēia wahī leka kekāhi mana'o no ke kūkākūkā ana. Inā maika'i ka mana'o, e 'olu'olu 'oe, e kahea mai ia'u a hiki iā kāua ke hui hou. Ka'u helu telepona ma Hilo, o 981-0196.

Mahalo nui i kou no'ono'o ana mai ia'u a me ka'u noi ha'aha'a iā 'oe. Na ke Akua pū me 'oe a me kāu po'e kāko'o.

O wau no me ka ha'aha'a,

Kepā Maly

Kepā Maly

Attachment.

Integrated Cultural Resources Management Planning · Historical & Archival Documentary Research
Oral History Studies · Development of Preservation and Interpretive Plans

Letter delivered to Papa Henry Auwae on September 24, 1998

KEPA – ENCLOSED IS COPY YOU REQUESTED.
Ed

Edward G. Stevens
76-6335 Leone Street
Kailua-Kona, Hawaii 96740
Phone: (808) 329-9255

September 10, 1998

West Hawaii Today
P. O. Box 789
Kailua-Kona, Hawaii 96745

To The Editor:

On 9/4/98 I sent in a commentary via your FAX line covering my response to a request by the Mauna Kea Advisory Committee for public input on a new General Plan being drafted for Mauna Kea Summit. I later realized I sent it in without my signature; and therefore would like to resubmit it with signature. A copy is enclosed. After you have read it, I hope you will feel it is worth printing. My intention in submitting this is to educate both the general public, and the Astronomy community as to why the Hawaiian segment objects to uncontrolled expansion and construction of observatories on the mountaintop. It is our Sacred Domain, and we would like to preserve as much of it as we possibly can. Thank you.

Ed Stevens
Edward G. Stevens

attachment

sent to: Honolulu Advertiser, Honolulu Star Bulletin, Hawaii Tribune Herald

Letter received from Ed Stevens on September 25, 1998:1

September 10, 1998

To The Editor:

Subject: Response to Mauna Kea Advisory Committee's request for public input

All Islands in the Hawaiian Group have their Sacred Places which were used since early times for spiritual communion. The most sacred of these places were the highest peaks of each Island. On the four major islands , there was Mount Waialeale on Kauai; Mount Kaala on Oahu; Haleakala on Maui; and Mauna Kea on Hawaii. Mauna Kea being the highest point throughout Polynesia had special significance because it was considered to be the "Gateway" to Heaven. When the ancient Kaula (priest, prophet) made their treks to the summit, it was to be nearest to Akua (Divine Creator), where prayers could be offered in the highest reverence.

Oral history and traditions tell us that burial sites are many at the higher elevations. The bones of very special personages were placed in Puu's (cinder cones) at or near the summit for safekeeping - - their sacred sanctuaries. It is said that some of these have since been violated by the construction of observatories now in existence.

We are beginning to hear horror stories of what the "un-sensitive" ones are planning for this, our spiritual domain. At the risk of obliterating all traces of our spiritual past, they want to cover our mountain top with shiny domes. Puu Ma Kanaka is in the danger zone; the Kaula Trail is in the danger zone; Puu Poliahu and Puu Lilinoe are in the danger zone; Shrines and special Pohaku's placed by our ancestors of the distant past in much of the area now designated as "Science Reserve" are in the danger zone.

Stop this madness - - - our cultural ties to the spiritual past are on the ENDANGERED List. Even endangered weeds and bugs get more attention than our Sacred Mountaintop. We the people of Hawaii have up to present been quiet but disturbed about what has been going on up there. We thought co-existence was possible, because the knowledge gained through astronomy is most beneficial to mankind. It seems that co-existence is falling on the wayside and proliferation wants to take over.

To the Kupuna's (Elders), keepers of tradition and oral history, I offer this reminder: Yesterday we were the Children; today we are the Kupuna's; tomorrow we will be the Ancestors - - - the Spiritual Aumakua's. As today's Kupuna's, we carry the knowledge passed to us. Certain knowledge we pass on; certain knowledge we retain. Then there is certain knowledge we traditionally guard dearly; knowledge we pass on selectively to only special ones who have been chosen to hold these secrets.

We look to our successors, the younger generations, as future Kupuna's - - - Kupuna's in training. It is to these people we pass our knowledge. In failing to pass important cultural

Letter received from Ed stevens on September 25, 1998:2 and spiritual knowledge, we depart our earthly realm with unfulfilled purpose.

We need to reassess traditions of the ancient past, if and when it becomes necessary to divulge certain bits of information, in order to protect that which we hold to be precious - - our Sacred Domain. Western culture and their belief system take lightly our claims of the specialness of Mauna Kea. We need to come forward to express our feelings; to document our knowledge of what will be destroyed or obliterated by the uncontrolled expansion of "Observatory City".

Most of the many shrines and special "Pohaku's" placed in the upper elevations between 11,000 and 13,000 feet, were put there by family groups of the distant past and used as a means to channel their prayers to the Divine Creator; much the same way as statues of Jesus and Mother Mary are being prayed to by various religions of today. Descendants of these family groups are still here among us, and some continue to hold their ties with these shrines. Mauna Kea is our Church - - - Mauna Kea was; Mauna Kea is; and Mauna Kea will always remain our *SACRED* place.

Ed Stevens

Edward G. Stevens
76-6335 Leone Street
Kailua-Kona, Hawaii 96740
Phone: (808) 329-9255

Letter received from Ed Stevens on September 25, 1998:3

KUMU PONO ASSOCIATES
Kepā Maly, Consultant · 554 Keonaona St. · Hilo, Hawai'i 96720
(ph./fax call first) 808. 981.0196 · (pager) 808.327.7189 · (e-mail) kepa@interpac.net

September 28, 1998

Mr. Ed Stevens
76-6335 Leone St.
Kailua-Kona, Hawai'i 96740

Ed – *Aloha mai,*

Mahalo for talking with me last week, and for sending me your letter. I hope that I will have the opportunity to speak with you and Mr. Lancaster *mā*. As we discussed, I am enclosing a copy of the recent historical research that I prepared on Mauna Kea. The oral history studies will add significant details to the historical research, and I will be making additions to the historical documentation as a part of the present study for the DLNR and University.

I am also enclosing a copy of the general outline for the oral history interviews that I am conducting. The questionnaire in no way seeks to limit the discussion, but gives some background for beginning the process. The personal knowledge, experience and interests of the interviewees will give shape to the over all interview.

If you have any questions, or if we can make arrangements to meet as a group and conduct some level of an interview, please call me (981-0196). If I am off island, please leave a message, and I will return your call as soon as I can. *Mahalo*!

Me ka ha'aha'a,

Kepā Maly
Kepā Maly

Enclosures: *Mauna Kea – Kuahiwi Ku Ha'o i ka Mālie* (Maly 1997)
Mauna Kea oral history interview questionnaire outline

Integrated Cultural Resources Management Planning · Historical & Archival Documentary Research
Oral History Studies · Development of Preservation and Interpretive Plans

Letter sent to Ed Stevens on September 28, 1998

KUMU PONO ASSOCIATES
Kepā Maly, Consultant · 554 Keonaona St. · Hilo, Hawai'i 96720
(ph./fax call first) 808. 981.0196 · (pager) 808.327.7189 · (e-mail) kepa@interpac.net

October 6, 1998

Ms. Lynn Lee
Land and Natural Resources Division
Office of Hawaiian Affairs
711 Kapi'olani Boulevard; Ste. 500
Honolulu, Hawai'i 96813

Dear Ms. Lee:

Aloha nui nō – My name is Kepā Maly, we have met on several occasions in the past, perhaps most recently, during a c. 1995 walk along the shore of Ka'ūpūlehu to discuss cultural and archaeological sites and concerns. Since that time, I have been working on a number of cultural resource management and oral history study projects around Hawai'i (as an independent consultant), and as a part of that work, I've had the privilege of doing oral history-consultation interviews with Madam Chair Frenchy DeSoto and Trustee H. Kihalani Springer.

With this letter, I wish to inform you that I have been contracted by Group 70 International, to conduct an oral history study and prepare an archival-historical summary report on Mauna Kea. The work is being conducted as a part of the State of Hawai'i's program to update the 1983 Master Plan for the Mauna Kea Science Reserve and Hale Pōhaku. (Should you have any questions regarding the larger master plan work, you may contact Jeff Overton at Grp. 70 – 523-5866, ext. 111.) As a part of the study, I have initiated contact with a number of *kūpuna, mākua* and others who have personal knowledge of, and experience on Mauna Kea. Those contacts have resulted in my beginning the process of recording oral history interviews.

Following discussions with DLNR-SHPD, the Mauna Kea Advisory Committee (Trustee Springer is a participant in the committee), and community members, I have prepared a general oral history questionnaire outline to help in the interview process. I am enclosing a copy of the questionnaire for you with this letter. I would like to request that the Office of Hawaiian Affairs (OHA) consider preparing a statement that would help document OHA's thoughts on Mauna Kea's place (both past and present) in native traditions and practices; concerns, if any, on the present uses of Mauna Kea; and recommendations for the future management of Mauna Kea.

I would be very happy to meet with you and others at OHA to discuss this further, at your earliest convenience. I may be contacted at the phone number and/or e-mail address above. Presently, I am tentatively scheduled to be at your offices on October 13th (10:00a.m.) for a meeting regarding the historical-archival and oral history study I conducted at Ka'ūpūlehu, and the resulting Integrated Resource Management Plan. Please let me know if we could meet to discuss the Mauna Kea work some time that day as well.

O wau nō me ka ha'aha'a,

Kepā Maly

enc.

Integrated Cultural Resources Management Planning · Historical & Archival Documentary Research
Oral History Studies · Development of Preservation and Interpretive Plans

Letter sent to Office of Hawaiian Affairs – October 6, 1998

KUMU PONO ASSOCIATES
Kepā Maly, Consultant · 554 Keonaona St. · Hilo, Hawai'i 96720
(ph./fax call first) 808. 981.0196 · (pager) 808.327.7189 · (e-mail) kepa@interpac.net

October 6, 1998

Kūnani Nihipali, Po'o
Hui Mālama I Nā Kūpuna 'O Hawai'i Nei
P.O. Box 190
Hale'iwa, Hawai'i 96712-0190

Dear Mr. Nihipali:

Aloha nui nō – I met you briefly in Hilo on August 25th, with Aunty Pua *mā*. Since that time, I have been contracted by Group 70 International, to conduct an oral history study and prepare an archival-historical summary report on Mauna Kea. The work is being conducted as a part of the State of Hawai'i's program to update the 1983 Master Plan for the Mauna Kea Science Reserve and Hale Pōhaku. (Should you have any questions regarding the larger master plan work, you may contact Jeff Overton at Grp. 70 – 523-5866, ext. 111.) As a part of the study, I have initiated contact with a number of *kūpuna, mākua* and others who have personal knowledge of, and experience on Mauna Kea. Those contacts have resulted in my beginning the process of recording oral history interviews.

Following discussions with DLNR-SHPD, the Mauna Kea Advisory Committee, and community members, I have prepared a general oral history questionnaire outline to help in the interview process. I am enclosing a copy of the questionnaire for you with this letter. I would like to request that *Hui Mālama I Nā Kūpuna 'O Hawai'i Nei* consider preparing a statement that would help document Hui Mālama I Nā Kūpuna 'O Hawai'i Nei's thoughts on Mauna Kea's place (both past and present) in native traditions and practices; concerns, if any, on the present uses of Mauna Kea; and recommendations for the future management of Mauna Kea.

I would be very happy to meet with you and members of *Hui Mālama I Nā Kūpuna 'O Hawai'i Nei* to discuss this further, at your earliest convenience. I may be contacted at the phone number, address, and/or e-mail address above. Please let me know if we could meet to discuss the Mauna Kea work some time soon.

O wau nō me ka ha'aha'a,

Kepā Maly

enc.

Integrated Cultural Resources Management Planning · Historical & Archival Documentary Research
Oral History Studies · Development of Preservation and Interpretive Plans

Letter sent to Hui Mālama i Nā Kūpuna o Hawai'i Nei – October 6, 1998

KONA HAWAIIAN CIVIC CLUB
Government Relations Committee
Chair: Ruby Keanaaina-McDonald
August 1, 1998

Madame Chair, Martha, members of the Island of Hawaii Council of Hawaiian Civic Clubs...Aloha kakahiaka. Mahalo for allowing me the opportunity to expand on Kona's Government Relations Committee efforts to you all.

As a follow-up to previous reports to my Kona club, I'd like to extend an invitation to members of this island council to visit the summit of Mauna Kea with us on **Saturday, August 29, 1998.**

Arrangements have been made with personnel from the State Historic Preservation Division; Pat McCoy, who has spent many years documenting and studying archaeological and cultural sites on Mauna Kea; Holly McEldowney, state historian/archaeologist and Marc Smith, Island of Hawaii archaeologist. Also, Bob McClaren of the Institute for Astronomy.

Weather permitting...we are to meet at **9:00 a.m. at Hale Pohaku.** Please pack a lunch and liquid refreshments. Lunch and refreshments will not be provided. Additional information is attached for your comfort and safety. (IFA Information bulletins 3 & 5)

Below are options for tour stops. The number of and length of stops will depend on the interests of the individuals attending and their health. For instance, we might do Lake Waiau towards the end of the tour so that those who are not up to the walk can go home.

1. Hale Pohaku - shrine, octopus lure manufacture site
2. Shrine (near road, Site 1)
3. Adze Quarry work areas
4. Summit Region - overview of the areas surrounding summit cones and distribution of shrines
5. Keck Observatory
6. Lake Waiau

The Historic Preservation Division staff is currently preparing an historic preservation plan for the Mauna Kea Science Reserve leased to the Institute for Astronomy (c. 11,000 acres) and for the Mauna Kea Ice Age Natural Area Reserve. The plan will address the long-term management and treatment of historic sites within these areas. Thus far we know that this large area includes at least 70 shrines scattered throughout portions of the Science Reserve, burial sites located on some *pu'u* in the summit region, places that may be of traditional, religious or legendary significance to the Hawaiian community and a large quarries area where stone adzes were made. The Institute for Astronomy is also in the process of preparing an Environmental Impact Statement (EIS) and Master Plan for the future development and use of the Science Reserve.

The HP division staff would appreciate any mana'o and/or concerns Hawaiian Civic Club members would have on the following:

1. Do you know of areas in the summit region that are of importance?

2. Do you know of any individuals or family that have ties to the mountain who may want to be consulted on the long-term management of the summit region?

3. Do you have any ideas on how the historic sites in the summit region should be protected and, if appropriate, should some be interpreted for the public?

4. Should identified pre-contact sites be used and altered by native Hawaiians and, if so, how should they be used? Examples: members of the Hawaiian community collecting stone from the quarry work areas or practitioners modifying shrines.

The above are just "food for thought" as you prepare yourself for an educational, cultural, spiritual and archaeological experience.

This *hua ka'i ka'a hele* (tour) is a joint partnership with the Kona Hawaiian Civic Club, state Historic Preservation Division, and the Office of Hawaiian Affairs- West Hawaii.

Should you have any questions, please contact me at 329-7368 (w), or 325-5372 (h).

Me ka mahalo a nui loa,

Ruby Keanaaina-McDonald, KHCC
Chair, Govt Relations Committee

Page 1 – Copy of Final AHCC Resolution (No. 98-16)
Received as e-mail communication from
AHCC President, Arthur Hoke on December 18, 1998

ASSOCIATION OF HAWAIIAN CIVIC CLUBS

A RESOLUTION

URGING THE PROTECTION AND PRESERVATION OF THE CULTURAL, RELIGIOUS, AND ENVIRONMENTAL RESOURCES OF MAUNA KEA

WHEREAS, Mauna Kea, Hawai'i is a place of unique cultural, religious and historic significance and is sacred to the native people of Hawai'i; and

WHEREAS, located on Mauna Kea is Lake Waiau, Keanakāko'i Adze Quarry, many *ahu*, and located on the summit and lower regions are the sole habitation of some of the most rare and endangered plant and animal species on earth – among them, the Native Hawaiian ecosystem called the *Māmane/Naio* forest where the endangered *Palila* bird lives, in the upper regions of the summit area where the endangered Dark-Rumped Petrel or *'ua'u*, a high altitude bird dwells, and numerous insect, the most famous of which is the *Wekiu* bug; and

WHEREAS, in 1968, the Board of Natural Resources (BLNR) leased 13,321 acres of ceded lands to the University of Hawai'i Institute of Astronomy (IFA) for a science reserve for a term of 65 years; and

WHEREAS, the 1985 Mauna Kea Science Reserve Development Plan Environmental Impact Statement (EIS) allowed for a total of thirteen (13) telescopes inclusive of the six (6) observatories previously built; and

WHEREAS, in November of 1984, the BLNR approved a Conservation District Use Permit (HA-2728) to the Smithsonian Astrophysical Observatory for a Submilimeter Array Telescope (SMA) or Interferometer that would consist of an array of six (6) 8-meter telescopes which would cover an area nearly ½ mile across and would impact important historic cultural sites; and

WHEREAS, a much larger Interferometer known as the Millimeter Array (MMA), comprised of at least 40 telescopes, each greater than 8-meters (or 24 feet) is in the planning stages to built on Mauna Kea summit; and

WHEREAS, in the 1997 Legislature, at the urging of the Hawaiian people who were dismayed and outraged at the desecration of cultural and historic sites on Mauna Kea, Senator Malama Solomon authored SCR 109, which called for an audit of the management of Mauna Kea and the Mauna Kea Science Reserve; and

WHEREAS, the Audit Report to the Governor and to the Legislature, completed in February of 1998, pointed out that the University of Hawai'i's management of the Mauna Kea Science Reserve was inadequate to ensure the protection of cultural or natural resources, and further, that historic preservation was neglected, and that the UH repeatedly violated terms of leases, permits and various agreements and regulations intended to protect the summit environment and resources; and

WHEREAS, the Legislative Auditor 1) requested that the University begin the process for the next "Master Plan", 2) recommended that DLNR review the EIS, 3) complete and implement the Historic Preservation Plan, and 4) adopt rules for the plan; and

WHEREAS, in response to the legislative audit, the University of Hawai'i has assembled a committee to aid in the assemble of a new management plan for the Mauna Kea Summit; and

WHEREAS, this committee will address, among others, the areas of endemic insect habitat, litter problems, plans for further development on the mountain, criticism by environmentalists, Hawaiian culture advocates, and political issues as they relate to ceded lands; and

KUMU PONO ASSOCIATES
Kepā Maly, Consultant · 554 Keonaona St. · Hilo, Hawai'i 96720
(ph/fax call first) 808. 981.0196 · (pager) 808.327.7189 · (e-mail) kepa@interpac.net

November 18, 1998

Ms. Winona Matsuzaki
Office of Hawaiian Affairs
Division of Land and Natural Resources
711 Kapi'olani Blvd., Ste. 500
Honolulu, Hawai'i 96813

Aloha kāua:

Thank you so much for calling and speaking with me this morning, regarding Mauna Kea. Pursuant to your request, I am enclosing two copies of the historical report I prepared "*Mauna Kea Kuahiwi Ku Ha'o i ka Mālie...*" (Maly 1997) — copies furnished by Native Lands Institute. I am also enclosing a copy of an October 6th, 1998 letter I sent to Lynn Lee regarding the Mauna Kea oral history study I am presently conducting as a part of the master plan up-date project for DLNR/UH-IfA—I am a sub-consultant to Group 70 International, and Jeff Overton should be contacted for any detailed information on the larger master plan project. With the letter is a copy of the general oral history questionnaire which I am using as a part of the present study. The questionnaire gives you an overview of the kinds of information being sought from knowledgeable *kūpuna* and *mākua*. To-date, I have conducted 12 interviews with 14 participants, ranging in ages from 49 to 93 years in age. I am drawing near to the end of the time allotted for the oral history interview process, but I feel that it is important to at least explore some general approaches to management, long-term protection, and recommendations that might be made by OHA in regards to Mauna Kea.

If you have any questions, or would like to forward some material to me, please contact me at your earliest convenience (numbers and address above).

O wau no me ka ha'aha'a,

Kepā Maly

Kepā Maly

enclosures.

Integrated Cultural Resources Management Planning · Historical & Archival Documentary Research
Oral History Studies · Development of Preservation and Interpretive Plans

Letter sent to Office of Hawaiian Affairs – November 18, 1998

WHEREAS, although the Association of Hawaiian Civic Clubs has participated actively in the preservation of Mauna Kea and in bringing forward many of the current issues, there is not a representative on the Mauna Kea Task Force.

NOW THEREFORE, BE IT RESOLVED, by the Association of Hawaiian Civic Clubs in convention at Nukoli'i, Kaua'i, this 14th day of November, 1998, that it protect and preserve the cultural, religious, and environmental resources of Mauna Kea by requesting a moratorium on all construction until the Mauna Kea Task Force can update and complete a revised management plan for Mauna Kea; and

BE IT FURTHER RESOLVED, that the University of Hawai'i appoint the Chair of the AHCC Standing Committee on Benefits and Entitlements, as a representative of the Association of Hawaiian Civic Clubs, to the Mauna Kea Task Force so that timely input and reports can be communicated to the component clubs of the Association.; and

BE IT FINALLY RESOLVED, that certified copies of this Resolution be transmitted to the Honorable Benjamin Cayetano, Governor of Hawai'i, to the Senate President, the Speaker of the House of Representatives, the Board of Regents of the University of Hawai'i, the UH-Institute for Astronomy, and the Dept. of Land and Natural Resources, Historic Preservation Council, the Natural Area Reserve Commission and the Mauna Kea Task Force.

The undersigned hereby certifies that the foregoing Resolution was duly adopted on November 14, 1998 at the 39th Annual Convention of the Association of Hawaiian Civic Clubs at Nukoli'i, Hawai'i

[signed - Arthur Hoke]
President
Attest: December ____, 1998

[signed – Lily Pā]
Corresponding Secretary
98-16

APPENDIX C: EXCERPTS OF INFORMATION RECORDED AS A PART OF THE MAUNA KEA ADVISORY COMMITTEE PUBLIC HEARINGS

MAUNA KEA SCIENCE RESERVE AND HALE PŌHAKU COMPLEX DEVELOPMENT PLAN UPDATE:

ORAL HISTORY AND CONSULTATION STUDY, AND ARCHIVAL LITERATURE RESEARCH

Ahupua'a of – Ka'ohe (Hāmākua District) and Humu'ula (Hilo District), Island of Hawai'i

MAUNA KEA SCIENCE RESERVE AND HALE PŌHAKU COMPLEX DEVELOPMENT PLAN UPDATE:

ORAL HISTORY AND CONSULTATION STUDY, AND ARCHIVAL LITERATURE RESEARCH

Ahupua'a of – Ka'ohe (Hāmākua District) and Humu'ula (Hilo District), Island of Hawai'i (various TMK)

BY

Kepā Maly • Cultural Resources Specialist

PREPARED FOR

Group 70 International
925 Bethel Street, Fifth Floor
Honolulu, Hawai'i 96813-4307

February 1, 1999

Kumu Pono Associates
Kepā Maly, Consultant
Historical & Archival Documentary Research · Oral History Studies · Partnerships in Cultural Resources Management · Developing Preservation Plans and Interpretive Programs

554 Keonaona St. · Hilo, Hawai'i 96720 · (ph./fax) 808.981.0196 · (e-mail) kepa@interpac.net

APPENDIX C:
EXCERPTS OF INFORMATION RECORDED AS A PART OF THE MAUNA KEA ADVISORY COMMITTEE PUBLIC HEARINGS

The documentation and comments below were recorded at public hearings of the Mauna Kea Advisory Committee. The hearings were held in Waimea; Kealakehe, Kona: and Hilo (UH-Hilo Campus Center), on August 31st, September 1st and 3rd, 1998. Following an introduction to the goals and scope of the hearings, participants were notified that the hearings would be recorded and the proceedings transcribed. The texts below come primarily from the typed transcripts, with paraphrased notes from staff of Group 70 International, where problems occurred during the recording process (full transcripts in the collection of Group 70 International).

In undertaking the oral history study for the Mauna Kea Master Plan Project, Maly contacted several of the individuals, or the organizations they belonged to, as a result of their testimony in the hearings process. Those individuals who expressed cultural concerns, but were unable to participate in interviews or further consultation, are quoted below. Documentation pertaining to traditions, practice, cultural values, and recommendations on further development on Mauna Kea are noted in the main part of the oral history study.

Speaker	Testimony
Kealoha Pisciotta[1]:	(Has written testimony – handed out color picture of her shrine) Native Hawaiian. Citizen of *Ka Lāhui Hawai'i*. Employee of James Clerk Maxwell Telescope. I'd like to voice concerns regarding sacred burials, the abridgement of right to worship, destruction of ahu, violations of the 1983 plan. The upper regions of Mauna Kea are sacred. It is the zenith of our ancestral roots. We venture there in reverence. It is the sacred temple of our supreme being. Mauna Kea is related in oral traditions throughout the Pacific. Astronomy is a noble endeavor. It asks the same questions today as our ancestors asked many years ago. The development on Mauna Kea represents a colonization and occupation of the mountain. The State has approved Commercial Activity Use Permits... [end of alloted testimony time; continued at end of hearing]

With the Commercial User's Permit there are up to 100,000 persons accessing the mountain. There is no enforcement personnel on site. The Institute for Astronomy allowed construction without completing archaeology studies. The dots on this map represent shrines. The activities on Mauna Kea have reached a new height in desecration. It is enough to wage war. Beyond the cultural class, there are jurisdictional and legal issues. There have been violations of the 1983 plan which called for 13 telescopes including 11 major and 2 minor facilities. There are now 25 telescopes, light collecting instruments, antenna and other structures.

You must understand interferometry to understand the impact. The components of interferometry are the number of elements (antenna), the

[1] See further contact documentation in *Appendix B*.

number of pads, and the space between the elements. The State and the Institute for Astronomy argue that the Smithsonian array is one facility. It is 24 pads and 8 antenna in a area ½ mile in diameter. It cannot be counted as one facility. This is a picture of what an array looks like. With an interferometer, there is no physical limit to expansion, you can just add antenna and foundations. Therefore counting is useless. Counting violates the spirit of the master plan. Not a single condition of the 1983 master plan has been adhered to and we are going to make another master plan. What assurances do we have that conditions will be adhered to? Developers are the stakeholders. Native Hawaiians are the right-holders to the land.

I am a native practitioner. This is a photo of my *pōhaku* which was taken down by an IfA employee and taken to the Hilo dump. I found the *pōhaku* and set it back up, put my Grandmother's birthday offering on it, and it was taken down again. I placed it back again and in April it was taken down again and has not been found. The Institute for Astronomy has apologized.

Mililani Trask wanted to appoint me to the Advisory Committee but Regent Stan Roehrig did not want me on the committee. My first amendment rights have been violated. The Institute for Astronomy has asked me to move my place of worship. The Advisory Committee must look at this – I was doing a simple thing, praying on Mauna Kea. Roehrig asked Mililani, why not litigate? Ka Lāhui wants to work with the Advisory Committee. My basic questions to the State and the Institute for Astronomy are what are the basic protections? The man who destroyed the *ahu* is stilled employed by the IfA. We need State enforcement officers. Maybe the State cannot afford this because leases are $1 each. All of the lands at Mauna Kea are ceded lands – 20 percent of revenue should be given to OHA. The land needs *kahu*-ship not just stewardship. In summary, I am not in support of any further development until protections are in place. The limit has been reached. There has been dubious stewardship under the State and Institute for Astronomy. Who is to be cited for going beyond the limit? We must assess impact in another way because of the nature of interferometry. Who is punishable? We have to live with the development that happened. I have worked on Mauna Kea for 10 years. I love the mountain and cannot support further development. (MKAC Public Hearing at Waimea – August 31, 1998)

Okay. The other thing I want to say is that in 1983, a committee was formed and in fact Group 70 participated in this process in 1983 and that committee was basically the same thing you guys are here. Hear input and integrating policies and regulations. One of those regulations was to limit the number of telescopes on the mountain to thirteen by the year 2000 in the Science Reserve. My concern is that since 1983 until now, the number of telescopes that was allowed based on recommendations and findings of the committee and the decision between all parties concerned, which is the University, the Department of Land & Natural Resources and the Institute for Astronomy, was that in order to protect the public trust and still a lot of expansion to allow for thirteen. 'Cause in 1983, there were already six telescopes built. So that limit was inclusive of the six already built. With the introduction of interferometry the limit has been allowed to be violated by twice the number, there's 25 up there. So I just want to impress upon the committee that there was a committee who did this and violations occurred. And now again, we have to go into the same process all over again. What insurance will we have that further violations won't occur after the findings and recommendations that's put together by this committee? I mean, ultimately if it's no secret that the University and IfA have both announced that they want to continue the expansion, honestly, violating the law, in this case, the rules and regulation means to the public and the right of the native Hawaiian take… Rights were not maintained. The public trust interest was not maintained in that violation, and so I think the committee needs to be looking about, not only how for the violation would not occur, but actually is there a deterrent. How should those bodies be punished in the short term for violations? For not protecting everybody's interests… [end of alloted testimony time; continued at end of hearing]

Aloha, I'd like to show everybody some pictures of shrines. It's not a complete survey …[inaudible]… I wanted to confirm what these people over here said. This site, all of these sites are still completely unprotected. And this is only a partial survey, not completed. And yet all of these telescopes are either completed, under construction or on the way to being under construction. All being built before the archeological survey was done. I want to say to Group 70, you have hired Rosendahl, I'd like to object to that individual's qualifications. I participated with some of his employees on the oral history study, and actually, it disturbs me when I looked over the actual …[inaudible]… Because I want to say in regards to cultural protection of the mountain, is that the fundamental problem, I know is their understanding. In order to protect our sites under Western law, we must violate our own laws. So the issue comes down to if you know where *iwi* is, if you know where sites are, funerary sites, what have you. If we reveal that, we will go against our own law. But if you don't, will it be disturbed?

Now there are some archaeologists who are attempting to put together a plan whereby they simply identify people with the knowledge as a resource. And if they are participants in the planning process for further development, they can see the blueprint of where it is going to be and they would have the right to say - It is going to disturb something that I know of. Because from a spiritual standpoint, if you are designated to keep knowledge, that yours to keep. And if you violate our spiritual law, then you forfeit your life. And like me, I walk this *'āina*. My genealogy connects me to this *'āina* , from Kaua'i. And so I have a responsibility to *mālama* that *'āina*, and in my case, I was one of the particular special cases whereby my religious site was desecrated. Where my shrine was removed twice. But I put the shrine there, 'cause I walk the *'āina* so that I have place where laid offerings and pray for my own safekeeping and my own "pononess." And so I have to object to Rosendahl, because there is to many

conflict s. Up here is a burial ground and that is surely going to come up as an issue.

These sites are all unprotected. For years, we have asked for more protection and what that translates to is State enforcement personnel, and we would like to participate as Hawaiians, *kia'āina*, to help to identify sites that should be protected. Some sites need to be more protected than others. They have all these technical terms. The National Parks talks about interpretive programs and things like that. But that works in some cases with cultural themes but not spiritual themes and *kahu*-ship is a different thing than custodian or stewardship. I think the Hawaiian community has asked me… I have participated with the Institute for Astronomy, DLNR, and other private institutions, help to revolve the issues. Because I hear a lot of people talking about economics. And Hawaiians are not asking anyone to take a loss. We are asking the public to understand how the loss is affecting us. How we are taking a loss. No Hawaiians are advocating throw these telescopes off the mountain. Like the brother said in Waimea, we have to live with what has happened. Probably if we had more understanding of what impacts… no, *a'ole*. No! And in the process, they are our community also. The people, the astronomy community. We can absorb them, we can take them in. But for me, my group, if I worship… I don't even know why it should be a question because there is twice as much development as should be allowed by law. Nobody's taking a loss. In the future maybe, they want to build more, but by the same token, I don't want to see the polarization occurring because it is not necessary. What is necessary, is for the State and the Institute for Astronomy to stop ignoring the Hawaiians, the Hawaiian concerns. Because they will polarize it, they will protest. Mauna Kea's slopes are sacred, people don't *wala'au* about it, that's the problem. Because they are scared. The Institute of Astronomy has to be responsible, they have the burden of proof to prove that they have not desecrated a burial. So that's my *mana'o*. (MKAC Public Hearing at Kealakehe – September 1, 1998)

Aloha. Hello to the committee. I've seen you for three nights in a row, I know you're sick of me, but I'm happy to still come. I have some handouts on the front counter…this is before my time starts, right…and it basically has the number of letters that I participated in writing in, pictures of the shrines on Mauna Kea and one of them which was the shrine that was taken down that belonged to me and my family, by the Institute for Astronomy.

My name's Kealoha Pisciotta. I'm a native Hawaiian and a citizen of Ka Lāhui Hawai'i, but I'm also an employee of the James Clark Maxwell submillimeter radio telescope. I've worked on Mauna Kea since I was 17 years old. I'm here to voice my concerns regarding Mauna Kea as a sacred mountain and my people most renowned *wahi pana*, or sacred place. I'm concerned about a number of things. The first is the sacred burial ground and the bones of our ancestors. The abridgement of my rights as a native Hawaiian to worship, by the Institute for Astronomy, to the desecration, destruction and removal of my shrine from Mauna Kea on two separate occasions. And the violations to the provisions set forth in the original 1983 Mauna Kea Master Plan, regarding the number of telescopes to be built in the Science Reserve.

But first, I'd like the record to reflect, that I am opposed to any further development atop of Mauna Kea. In 1983, the Advisory Committee, just like this committee was formed to create the Mauna Kea Complex Development Plan, or the Master Plan. It was this committee that established the policies and regulations not only that governed development of astronomy, but also were meant to protect the resources and interests of the public and the native Hawaiians because of Mauna Kea's ceded lands. One of those regulations or laws was the limit set on the number of telescopes allowed at the top of Mauna Kea by the year 2000. That number was 13. Today however, there are over 25 telescopes, observatories, antennas, mirrors or light collecting surfaces that have been built or are under construction. Not even including the foundations or the pads or support buildings of the interferometers. If we include those, that number would be over 50.

A lot of people don't understand what interferometers or arrays are, this is a picture of a typical interferometer. The State and IfA continue to assert that it's one telescope observatory facility. Anyway, in light of that fact, I think it's safe to say that the astronomical community has not only exceeded its quota of telescopes for this millennium, but also for the next. Another one of the rules that was established by the 1983 Mauna Kea Advisory Committee required that a comprehensive historic preservation plan be completed and implemented. However to date, that Plan remains unfinished. I hear the beep. In other words, over two times the number telescopes has been allowed to be built without a completed archeological survey. I just wanted to speak to Dr. Steiger...Hi, I know him from a long time ago. His comment made about no opposition from the native Hawaiian community way back when. There's hardly any opposition now and the only reason is because of the sacred nature of Mauna Kea. It's of the highest esoteric order and part of the provisions in that is silence and secrecy. The highest born of our ancestors are buried there. To reveal that, by Hawaiian law, means that you must forfeit your life. Those are the rules. So we either follow the rules of the Hawaiian law or spirituality or we follow the laws of the Western way.

Now, I'm not opposed to astronomy in general, but I'm opposed to further expansion because of these violations and because I don't think anyone here will be punished. The State, IfA or anyone else who's accountable. The last thing is that I just want to point out, this map shows all the shrines on Mauna Kea, but they're not completed. This is just a general uncompleted survey. There are many. (MKAC Public Hearing at UH-Hilo – September 3, 1998)

Nāmāhana Kino[2]: I am known as *kupuna* Nāmāhana Kino, and also by other names. My ancestors go way back to the beginning of time to Papa and Wākea. I don't have to prove my genealogy to any of you because we have already done so in my own family. We do...I heard what this young man just said...yeah to open it up to everybody. Portions perhaps, but not all portions. Our mountain is sacred to us. And you, or those who are not of Hawaiian nature or in the spirit, will not every understand what connection we have with the *'āina*, with the land, with the water, with the elements, because that is not the Western mind. Thinking. And you can go "Hmm! Ohh!" It doesn't matter to you. 'Cause what I am trying to say is all of you who are on the committee I find *hewa*! Because you have not included, in your determination, out of the 24 people that sit here, you have not included the grass roots people.

I do not see...you have 24 people and how many of them are of the *koko*? How many of them are of the Hawaiian people? Maybe 9, 10? They're even still outnumbered, even if they still put in their suggestions to you, they are, according to the Western world, outnumbered. I am concerned of what is being done to the destruction of the *'āina* itself. Now those of you Hawaiians, even though you are Hawaiians, and those of you who are Hawaiians in the audience, if you are not aware that that mountain was used, and is being used, and does contain our *iwi*, then you are more blinded and you do not know your history. We have people that have their pikos, their na'aus in Lake Waiau. We have burials in many of the pu'us and we as Hawaiians do not have to tell you where they are because that is not your concern, and it is not your business! Now my suggestion is like the young man, the other young man, said stop what you're doing. Please get the input from those who have the *koko* and have the genealogy, and who know their history, and who have been receiving dreams and visions because you have not taken that into consideration. So I look at this committee as a big *hewa*. And I cannot just take that, and it makes me angry. I am very filled with anger but I realize things can be worked out because our ancestors looked at the heavens, that is part of their way that is how we navigated. And I know that something can be arranged, but not like this. So my suggestion is include the grass roots people. (MKAC Public Hearing at Waimea – August 31, 1998)

Leina'ala. That is my legal name [chuckles]... [inaudible] ... Excuse me. Time on. I don't have much more to say other than... You heard my *mana'o*. The giving of the sacredness...The sacredness was given by this young man. I, naturally, am against the expansion of the mountain, mainly because of the damage it's going to do to many of the pu'us and to the *'āina*. I do understand that the archeological examination; what do they call these things? Survey. Has not been fully completed. And lo and behold, they are not pointing out the areas that are sensitive to our people.

[2] See further contact documentation in *Appendix A*.

I don't know what it is going to take to coexist, other than, perhaps coming together and trying to find a solution of what, I really don't know. I heard the young man saying of the science with the domes and the astronomy and it lifts my heart because I say this is what we are all about. Our ancestors did look in the heavens and they use some of the tools up there to look up to where our god came from, where we could meet and connect and hold this uplifting of the hearts and the soul. So this young man who said excuse him for being *haole*. Oh please, I hope we didn't give you that impression that we are against haoles. Because we as Hawaiians, are very loving people and we embrace. It's the hearts of the individuals that we look at. It is not the color of your skin or the slant of your eyes, because we, as Hawaiians, we also have those that are terrible. They sell us out. They sell one another out. Okay so it is not the color of the skin. I feel like that is what we Hawaiians are all about – giving the love and I hope truly that something can be done for those who are in the science area, like Kealoha, who understands the impact of this mountain, who has worked. People like her that do understand the nature of how you can damage the *'āina* and therefore disturb all of us.

It is a sensitive thing. I do not envy the committee. And last night when I said to the committee you are *hewa*, I meant that only because of your lack, of not having the input of the grass root people. You need to hear from the native Hawaiian groups and those who do have connections to that land up there. And I still hold firm to that, so my suggestion is, hopefully, that you will get those people who have grouped. At this moment, I do speak for about 151 of my people. I have their permission and that is only part of them 'cause I haven't notified all. But I do have their permission to speak on their behalf, so I am representing 151 people and they do have ties to Poli'ahu. And that's all I've got to say. Thank you very much. (MKAC Public Hearing at Kealakehe – September 1, 1998)

Good evening, I'm Leina'ala McCord, known as *kupuna* Leina'ala. Of course, my interest is based on native Hawaiian viewpoint. I am against the expansion of telescopes that are against what my people have held sacred for many years at the mountain. Based on all the details, we're not saying that we are against people looking at the heavens. My ancestors have done this for generations, thousands of years. It is a balance that must be obtained and gotten by talking to the people that have influence on the mountain and who's duty and responsibility is theirs and theirs alone and this is the native Hawaiian.

Now have attended both meetings, both in Waimea and in Kona for this particular committee so they have heard my *mana'o*. But I also wanted to advise the public that I can consider this group of Advisory Committee as *hewa*, for they have performed a gross faux pas by not including in their group, and in their comprising of the members sitting on the board, native Hawaiians. Because who does the mountain...what jurisdiction does the mountain have, but the Hawaiian people have that jurisdiction. It belongs

to them. It is a trust, it's ceded land, etc., etc., you can go on and on. But, as I said we're not against people looking at the heavens.

This is part of our God head, so there has to be a solution that people can work towards and yet not ignore the desecration that has occurred and we do have witnesses as to where bones have been buried, they have been dug up and buried in places hiding, so that ...You see, if the contractors would let us know, it would be a delay. So, I'm not talking out just the top of my hat. We Hawaiians are very particular, where they dig. And with so many telescopes that I have heard...Now nobody has come and said this...90 telescopes on top of the mountain is just a little bit too much. They have already gone over their amount right now, based on their original 1983 master plan. So, yes I am against the expansion without the input of native Hawaiian people, who have genealogical ties to this mountain and do worship and have their traditions and culture based there.

So, if you have observed the mountains for 15 years, that's wonderful. We have been doing it for centuries. Okay, thank you. (MKAC Public Hearing at UH-Hilo – September 3, 1998)

Abe Kamakawiwo'ole:

My name is Abe Kamakawiwo'ole and I look at the stakeholders. But you know, we are talking about something else As the astronomers look out into the sky, they look at something sacred. But yet the people who give you that job are not looking at what is sacred. Before I forget, I have to acknowledge who I am here — *E aloha e ke Akua. E aloha e nā Akua. E aloha e nā aumākua. E aloha e nā kūpuna.* The mountain is part of us and we are part of that mountain. What is gone here is sacred. When you look up there you can look at life of man. Life is sacred. Some of the things that have not been mentioned yet, here, is that as Hawaiians look to *kalo* as our family. The mountain is a source of water. And everything that happens to that water goes over the land, underneath the land, and finally we get it as it goes out to the sea. Myself, how I look at it is this, the people that I am talking to, you might work for the federal government, you work for companies, you can work for the State, County, but what is gone here is you are dealing with the wrong people.

Look at development now. What are the Hawaiians doing? What do we have to gain from it? In fact, what do our people out in the communities have to gain from it? Everything is tourism, everything is business. In order for things to work, I do not look down upon the scientific community and the people who actually do the work. I look at how this is being done. Number one, this is not your land. So whatever you do you are stealing. Is this what...so when we go out in the schools now we have to tell the people this. Why should we? everyone is supposed to be grown up. And this is what persists here. I don't like when I go to a place and I see Hawaiians sitting on a committee and I don't know how they feel. I know how it feels, people need jobs. What if I was to ask you outside this room, who you are. I believe that certain things can be done as long as you respect us.

How can you do it when you don't respect us. In not respecting us if you don't respect the life that we have and you are living on the land that has life.

I don't know what else I can say and I don't know how to resolve it, but that is the basic problem. It is a problem for everything because I am also involved in Hāmākua. Actually I can say that as a job, the mountain, when I was up in Pā'auhau *mauka*, they gave me orientation, I looked up and you know, not like when I went to Florida later on...no mountains. I know where I am, I know who I am, and so do the people here. There are things up there that are sacred and should be respected. But you will not learn it because it is not for you to learn. The only people you can learn it through...I think that the scientific community can do it...but if you look at from a business perspective, that's *hewa*. Thank you... [end of alloted testimony time; continued at end of hearing]

The thing is what we have is the right mountain for the wrong country. And for the people who...some of the things that's supposed to happen. I think we have a French company up there, right? On that mountain? And the State, during the time that they were dropping bombs down on Tahiti, which are also our brothers, how come those people still stayed up there on the mountain? Hawaiians wouldn't let that happen. (MKAC Public Hearing at Waimea – August 31, 1998)

Luana Adams: Is 22 years old. Just finished a degree in anthropology and has returned to Hawai'i. What is happening on Mauna Kea is typical of the paternalistic Western world. It is not universal for every cultural group to seek the answer to the basis of its existence. For many cultures it is *kapu* to ask. What the *kupuna* says goes. In Hawai'i, there is no question who the *'āina* belongs to. Astronomy does not perpetuate history. Tourism is not the only way to survive. People survived before visitors arrived. Science is not the only way to make a living. You must consider the views of other people. Mauna Kea does not belong to you or to Hawaiians. It belongs to the Gods, whichever you believe... [end of alloted testimony time; continued at end of hearing]

(asks a question about the archaeology and notes): I spoke with someone involved with the other master plan. He recalled six bundles of bones were removed from the site where the first observatory was constructed on. What was done with those bundles? Were they repatriated, do you know? Six individuals, in fetal positions, wrapped. (MKAC Public Hearing at Waimea – August 31, 1998)

Sheri Adams: I am Luana's mother. We recently returned to Hawai'i, so I am behind the times on news. I lived for 8 years on the mainland for my children's education. I want to comment on the request to get oral history. Tutu would be the best to share. Fifty years ago my *tūtū* shared his knowledge of planting customs, out of *aloha*. The Hawaiian planting calendar relayed by him was printed by others for profit. My question is, what is the

purpose of the oral history being sought? Will it be used to develop more for a small portion of the community? If the reason is for the tourism industry, the money does not trickle down. With development, land is rezoned, taxes are raised and people must sell their land. (MKAC Public Hearing at Waimea – August 31, 1998)

Kaliko Kanaele: I have been to a lot of these meetings. The excuse for everything is the economic situation. Sugar just left. The Kanaka Maoli Church will be having services on Mauna Kea. We are researching *ahu*. Things get watered down in the name of doing it all together. The annexation was not correct. The land is ours. You will soon be negotiating with Hawaiians. It will be good when Hawaiians run things. It is for our people to do this planning. (MKAC Public Hearing at Waimea – August 31, 1998)

Ed Stevens[3]: I am Ed Stevens. I might add that I fully concur with Senator Solomon's recommendations. I think that's great. Before you start my time, can I just say something? [chuckles] Could I have another minute extra? I am disappointed that the full committee is not here because this is to me a very sensitive subject that I intend to cover. Three minutes is a very short time for something that would probably take 4 hours, but being in a rush, I will try to be as clear as possible and read fast. I would like to leave this copy. It is addressed to the committee. Could I ask that copies to given to each member? Thank you.

(Adds further documentation to his testimony and responds to other comments from attendees)
All islands in the Hawaiian group have their sacred places which were used since early times for spiritual communion. The most sacred of these places were the highest peaks of each island. On the four major islands, there was Mount Wai'ale'ale on Kaua'i, Mount Ka'ala on O'ahu, Haleakalā on Maui and Mauna Kea on Hawai'i. Mauna Kea being the highest point throughout Polynesia, had special significance because it was considered to be the gateway to heaven. When the ancient *kāula*...these were the priests, the prophets. When the ancient *kāula* made their treks to the summit, it was to be nearest to *akua* where prayers could be offered in the highest reverence.

Oral history and traditions tell us that burial sites are many in the higher elevations. The bones of very special personages were placed in the pu'us at or near the summit for safekeeping, for their sacred sanctuaries. These were things that were done in ancient days. Now it is said that some of these have already been violated by the construction of the now existing observatories. The observatories that are there now when under construction, it has been said, that there were violations. We are beginning to hear horror stories about what the unsensitive ones are planning for this,

[3] See further contact documentation in *Appendix A*, and the interview with Alika and Anita Lancaster (October 21, 1998).

our spiritual domain. At the risk of obliterating all traces of our spiritual past, they want to cover our mountain top with shiny domes.

Pu'u Mākanaka, very special place for those who know it is in the danger zone. See this outline. The Kāula Trail is in the danger zone. The Kāula Trail which went down along side Pu'u Mākanaka on down to Keanakolu, etc. It is in danger, in the danger zone. Pu'u Poli'ahu and Pu'u Lilinoe and both in the danger zone. Shrines and special pohakus placed by our ancestors of the distant past in much of the area, now designated as the Science Reserve are in the danger zone.

I ask the committee, I ask the University, I ask the Department of Land & Natural Resources, look into your hearts, stop this madness. Our culture and ties to the spiritual past are on the endangered list. Even endangered weeds and bugs get more attention than our sacred mountain top. In conclusion, I say that we, the people of Hawai'i, have up to the present, been quiet, but disturbed about what has been going on up there. We thought coexistence was possible because the knowledge gained through astronomy was most beneficial to mankind. It seems, however, that coexistence is failing, is falling on the wayside and proliferation wants to take over. Thank you. [end of testimony time; continued at end of hearing]

Regarding the desecration, if things are done in a positive spiritual environment, the things are made right, that in point of time, when these eye witnesses come forward. There are eyewitnesses to this desecration. They are afraid to come forward because of the implications, what it can do to them., the harm that come happen to them. So al I can say is that we hope that some day they will come forward and bear witness of what had happened, not for the sake of punishing the perpetrators, but for the sake of finding the *iwi* and putting them there were they belong. To reinter them with the dignity that they deserve. Once done, the atmosphere will turn positive. The mountain top will take on a more positive energy. And I thank you for your comments.

It's very important that all those who make the decision, understand what she said. In that those who know what's up there are reluctant to come public because, as we said, it is violating the law of Polynesia. And even for myself, I just scratched the surface of what is there in my mind and I had a reluctance to divulge it here, because I know will be some Hawaiians who will be offended by my even coming out tonight. We need to get over that if we are going to correct the problem. We need to come out and begin to testify as Hawaiians, so that people can understand it. That is going to take a while to happen.

That the Polynesian people begin to embrace that idea of coming out. Otherwise, you take the consequences. So I think that was a very important statement that she made. I know this is the statement that I can make by the Institute of the Astronomy, "but they don't care. Nobody is making a ruckus about what we are doing." We do care but we don't come out

because of our own sacred thoughts. So it is kind of a Catch-22 how we resolve it.

I see one way, as I mentioned in my talk here, coexistence. We can still coexist, but they have to get rid of some of the crazy ideas they get up there. What they want to put up there. Because where they want to put them is in the areas that are marked here. The places that shouldn't have those developments. So where do we have agreement as to where to go, we they need observers up there when they start excavating. We have, up until this very date, never had a representative of the Hawaiian community up there to observe excavation, and because of that lack of observers, you don't know how many things have really happened that should not have happened.

I can see the point of the contractors up there. If you don't report it, you don't get delayed. Once you report an excavation, you can get held up for months and they don't want that 'cause they lose money. So up there is so easy to hide. A couple of bones might shut down the job where they are digging and then the employees come back say, they are pig bones. Pig bones, my eye. Pigs don't go up 13,000 feet, so a cover up is going on. [pointing to an individual] I am not here to say something to dispute what I am saying. (MKAC Public Hearing at Kealakehe – September 1, 1998)

I had made testimony 2 days ago in Kona and I submitted my testimony. Tonight I was prepared to address the Polynesian segment of the audience, but I've changed my mind. I would like to go back to my first testimony because I feel the need to educate the audience here. I reach out to you. I ask that you hear what I say, because I may use the words sacred again. I don't mean to beat it to death, but I need to use those words to emphasize what I'm trying to say to you, so that you will understand what's the big deal? What's the matter with the Hawaiians? Well, I intend to, try to explain to you why it is a big deal.

All islands in the Hawaiian group have their sacred places which were used since early times for spiritual communion. The most sacred of these places were the highest peaks of each island. On the four major islands, there was Mount Wai'ale'ale on Kaua'i; there was Mount Ka'ala on O'ahu; Haleakalā on Maui; and Mauna Kea on Hawai'i. It has been said, that in earlier times, there were ahus, stone platforms which represented the altars for the community. Some still remain. I believe, Haleakalā still has, I believe Wai'ale'ale still has. Mauna Kea looks like rubble right now, where it should be. But anyway, Mauna Kea being the highest point throughout Polynesia, had special significance because it was considered to be the gateway to heaven. When the ancient *kāula*, these are the Hawaiian prophets, priests. When they made their treks to the summit, it was to be nearest to *akua*, the creator, where prayers could be offered in the highest reverence.

Oral history and traditions tell us that burial sites are many at the higher elevations. The bones of very special personages were placed in the *pu'us*, the cinder cones at or near the summit. These were the special ones, as Alika mentioned a few names, Hawai'i Loa, our hero, was placed up there among many of the other heroes that we revere. They were placed at or near the summit for safe keeping. These were their sacred sanctuaries. And, it has been said, that some of these have already been violated by the construction of the now existing telescope sites. We are beginning to hear horror stories of what the unsensitive ones are planning for this, our spiritual domain. At the risk of obliterating all traces of our spiritual past, they want to cover our mountain tops with shiny domes.

Special places, and I refer to those maps there, the one on the left. See that perfect circle with, pardon the expression, three nipples? Why a perfect circle with nipples, those are significant sites for the observatory, perfect places for new sites to be built. Pu'u Mākanaka is on the danger list. Don't touch Pu'u Mākanaka. It is too special. We will not accept that desecration. Leave Mākanaka alone. Coming up between Pu'u Mākanaka and the summit, that plain in the east and southeast plain, are pok-a-dot with shrines and special *pōhaku*, special stones. It's dotted. That area between Pu'u Mākanaka and the summit has been said, is designated for that sub millimeter array of 90 antennas.

Bad...The Kāula Trail...*kāula* was again I say was the priest, the prophets, our spiritual personages who went up that mountain to do their homage to God. That trail, what remains, is mainly the essence of that trail. Those of us who know, we know the path. It's been deteriorated from lack of use. When energy walks up there, you don't need trail. Anyway, that trail is a major significance to the Polynesian people because of what it was intended and used for. It will be obliterated if this madness continues. Pu'u Poli'ahu, unfortunately was scarred several years when they cut the road of her face, right up to her crown. People drive up there now, randomly for just recreational. And, its like I would say, how would you like if these people drove on you mothers grave? Same thing, this is how we feel about that desecration. Pu'u Poli'ahu represents what was said earlier. We revere the essence of Poli'ahu who is one of God's angels.

The danger zone, which includes the shrines and the special *pōhaku* that I mentioned earlier are subject for demolition if this madness continues. So, I ask the people to bear with what we say when the Hawaiians speak of sacredness. We're not speaking out of hollow thoughts. We speak because it's from our heart. That place is a special place and we need to preserve it for our descendants. I would classify those special sites as being on an endangered list. We hear testimony about endangered weeds and endangered plants. They get more attention than our sacred domain. And, I think we ought to give a little more respect to our sacred domain.

In conclusion, I say, that we, the people of Hawai'i have up to the present, been quiet, but disturbed about what's been going on up there. Somebody

mentioned earlier, "Oh, nobody cares." We care, but we're quiet about it. We've manage to maintain our composure up until now. We thought coexistence was possible because the knowledge gained through astronomy was most beneficial to mankind. We acknowledge that. We think its great having the observers, the astronomers up there doing their work. But, we need control. Control can be done, but it seems coexistence is falling on the wayside and proliferation wants to take over. Thank you. (MKAC Public Hearing at UH-Hilo – September 3, 1998)

Reynolds Kamakawiwo'ole[4]:

Aloha mai, tonight is a very important time for our people to share their *mana'o*, to all that is present. When I speak in this testimony, I allow myself receive all the spirits that are gathered from [inaudible]. So, therefore listen to what I'm about to tell you, what is felt about the management of Mauna Kea. First of all, to just to address the spirituality. It is the home of Poli'ahu, the Snow Goddess and she tells me that she has been desecrated. If continued, she will show her power. This is not a threat, this is her will. You must listen to the people, especially the native Hawaiians who are culturally and spiritually connected to Mauna Kea.

This mountain is the one and only. Many of our people will not allow more desecration by constructing new telescope facilities. However, I've been told that no matter what, the plans are to go ahead. Spiritually, this information is shared to those in the physical so that they may approach this in a manner to awaken our people. I remember how the sugar plantations, here in the area, just plowed, to many of our sites and now observatories upon our Mauna Kea. They look like mushrooms and I say enough is enough. Now this is another statement received spiritually.

"You know as you come to do what you want with my mountain, but in whose interest? I have felt the destruction that negligent people who wants me. Those that believe that I exist are blessed, so that they can practice their rights and know there's much more about Mauna Kea. Several people have disappointed me, but I have forgiven them. Now, I see the support from people and I reveal myself through this statement. No more can you do this. You must stop or I'll stop you. What is on me, will stay until forever. I feel for you as you do not get it. Hawaii is not an ordinary place. It has many powerful sites. These sites which have been desecrated, are revealing itself to its people throughout the Earth. Not only are Hawaiians in the picture, but many of the races are spiritually called upon to stop further development. It's like candy. It's hard to stop the desire until you know that it could hurt you and cause you decay. Do not decay me for I have provided the beauty. If I was a woman in the physical, would you desecrate me? Sleep on it tonight."

[4] See further contact documentation in *Appendix A* (in communications with Ed Stevens and the oral history interview with Alika and Anita Lancaster – Oct. 21, 1998).

Therefore, I Reynolds Kamakawiwo'ole, strongly oppose further development on Mauna Kea as a native Hawaiian. As a member of the Royal Order of Kamehameha, as a Nā Koa of Pu'u Koholā, as a citizen of the Kingdom of Hawai'i. As far as I'm concerned, the activities of Mauna Kea, to continue development is not acceptable. And is not spiritually acceptable to our Hawaiian people. Further, I feel this is similar to the overthrow of the Hawaiian Government, but in this case, Mauna Kea, Poli'ahu will speak to others as soon you will have an army to deal with. Then what? You must be in tune, what is the truth. Do not be influenced by money and material, for it will take you down. Be receptive to our culture, and *ho'olohe*, for she has spoken. Let these thoughts be received and blessed. *Mahalo nui loa.* (MKAC Public Hearing at UH-Hilo – September 3, 1998)

Maile AkimSeu[5]: *Mahalo nui* for this *kuleana* that I have to stand before you. I represent many *kūpuna*, from many groups because they are unable to be here tonight. These are just some of the questions that may have been answered but these are the questions they want to be presented tonight.

Number one, who has the title to the land that is being discussed and who gave U of H the entrustment to decide what is to be done to this property?

Number two, what guaranty is there that no violation to artifacts, to old ancient bones in ground will be done in the area of consideration?

Number three, what is to stop a group of people consisting only Hawaiians that has the expertise and credentials, the decisions of the use of our very own Mauna Kea?

Number four, where will the funding for the advisory suggestion for the use of the land come from?

Number five, what is the environmental impact on this area and the land surrounding it?

Number six, What is the economic impact on this area and the land surrounding it, both costs and benefits, to Hawaiians?

Nui ko'u ha'o i kēia mauna o Mauna Kea. These were the grounds that my *kupuna* walked and sleep. As a young *keiki* of my *kupuna* I was always told by her that "the *mauna* needs to have more respect." As people of Hawaii nei and *kanaka maoli* I also embrace the concept of Ka Lāhui. I am a citizen. And I also embrace the knowledge and understanding of Hawai'i Loa, who is our progenitor. I thank Alexander Lancaster to make mention of this Hawai'i Loa. 'Cause many of our ancestral bones are buried there. We know for a fact that many bones were removed and we were not informed. I have had many encounterment with the State archaeologist, I

[5] See further contact documentation in *Appendix A*.

will not name names because I have been in...the responsibility of protecting and preserving our *heiau*. We are now trying to get many people and many Hawaiians involved in the protection of our many *heiau* and *pu'u*.

My Hawaiians, many of them don't quite understand but the old people are now coming forward and they are very *hūhū*, very angry, very upset of what is happening on that mountain.

If it was said earlier that were called upon to sit and *kūkākūkā*, even if it was done by the President of the University of Hawai'i, I don't think you would need to have this public hearing here tonight. And I agree with many of my Hawaiian people, if we do not protect what we have now... We have lost so many, so many things in our life and in our history. I speak for my generation, of the clan of 'Umi-a-Līloa. I also speak for some of my *kūpuna*, with the Keōua clan. I represent my *kūpuna* here tonight.

My Hawaiian people don't show their anger. But, we are called upon to make decisions. We have this public hearing tonight and I attended one advisory meeting that I was told I should not be there. I traveled throughout the different parts of the country and I love going to New Zealand because they respect their mountains, they respect their history, they respect their culture and they respect their language. They keep telling us, "you Hawaiians, what are you doing? Protect your *'āina*, protect your mountains, protect your ocean. So many people are coming and doing too much *hewa* and we see that."

So, what happened to our children, who we sent to be educated in the different parts of the world. They're not home here, 'cause they're gone. If you asked me tonight, If we could have made a plan together with President Mortimer and the people here on the advisory team. I know many of them. I know their hearts. I know where they are. I know what they want to do. They want to help. Many of them want to help. We need to help one another. The *kūpuna* are the expertise of our *'āina*, of our *mauna*. Don't shut us down. Give us the benefit that we can do for ourselves as Hawaiians. *Na ke Akua e ho'opōmaika'i iā 'oukou.*

I'd like to tell you a story and this is a story in the '60's and '70's. I lived in Keaukaha and a decision was made for Keaukaha that we were gonna develop it...or someone was gonna develop it or someone was gonna develop it into industrial and commercial area. Heavy and light industry. The people came together because a small area of Keaukaha was going to be residential. If any of you know Keaukaha, Ka'uhane [Street], all the way down to Todd [Street], was only gonna be the residential area. The rest if the area was gonna be heavy and light industry. The *kūpuna* again, came forward and said, "Who are these *kolohe* people, want to displace us again from our *'āina* that was given to us that was not good. The land was not good. We made it flourish, we made it good and now they want it?"

All of you Hawaiians who are in this room tonight. We need to join forces. We need to say to these people on these kinds of committees, that we need to be part of their committee. *Mahalo*. (MKAC Public Hearing at UH-Hilo – September 3, 1998)

APPENDIX D:
MAUNA KEA — AN OVERVIEW OF ARCHIVAL AND HISTORICAL DOCUMENTARY RESEARCH

MAUNA KEA SCIENCE RESERVE AND HALE PŌHAKU COMPLEX DEVELOPMENT PLAN UPDATE:

ORAL HISTORY AND CONSULTATION STUDY, AND ARCHIVAL LITERATURE RESEARCH

Ahupua'a of – Ka'ohe (Hāmākua District) and Humu'ula (Hilo District), Island of Hawai'i

Kumu Pono Associates

Historical & Archival Documentary Research · Oral History Studies · Partnerships in Cultural Resources Management · Developing Preservation Plans and Interpretive Programs

MAUNA KEA SCIENCE RESERVE AND HALE PŌHAKU COMPLEX DEVELOPMENT PLAN UPDATE:

ORAL HISTORY AND CONSULTATION STUDY, AND ARCHIVAL LITERATURE RESEARCH

Ahupuaʻa of – Kaʻohe (Hāmākua District) and Humuʻula (Hilo District), Island of Hawaiʻi (various TMK)

BY

Kepā Maly • Cultural Resources Specialist

PREPARED FOR

Group 70 International
925 Bethel Street, Fifth Floor
Honolulu, Hawaiʻi 96813-4307

February 1, 1999

Kumu Pono Associates
Kepā Maly, Consultant
Historical & Archival Documentary Research · Oral History Studies · Partnerships in Cultural Resources Management · Developing Preservation Plans and Interpretive Programs

554 Keonaona St. · Hilo, Hawaiʻi 96720 · (ph./fax) 808.981.0196 · (e-mail) kepa@interpac.net

APPENDIX D: MAUNA KEA — AN OVERVIEW OF ARCHIVAL AND HISTORICAL DOCUMENTARY RESEARCH

Table of Contents

Introduction

The primary source of archival literature cited in this Appendix are five previously published studies—McEldowney and McCoy (1982), Cordy (1994), Kanahele and Kanahele (1997), Maly (1998), and Langlas et al., (draft – February 1997). Combined, these studies reference much of the archival literature known to be available for Mauna Kea. This overview of archival and historical literature pertaining to Mauna Kea, focuses on several of the outstanding documentary components of the referenced studies. Of particular interest, it will be seen that at several points the historical records coincide with information—thus, demonstrating continuity and time-depth in knowledge—recorded as a part of this oral history study and information collected by Charles Langlas of the University of Hawai'i-Hilo Campus (Langlas et al., Draft Feb. 1997).

Rather than rewriting the information of past authors, this appendix includes verbatim and annotated excerpts of the original documentation. The original studies provide readers with a foundational understanding of various facets of the history and cultural significance of Mauna Kea. *The full reports should be referenced for a complete record of their archival resources.*

It is noted here, that Pat McCoy, Ph.D., and Ms. Holly McEldowney Ph.D., (both of whom are presently with the State Historic Preservation Division) have been working on Mauna Kea for a period that covers more than 20 years. McEldowney's 1982 report, *"Cultural Resources Reconnaissance of the Mauna Kea Summit Region"* (Report 1. Ethnographic Background of the Mauna Kea Summit Region), was conducted as a part of the original work for development of the Mauna Kea Master Plan. Because of the detailed nature of her study, it has been cited by most Mauna Kea–vicinity researchers that have followed her (this author included). Thus, primary citations of McEldowney's work are cited in several more recent studies, which also comment on the subsequent relationship of further research. At the present time, McEldowney and McCoy are preparing the State's cultural assessment and archaeological analysis of data they and other researchers have compiled (title and date of publication presently unavailable).

Additionally, it is noted here that one of the most recent Mauna Kea–vicinity studies completed, provides readers with important cultural documentation specifically from the perspective of native practitioners—noted authorities of Hawaiian customs, beliefs, practices, and culture — and is titled *"A Social Impact Assessment – Indigenous Hawaiian Cultural Values of the Proposed Saddle Road Alignments"* (Kanahele and Kanahele 1997). In it, readers are introduced to Hawaiian cultural values, protocols, and practices; attachment to landscape; and the importance of nature in Hawaiian ritual and life. Co-author, Mrs. Pualani Kanaka'ole Kanahele also participated in the oral history and consultation phases of the larger study to which this appendix is attached. Thus, only selected excerpts of her 1997 assessment study are cited below. Readers are urged to read her contributions to the oral history study and the full assessment study prepared by her and her husband.

Lastly, a recent study on Mauna Kea, with specific emphasis on traditions and history of the summit region, was prepared by this author (Maly 1998). That study includes detailed historical documentation recorded by native Hawaiian authors and historic documentation compiled from the middle 1800s to the early 1900s by various surveyors and visitors to Mauna Kea. Portions of that study are repeated here as well.

Ross Cordy Ph.D., of the State Historic Preservation Division researched and prepared a cultural synthesis for the Hāmākua District, including the summit of Mauna Kea (Cordy 1994). In his work, he cites McCoy, McEldowney and many other earlier researchers, and includes important observations and recommendations in regards to Mauna Kea. The following excerpts are cited verbatim from his study:

I. A Regional Synthesis of Hāmākua District, Island of Hawai'i (Cordy 1994)

Historic Information on General Site Patterns

Archival data on traditional land use patterns for this subregion of Hāmākua are quite sparse. This area again was above the *'ōhi'a–koa* forest and included two vegetation zones: the open *māmane* forests and scrub, alpine tundra vegetation at higher elevations above treeline. The Boundary Commission records clearly indicate that most *ahupua'a* ended at the *'ōhi'a–koa* forest borders, while a very few extended into the *māmane* zone. These few seem to have been Kamoku, Honokaia, Nienie, Pā'auhau, Kalōpa, Ka'ohe, Koholālele, and Kūka'iau (north–south). Pā'auhau and Ka'ohe encompassed vast areas of the *māmane* forest, and Ka'ohe included the higher areas above the tree–line. It is important to repeat, however, that the archival records show that the houses, major *heiau* and farmlands of these and the other East Hāmākua *ahupua'a* were on the lower slopes below the *'ōhi'a* forest — in the Mauna Kea Windward Slopes subregion. These *ahupua'a* also gathered resources from the *'ōhi'a* forests.

Ka'ohe's southern borders, which lay within this subregion, ran primarily along a series of cinder cones. Ka'ohe cut–off Koholālele at Pu'ukea and Pu'u o Kihe, then ran south to 'Iolehaehae, and then across the island above Hilo to [Pu'u] Kanakaleonui to [Pu'u] Kaupakuhale to Pu'u Kole and to Pu'u Kalepeamoa or Kalepe a Moa near today's observatory camp at Hale Pohaku (BCB Hawaii: Ka'ohe *Ahupua'a*).

I. The Māmane Lands

Special resources within the *māmane* zone are implied in the records. Border testimonies for Humu'ula *ahupua'a*, the *ahupua'a* in Hilo which extended inland along side part of Ka'ohe, note:

> The *mamani* and *pili* are on Humuula, the
> woods on the *makai* lands.
> (1873 testimony of Hanioa)
> (BCB, Hawai'i,B:44)
>
> where ever the *mamani* grew above the
> woods was Humuula, and the land below
> the *mamani* belonged to the *makai* lands.
> (1873 testimony of Parker) (BCB, Hawai'i, B:32)

Similar borders and resource use rights would appear likely for the few *ahupua'a* in Hāmākua which entered the *māmane* forest and cut–off the others at the *'ōhi'a–koa* woods.

Unfortunately, these resources are not clearly specified. "Pili grass" may have been a generic term for grass, but it may have been a special resource for thatching certain structures. *Māmane*, itself, was important, being preferred for adze handles (McEldowney 1979: 32; Judd n.d.) and also being used for house posts and *holua* sleds (Buck 1957:83, 383). Meat birds—the *nēnē* goose and the *'u'au* or dark–rumped petrel *(Pterodroma phaeophygia)* — may have been special resources found in these *mamane* forests. The nestling petrels evidently were a delicacy restricted to chiefs, with the other age ranges available for all ranks to eat (Hommon & Ahlo 1983:22; McEldowney 1979.32–3; Henshaw 1902; Lyons 1875: 111). The petrel is a pelagic seabird whose primary food is the *mamane* seed and whose breeding season is May to October (Stemerman–Kjargaard 1985:3). The *'u'au* is presently in more inaccessible areas, but it once may have been fairly common (Stemerman–Kjargaard 1985:3; McEldowney 1982:1.8), and this factor needs to be considered in relation to exploitation patterns, Hawaiian sites, and *ahupua'a* borders. So "hardwoods and birds" may have been the major resources of the lower parts of this subregion (cf. McEldowney 1979:32). Other resources of the *mamane* zone are unclear. [Cordy 1994:86]

Exploitation of the above resources suggest short–term camps would have been used when Hawaiians were in the area, but the archival documents reviewed are silent on this matter. McEldowney's (1982:1.13) research, which included Hilo *māmane* areas, revealed that "native guides" for visitors in the 1800s did "have knowledge of shelter caves, overhangs, and water sources".

Only two kinds of sites are clearly documented in the accounts for the *māmane* zone. One was a major trail on the seaward side of Manna Kea, running parallel to the sea above the *'ōhi'a–koa* forest. It connected at least the Kohala–Waimea–Waipi'o areas to the Hilo area, descending down the Wailuku River to Hilo (cf. McEldowney 1979:29–30). This seems to have been "the trail of Poli'ahu" which 'Umi's army took in their conquest of Hilo District (Kamakau 1961:16–17). It also was the "mountain road" on which Rev. Baldwin and his guides got lost in the fog (March 26, 1834 letter to Chamberlain), and it seems to have also been the Laumaia Road shown far inland on the 1864 Wiltse map of Koholālele *ahupua'a* and mentioned in some Boundary Commission testimonies (BCB, A: Ahp. of Koholālele, B:Ahp. of Kuka'iau). This trail seems to be close to today's Mānā–Humu'ula Road, built between 1874–1894 as a wagon road to the Humu'ula Sheep Station (Hommon & Ahlo 1983: 28). [But see McEldowney's, 1982:1.13, analysis indicating shifts of the trails in the late 1800s.] Clusters of short–term camps along this trail would be expected, as well as rest areas (*o'io'ina*), shelters, water sources, and trail markers (McEldowney 1982:1.6).

[It should also be noted that, within forest lands, another major trail skirted the base of Mauna Loa on its inland side — very roughly approximating the Saddle Road. This trail is discussed under the Interior Plateau subregion. The trail rose from Hilo, with Puna and Ka'ū branches, skirted the mountain and then descended to Waimea with branches then leading off to coastal Hāmākua and Kohala.]

Branch trails leading off these major routes to higher elevations were not identified by Hawaiians in the Boundary Commission records or other sources studied by McEldowney (1982) or this author. Landmarks seem to have been focale points for travelling, rather than trails (McEldowney 1982:1.6, 1.13).

The second site type documented was burials. In the Kūka'iau and Ka'ohe *ahupua'a*, there are several cinder cones near the 7,500 foot elevation — Pu'u Kihe (7,821 feet)

and adjacent 'Iolehaehae. Witnesses testifying on Kūkai'au's borders noted the following:

[On "Puuokihe"]...pile of stones on sand
and *aa*, a burying place of Hamakua
people in olden times.
(1880 testimony of Kauahipaula)
(BCB, Hawai'i, B;443)

[Pu'uokihe]...it belongs to Kaohe
[*ahupua'a*] and above that is where people
were buried in old times, when people
used to make fishhooks from the bones.
(1880 testimony of Kahue)
BCB, Hawai'i, B:444)

Formerly, when any one died, on all those
lands, Kaao, Kaawikiwiki, etc. would not
wail at night wrap up, and take into the
mountain and bury secretly, lest the bones
be used to make fishhooks.
(1880 testimony of Kahue)
(BCB, Hawai'i, B:444)

There are graves on Puuokiha, and also
at Iolehaehae, and many other places...
used to carry body secretly and bury
in mountains.
(1880 testimony of Nainoa,
who was "very old")
(BCB, Hawai'i, B:447)

This evidence indicates tat in some East Hāmākua *ahupua'a*, burial was common on the cinder cones, or above, on Mauna Kea. This area seems to be in the upper *māmane* zone or even above the treeline. Although burial was secret, piles of stone (whether carefully built or mounded is unclear) probably marked some of these graves. [Cordy 1994:87

2. The Higher, Subalpine Lands

The lands above the *māmane* treeline belonged to Ka'ohe *ahupua'a* alone at European contact. Myths, although few are recorded, reveal that this zone was sometimes associated with Poli'ahu, a goddess associated with this snow–covered mountain and an occasional rival of Pele (Beckwith 1940:222; McEldowney 1982). And indeed, with cold, fog, and snow being common and impressive natural phenomena in contrast to the otherwise semi–tropical Hawai'i Island, it is quite logical that many place spirits of importance would be associated with the area.

The only traditional land use clearly documented historically for this area is the quarrying of stone for adzes. Although stone adzes were rapidly replaced by metal after European contact, elderly people were aware of adze quarrying on Mauna Kea.

Kaluakaakoi a cave where they used to get
stone adzes out.
(1873 testimony of Haiki on the
Humu'ula–Ka'ohe border)
(BCB, Hawai'i, B:41)

My parents told me Humuula went to
Kaluakaakoi and Poliahu. We used to go
there after adzes for Humuula people.
(1873 Haiki testimony)
(BCH, Hawai'i, B: 41)

It is suggested that this knowledge from the prior generation or two indicates quarry use could have lasted to between the 1770s–1840s (McEldowney 1982:1.7). Further specifics are lacking in this archival material.

As noted above, in leaving the major inland trails and travelling up into these elevations, no trails were mentioned by Hawaiians in the 1870s Boundary Commission records, nor do any appear on the 1862 Wiltse map (McEldowney 1982). Indications suggest landmarks were used for directions, rather than following a specific path (McEldowney 1982). [Note: Trails on today's U.S.G.S. maps are recent — cf. McEldowney 1982.]

Accounts by travellers in the late 1800s identified burial areas in these higher elevations (McEldowney 1982:1.8). In 1892 Alexander saw burials on Pu'u Lilinoe and stated:

Here, as at other places on the plateau, ancient graves are to be found. In olden times, it was a common practice of the natives in the surrounding region to carry up the bones of their deceased relatives to the summit plateau for burial.

(Alexander 1892 in McEldowney 1982:1.8).

3. Post–Contact Patterns

After European contact, land use in the Upper Slopes of Mauna Kea changed. Adze quarrying rapidly halted with the availability of metal. Cattle were introduced and soon ran wild. In the 1820s–1830s, bullock hunters entered the area (e.g., A. Simmons, S. Parker) and shot wild cattle which lived above the *'ōhi'a–koa* forest or woods. These hunters lived In places above the woods for short periods (Simmons 1873 testimony in BCB, Hawai'i,B:28). A result of the presence of cattle was severe destruction of the upper limits of the *'ōhi'a–koa* forest, becoming noticeable in the 1850s (Sandwich Islands Monthly Magazine 1856:44–47 in Barrera & Kelly 1974:Exhibit D).

the woods do not extend so far *mauka* as
they did twenty years ago...[because the
cattle had been] barking the trees and
destroying the underbrush.
(Simmons 1873 testimony)
(BCB, Hawai'i,B:30)

This damage did not directly impact habitation and agricultural areas as in Waimea (Kelly & Nakamura 1981; Clark 1983:4849), because these lands in East Hāmākua were far away from the shore, but the damage evidently did increase the grasslands of upper Mauna Kea. After the 184Os, the Parker Ranch spread into these grasslands, with the ranch's headquarters being established in Mānā (Kelly 1974:44) in the inland Hāmākua *ahupua'a* of Kamoku near Waimea. In brief, traditional land use of this subzone very rapidly declined after European contact and appears to have ended well before the end of traditional patterns on the Lower Slopes of Mauna Kea. [Cordy 1994:88]

Summary

Clearly the historical and archaeological information indicate that this subregion of Hāmākua was used repeatedly – for short periods of time – to extract special high elevation resources, bury the dead, and make offerings at the summit shrines to deities associated with the mountain. Collection of forest products (e.g., *mamane*) and hunting of birds (petrel and *nēnē*) appear likely to have occurred in the *māmane* forests up to the edge of the treeline at aa. 8,500–9,000 feet. Campsites for such collection have yet to be found, but survey in the forest is extremely restricted. The quarry campsites near the treeline and above do contain petrel in large amounts. These campsites, however, seem related to the quarry activities primarily taking place above the treeline at cold, high elevations where work is difficult even in modern conditions.

Quarrying, while focusing on adze basalt, also included extraction of volcanic glass and dunnite/gabbro for cutting tools and octopus fishing gear sinkers. Archaeology has shown the details of the quarrying work — workshops of differing types and associated shelters and importantly occupational shrines to obtain the aid of deities. The craftsmen seem to have worked in sets of two, with those more skilled working in the escarpment areas. How large an overall team of workers and their support personnel were is still unclear. Initial study of the distribution of finished adzes around the island suggests the completed adzes were exchanged through personal exchange systems, not through organized central control. So, perhaps each quarry team was relatively small and headed by a single craftsman or two. How many teams would have representatives on the mountain in any one summer season is also uncertain and awaits further archaeological analyses.

Burials have been found scattered about this subregion. Some *ahupua'a* used special cinder cones in the lower *māmane* forest for burying their dead. A few burials have been found on cinder cones at extremely high elevations — even up on the mountain's summit. Whether these high elevation burials were places where quarriers who died on the mountain were buried, or whether these were special burial places, is yet unkown [sic].

Most striking, archaeologists have found small shrines encircling the summit of the mountain. Without adze material, these shrines seem not to be related to the slightly lower quarries. Rather, they seem connected to other deities associated with the mountain's highest reaches — where snow, storms and elevation sickness are most pronounced and where one can see over vast areas of the island. Whether users of the quarries made special trips up to these shrines while working on the mountain or whether other people came up the mountain solely to make offerings to these deities is currently unknown. Campsites have not been found near these shrines, so visitors apparently came during the day and soon departed.

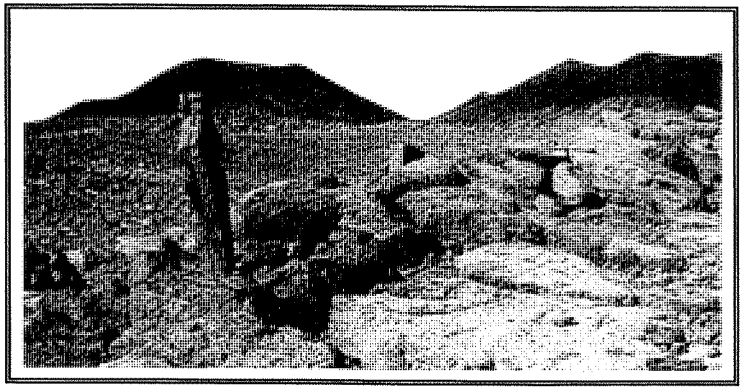


Figure 1. Photograph of shrine with upright and paving extending to right (G28-59; 16,183) (Cordy 1994:93)

> These sites on Mauna Kea — shrines, burials, quarries, campsites, and presumably forest collection/bird bunting sites — are far, far away from their users' homes. The residents of Ka'ohe and Pā'auhau *ahupua'a*, within which this subregion lies, had their permanent houses and farms down near the shore of East Hāmākua, below the *'ōhi'a* forest and far below the *māmane* forests. Any users not from these *ahupua'a* would have had somewhat similar coastal house and farm patterns. Only those who have been up on Mauna Kea can clearly appreciate the point of the mountain's distance from the shore. Additionally, the use of this subregion can only be completely visualized after visiting the mountain and walking about its *mamane* forests and up above the treeline. This mountain is immense — and at its higher elevations, cold and harsh and awesome. The shrines — to now unknown deities — seem in an appropriate place. The quarriers must have constantly felt the presence of the gods. [Cordy 1994:102-103]

In closing his study, Cordy (1994) sets forth several recommendations for ensuring long-term protection of the unique cultural resources of Mauna Kea. Summarized, these include:

A. Expand the preservation area on Mauna Kea to include the best sinker quarry sites and shrines near Kalepuumoa [sic–Pu'u Kalepeamoa], to include the summit shrines, to include the quarry sites extending down below the Natural Area Reserve and the National Historic Landmark, and to include burials found on surrounding cinder cones...

B. Include historic preservation concerns directly into the management operations of these lands — including the Natural Area Reserve...

C. Enforcement to prevent accidental damage... The sites are fairly fragile and not easily visible, so they can be damaged by uncontrolled vehicle and pedestrian access... [Cordy 1994:131-132]

2. *Archaeological Inventory Survey and Historic and Traditional Cultural Assessment for the Hawai'i Defense Access Road A-AD-6(1) and Saddle Road (SR 200) Langlas et al. (Draft Feb. 1997)*

This study was prepared in conjunction with the proposed realignment of the Saddle Road (Highway 200). While the specific focus was the "saddle" region at the base or lower elevations of lands around Mauna Kea, documentation cited herein does provide readers with important information on land use and some of the mountain-based traditions. Of particular interest, one elderly native Hawaiian with whom Langlas spoke (the interviewee's name was not released), described several traditional Hawaiian cultural sites in the vicinity of the Saddle Road Study area. This interviewee was the only one with whom Langlas spoke that had first hand knowledge of ceremonial sites in the Saddle region (Langlas et al. Draft Feb. 1997:136). Langlas does not provide any documentation that may have been discussed, about the higher mountain elevations, but the following descriptions do offer some insight into the significance of landscape and beliefs, practices, and customs of the ancient people.

The elder interviewee described a total of six ritual sites, they are:

> *Papa Hemolele*, a flat area *mauka* of the old trail from Waimea to Humu'ula, on the south side of Waiki'i Gulch. It was stated that there were many altars at this location, where people offered prayers for peace, rain, and various things, and there may also have been human sacrifice offered at certain features in the vicinity (Langlas et al., Draft Feb. 1997:130);
>
> *'Āina Kao*, a ritual site in Pi'ihonua, near the horse trail and southwestern corner of Puu Oo Ranch. Rituals associated with this location were performed in ceremonies for ordaining warriors (Langlas et al., Draft Feb. 1997:132);
>
> *'Āina Hānau*, a ritual site in Pi'ihonua, near the vicinity of the present-day 13 milepost. Women went there to give birth. It was believed that children born at 'Āina Hānau would grow up to be healthy and strong (Langlas Draft Feb. 1997:133);
>
> *'Āina 'Ākau*, a ritual place perhaps in the uplands of Punahoa. There were platforms in the area that were associated with the kings of the land. The platforms were changed with the kings. There was also reportedly a large platform which was used for preparation of bodies for burial (Langlas et al., Draft Feb. 1997:133);
>
> *'Āina Kahukahu*, a ritual site near the present-day Saddle Road (mileposts 8 and 9), in the land of Ponahawai. There were reportedly several altars at this location, and prayers were offered here for safety while traveling. Other rituals were also observed at 'Āina Kahukahu, one included the offering of prayers to ensure that spirits of the dead found their way home (Langlas et al., Draft Feb. 1997:133-134);
>
> *Pu'u Kamokumoku* was given as the original name for Pu'u Kalai'eha. It was a place where powerful *kāula* (prophets) lived, and where they offered prayers to the god 'Io. The *kāula* offered prayers to 'Io to help fulfill the prophecies and plans of the *ali'i* (Langlas et al., Draft Feb. 1997:134).

The interviewee also provided Langlas with information pertaining to burial sites and former homesteads in the Saddle region. Efforts to locate the exact locations of the ritual sites and other features discussed by the interviewee were unsuccessful (Langlas et al., Draft Feb. 1997:135-136). Langlas reported that —

> ...none is presently being used by Hawaiian religious practitioners. In general, however, Hawaiians believe that *heiau* and other ritual sites still have *mana* (religious power) because of their previous use. In Western terms, they are still sacred sites (Langlas et al., Draft Feb. 1997: 136).

Further descriptions of history, practices, and occurrence of features are excerpted below from the work of Langlas et al.:

> ***Cultural Context***
>
> The project area was used by Hawaiians long before Western contact began. Prehistoric trails crossed the Saddle from west to east and from south to north, both for ease of travel between districts and for access to interior resources. On the West Side, the project area has been thought too dry to have been exploited by Hawaiians for agriculture. The dry upland forest was mainly exploited by birdcatchers hunting birds valued for their feathers. However, there may have been some Hawaiian agriculture at about 1,200 to 1,500 m (4,000 to 5,000 ft) in the "fog belt" of Waikōloa *ahupua'a*, because there is evidence of prehistoric and historic Hawaiian agriculture at that elevation in Pu'uanahulu *ahupua'a* directly to the south.
>
> The Saddle itself was exploited especially by birdcatchers. They sought the *'ua'u* (dark-rumped petrel), *nēnē* (Hawaiian goose) and *kōloa* (Hawaiian duck) for meat, and various smaller birds for their feathers. The Saddle also provided access to the adze quarry at the summit of Mauna Kea to the north. The Mauna Kea quarry was the source of the best-quality basalt for adzes in the Hawaiian islands. Adzes made from Mauna Kea basalt were distributed over the whole of Hawaii Island and beyond. Shelter caves in the Saddle area were evidently used both by birdcatchers and by workmen going up to the quarry and back.
>
> The forested East Side, downslope from the Saddle, was again exploited mainly by birdcatchers, who sheltered in caves or built houses. From about 2500' on down (from milepost 9), the forest was also used to obtain *koa* logs to carve canoes and to plant bananas in forest clearings. Near the eastern end of the project area, yams were planted in forest clearings as well. The permanently cleared *kula* (open land), which was heavily used by Hawaiians for agriculture, began just below the project area at about 330 m (1,100 ft) (milepost 5).
>
> During the nineteenth century, traditional Hawaiian use of these interior resources gave way to Western-inspired exploitation. Herds of wild cattle, sheep and goats multiplied on the grasslands of the West Side and Saddle. Western settlers and Hawaiians began to hunt these wild herds, and later they established ranches. The whole area eventually came under Parker Ranch, centered at Waimea. By the late nineteenth century, a wagon trail connected Waimea to Humu'ula in the Saddle. In the twentieth century automobiles used the old wagon trail to reach the Saddle from Waimea, until it was replaced by the Saddle Road during World War II.

The forested East Side was less valuable to Westerners, although there was some lumber milling of *koa* and *'ōhi'a*. The middle elevation forest (from 1,800 m to 450 m) was little used in the nineteenth century and was turned into a forest reserve in the twentieth. The trail which had passed through the forest and connected Hilo with the Saddle became little-used in the twentieth century The upper elevation forest (above 1650 m) was cleared for ranching, and became Pu'u 'Ō'ō Ranch, owned by the Shipman family of Kea'au. The lower elevation forest (below 420 m), including the lower parts of Kaūmana and Ponahawai, was cleared for growing sugar cane, which was carried by a flume system to Hilo to be milled. [Langlas et al., Draft Feb. 1997:7]

Pohakuloa Training Area (PTA)

Caves and trails dominate the archaeological sites in the PTA. The first recorded research in the area resulted in documenting two small caves (Site 5000 and 5001) (Hansen nd. IN Cordy 1994:108). Subsequently, an extensive aerial survey with some surface sampling encountered more late-prehistoric and historic period occupation caves and trails (P. H. Rosendahl 1977). Later, David Cox of the Corps of Engineers examined the route of another firebreak road and located additional small caves probably associated with Site 5000 (Cox 1983a). Streck (1984,1986), Streck and Watanabe (1986), and Watanabe (1986) located additional habitation caves in the western portions of the PTA. Radiocarbon samples from the caves yielded age ranges of AD 900-1700 (Streck 1986:36).

Several caves were located and tested by Athens and Kaschko (1989). Radiocarbon results indicate the sites were initially occupied between AD 1000 and 1200, and were heavily used from AD 1400 to 1450. Bird bone was recovered from the sites; the assemblage indicated that activities at the sites consisted primarily of obtaining juvenile petrels and collecting birds for feathers. The younger birds are thought to have been exclusively reserved for high-ranking *ali'i* (Henshaw 1902:120).

An inventory survey along the route of SR 200 through the PTA encountered previously recorded sites (5002, 5003, 7119) and one new site (14638) (Welch 1993). Site 14638 is a lithic scatter with three associated small caves. Test excavations in the cave at Site 5003 revealed deposits containing large amounts of faunal material (both birds and mammals), lithic material, wood samples, and charred matter.

There have been several surveys associated with a power line, firebreaks, and the middle area of the Saddle Road (Barrera 1983, 1987; Cox 1983b; Kam 1982, 1983; Kalima and Rosendahl 1991; Rosendahl and Rosendahl 1986). No archaeological sites, however, were encountered during these surveys. [Langlas et al., Draft Feb. 1997:12]

Specific references to the Mauna Kea summit regions include the following discussion about the Mauna Kea adze quarry complex:

Mauna Kea Adze Quarry

The prehistoric basalt quarries near the summit of Mauna Kea were identified as early as the early 1800s (Goodrich 1833 IN McCoy 1977). The quarries have since been an area of interest (Alexander 1982; Brigham 1902; Cordy 1994; Emory 1938; Loo and Bonk 1970; Wentworth et al. 1935). The Mauna Kea Adze Quarry Site (4136) is listed on the NRHP and is a National Historic Landmark.

Significant research investigations have taken place at the quarries within the last two decades. Excavations in the quarry locality (Cleghorn 1982; McCoy 1977, 1982, 1990; McCoy and Gould 1977) have revealed layers containing midden, litbic reduction materials, and artifacts. Midden remains include... [Langlas et al., Draft Feb. 1997:11] ...shellfish and plants brought from lower elevations. Food plants included taro (Allen 1981, McCoy 1990) presumably brought from lower elevations. Radiocarbon dates in the quarry complex indicated initial use by about AD 1100 with more intensive use after AD 1400 (Cleghorn 1982). Use of the quarry diminished substantially prior to Western contact.

Shrines, consisting of large upright stone slabs, are present near the quarries (McCoy 1981, 1990). These features reflect the importance of ritual in association with the quarrying. Most of the shrines were conspicuously located, near the workshops and above the entrances to rockshelters. Shelters were found in association with springs on the southern slope of the mountain (McCoy 1990). Tests at these sites encountered flakes, midden, and hearths, suggesting that the occupations were temporary. The shelters may have been occupied while obtaining water, wood, and food, and may have also served to acclimate people for the rigorous conditions to be encountered above that level (McCoy 1986:91). Radiocarbon dates indicate that these sites were occupied between AD 1100-1800... [Langlas et al., Draft Feb. 1997:12]

Trails

It is difficult to determine where prehistoric trails ran through the northern interior, or even how many trails there were. McEldowney (1979:29) makes this point after examining the evidence for trails running up into the Saddle from Hilo. Neither historic accounts nor archaeological surveys provide firm evidence for the prehistoric trails. Some prehistoric trails have surely been covered by historic lava flows... [Langlas et al., Draft Feb. 1997:16] ...and others have been replaced by historic trails or roads, so that historic accounts of trails used don't necessarily reflect the prehistoric trails in the area. Archaeological surveys have been limited in extent. Moreover, the physical evidence of a "trail" is often itself limited. Judging by the accounts of those who have taken old trails in open country (Paris and Ah Sam Ints.; Eric Pearthree, personal communication) the evidence is discontinuous. There was probably no built trail over grassland or *pāhoehoe* lava flows, only a route between known land marks. That is presumably the reason why early travelers (e.g., Bird 1974 [1890]: 231) sometimes say there was "no trail." Where the trail goes over a rougher *'a'ā* flow, the trail becomes evident because it was cleared to make for easier travel... [Langlas et al., Draft Feb. 1997:19]

Langlas et al. continue their discussion by providing readers with descriptions of the following trails — "Waimea to Kala'i'ehā/Pu'u 'Ō'ō Trail; Kala'i'ehā to Pu'u 'Ō'ō to Keanakolu Trail; Hilo to Kala'i'ehā/Pu'u 'Ō'ō Trail; Pu'u 'Ō'ō to Volcano Trail; Kona to Pu'u Ke'eke'e Trail; Hualālai-Waiki'i Trail; Mid-PTA Trail; and Kona-Volcano Trail" (Langlas et al., Draft Feb. 1997:19-21). Because his study area focused on the Saddle and lower elevations of Mauna Kea, Langlas does not give specific descriptions of the trails that ascend the mountain and reach the summit region.

Work conducted for the present oral history study included discussions on the mountain trails and also added further details to accounts of transition from native and historic trails to

Saddle Road. Of particular interest to the mountain trails, interviews with Johnny Ah San, Theodore Bell, Sonny and Daniel Kaniho, Alika and Anita Lancaster, Albert K. Haa Sr. (and Jr.), Lloyd Case, and Irene Lindsey-Fergerstrom (with Romona Fergerstrom-Kalalau and relatives of the Lindsey-Kealamakia line) provide descriptions trail systems that approach the summit of Mauna Kea from all sides of the mountain. Several of these trails were still traveled by the interviewees in their youth, or were described by their elders who still used the trails through the 1930s. Two of the trails, the Makahālau-Waiau Trail, Waiki'i-Pu'u Lā'au-Waiau Trail (see interviews with Kahalelaumāmane Lindsey and Theodore Bell Sr.) are generally unknown to most people today. Another important trail described in the interviews is the Laupāhoehoe-Waipunalei-Keanakolu Trail to the summit of Mauna Kea (see the interview with Johnny Ah San).

Adze-making and Bird-catching

The trails were also used by those who exploited the interior to make adzes or to catch birds. At the summit of Mauna Kea is the well-known adze quarry, which was extensively worked by Hawaiians because its dense basalt provided the best rock for making adzes. Adze preforms were chipped out at the quarry and then were further processed at various workshop/habitation sites. Many processing sites near the quarry have been investigated; also investigated were two other sites a bit lower, on the south side of Mauna Kea, at Hopukani Spring and Liloe Spring (Cordy 1994:85-103.) All of the sites lie outside the project area to the north. In the Saddle itself, most of the cave shelters investigated lie on the west side of PTA. An argument was made by Hommon and Ahlo (1983:48) that the shelters were occupied by people bringing basalt from the quarry and working it in the shelters. However, later research has failed to discover any appreciable number of basalt fragments or adze blanks. Most researchers now assume the west PTA sites have no connection with the adze quarry, and were used instead to exploit birds (Athens and Kaschko 1989:54; Cordy 1994:114). Recently, Welch (1993:*passim* especially pp. 85-87) has reported on a cave shelter (SIHP Site 5003), in the Saddle Road corridor (Ex-2) just south of Mauna Kea State Park, which does seem connected with the quarry. Excavation recovered numerous basalt flakes, indicating that the Hawaiians who used the cave were processing adzes. Welch's interpretation is that Hawaiians used the cave shelter on their return from the quarry to the lowlands, and did some processing while they stopped. There may be other such shelter-cave sites connected to use of the quarry in the area. The adze quarry presumably was in the *ahupua'a* of Ka'ohe, and all the processing sites so far reported lie within Ka'ohe. However, there is some evidence that not only Ka'ohe people exploited the quarry. Waiki, one of the witnesses to the Boundary Commission stated that his parents told him that Humu'ula people used to go up to the quarry to get adzes.[1] Local informants familiar with the Pu'u 'Ō'ō area told me of a couple of caves there which contain adze fragments, including one called Ioane's cave (Bergin Int.).

The interior of the island in general was exploited for birds, especially perhaps the relatively large *nēnē*, *kōloa*, and *'ua'u*, valued for their meat. The *'ua'u* nested in burrows or under rocks in the saddle area in great numbers in the nineteenth century.

[1] Note however that Waiki's testimony might be considered suspect. He was on of the men who guided the first survey of Humu'ula by Wiltse and who claimed that the boundary of Humu'ula went up to the adze quarry at the summit of Mauna Kea. Other witnesses denied that claim.

Lyons (1903: 25) indicates that it was mainly Ka'ohe where they nested, and Henshaw (1903:130-31) was told that they nested "in the lava." The plump juveniles were considered a delicacy by Hawaiians. They were pulled out of their burrows, carried down and presented to the *ali'i*. Archaeologist Eric Pearthree (personal communication) reported finding a "layered, easily broken" lava flow in the central part of PTA which appears to have been a nesting place for *'ua'u*, exploited by Hawaiians. The flow seems to have been dug up, and a habitation cave in the area contains *'ua'u* bones. By 1900, the *'ua'u* were practically gone from the Saddle, having been eliminated by mongoose (Henshaw 1903:131). Although the PTA area may have been the richest area for *'ua'u* it was probably not the only one. In 1954, Richardson and Woodside (1954) found nesting sites and recently killed birds on the east and south slopes of Mauna Kea, at 2,740–3,050 m (9,000–10,000 ft) elevation.

Athens and Kaschko (1989:85-90) investigated 16 archaeological sites in the western part of Ka'ohe (MPRA section, Pohakuloa Training Area), south of the Saddle Road. They argue that the sites were occupied on a short-term basis by birdcatchers. They recovered a large quantity of *'ua'u* bone, and lesser quantities of *nēnē* and of forest birds. Forest birds caught for their feathers – the *mamo*, *'o'o*, *'i'iwi*, *'o'u*, *'apapane*, and *'amakihi* – were probably commoner in the windward *'ōhi'a* forest than in the Saddle, but were also caught in Humu'ula and Ka'ohe. Scott et al. (1986:106-7,159,164) note that three of the feather birds, the *mamo*, the *'o'o* and the *'i'iwi*, moved into *māmane* forest (found in both Humu'ula and… [Langlas et al., Draft Feb. 1997:22] …Ka'ohe) to feed during the blooming season. According to Athens and Kaschko (1989:24-5) ornithologist Kjargaard states that *'i'iwi*, *'apapane*, and *'amakihi* are still found in the Pohakuloa Training Area, mainly in *'ōhi'a* forest.

Historical evidence as well as archaeological evidence indicates that Ka'ohe and Humu'ula were exploited by birdcatchers, just as the uplands of the East Side and West Side were. An early map refers to a story about Naohuleelua at the southeast corner of Ka'ohe, said to be the "scene of battle between Hāmākua and Kona birdcatchers, settled with bows" (Map Reg. 1641, 1891). The Boundary Commission testimonies make clear that birdcatchers were active in Humu'ula, on the *pili* and *māmane* lands situated above the woods that lay on the *makai* (shoreward) side of Humu'ula.

> I used to go bird catching on Pi'ihonua with Malo and others. Humuula people catching birds outside of the woods, and Pi'ihonua people catching them to the *mauka* edge of the woods. That was the boundary and my kupuna told me fights used to occur if the Humuula men went below the edge of the woods or if the Pi'ihonua people went above them. (Testimony of Kamalo, BC Book B: 22-23)
>
> [I] used to go onto Humuula after birds. If folks from the *makai* lands came after birds in the *mamane*, the Humuula people would take them from them, and if we went into the bush after birds, the people of the *makai* lands would take them away from us. (Testimony of Hanioa, BC Book B: 44-45)
>
> In olden times only three men [the men of three lands?] ran after Uau on the mountain along the side up Kaohe above, Humuula below and Piihonua the foot of the mountain. (Testimony of Hoakimoa, BC Book D: 53)

The historical evidence is not specific as to the birds that Hawaiians caught in the Saddle, aside from the last reference to *'ua'u*. It seems likely that the larger meat birds were a more important resource than the feather birds. In addition to the *'ua'u*, *kōloa* (Hawaiian duck) and *nēnē* (Hawaiian goose) were also present in the area. G. T. Allan (Anon 1847b) describes hunting for *nēnē* in the eastern saddle area, where they fed on wild strawberries near pools of water. W. D. Alexander (1892) says that both the *nēnē* and the *kōloa* were found near Kala'i'ehā in the "Middle Ground," the name used then for Kīpuka 'Ainahou. Probably *kōloa* frequented some of the upland ponds because they were called *wai kōloa* (duck ponds) (see BC Book B: 34 for ponds in Hakalau, near the Humu'ula boundary; see McEldowney [1979:29] for ponds in Pi'ihonua near the Humu'ula boundary.)...

Cattle-hunters

As the mid-elevation slopes of Mauna Kea were covered with *pili* grass mixed with *māmane* trees, they provided a natural pasture where wild cattle multiplied. Cattle (along with sheep and goats) were first released by Vancouver in 1792. Ellis (1963[1827]: 291) indicates that wild cattle were already numerous on Mauna Kea when he traveled Hawaii Island in 1823. They became a target for "bullock hunters" who killed them for their hides and tallow, usually leaving the meat to rot. They were shot, trapped in pits, or driven into corrals that had long wings to entrap them. The earliest hunters seem to have been Westerners, such as John Parker, who was already hunting cattle for the king when Ellis passed through (Ellis 1963 [1827]:274). On his 1834 ascent of Mauna Kea, botanist David Douglas met two partners from Hilo, James Castle and a Mr. Miles, who had a lodge in Humu'ula above the forest near Pu'u 'Ō'ō. Castle and Miles were engaged in killing cattle and drying the meat (Hooker 1839:400). [Langlas et al., Draft Feb. 1997:23]

While Castle and Miles operated at Pu'u 'Ō'ō in the 1830s G.A. Simmons and Ned Gurney operated at Lahohinu, near Keanakolu (BC Book B:30). In his 1873 testimony to the Boundary Commission (BC Book B:30), Simmons says that the cattle are killing the trees and have pushed the forest line shoreward in the last twenty years.

Native Hawaiians became cattle hunters a bit later, including Waikiiliilii and Hoakimoa, natives of Humu'ula who gave testimony to the Boundary Commission in 1873 and 1891, respectively (BC Book B:53, Book D:52). In 1841, Pickering (n.d.;170-1), while climbing Mauna Kea from Hilo, came across Hawaiians drying beef. This was at about 1,520 m (5,000 ft) and probably in Pi'ihonua. Farther on he reported seeing a ruined cattle pen near a "bed of clinkers" and Castle's now-abandoned lodge near Pu'u 'O'o. Probably the cattle-hunting business was no longer so productive by that time; 1841 was the year that Governor Kuakini placed a five-year *kapu* on killing wild cattle because so many had been killed (Brundage 1971:9). Castle was again shooting wild cattle "a great deal of the time" in 1853-54, according to testimony of Frederick Lyman (BC Book B:58-59).

Ranching began in Waimea in the mid-nineteenth century, but many wild cattle were still being killed for their hides up to 1900 (Brundage 1971:15; Wellmon 1969:1834). When the Waimea Grazing... [Langlas et al., Draft Feb. 1997:24] ...Company leased Humu'ula from Kamehameha III in 1862 (Map Reg. 668), it bought the right to kill the wild cattle there (LF, R. A. Lyman letter, Nov. 9, 1869). Isabella Bird (1974:233) wrote that on her 1873 journey there were many wild cattle on Mauna Kea and many men, "...who live half savage lives in the woods, gaining their living by lassoing and shooting these animals for their skins." Still later, Eben Low described the killing of

wild bulls for their hides up on Mauna Kea in the 1900s (Hobbs 1939:97-101). By that time, the animals were roped from horseback and killed with a knife. Low said that rifles were "prohibited" because they would scare the animals away and spoil the hides by making holes in them. Even today, the wild cattle have not been completely eliminated and some still roam the forested ranch land east of Puakala (Olivera Int. 2)... [Langlas et al., Draft Feb. 1997:25]

Summary

In concluding their analysis of information collected during their studies, Langlas et al., observed:

> The history of the general project area has been previously described by several writers, most importantly by Wellmon (1969) for the West Side and Saddle, by McEldowney (1979) and Kelly et al. (1981) for the East Side. The present study adds to our understanding mainly by providing detail on the... [Langlas et al., Draft Feb. 1997:137] ...twentieth-century use of the area, derived from interviews with individuals [who] lived and worked there. For example, the study describes in detail Parker Ranch's farming operation at Waiki'i between 1920 and 1950, and documents the establishment of a largely Japanese farming community in upper Kaūmana at the turn of the century.
>
> Ranching played a significant role in shaping the historic landscape of the West Side and the Saddle, which came under the control of Parker Ranch, and the upper East Side, which came under Shipman's Pu'u 'Ō'ō Ranch. Pasture lands were marked out with barrier walls made of stone. The historic southern boundaries of the Humu'ula Sheep Station occur within the project area. Trails were co-opted or built and maintained, to facilitate the movement of cowboys and stock across the island, from pasture to market and between pasture areas. The old wagon road between Waimea and Humu'ula was created to carry wool from Humu'ula Sheep Station to the harbor at Kawaihae west of Waimea. In the era of automobile traffic, it became the main route to the Saddle, used even by cowboys and tourists going up there from the east coast.
>
> Transportation across the Saddle has taken a variety of forms over the past. During prehistory, foot travel took place over unmodified *pāhoehoe* and grassland, and on stepping stones over rough *'a'ā* flows. Trails were modified and/or built with basalt cobbles in thin, meandering pathways during historic times, to facilitate the movement of horses, mules and cattle. Carts and wagons required different paths. The portion of the old wagon road to Humu'ula, investigated during the archaeological survey, is notably different in morphology than the prehistoric or historic stone trails. The deep and wide path in the soil at the base of Mauna Kea was likely created as the result of the passage of wagons, rather than created prior to their passage. Multiple parallel tracks are common, probably created as the result of expeditious maneuvering around temporary obstacles.
>
> Further development of roads in the area was stimulated by World War II and the need to travel through the interior in case of a Japanese attack which might hinder travel along the coast. Roads capable of carrying cars, trucks, and tanks were created by bulldozing. The path chosen for the World War II-era Saddle Road included portions of the old wagon road to the west, some previously unmodified areas in the

Saddle, and portions of the Hilo- Pu'u 'Ō'ō trail on the east. Historic walls associated with earlier ranching activities were breached. Later, maintenance and upgrading of the Saddle Road resulted in some deviation from the original World War II route… [Langlas et al., Draft Feb. 1997:138]

3. A Social Impact Assessment (Kanahele and Kanahele 1997)

Pualani Kanaka'ole Kanahele[2] and her husband Edward L.H. Kanahele were contracted to prepare a cultural assessment study in conjunction with the proposed realignment of the Saddle Road (Highway 200) (Kanahele and Kanahele 1997). The authors are noted authorities of Hawaiian customs, beliefs, practices, and culture, and they provide readers with important cultural documentation from the perspective of native practitioners. The study, titled "*A Social Impact Assessment – Indigenous Hawaiian Cultural Values of the Proposed Saddle Road Alignments*" presents readers with detailed discussions of Hawaiian cultural values, protocols, and practices; attachment to landscape; and the importance of nature in Hawaiian ritual and life.

The following narratives are excerpted verbatim from the report by Kanahele and Kanahele (1997). While the work focused on the narrow study area corridors of the Saddle Road realignment, in a very Hawaiian manner, the authors looked at the broader relationships of cultural and natural landscapes, extending from the *piko* (summit) of Mauna Kea, to the sea.

TRADITIONAL AND SPIRITUAL
NATIVE HAWAIIAN ENVIRONMENT
The Environmental Impact Statement, A Hawaiian Cultural Perspective

Vertical Land and The Importance of Place Names

The projected alignment of the Saddle Road on Hawai'i *mokupuni*[1] traverses the *'āpana*[2] of Hilo, Hāmākua and Kohala. The other land sections impacted by the Saddle Road corridor are the *ahupua'a*[3] of Waimea, Waikoloa Uka, Pā'auhau Uka, Ka'ohe, Humu'ula, Pi'ihonua, Ka'umana, Punahoa and Ponahawai. The most prominent, celebrated and sacred of all areas traversed is the natural land feature and *wahi pana*,[4] Mauna Kea.

The road alignment involves minimal land space from within these land sections however it travels through the upper region of this island and this area is considered sacred for many reasons. These land sections and land features represents half of the island of Hawai'i despite the insignificant amounts of land the selective features actually use.

An initial investigation into place names will reflect on the reasons for the names and the relationship of this area of concern with the indigenous people, their philosophy of life and their gods. The popular interpretation of Mauna Kea is "white mountain". Mauna Kea is known world wide and is regarded by many as the highest island mountain, the highest mountain in the world from below sea level and the best

1 *Mokupuni*; island.

2 *'āpana*; political and vertical land sections or districts.

3 *Ahupua'a*; political and vertical land section within an 'āpana. An old tax land section,

4 *Wahi pana*; a special or sacred physical place.

[2] Mrs. Kanahele also participated in the oral history and consultation phases of the present study to which this appendix is attached (see consultation and interview records dated December 1st and 11th, 1998.

mountain from which outer space can be viewed. To the native Hawaiian Mauna Kea is a *Kupuna*[5] and an *one hānau*[6] and therefore is very personal and not just a mountain mass. The following chant reveals the source from which the name Mauna Kea originated… [Kanahele and Kanahele 1997:5]

…White mountain is very descriptive and literal translation of the mountain however the mountain is afforded dignity and a sense of family to be named in honor of Wākea[8] or Sky Father. When considering the mountain as a namesake of Wākea it takes on that persona and philosophically it personalizes the mountain giving it deep roots and a genealogy. The genealogy goes back to the "Wākea of time" or the beginning. Therefore "Ka Mauna a Kea" or "Mauna Kea" allows the sacred and common name to assimilate without forgetting one or the other.

Lono-nui-ākea[9] was the original name for this island and eventually the name was usurped by Hawai'i. Lono-nui-ākea is the sacred name of the god Lono. Lono is the god of stormy weather, dark clouds and rain. Throughout Polynesia, two islands were honored as "Ka inoa akua"[10] which are Lono-nui-ākea-Hawai'i and Kanaloa[11]-Kaho'olawe. To our ancestors these two islands were endowed with godly *mana*[12] befitting the name.

Hāmākua, according to our oral history was a name given by Hawai'iloa[13] to his youngest son [See *Appendix F* for an overview of the Hawai'i Loa legends]. The *'āpana* of Hāmākua houses the very top of Mauna Kea and stretches to Mauna Loa. The *ahupua'a* of Ka'ohe is within Hāmākua and like this 'āpana envelopes the very top of Mauna Kea and stretches to Mauna Loa. The word "Ka'ohe" simply means "the bamboo". Bamboo was a vegetable manifestation of the primordial god Kāne and were used as water carriers. Sometimes water became trapped in the upright green bamboo and this was given as offering to the gods or used medicinally. Ka'ohe was perhaps a description of the many river beds which time and water carved through that section of Hāmākua because of the process of erosion. These are the land sections on which the very top of Mauna Kea rests…

The *ahupua'a* of Humu'ula parallels Ka'ohe on the Hilo side of the mountain. Humu'ula was a kind of hard reddish, brown, yellow or green rock. The reddish and brown rock was probably more commonly found in the Humu'ula *ma uka*[14] area.

---

5 *Kupuna*; grandparent ancestor.

6 *One hānau*; sands of my birth. birth place, home.

8 Wākea; the original father of all Polynesians, known also as Sky Father, thought to be the god of light, and husband of Papa.

9 Lono-nui-ākea; the greater form of the god Lono who was god of storm rains, dark clouds and the makahiki.

10 "Ka inoa akua"; literally "the god name" or namesake.

11 Kanaloa; the god of the ocean, ocean travel and navigation.

12 *Mana*; power, inner source or outward acquisition, sometime this power is inherited.

13 Hawai'iloa; a legendary navigator who traveled the great ocean for many generations and touched on many islands in the Pacific as well as the large continents.

14 *Ma uka*; upland, a towards the mountain location.

Another landmark within the reach of the Saddle Road corridor…is Ka Pu'u-a-Pele[15]. The top of this cinder cone marks the joining of the *'āpana* of Kona, Kohala and Hāmākua. These large cinder cones served their purpose well in distinguishing land boundaries. [Kanahele and Kanahele 1997:7]

The Hiapo

Mauna Kea is the *piko*[16] of the island and this is another reason this area is considered sacred. This *piko* is the initial provider of the land mass of Hawai'i *mokupuni*. Hawai'i was also the first child of Papa and Wākea as stated in "*Mele a Paku'i*":

'O Wākea-kahiko-luamea
'O Papa, Papa-hānau-moku-ka-wahine
Hānau kahiki-kū, kahiki-moe
Hānau ke-a-papa-nui
Hānau ke-a-papa-lani
Hānau Hawai'i ka moku makahiapo
Keiki makahiapo a lāua
'Wākea lāua 'o Kāne
'O Papa Walinu'u ka wahine[17]

It was Wākea-kahiko-luamea
It was Papa, Papa-hānau-moku-ka-wahine
(Papa the woman who gives birth to islands)
Born was the upper horizon, the lower horizon
Born was the lower heavens
Born was the upper heavens
Born was Hawai'i the first-born island child
The eldest, first-born child of theirs
Of Wākea together with Kāne
And Papa of Walinu'u was the woman

According to this *mele* Hawai'i was the *hiapo*[18] or the eldest island child of theirs. There is a definite connection to the eldest child, Hawai'i, and the mountain of Wākea as significant in their relationship to the *hiapo* philosophy of the Hawaiians as to the Polynesians. The birthright and responsibilities of first-born did not diminish with Mauna Kea or Hawai'i just because they… [Kanahele and Kanahele 1997:8]

---

15 Ka Pu'u a Pele; the cinder cone, a specific cinder cone just west of Pohakuloa Military Camp and south of the existing Saddle road, this cinder cone marks the comers for the districts of Kona, Kohala and Hāmākua.

16 *Piko*; the navel, the center of a beginning or ending.

17 *Mele a Paku'i*; Song of Paku'i which is one of the poetic history of our island's birth.

18 *Hiapo*; the eldest child of any family, the child was responsible for the traditions of the family and usually received the family's birthright.

...are in animate land features. Their responsibilities and resources are needed for the growth and well-being of the island and all living forms of this mokupuni.

Wākea and Papa are our original parents. Mythologically they are the marriage of sky and earth. Wākea, Sky Father and Papa, Earth Mother. Between the two all things were born. The *kalo*[19] was their first food child and our elder brother who fed all *kanaka maoli*[20] from the Wākea of beginning time until today. During the time of *ali'i*[21] it was important for them to trace genealogy to the *kalo* and eventually to Wākea and Papa. When the genealogy could prove the connection they received the extremely high status of the senior line or *hiapo* line.

Mauna Kea falls in the senior line genealogy. During the 1880's, Emma Rooke, the wife of the late Alexander Liholiho Kamehameha and David La'amea Kalākaua were in competition for the position of ruling chief for this kingdom of Hawai'i. Both of them needed to prove their connection to the senior line and connect back to a *wahi pana*. David La'amea Kalākaua went to Kanaloa-Kaho'olawe to bathe in the waters of the ocean god Kanaloa. Emma went to the top of Mauna Kea to bathe in the waters of Waiau. The ceremony was to cleanse in Lake Waiau at the piko of the island. The water caught at Lake Waiau was considered pure water of the gods much like the water caught in the *piko* of the *kalo* leaf is thought of as being pure therefore it was used medicinally. Two other critical points for this ceremonial decision is the fact that Mauna Kea is the highest peak on the islands and therefore possess the highest esteem when considering *wahi pana*. Mauna Kea is also first-born mountain child of Papa and Wākea and this fact will then make the connection to the senior line... [Kanahele and Kanahele 1997:9]

Conclusion

The native Hawaiian was a creature of the land and his environment was his life line. He recognized and practice respect for hierarchy or *hiapo* for man and land alike. The mountain is sacred because it is the sacred child of Wākea. It is also the nourishment source for our land. The mountains and land were genealogically connected to him through the original ancestor, Wākea and Papa. The mountains or land, water and sky were a necessary part of life cycle. The taro was his older brother of the land and provided sustenance. The coral was also an older brother (of the sea) and was the means through which other food could be acquired. The hierarchical system of practice instill the sense of rank of man and god and height of land as most sacred. Within the hierarchical food system another set of rules apply. The older or larger trees are primary and most sacred. The others animals who find their residence or food source on these trees are secondary.

The *lōkahi* [*] system complements and maintains the well being of the whole entity. Therefore everything is important because each has a function.

---

19 *Kalo*; taro, *colocasiurn esculenta*, this is our staple food and is raised in the best possible soil conditions.

20 *Kanaka maoli*; indigenous native.

21 *Ali'i*; chiefs, elite of the society.

[*] *Lōkahi*; described by the authors as "a system of working in unity and harmony" (1997:13)

Water was and is necessary for all life forms. Laws for water and the use of water were formulated so all had exposure to water. Water that did not touch ground was highly prized. Such as the water in the lake on Mauna Kea and the water in the *piko* of the taro leaf. Water that moved underground or over land from the mountain to the sea was sometimes funneled into irrigation channels and fed the older brother *kalo* and was also treasured. The mountain and the *waoma 'ūkele* attracted the atmospheric water and we are fortunate to benefit from this natural cycle of water flow.

These points provide a sense of the most important beliefs and values that were practices by our Hawaiian ancestors and are the beliefs and values that are integral to our modem Hawaiian culture... [Kanahele and Kanahele 1997:16]

Kanahele and Kanahele (1997) also included a series of recommendations in their assessment study regarding the proposed Saddle Road action. While the recommendations were focused on the proposed Saddle Road realignment, the implications and applicability of the recommendations to the present Mauna Kea study can be appreciated. For specific discussions and recommendations pertaining to Mauna Kea, see the consultation and oral history interview records provided by Mrs. Kanahele in this study.

RECOMMENDATIONS REGARDING: TRADITIONAL AND SPIRITUAL NATIVE HAWAIIAN ENVIRONMENT

It is strongly recommended that the following not be disturbed but in any case if the preferred alignment can not avoid disturbance then extreme mitigation should occur:

* Any *heiau* found along the alignments
* Any grave site along the alignments
* Any water source along the alignments
* Any disruptive action which will cause harm and disturbance to any water source
* Any large or old tree stands and kīpuka along the alignments
* Any infringement upon the sanctity of the mountain top because of the alignments
* Any disfigurement of natural land features such as cinder cones.

The Saddle Road alignment, again, will be using minimal amount of land however it impacts upon half the land sections of this island. The new corridor in terms of the Hawaiian culture almost touches the top of Mauna Kea. I am not aware at this time of any *heiau* sites or burial sites which the road will impact directly upon. However the forest is directly inline with the alignment. The *mamane* forest...is very old and perhaps the last stand of *mamane* left. According to the hierarchy system the important entity is the food source not the one who feeds off of it. The *mamane* forest is the consideration not the *palila*. The forest is not mobile and therefore this cultural resource is the focus.

Cultural impact can be "softened or mitigated" in this case. If there is not the opportunity of planting a new forest or acquiring and dedicating other *mamane/naio* forest as an extreme mitigation then accommodating the old forest as an absolute preserve is the culturally correct Hawaiian protocol that one must follow to avoid a negative cultural impact. To do otherwise violates and negates proper Hawaiian protocol and creates a negative Hawaiian cultural impact! [Kanahele and Kanahele 1997:17]

NATIVE HAWAIIAN CUTLTURAL PROTOCOL MILIEU

This cultural impact assessment did not discover any cultural protocol that were directly concerned with the proposed Saddle Road topographical corridor alignments. However, there are concerns that negative cultural impacts generated by the development will be created because of the belief by native Hawaiians that within the Saddle Road area there are detrimental or other such residual forces that exist. Other beliefs indicate that intrusion in areas not heretofore despoiled or developed will result in the release of negative energy. These beliefs left unaddressed by not instituting the proper protocol of "release" or "sanctification" can result in a negative public image of the development. Proper cultural protocol can be completed in order to generate an atmosphere of positive thought or feeling. Nevertheless not all negative impacts can be mitigated by the use of cultural protocol since there are actions that are so culturally negative or culturally detrimental that it can not be mitigated by the use of cultural protocol.

Another point of consideration is that if cultural protocol is done by the developer then only appropriate individuals should be consulted. For instance, if the beliefs or area are associated with native Hawaiians and the "old" culture then a native Hawaiian who follows the ways of the "old" culture should practice the desirable protocol. As an example an ethnic German and follower of Calvinism would not perform a ritual in an Iranian Islamic mosque nor would a ethnic Japanese follower of Buddha perform a ritual in a fundamentalist Christian church. Indeed, it does no good to mix one's metaphors or mix one's protocol practitioners.

OVERALL CONCLUSSIONS

This cultural impact assessment reaches the following conclusions:

1. Negative cultural impacts regarding all proposed Saddle Road alignments were not found except for these potential areas:
   a. First and foremost we find that there shall be <u>Negative Cultural Impact</u> if the alignments that traverse the *Mamane/Naio* forest are developed with out the possibility of cultural impact mitigation.
   b. An alignment that is constructed through the *Mamane/Naio* forest or its boundaries can diminish its cultural viability due to proximity of disturbance should be avoided. However, with extreme mitigation that can meet the requirements of the ***lokahi*** concept then negative cultural impact can be severely diminished or avoided altogether.
2. The developer should be aware that unplanned or unregulated forest or natural area access will result in a <u>Negative Cultural Impact</u> after the proposed Saddle Road improvements are completed... [Kanahele and Kanahele 1997:21]
3. Any construction activity within a Kīpuka or activity that will diminish the cultural viability of a Kīpuka will result in a <u>Negative Cultural Impact</u>. We see no possibility of cultural impact mitigations if an alignment is constructed through a Kīpuka or if construction diminishes the Kīpuka's viability due to proximity of disturbance... [Kanahele and Kanahele 1997:22]

4. "Mauna Kea – Kuahiwi Ku Ha'o i ka Mālie" (Maly 1998)

In August 1996, Lehua Lopez, President of the Native Lands Institute: Research & Policy Analysis, Inc., working cooperation with several Native Hawaiian organization and environmental groups, contracted this author to prepare a historical report on Mauna Kea. Work for that study was conducted primarily in the period from August 1996 to March 1997, with supplemental information added through final publication in May 1998. The study provides readers with detailed historical narratives recorded by native Hawaiian authors and informants, and historic period visitors, and covers the period from about 1820 to 1930[3]. The primary documentation coming from the period of 1860 to 1917. The study, titled "*Mauna Kea – Kuahiwi Ku Ha'o i ka Mālie: A Report on Archival and Historical Documentary Research; Ahupua'a of Humu'ula and Ka'ohe, Districts of Hilo and Hāmākua, Island of Hawai'i*," is the source of the following narratives.

Mauna Kea—Overview of a Cultural Landscape

Native traditions describe the "birth" of the Hawaiian Islands and the presence of life on and around them, in the context of genealogical accounts. One Hawaiian genealogical account, shares that Wākea (the expanse of the sky) and Papa-hānau-moku (Papa—Earth-mother who gave birth to the islands)—also called Haumea-nui-hānau-wā-wā (Great Haumea—Woman-earth born time and time again)—and various gods and creative forces of nature, gave birth to the islands. Hawai'i, the largest of the islands, was the first-born of these island children. As the Hawaiian genealogical account continues, we find that these same god-beings, or creative forces of nature who gave birth to the islands, were also the parents of the first man (Hāloa), and from this ancestor, all Hawaiian people are descended (cf. David Malo 1951:3; Beckwith 1970; Pukui and Korn 1973).

In some genealogical chants, Mauna Kea is referred to as "*Ka Mauna a Kea*" (Wākea's Mountain), and it is likened to the first-born of the island of Hawai'i (Pukui and Korn 1973). A *mele hānau* (birth chant) for Kauikeaouli (Kamehameha III) describes Mauna Kea in this genealogical context:

O hānau ka mauna a Kea,	*Born of Kea was the mountain,*
'Ōpu'u a'e ka mauna a Kea.	*The mountain of Kea budded forth.*
'O Wākea ke kāne, 'o Papa,	*Wākea was the husband, Papa*
'o Walinu'u ka wahine.	*Walinu'u was the wife.*
Hānau Ho'ohoku he wahine,	*Born was Ho'ohoku, a daughter,*
Hānau Hāloa he ali'i,	*Born was Hāloa, a chief,*
Hānau ka mauna, he keiki mauna na Kea...	*Born was the mountain, a mountain-son of Kea...*
(Pukui and Korn 1973:13-28)	

Through genealogical accounts like the ones above, readers today, begin to understand that in Hawaiian culture, natural and cultural resources are one and the same. All forms of the natural environment, from the skies and mountain peaks, to the

[3] Primary repositories of documentation cited in the study was found in the collections of the Hawai'i State Archives, Land Management and Survey Divisions, and Bureau of Conveyances; collections of the Bernice Pauahi Bishop Museum and Hawaiian Historical Society; and the University of Hawaii-Hilo Campus, Mo'okini Library.

watered valleys and plains, and to the shore line and ocean depths are the embodiments of Hawaiian gods and deities.

In both its genealogical associations and its physical presence on the island landscape, Mauna Kea is a source of awe and inspiration for the Hawaiian people. Many of the traditions of Mauna Kea are directly attributed to the interaction of gods with the land and people. In Hawaiian practice, elders are revered —they are the connection to one's past—and they are looked to for spiritual guidance. Because of its place in the Hawaiian genealogies, Mauna Kea, the landscape itself is a sacred ancestor.

On the island landscape of Hawai'i, Mauna Kea is a mountain on which three major land districts rest (they are Hilo, Hāmākua, and Kohala). Within these large districts, are many smaller land divisions or *ahupua'a*, which are also supported by the resources of Mauna Kea. Two ahupua'a, Ka'ohe in the district of Hāmākua, and Humu'ula, in the district of Hilo, embrace the upper slopes and highest elevations of Mauna Kea. In 1875, Curtis J. Lyons, son of Reverend Lorenzo Lyons, of Waimea, and one of the foremost surveyors of the Hawaiian Kingdom, authored a paper on "Hawaiian Land Matters" (Lyons 1875). In his discussion, he provided important references to Mauna Kea and it's relationship to the *ahupua'a* of Ka'ohe and Humu'ula and neighboring lands (underlining is used to emphasize selected points):

> The ordinary *ahupuaa* extends from half a mile to a mile into this [forest] belt. Then there are larger ahupuaas which are wider in the open country than others, and on entering the woods expand laterally so as to cut off all the smaller ones, and extend toward the mountain till they emerge to the open interior country; not however to converge to a point at the tops of the respective mountains. Only a rare few reach those elevations, sweeping past the upper ends of all the others, and by virtue of some privilege in bird-catching, or some analogous right, taking the whole mountain to themselves... The whole main body of Mauna Kea belongs to one land from Hamakua, viz., Kaohe, to whose owners belonged the sole privilege of capturing the *ua'u*, a mountain-inhabiting but sea-fishing bird. High up on its eastern flank, however, stretched the already mentioned land of Humuula, whose upper limits coincide with those of the *mamane*, a valuable mountain *acasia*, and which starting from the shore near Laupahoehoe, extends across the upper ends of all other Hilo lands to the crater of Mokuaweoweo... (Lyons 1875:111)

Kekāhi Inoa 'Āina a me nā Wahi Pana 'o Mauna Kea
(Some Place Names and Storied Places of Mauna Kea)

There are many place names on the landscape of Mauna Kea that remind us of the broad relationship of natural landscape to the culture and practices of the Hawaiian people. The occurrence of place names extending from the shore line to the summit of Mauna Kea, is important in that it demonstrates the Hawaiian familiarity with the sites and features, and varied elevations of the mountain. History tells us that named locations were significant in past times, and it has been observed that "Names would not have been given to [or remembered if they were] mere worthless pieces of topography" (Handy and Handy with Pukui, 1972:412; and Coulter 1935). In ancient times, named localities served a variety of functions, including — (1) triangulation points such as *ko'a* (land markers for fishing grounds and specific offshore fishing localities); (2) residences; areas of planting; (3) water sources; (4) trails and trail-side

resting places (*o'io'ina*), such as a rock shelter or tree shaded spot; (5) *heiau* or other features of ceremonial importance; (6) may have been the source of a particular natural resource or any number of other features; or (7) the names may record a particular event or practice (e.g., use for burials, or making of *ko'i* {adzes}) that occurred in a given area.

Through a study of historic literature it is seen that the landscape of Mauna Kea has played an important role in the growth and evolution of the Hawaiian traditionary narratives and the cultural significance of Mauna Kea to the Hawaiian people. Early traditional and historic accounts, as well as a number of historic survey maps from ca. 1862-1892 identify several sites and features that bear the names of Hawaiian gods and goddesses that are intimately associated with the history of the mountain (such maps include Register Maps No.s 668, 1210, 1641, 1718, and 1860). In the summit region of Mauna Kea (from approximately 11,000 feet and above) and on the lower mountain slopes are found several features associated with Hawaiian gods and deity. Among the identifiable place names—deity names are the following:

Mauna Kea – May be literally translated as "White Mountain," because during the winters, the summit is often covered with snow. The peak of Mauna Kea (Pu'u Kūkahau'ula) stands 13,796 feet above sea level. Also, early native accounts (cf. Malo 1951 and Kamakau 1991) suggest that other translations are appropriate. One such account, recorded by an elderly Hawaiian source in c. 1917 by researcher and translator, Theodore Kelsey tells us that "Mauna Kea" may also be translated as "Wakea's Mountain." Wākea, also written and pronounced as Ākea and Kea, was the god-father of the island of Hawai'i. The island child was born by Papa or Haumea, the goddess who gave birth to islands. Mauna Kea as a place name, can be traced to the earliest written and cartographic resources of the Hawai'i; for examples see the Journals of Captain James Cook (Beaglehole 1967) and S.C. Wiltse (in Register Map No. 668).

Houpo-o-Kāne
also written
Ka-houpo-o-Kāne – May be literally translated as "The chest (bosom) of Kāne." The god Kāne is believed to be foremost of the Hawaiian gods, and is credited with creation, procreation, light, waters of life, abundance, and many other attributes. A land being likened to the chest of Kāne, can imply that the land was cherished and blessed by the god Kāne. S. N. Hale'ole's tradition of Lā'ie-i-ka-wai (In *Kū 'Oko'a* 1862-1863), records that "Kahoupokane" was one of three companions of Poli'ahu. The other two companions were Lilinoe and Waiau.

The area identified as Ka-houpo-o-Kāne is situated below Waiau, on the southwestern slopes of Mauna Kea, in the land of Ka'ohe (*see Register Map 1641*). One of the primary attributes of Kāne are the *wai ola* (life giving waters), sacred springs and water sources made by Kāne around the islands, to provide for the welfare of the people and the land (cf. Kamakau 1976 and Beckwith 1970). Interestingly, at Ka-houpo-o-Kāne are found the waters of Pōhakuloa, Hopukani, and Waihū (also known by the name "Ka-wai-hū-a-Kāne").

Pu'u Lilinoe – Lilinoe hill (Interpretive): named for the goddess Lilinoe (Mist), a goddess of mists and sister of Poli'ahu (Pukui and Elbert 1971:392). Traditional accounts (cited in Maly 1998) also identify Lilinoe as having been a chiefess, who secluded herself on Mauna Kea, and upon her death, she was also buried in a cave near the summit. Lilinoe is a hill that rises to 12,956 feet above sea level, and situated to the southeast of the summit peak. As a place name, Lilinoe is cited in accounts dating back to at least the 1500s (cf., Kamakau 1961:215, 285), and is cited in surveys and testimonies in 1873 (Lyons Reg. Map No. 1641).

During the course of conducting this study, it was found that the original field survey books of W.D. Alexander, identify the presence of a *heiau* or possible burial platform near Lilinoe, on the Lilinoe side of a trail and the "axe maker's caves" (1892 – Reg. No. 429 in the collection of the State Survey Division).

Pōhaku-a-Kāne – May be literally translated as the "Stone made by Kāne." A traditional Hawaiian account recorded in the early twentieth century tells us that Pōhaku-a-Kāne, also called *Ka-paepae-kapu-a-Kāne* (the sacred platform of Kāne), was named for a form taken by the god Kāne. A platform near Waiau was named for and dedicated to this deity (see the historical narratives in Maly 1998).

Kū-ka-hau-'ula – Kū of the red hewed dew or snow: named for a male deity form of the god Kū and lover of Poli'ahu, goddess of the mountain. Kūkahau'ula is identified in the Boundary Commission testimonies of 1873 as the highest peak on Mauna Kea (now generally identified as Mauna Kea peak or Pu'u Wekiu) and is recorded by C. Lyons in his 1884 survey the summit peaks of Mauna Kea (cf. Register Map 1210 of 1884; in the collection of the State Survey Division).

Ka-lua-kā-ko'i – The cave (or pit) for making adzes (Literal). Kaluakāko'i was identified by native informants as early as 1862, and recorded by Wiltse on his survey map of the *ahupua'a* of Humu'ula (Register Map 668). The site is identified in oral testimonies of native Hawaiians ("Kaluakaakoi" cf. Boundary Commission Testimonies of 1873; in Maly 1998), who's families had collected the dense stone for making *ko'i* or adzes. By the 1890s, the name was being written as "**Ke-ana-ka-ko'i**" (translated similarly to the earlier name). Though the name, Kaluakāko'i is not directly associated with a deity, the god Kū, in a variety of his forms, was evoked in the rituals and observances associated with procuring the stone and making the adzes (cf. Malo 1951; cited in this study).

Pōhaku-loa – May be literally translated as the "Long Stone." A traditional account recorded in the early twentieth century tells us that Pōhakuloa was named for a deity who was a guardian of *Ka-wai-kapu-a-Kāne* (The sacred water of Kāne) at Waiau. The name Pōhakuloa is applied to a land area, gulch, and water source situated on the slopes of Mauna Kea and making up a portion of the saddle between Mauna Kea and Mauna Loa. As a place name, Pōhakuloa can be traced back to a least the Boundary Commission testimonies of native informants in the 1870s.

Pu'u Poli'ahu – Poli'ahu hill (Interpretive): named for Poli'ahu (Clothed or garment covered breast), goddess of the snows of Mauna Kea. A hill that reaches 13,612 feet above sea level, Pu'u Poli'ahu is to the west of the summit peak. Poli'ahu is recorded as a place name in accounts dating back to at least the 1500s (e.g., Kamakau 1961:16-17), and is cited in surveys as early as the 1860s (Wiltse Reg. Map No. 668).

Waiau – Is literally translated as "Water current," or "Swirling water." In 1862-1863, S. N. Hale'ole penned the traditional account of "Lā'ie-i-ka-wai" in the Hawaiian newspaper, *Kū 'Oko'a*, translated by Martha Beckwith (1919 and 1970). In Hale'ole's original account (viewed by the author in the microfilm collection of the University of Hawai'i-Hilo, Mo'okini Library) the place name was printed "Waiau[4]." Hale'ole recorded that "Lilinoe, Waiau, and Kahoupokane" were three god-companions of the goddess Poli'ahu (Hale'ole Jan. 24, 1863).

In 1873, ten years after Hale'ole's writing, native informants (some of whom were close to 90 years old), testifying before Boundary Commission, identified the pond as being named Waiau (see Maly 1998).

Two other early historic accounts also reference the site, simply identifying it as the spring or pond of Poli'ahu. In 1870, Samuel Kamakau recorded that in the 1500s, the already "ancient mountain trail between Hāmākua and Hilo passed Poli'ahu's spring at the summit" (Kamakau 1961:16). During his mapping survey of Humu'ula in 1862, Wiltse cited the presence of "pond Poli'ahu" (Register Map No. 668). Wiltse did not personally see the pond of Poli'ahu (Waiau), but was provided information from native informants who guided him through the Humu'ula region.

Another traditional account recorded in the early twentieth century tells us that the crater and lake known by the name Waiau, were named for a goddess chiefess "*Ka-piko-o-Waiau*," who was the ward of Poli'ahu and Lilinoe (see account from the story of Ka-Miki, translated by this author – Maly 1998). Indeed, Waiau is situated to the southwest of the summit at an elevation of 13,007 feet above sea level, and, is figuratively watched over by the higher peaks.

Conclussion

Since 1900, several studies of historic sites have been conducted on lands that rest upon the slopes of Mauna Kea. Among the studies were those of Thos. G. Thrum (1908), and J.F.G. Stokes in 1906-1907 (Stokes and Dye 1991), who reported on *heiau* of the island of Hawai'i. Unfortunately, the studies did not include documentation of sites in mountainous region of Mauna Kea. In between 1930 to 1932, Alfred E. Hudson conducted a survey of archaeological sites of east Hawai'i (Hudson ms. 1932) for the Bishop Museum. While working in Puna, Hudson met with a Mr. Kaomea of Pohoiki. In their discussion of

[4] Relying upon Beckwith's 1919 and 1970 translations of Hale'ole's "Lā'ie-i-ka-wai" texts, previous writers have perpetuated a typographical error in the name of Waiau. Typed as "Waiaie" in Beckwith's manuscripts, later writers assumed that Hale'ole had not used the name "Waiau," thus crediting later authors with use of the name (cf. McEldowney 1982:A-6). As a part of the present study, the author reviewed Hale'ole's texts in the Hawaiian newspaper *Kū 'Oko'a* (1862-1863), and found that Hale'ole had indeed used the name "Waiau," not "Waiaie."

Mahinaakaaka Heiau in Keahialaka, Mr. Kaomea informed Hudson that there was another *heiau* of the name Mahinaakaaka, on Mauna Kea. Mr. Kaomea told Hudson that:

> "The stones for this *heiau* were carried to Mauna Kea from Waikahekahe [Puna]." (Hudson ms. 1932:370)

No further documentation was recorded.

Holly McEldowney's 1982 report (prepared in conjunction with an Archaeological Reconnaissance Survey by P. McCoy) on ethnographic resources for Mauna Kea and environs (cited earlier in this study), provides readers with perhaps the first detailed study of historical accounts for Mauna Kea. In his part of the 1982 study, Patrick McCoy observed:

> The construction and operation of new telescopes and proposed improvements associated herewith, such as paved roads, constitute a potential adverse effect on the integrity of the archaeological resource base and the fragile alpine environment in which it exists… For immediate planning purposes, the following alternative mitigative measures should be adopted as minimal requirements:
>
> (1) An <u>intensive</u> archaeological survey should be undertaken prior to the construction of any new telescopes in a specified area.
>
> (2) Avoidance of construction and related activities on or in proximity to known archaeological sites; if this is not feasible in terms of telescope location requirements, then alternative measures should be discussed and agreed upon by the SHPO and the Hawai'i Institute for Astronomy.
>
> Finally, the proposed Mauna Kea Science Reserve Master Plan should include provisions for the development of a cultural resource management plan. [McCoy 1982:2.34]

The primary authors cited in this appendix provide readers with a wide range of documentation pertaining to Mauna Kea. The material spans generations, culture, and perspectives, with sources ranging from native historians and practitioners to ethnographer and anthropologists. Regardless of background, all writers find common ground when acknowledging the significance of Mauna Kea in the history of the Hawaiian people.

The native traditions and historical accounts, the Boundary Commission testimonies and articles and journals cited in the various studies demonstrate the depth of native Hawaiian knowledge of the natural and cultural landscapes of Mauna Kea. The *cultural attachment*—relationship to environment and practices were, and remain, integral to the physical and spiritual well-being of the native residents of Hāmākua and Hilo, and all who viewed Mauna Kea.

> Indeed, Mauna Kea is awe-inspiring. There is a spiritual well-being in seeing, and being upon Mauna Kea. Uniformly, every Hawaiian interviewee that I have

> spoken with, about Mauna Kea, a strong attachment to Mauna Kea, and nearly everyone feels disheartened about the highly visible presence and impact of the telescopes and development in the summit region of Mauna Kea.

He Wahi Mo'olelo Kupuna (An Elder's Traditions)

The cultural attachment that many Hawaiians share with their landscape is difficult for some people to understand. It is a relationship born of centuries of residency in these islands which some believe to be the offspring of ancient gods. During a recent stay in Hilo, Tūtū Lilia Hale, an 86 year old native Hawaiian cultural practitioner was reminiscing with the author about her upbringing with her *kūpuna* (elders). In our conversation she commented, "*The Hawaiians are an earthy people. We relate everything back to our relationship with the earth around us.*" She then shared her recollections of going to the upland forests with her grandfather Samuel Kekino Kanahele, to gather *lā'au* (plants – herbs) for medicinal purposes, and the protocols which she grew up with in this practice.

The following narratives are excerpted from an interview we recorded, and her story helps put into native perspective, the depth and significance of the relationship that Hawaiians share with the earth. Her rich story may help some people further appreciate the Hawaiian attachment to place. As will be seen below, native beliefs, customs, and practices are important in all aspects of Hawaiian life, and it is difficult, if not impossible to separate nature and earth from the life of the *kānaka Hawai'i* (Hawaiians). Spirituality permeates everything.

Lilia Wahinemaika'i Ka'apuiki Kanahele Keli'inohomoku Hale (LH)
An account pertaining to the customs of her grandfather going to the forest; collecting herbs for medicinal purposes; and the love and relationship of the Hawaiians for the land.
(Recorded on the 24th day of January 1999, 2:30 p.m., with Kepā Maly)

Tūtū Lilia Wahinemaika'i Ka'apuiki-Hale is a cherished Hawaiian elder who was born at Kapālama (Pālama), O'ahu. Immediately after birth, she was taken in the custom of *hānai* (adoption) by her maternal grandfather Samuel Kekino Kanahele. During the first 16 years of her life, Tūtū Hale lived at Māla'e, Molokai; Wailuku, Maui; Kekaha, Kaua'i; and Wai'ōhinu (Ka'ū), Hawai'i. Today, Tūtū Hale is well known around the Hawaiian islands for her love of God, and for her knowledge of her *'ālelo makuahine* (mother tongue – Hawaiian language) and some of the traditions of her ancestors. We first met on Lāna'i in the 1970s when she was visiting her cousin Daniel Ka'ōpūiki Sr. (my adoptive grandfather) and family.

The interview was conducted in Hawaiian, the translations are verbatim from the original recording.

KM: …Yesterday, you shared some stories about your grandfather.

LH: Yes.

KM: His manner of going to the uplands, and about the relationship of the Hawaiians with the earth. Could you perhaps share some of those stories now?

LH: Yes, I can remember some of the things of my youth.

KM: Yes.

LH: See, the Hawaiian people, they didn't greet one another with a kiss, they drew close breathed out [and also took in the other's breath]. [gestures the greeting] They breathed out to you, and you breathed out to them — this is "*hā*." When we say "*aloha*," the true pronunciation is "*alo-hā*," which means, "in-the-presence-of-the-breath-of-life." The breath of life, *hā*, comes from God, and in saying *aloha*, we mean that we are in the presence of God. And that is how the ancient Hawaiians greeted one another.

KM: Hmm.

LH: By breathing, that was how they could…by your breath, the nature of your breath, they could discern if you were ill.

KM: Hmm.

LH: One time in my youth [about 5 or 6 years old], a woman came, one of my elders, an aunty. She greeted my grandfather with the breath. Breathing [gestures her grandfather breathing in], at the time that he breathed, (he said) "Oh my! You are ill…" But they didn't say what the nature of the illness was.

KM: Hmm.

LH: They knew just by breathing in, the nature of the illness. Grandfather said, "You need to go and make it right [spiritually], and then come back."

KM: Hmm.

LH: So this aunty left. My grandfather said, "Lilia we two are going to the forest." I took his basket and things, and I went with my grandpa. My grandfather didn't just go. He traveled with care, watching each place he stepped. That's how we traveled…the Hawaiians, in the forest. My grandfather stood, and he prayed, asking permission to enter into the forest. And then once in there, he would know which medicine to gather for this aunty.

KM: Hmm.

LH: I asked him, "Why are you praying here?" (My grandfather said) "Because, this forest was before us. God made the forest, therefore, it is necessary to ask 'may we travel here?' Before you step on and crush something in this place." My grandpa moved very carefully, observing all that was around him. Arriving at one place, there were a lot of the plants growing, but he didn't gather from there. He went and searched out a place where only one of the plants was growing and he took that. They [the Hawaiians] also didn't just pull out the plants [gesturing with her hands], they took it carefully.

KM: Hmm.

LH: I asked him, "Why are you doing it like that?" (My grandfather said) "Because this is a family, afterwards, the (plants) will grumble among themselves, and the medicine will not work." They likened the plants to a family. If you take only one child, the others will want to go as well.

KM: Yes, yes.

LH: It's exactly the same with the plants, because they are the children. Therefore, take only the single ones. Now, if it is only one herb, like my grandfather was gathering, that was called *lapa'au*. If it was two, three, or some different amount, it was called an *'apu*.

KM: An *'apu* [a mix of various herbs into one medicine].

LH: Now, while looking, he didn't make any sound, no noise. He went and looked, he pulled from here, from there–if it was an *'apu*–and he would pick with care. Then we returned home. Not speaking, he was not talkative at all. If I spoke [gesturing hand to mouth] "Keep the voice quiet." I understood, so I wasn't nosy. So we'd go home, and he would wash the herbs…

But, I've forgotten something. Before we would go, my grandpa would take a bath, he would cleanse himself outside. He would also clean inside, spiritually, if there were bad thoughts, or what. Those things were cut. Because (he would say) "Rubbish can't help rubbish."

KM: Hmm.

LH: If you aren't clean, you can't help the one with the rubbish." That is the way the Hawaiian people think. So as I said, we would go. The Hawaiian people of that time, were very respectful and careful of what they did. They didn't just step anywhere. No!

KM: Hmm.

LH: Their work was done with respect. When we went, there were no loud voices. The plants were the important thing that we desired to go and gather. And he didn't make like this [gestures, yanking out the plants], he gathered carefully. Then we would go home. Now my job was to light the fire and heat the stones. My grandpa, he would pound the herbs, and strain them into a bowl…

… Now if it is a severe illness, the medicine would be taken twenty-five times [holding her hand in front of her], *'elima kualima.*

KM: Hmm.

LH: If it was severe.

KM: Yes.

LH: If it was an illness…sick but not too bad, just five times (*piha ke kualima*), a full hand [holding her hand in front of her], was good.

KM: Yes, a full hand (*piha ke kualima*).

LH: Yes, illness for five [days of medicine]. For the Hawaiian people, five was the number… What is the word? Complete.

KM: Complete.

LH: Then it was done. Not four or three, but five, like the hand.

KM: Yes.

LH: So it was done like this by the people [hold her hand in front of her, gesturing with her fingers], with people and the animals. You have a head, two arms, two legs.

KM: Hmm.

LH: Complete. [gesturing with her hand] It's the same with the animals, five, a head, and four legs, complete. The birds, the head, wings, and feet, five. The fish are the same, the nose, tail (with two points) and fins, five. That was their formula [smiling].

KM: Yes.

LH: The count is the formula. They took it in the night and day.

KM: Hmm, so in the night and day. Two times a day for five days?

LH: Yes. Then you rest two days. That's how they did it—my grandfather, five times, night and day. Then you rest two days. If the illness persists, you begin again. If it's not too strong, the one set is enough, five times is enough.

KM: So intelligent, the ways of the elders.

LH: Because they likened themselves, the body to the earth. The body was not separate by itself, and the earth was not separate, we came from the dirt. We are the same. There is nothing else, we live by the things of the soil.

KM: Yes, it's like you said the other evening, "The Hawaiians are an earthy people…"

LH: It's so. The Hawaiians are of the earth, all things are connected to the earth.

KM: Yes… Thank you so much for sharing this story. It is a treasure for the people of this land.

LH: You know, Kepā, I am happy. If you ask me something, like this, it is a great pleasure for me to tell you because you are one who cherishes things Hawaiian.

KM: Hmm. And like you said, the Hawaiians are an earthy people.

LH: Oh yes, they are. [smiling] That's why we are called the brown race.

KM: And everything relates back to the earth, everything that they did.

LH: Oh yes, everything went back to the earth. And you know that.

KM: Yes.

LH: We Hawaiians have to respect the earth because it was made before us.

KM: Yes.

LH: You know, they say, [gesturing with her hand] "Lay the palm of the hand out to the sun, you'll be hungry! Turn the hand down and work, you'll be satisfied!"

KM: Yes, do good work. And Tūtū papa Ka'ōpūiki said, "When the hands do good work, the mouth will eat good food!"

LH: Yes.

KM: The elders were so wise.

LH: Yes.

KM: It's so interesting!

LH: You know, our Hawaiian people…this is not simply smart, this something that is natural to those who are native to a land. The natives of the land. They lived here, they ate of it, and slept upon the land. It is the land that gave then their wisdom.

KM: Hmm!

LH: This is the reason that the Hawaiians prayed like this [gesturing with both hands lifted up to the heavens]. They understood, that God was in heaven. And the things of the land, we give thanks to God for all the things of the land…

What *kūkū* Lilia Wahinemaika'i Hale shared above, is rooted in the traditions of her *kūpuna*, and is a way of life for her. While not everyone may be able to express the thoughts in the same way—a privilege of her age and experiences—it will be seen that the cultural attachment to Mauna Kea is strong among all the individuals who were asked. While the words spoken in the Mauna Kea interviews are expressed in different ways, tbe thoughts remain consistently focused.

Mauna Kea, kuahiwi ku ha'o i ka mālie
Mauna Kea [is the] astonishing mountain that stands in the calm.
(cf. Pukui 1983:2147)

REFERENCES CITED

Alexander, W.D.
1892 *The Ascent of Mauna Kea, Hawaii.* The Hawaiian Gazette. Honolulu.

1892 Field Note Book No.429. Hawai'i State Survey Office.

Allen, M.S.
1981 *An Analysis of the Mauna Kea Adze Quarry Archaeo-botanical Assemblage.* Master's thesis, University of Hawaii Department of Anthropology, Honolulu.

Athens, J.S., and M.W. Kaschko
1989 *Prehistoric Upland Bird Hunters: Archaeological Inventory Survey and Testing for the MPRC Project Area and the Bobcat Trail Road, Pohakuloa Training Area, Island of Hawaii.* International Archaeological Research Institute, Inc. Submitted to U.S. Army Engineer District, Pacific Ocean Division.

Barrera, W.J., Jr.
1983 Saddle Road, Hawaii Island: Archaeological Reconnaissance. Chinago, Inc., Honolulu. Submitted to EDAW INC.

Barrera, W.J., Jr., and M. Kelly
1974 Archaeological and Historical Surveys of the Waimea to Kawaihae Road Corridor, Island of Hawaii. Departmental Report Series 74(1). Department of Anthropology, B.P. Bishop Museum, Honolulu.

Beaglehole, J. (ed.)
1967 *The Journals of Captain James Cook on his Voyages of Discovery. Vol. 3. The voyage of the Resolution and Discovery.* Cambridge University Press, New Haven.

Beckwith, M.
1919 *"The Hawaiian Romance of Laieikawai."* IN 33rd Annual Report of the Bureau of American Ethnology, Smithsonian Institution, pp. 293-360. Washington: U.S. Government Printing Office.

1970 *Hawaiian Mythology.* Honolulu: University of Hawaii Press.

Bingham, H.
1969 *A Residence of Twenty-one Years in the Sandwich Islands.* New York.

Bird, I.
1974 *Six Months in the Sandwich Islands.* University of Hawaii Press.

Boundary Commission Books
1873-1905 Microfilm Collection of the University of Hawai'i at Hilo, Mo'okini Library.

Brigham, W.T.
1902 Ancient Hawaiian Stone Implements. Bishop Museum, Memoirs Vol., No. 4, Honolulu.

Brundage, L.
1971 Alfred W. Carter, Hawaii's dean of cattlemen, and notes on Hawaiian livestock. Kamuela, Hawaii.

Buck, P. (Te Rangi Hiroa)
1957 *Arts and Crafts of Hawaii.* Bishop Museum Special Publications, 45.

Clark, J.T., and P.V. Kirch
1983 *Archaeological Investigations of the Mudlane-Waimea-Kawaihae Road Corridor, Island of Hawaii.* Department of Anthropology, B.P. Bishop Museum, Honolulu. Submitted to the State of Hawaii Department of Transportation.

Cleghorn, P.L.
1982 *The Mauna Kea Adze Quarry: Technological Analyses and Experimental Tests.* Unpublished Ph.D. dissertation., Department of Anthropology, University of Hawaii.

Cordy, R.
1994 *A Regional Synthesis of Hāmākua District Island of Hawai'i.* Historic Preservation Division Department of Land and Natural Resources. State of Hawaii.

Cox, D.
1983a *Site Visit and Archaeological Reconnaissance of the Firebreak Route Along Puu Kulua Road, Pohakuloa Training Area (PTA), Island of Hawaii.* Submitted to U.S. Army Corps of Engineers, Pacific Ocean Division by David W. Cox, Archaeological Technician, Corps of Engineers, Honolulu District.

Coulter, J.W.
1935 A Gazetteer of the Territory of Hawaii. Honolulu.

Ellis, W.
1963 *Journal of William Ellis.* Honolulu: Advertiser Publishing Co., Ltd.

Emory, K.
1938 The Adze Makers of Mauna Kea. *Paradise of the Pacific* 50(4):21-22.

Haleole, S.N.
1862-1865 *"Ka Moolelo o Laieikawai"* In *Kū 'Oko'a* 1862-1863 (cf. Jan. 24, 1863).

Handy, E.S.C., E.G. Handy, with M.K. Pukui
1972 Native Planters in Old Hawaii, Their Life, Lore, and Environment. B.P. Bishop Museum Bulletin 233. B.P. Bishop Museum Press.

Henshaw, H.W.
1902-1903 *Complete List of the Birds of the Hawaiian Possessions, with notes on Their Habits.* The Hawaiian Annual for 1903 and 1904. Thos. G. Thrum, Honolulu.

Hobbs, J.F.
1939 Our Fourth Industry is Livestock. *Hawaiian Annual.* Thos. G. Thrum, Honolulu.

Hommon, R.J., and H.M. Ahlo, Jr.
1983 A Research Design for Archaeological Studies at the Pohakuloa Training Area, Island of Hawaii. Science Management, Inc. (Honolulu). Prepared for U.S. Army Corps of Engineers.

Hooker, Sir W.J.
1839 A brief Memoir of the Life of Mr. David Douglas, with extracts from his Letters. *Hawaiian Spectator* 2 (1):396-428. [corrected version of Douglas's Journal dealing with his ascent of Mauna Kea and Mauna Loa]

Hudson, A.E.
ms. 1932 Archaeology of East Hawaii. Bishop Museum. Honolulu, Hawaii.

Kalima, L., and P.H. Rosendahl
1991 *EIS Addendum Report, Archaeological Survey of 138KV Powerline No. 2. Districts of North and South Hilo, Hamakua, and South Kohala, Island of Hawai'i.* Paul H. Rosendahl, Ph.D., Inc. Submitted to CH2Mhill.

Kamakau, S.M.
1961 *Ruling Chiefs of Hawaii.* Honolulu: Kamehameha Schools Press.

1976 *The Works of the People of Old: Na Hana a ka Po'e Kahiko. B.P. Bishop Museum Special Publication* 61. Bishop Museum Press, Honolulu.

1991 *Tales and Traditions of the People of Old, Nā Mo'olelo a ka Po'e Kahiko.* Bishop Museum Press, Honolulu.

Kanahele, P.K., and E. L.H. Kanahele
1997 A Social Impact Assessment – Indigenous Hawaiian Cultural Values of the Proposed Saddle Road Alignments. Project A-AD-6 (1). Hilo, Hawai'i.

Kelly, M., B. Nakamura, and D. Barrere
1981 Hilo Bay, A Chronological History, Land and Water Use in the Hilo Bay Area, Island of Hawaii. Department of Anthropology, B.P. Bishop Museum, Honolulu. Prepared for U.S. Army Engineer District, Honolulu.

Korn, A.L. (translator)
1981 Fourteen Years in the Sandwich Islands, 1855-1868; Charles De Varigny. The University Press of Hawaii and the Hawaiian Historical Society. Honolulu

Langlas, C. Ph.D., et al.
draft 1997 Draft Environmental Impact Statement – Saddle Road (State Route 200) Mamalahoa Highway (State Route 190) to Milepost 6. County of Hawaii, State of Hawaii, FHWA Project No. A-AD-6(1). Technical Appendices- Volume IV Archaeological, Historic and Traditional Cultural Assessment. Prepared for U.S. Dept. of Transportation FHWA-Central Federal Lands Highway Division and Hawaii Dept. of Transportation. Paul H. Rosendahl, Ph.D., Inc., (Report No. 1522-022897). Hilo, Hawaii.

Loo, V.H., and W. Bonk
1970 A Historical Site Study and Evaluation of North Hawaii. Anthropological Research International. Prepared for Hawaii County Planning Department.

Lyons, C.J.
1875 Land Matters in Hawaii. *Islander*, Honolulu.

1903 A History of the Hawaiian Government Survey with Notes on Land Matters in Hawaii. Appendixes 3 and 4 of Surveyor's Report for 1902. Honolulu. (Land Matters was originally written and published in the "Islander," 1874.)

Malo, D.
1951 *Hawaiian Antiquities.* Honolulu, B.P. Bishop Museum.

Maly, Kepā
1998 "*Mauna Kea Kuahiwi Ku Ha'o i ka Mālie*" A Report on Archival and Historical Documentary Research; Ahupua'a of Humu'ula and Ka'ohe, Districts of Hilo and Hāmākua, Island of Hawai'i. Prepared for Native Lands Institute. Hilo, Hawai'i (published May 1998).

McCoy, P.
1977 Archaeological Investigations at the Mauna Kea Adz Quarry Complex, Hawaii: Preliminary Results of the 1975-76 Fieldwork. Paper presented at the 42nd Annual Meeting of the Society for American Archaeology. New Orleans, Louisiana.

1981 Stones for the Gods: Ritualism in the Mauna Kea Adz Quarry Industry, Hawaii. Paper presented at the 46th Annual Meeting of the Society for American Archaeology. San Diego, California.

1982 Report 2. Archaeological Reconnaissance Survey. In Cultural Resources Reconnaissance of the Mauna Kea Summit Region, H. McEldowney & P. McCoy. Bishop Museum ms. 110192. (Prepared for Group 70 International)

McCoy, P.C., and R.A. Gould
1977 Alpine Archaeology in Hawaii. *Archaeology* 30 (4):234-243.

McEldowney, H.
1979 Archaeological and Historical Literature Search and Research Design: Lava Flow Control Study, Hilo, Hawai'i. Bishop Museum ms. 050879. B.P. Bishop Museum, Honolulu.

1982 Report 1. Ethnographic Background of the Mauna Kea Summit Region. In Cultural Resources Reconnaissance of the Mauna Kea Summit Region, H. McEldowney & P. McCoy. Bishop Museum ms. 110192. (Prepared for Group 70 International)

Pukui, M.K.
1983 *Olelo Noeau.* B.P. Bishop Museum Special Publication 71. Bishop Museum Press, Honolulu.

Pukui, M.K., and S. H. Elbert
1971 *Hawaiian-English Dictionary.* 4th edition. Honolulu: University of Hawaii Press.

Pukui, M.K., and A.L. Korn
1973 The Echo of Our Song. Chants and Poems of the Hawaiians. Honolulu: University Press of Hawaii.

Rosendahl, M.L.K., and P.H. Rosendahl
1986 Archaeological Reconnaissance Survey, Saddle Road Shoulder Project, Lands of Punahoa 2 and Piihonua, District of South Hilo; Land of Humuula, District of North Hilo; Land of Kaohe, District of Hamakua; and Land of Waikoloa, District of South Kohala, Island of Hawaii. PHRI Report No. 229-051486. Prepared for Juvik & Juvik.

Rosendahl, P.H.
1977 Archaeological Inventory and Evaluation Report for Installation Environmental Impact Statement for U.S. Army Support Command Hawaii (USASCH). Part 1: Report Text; Part 2: Tables. Prepared for Department of the Army, U.S. Army Engineer Division, Pacific Division, by Department of Anthropology, B.P. Bishop Museum, Honolulu.

Scott, J.M., S. Mountainspring, F.L. Ramsay, and C.B. Kepler
1986 Forest Bird Communities of the Hawaiian Islands: Their Dynamics, Ecology and Conservation. Studies in Avian Biology, No. 9. Cooper Ornithological Society. Allen Press, Ltd., Lawrence, Kansas.

State of Hawai'i
Ms. Files cited in text from the collections of the:
Hawai'i State Archives
Department of Land and Natural Resources — Bureau of Conveyances
Department of Land and Natural Resources — Division of State Parks
Department of Land and Natural Resources — Land Management Division
Department of Land and Natural Resources — State Survey Division

Stemmermann-Kjargaard, M.
1985 *Avian Survey of the Hale Pohaku Area. In Draft Supplemental Environmental Impact Statement Amendment to the Mauna Kea Science Reserve Complex Development Plan for Construction Camp Housing at Hale Pohaku, Hamakua, Mauna Kea, Hawaii,* Appendix B. MCM Planning, Honolulu.

Stokes, J.F.G., and T. Dye
1991 Heiau of the Island of Hawai'i. *Bishop Museum Bulletin in Anthropology* 2. Bishop Museum Press, Honolulu.

Streck, C.F., Jr.
1984 *Archaeological Reconnaissance Site Survey of Five Land Parcels at Pohakuloa Training Area (PTA), Island of Hawaii, Hawaii.* Submitted to Headquarters, U.S. Army Support Command Hawaii (U.S. Engineer District, Honolulu).

1986 *Aerial Archaeological Reconnaissance Site Survey for Proposed Artillery Firing Points, Firebreak/Road Route, and other Facilities at Pohakuloa Training Area (PTA), Island of Hawaii, Hawaii.* Submitted to Headquarters, U.S. Army Support Command Hawaii (U.S. Engineer District, Honolulu).

Streck, C.F., Jr., and F. Watanabe
1986 *Trip Report: Aerial Archaeological Reconnaissance Survey for the Revised Proposed Site for the Multi-Purpose Range Complex, Pohakuloa Training Area, Hamakua, Island of Hawaii – 31 Mar – 4 Apr 1986.* Submitted to U.S. Army Engineer District, Honolulu.

Thrum, T.
1908 *Heiaus and Heiau Sites Throughout the Hawaiian Islands.* Island of Hawaii. Hawaiian Almanac and Annual for 1909:38-78.

Watanabe, F.K.
1986 Final Report for Archaeological, Aerial and Limited Ground Reconnaissance of Various Parcels Situated at Hawaii Island Selected as Potential Military Training Areas. Prepared by U.S. Army-Corps of Engineers (Honolulu District) for U.S. Army Support Command, Hawaii.

Welch, D.J.
1993 Archaeological Survey and Testing for the Saddle Road Improvement Project, Pohakuloa Area, Island of Hawaii, Hawaii. International Archaeological Research Institute, Inc., Honolulu. Submitted to Central Federal Lands Highway Division, Federal Highways Administration, under contract CX 8000-0-0031 to the U.S. Department of the Interior, National Park Service, Western Region Interagency Archaeological Services Branch, San Francisco.

Wellmon, B.
1969 The Parker Ranch: A History. Ph.D. dissertation, Texas Christian University. University Microfilms.

Wentworh, C., J.W. Coulter, and C.E. Hartt
1935 The Mauna Kea Expedition of 1935. Hawaiian Academy of Science. Manuscript on File at B.P. Bishop Museum Library.

APPENDIX E: LIMITED OVERVIEW OF THE HAWAI'I LOA TRADITIONS

MAUNA KEA SCIENCE RESERVE AND HALE PŌHAKU COMPLEX DEVELOPMENT PLAN UPDATE:

ORAL HISTORY AND CONSULTATION STUDY, AND ARCHIVAL LITERATURE RESEARCH

Ahupua'a of – Ka'ohe (Hāmākua District) and Humu'ula (Hilo District), Island of Hawai'i

MAUNA KEA SCIENCE RESERVE AND HALE PŌHAKU COMPLEX DEVELOPMENT PLAN UPDATE:

ORAL HISTORY AND CONSULTATION STUDY, AND ARCHIVAL LITERATURE RESEARCH

Ahupua'a of – Ka'ohe (Hāmākua District) and Humu'ula (Hilo District), Island of Hawai'i (various TMK)

BY

Kepā Maly • Cultural Resources Specialist

PREPARED FOR

Group 70 International
925 Bethel Street, Fifth Floor
Honolulu, Hawai'i 96813-4307

February 1, 1999

Kumu Pono Associates
Kepā Maly, Consultant
Historical & Archival Documentary Research · Oral History Studies · Partnerships in Cultural Resources Management · Developing Preservation Plans and Interpretive Programs

554 Keonaona St. · Hilo, Hawai'i 96720 · (ph./fax) 808.981.0196 · (e-mail) kepa@interpac.net

APPENDIX E:
LIMITED OVERVIEW OF THE HAWAI'I LOA TRADITIONS

In the process of conducting the oral history and consultation program for the present study, the author was told of the association of a legendary figure, Hawai'i Loa, with Mauna Kea. Hawai'i Loa, according to legend, was an ancient chief who came with his retinue to settle the Hawaiian Islands. Legend has it that Hawai'i Loa was the original founder of the Hawaiian race, his accounts at times usurping the native traditions of Wākea and Papa (Sky-father and Earth-mother). Below, are two synopses of the legend recorded by Martha Beckwith (1970):

(a) Fornander version. Hawaii-loa is born on the east coast of a "Land of the yellow sea of Kane. He makes long fishing excursions, sometimes of months at a time, with his chief navigator Makali'i (Eyes of the chief) who is an expert in star lore (*kilo-hōkū*), and on one of these they steer east and find a fertile land where coconuts and *awa* grow. Sometime after their return he migrates with his family and a great following, but as he alone takes his wife and children, the whole Hawaiian race is descended from the one stock. From time to time he voyages south to bring back mates for his children out of his brother Ki's[1] family. He brings Ki's oldest son Tu-nui-ai-a-te-atua as husband for his favorite daughter Oahu, and their son Tu-nui-atea is born at Keauhou on Hawaii and the district of Puna named for the father's district, Puna-auia, in Tahiti. He brings Te-arii-tinorua [the chiefess with dual forms] from Tahiti to become a wife for Tu-nui-atea; Ke-alii-maewa-lani (Kauai) is their son, from whom the Kona people are descended. Hawaii-loa's wife Hualalai bears her last child Hamakua and is buried on the mountain of Hawaii that bears her name... (Fornander IN Beckwith 1970:363-364).

(b) Kepelino version. Hawaii-nui [another name for Hawai'i Loa] is a fisherman from lands adjoining Kahiki-honua-kele. He knows the sea called "Sea where the fish run..." which used to lie where these islands now lie. He sailed from Kahiki-honua-kele and discovered these islands, first Kauai, then Oahu, the Maui group, then Hawaii, which he named after himself. The other islands he named after his children, and various land divisions after his eight navigators who sailed with him, of whom Makali'i was chief. To return to Kahiki they sailed west guided by the star Hoku-loa (Kepelino IN Beckwith 1970:364).

In 1969, Dorothy Barrere, Bishop Museum ethnographer and editor, investigated the origin of the legends. She carefully detailed the circumstances around the evolution and publication of the Hawai'i Loa legends. Barrere noted:

[1] Ki, also written as Tii in Fornander's texts, is a name also handed down in Tahitian legends as an ancestral chief (Fornander 1969:161). The name Tii is written as Ki'i in its Hawaiian form, and in Fornander's Kumuhonua genealogical chart, he identifies Ki'i as one of the sons of Hawai'i Loa and Hualalai; among the names of Ki'i's siblings are found Kanaloa (Kaho'olawe), Maui, O'ahu, and Kaua'i (ibid.:183).

In the Hawaii Loa legend(s) Fornander's informants departed from Biblically-inspired tales and entered into the realm of pure invention in their attempts to account for the peopling of the Hawaiian Islands. Kepelino's story as written in 1868 is a plausibly told legend, but the "biographical" material found in Fornander's notes (1919-1920, 6(2):271, 275, 278-279, 280-281) reveal the extent of the invention. They also disclose a knowledge of Pacific geography and of an ethnic relationship among Polynesia peoples that were unknown to the Hawaiians before western contact, and so could hardly have been incorporated in an authentic tradition (Barrere 1969:37).

In 1995, the author spoke with Mrs. Barrere about the Hawai'i Loa traditions and she shared some insights into the origins and context of the accounts. Mrs. Barrere noted that the story was collected by Fornander while he was superintendent of schools and was spending a great deal of time on Maui. During this time (c. 1850s-1860s), Hawaiian historian Samuel Kamakau was also living on Maui, and was in regular communication with Fornander. She first suspected the legends' antiquity because Fornander recorded it in English, and even noted that it had not been written out in Hawaiian. It is Barrere's opinion that the intention behind using the name "Hawai'i Loa" in the legend in the c. 1860s was to celebrate a Hawaiian legacy of chiefs and navigators. In this context, *Hawai'i Loa was not named after one man, but with the memory of the fact that ancestral people had migrated from Kahiki to Hawai'i* (see also the interview with Pualani Kanahele for further elaboration in this regard). Barrere also noted that it was Fornander who inserted the name Hawai'i Loa into the authentic Hawaiian genealogies, as recorded by Kamakau and others, and it is at that point that the name became a person–the progenitor of the Hawaiian race (pers comm. Dorothy Barrere; March 11, 1995). Thus, Barrere contends that the legends are of historic origin, intertwined with aspects of ancient knowledge and lore (Barrere 1969:37).

Barrere (1969) notes the Kepelino legend is "clearly patterned on Genesis 1:1-10" (Barrere 1969:6). Of Fornander's account, Barrere concludes that "there are few points of similarity between Kamakau's and Kepelino's own written stories and... [Fornander's] ...adaptation" (Barrere 1969:16). Barrere also indicates that various "Hawaiian" legends have a remarkable similarity to stories of the Bible, and are filled with contradictions to the vast body of Hawaiian lore and historical accounts published during the 19th century. Barrere's 1969 study documents how Hawaiian history may have been modified in order to facilitate a higher degree of acceptance of Hawaiian "traditions" by the foreign residents and evolving powers; she notes that "In writing about the Kumuhonua legends in the c. 1860-1870s, Kamakau and Kepelino were working on fitting themselves [and their histories] into the Christian concept" (pers. comm. Barrere and Maly, March 11, 1995).

Another former staff member at the Bishop Museum, Kenneth Emory, wrote an article entitled "Origin of the Hawaiians" in which he critically examines the legend of Hawai'i Loa. Emory states that, though Kamakau mentions Hawai'i Loa, neither the writings of Malo nor Ellis "a quarter of a century earlier" mentioned Hawai'i Loa (Emory 1959:32). He states:

> Kamakau's oft quoted 'tradition' incorporates much knowledge of geography gained by the Hawaiians through European contact and runs counter to earlier recorded traditions. It has every appearance of a post-European neo-myth, of which there are many composed in answer to questions and suggestions made

> by foreigners. As representing reliable ancient Hawaiian traditions, and therefore as having significance for historical reconstruction, it is valueless (Emory 1959:32).

As Barrere implies above, the similarity of Hawaiian legends to biblical stories does not mean that the entire legends are fabrications, but rather, that the original legends have been modified. The legend of Hawai'i Loa[2] the navigator is perhaps related to earlier Polynesian legends. S.P. Smith, writing in 1913, discusses the relationship between Maori, Hawaiian, and other Polynesian legendary accounts of a legendary chief-navigator and settler of Polynesian islands:

> Seeing how ancient this canoe 'Uruao' is, according to Maori traditions, it is not surprising that we have so little about it and the voyages of its Captain Tama-rereti. It is, nevertheless, the case that he is renowned as a voyager, and taking all other things into considerations we are justified in concluding that Indonesia, at any rate, if not other lands in eastern Asia, was the scene of his nautical exploits. I have already hinted at the possibility of Tama-rereti being identical with Hawaii-loa (Hawaiki-roa in Maori). According to both the Hawaiian and Maori traditions there were the earliest known voyagers of the Polynesian race, Fornander says of him (loc. Cit.. Vol. I., p. 25):—"This chief was a noted fisherman and great navigator, and on one of his maritime cruises, by sailing in the direction of the star Iao (Jupiter, when a morning star) and of the Pleiades, he discovered land which he called after his own name [Hawaii], and other islands after his children. Delighted with the country, he returned to his native land after his wife and family, and having performed the same eastern voyage in the direction of the morning star and the Pleiades, crossing the ocean which is called by the diverse names of Kai-holo-o-ka-ia [Tai-horo-o-te-ika in Maori] 'the sea where the fish do run,' Ka-Moana-kai-maokiokia-Tane [Te-Moana-tai-maotioti-a-Tāne in Maori] 'The spotted, many coloured ocean,' and also Moana-tai-popolo [Moana-tai-poporo in Maori] 'the blue, or dark green sea'—he arrived the second time at the Hawaiian Islands, and he and his family and followers were their first human inhabitants... (Smith 1913:21).

In 1929, Bruce Cartwright of the Bishop Museum, wrote an article in which he also supported the idea that the legend(s) of Hawai'i Loa had its roots in earlier traditions of Polynesia. He observed:

> Judge Fornander says that the translation of the legend of Hawaii-loa was "compiled and condensed in English from Kepelino and S.M. Kamakau." This legend seems to be a summary of statements contained in many other Hawaiian legends and genealogies. At the time it was recorded in writing many Hawaiians had become Christianized and were familiar with Biblical history. The temptation to interpret certain incidents similar to those in

[2] In the Hawaiian Ethnological Notes of the Bishop Museum are a few references from the work of Thos. Thrum, among the papers are found the following hand written notes: "Hawai'i—Ha-wai-'i, old water flume; Ha-wai'i (Hawaii-loa) is the Noah of the Hawaiian Race, ask Fred Beckley to explain further" (nd. Thrum Place Name File H-106).

> Biblical history as being in fact the Hawaiian rendering of Biblical events seems too have influenced the translators. This unfortunate condition has more or less discredited the ancient Hawaiian legends on which the legend of Hawaii-loa is based, branding them, in the opinion of many modern students, as "doctored accounts, influenced by Christianity." On the other hand the fact that many of the persons mentioned are and have been accepted by Hawaiians of chieftain rank as their ancestors, warrants a thorough study of the history of these chiefs and of whatever ancient definite statements can be gathered... (Cartwright 1929:105).

Cartwright proposed that Hawai'i Loa indeed reached Hawai'i and established people under him who were responsible for peopling and governing the islands, and that Hawai'i Loa himself left the Hawaiian Hawai'i for another Hawai'i or "Havaii" (Cartwright 1929:115). Cartwright notes that:

> Havaii (Invoked space that filled) was of undisputed prestige among the islands in ancient times and is still the proudest island in all the Society group, being the center of their history, their religion and their heraldry... Havai'i exercised a political and moral sway as the emporium of all the Maori tribes of Polynesia [cf. Ancient Tahiti, by Teuira Henry, JPS Bull. 48, p.116, 1928]... The Hawai'i Loa legend seems then in fact to be a scrap of the ancient history of Ra'iatea and Tahiti which has been preserved in Hawaii although apparently lost in Tahiti and Raiatea (Cartwright 1929:119).

As evidenced in the interviews with Mr. and Mrs. Alika Lancaster and Pualani Kanaka'ole-Kanahele, the traditions of Hawai'i Loa, are an important linkage between traditional Hawaiian genealogies and those found in the Christian Bible. Indeed, portions of the Hawai'i Loa tradition and genealogy are commonly cited in genealogical accounts of the Mormon Church in Hawai'i and tie back to the Book of Mormon.

REFERENCES CITED

Barrerè, D.B.
1969 The Kumuhonua Legends: A Study of Late Nineteenth Century Hawaiian Stories of Creation and Origins. *Pacific Anthropological Records* No. 3. Department of Anthropology, B.P. Bishop Museum, Honolulu.

Beckwith, M.
1970 *Hawaiian Mythology*. Honolulu: University of Hawaii Press.

Cartwright, B.
1929 The Legend of Hawaii-Loa. *The Journal of the Polynesian Society* 1929, Vol. 38.

Emory, K.P.
1959 Origin of the Hawaiians. *Journal of the Polynesian Society* 1959, Volume 68.

Fornander, A.
1916–20 Fornander Collection of Hawaiian Antiquities and Folk-Lore. *Memoirs of the Bernice Pauahi Bishop Museum* (9 vols.). Bishop Museum Press, Honolulu.

Kamakau, S.M.
1961 *Ruling Chiefs of Hawaii*. Honolulu: Kamehameha Schools Press.

1991 Tales and Traditions of the People of Old. Honolulu: Bishop Museum Press. (Edited by D. Barrere)

Smith, S.P.
1913 The Lore of the Whare-Wananga. Part II. Te Kauwae-raro, or "Things Terrestrial." *The Journal of the Polynesian Society*, 1913, Volume 22.

MAUNA KEA SCIENCE RESERVE
MASTER PLAN

APPENDIX J

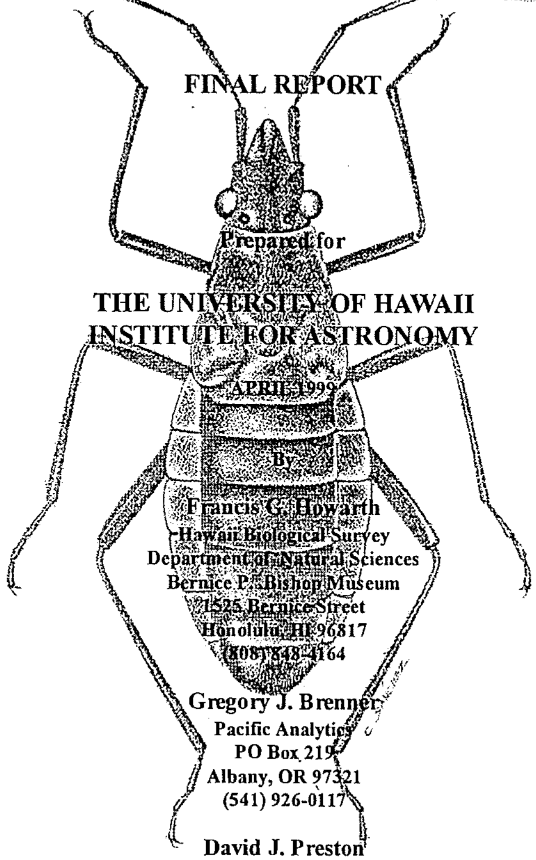
An Arthropod Assessment within Selected Areas of the Mauna Kea Science Reserve – Final Report

Francis Howarth, Gregory Brenner, and David J. Preston

May 7, 1999

MARCH 2000

AN ARTHROPOD ASSESSMENT WITHIN SELECTED AREAS OF THE MAUNA KEA SCIENCE RESERVE



FINAL REPORT

Prepared for

THE UNIVERSITY OF HAWAII
INSTITUTE FOR ASTRONOMY

APRIL 1999

By

Francis G. Howarth
Hawaii Biological Survey
Department of Natural Sciences
Bernice P. Bishop Museum
1525 Bernice Street
Honolulu, HI 96817
(808) 848-4164

Gregory J. Brenner
Pacific Analytics
PO Box 219
Albany, OR 97321
(541) 926-0117

David J. Preston
Hawaii Biological Survey
Department of Natural Sciences
Bernice P. Bishop Museum
1525 Bernice Street
Honolulu, HI 96817
(808) 848-4194

AN ARTHROPOD ASSESSMENT WITHIN SELECTED AREAS OF THE MAUNA KEA SCIENCE RESERVE

FINAL REPORT

Prepared for

THE UNIVERSITY OF HAWAIʻI
INSTITUTE FOR ASTRONOMY

7 May 1999

By

Francis G. Howarth
Hawaiʻi Biological Survey
Department of Natural Sciences
B.P. Bishop Museum
1525 Bernice Street
Honolulu, HI 96817

Gregory Brenner
Pacific Analytics
PO Box 219
Albany, OR 97321
(541) 926-0117

David J. Preston
Hawaiʻi Biological Survey
Department of Natural Sciences
B.P. Bishop Museum
1525 Bernice Street
Honolulu, HI 96817

AN ARTHROPOD ASSESSMENT WITHIN SELECTED AREAS OF THE MAUNA KEA SCIENCE RESERVE

FINAL REPORT

I. TABLE OF CONTENTS

II. EXECUTIVE SUMMARY

The Mauna Kea Science Reserve (MKSR) is located on the summit of the tallest mountain in Hawai'i, (13,795 feet). The upper reaches of this extinct shield volcano are the site of a unique natural environment, and also the site of one of the world's foremost astronomical observatories. The agency charged with management of both the environment and the observatory complex is the Institute for Astronomy (IfA), an affiliate of the University of Hawai'i.

Over the last 20 years, the IfA has been concerned with the status of rare plants and animals found on or near the summit of Mauna Kea. Among these concerns is a special interest in the arthropod community. The IfA has established a program to gather the information necessary for protection and management of resident arthropod species, including the Wekiu bug and lycosid spiders. This report presents the results of a study of the Mauna Kea arthropod community that took place in 1997-98.

Six core tasks were assigned to this study: (1) a comparison of current Wekiu bug trap capture rates to those found in the 1982 Bishop Museum summit arthropod assessment, (2) an assessment of the seasonal fluctuations of Wekiu bug populations,
(3) identification of Wekiu bug habitat within the buffer zone of the MKSR,
(4) a comparison of Wekiu bug occurrence between the summit and buffer areas,
(5) a comparison of arthropod diversity between summit and buffer areas, and
(6) development of management recommendations for the MKSR to preserve and protect resident arthropod populations.

We present the results and discuss the implications of the findings, for each of the five study tasks. We also furnish and discuss recommendations for management of the MKSR to preserve and protect resident arthropod populations. Maps, figures, and tables are included for clarity of understanding. We also provide a list of the literature cited in the report.

Field work began April 1997 with the development and testing a new pitfall trap designed for effectiveness in capturing Wekiu bugs, survival of Wekiu bugs, and comparability to traps used in the 1982 study. After two reconnaissance trips in June and

July1997, a sampling plan was statistically designed to adequately sample all areas of interest, and to allow for valid comparisons to the 1982 study. Sampling began in August 1997 at the summit areas of Pu'u Wekiu and Pu'u Hauoki and ended in September 1998 with a final reconnaissance and sampling of buffer areas.

Significantly fewer Wekiu bugs were captured in the 1997-98 pitfall study than during the 1982 study, corroborating incidental observations that the bug has declined. Furthermore, there was strong evidence that the Wekiu bug capture rate during the 1982 study was significantly greater than the Wekiu bug capture rate during the 1997-98 study. Lycosid spiders were also less abundant, but the difference was not significant, and observational data suggest that its population is comparable to its 1982 level. The endemic moth, *Agrotis* sp., appears to have expanded its range within the MKSR since 1982.

There was little significant seasonal variation in the number of traps that captured Wekiu bugs. Trap captures were always much lower on Pu'u Wekiu relative to Wekiu bug trap captures on Pu'u Hauoki. Seasonal peaks occurred in May and July but were not significant. No Wekiu bugs were seen or captured during the January trapping. Lycosid spider activity did not vary significantly with season.

Several "Type 2" (Scoria slopes) and "Type 5" (Talus deposits) areas were located in the buffer zone of the MKSR, including potentially suitable Type 2 habitat as low as the lower boundary of the MKSR, at about 11,800 feet. We recommend that these areas be further sampled to determine the lower limits of the Wekiu bugs. Several prospective sampling sites within the "buffer zone" were determined in consultation with the IfA.

Only six Wekiu bugs were seen during the survey of the buffer zone areas. All were in "Type 2" habitat. There was convincing evidence that Wekiu bugs are more likely to occur in the summit area than in the sampled buffer areas. The odds of finding a Wekiu bug in a summit area pitfall trap was estimated to be 4 times greater than finding a Wekiu bug in a buffer area pitfall trap. The lycosid wolf spider was widespread but not abundant. A few were seen or trapped in every area sampled. There was no evidence that lycosid spiders are more likely to occur in the summit area than in the sampled buffer areas.

Within the summit area, the average capture rate of Wekiu bugs in disturbed areas was 0.27 bugs per 3 day sampling period. The average capture rate of Wekiu bugs in undisturbed areas was 0.11 bugs per 3 day sampling period. There was strong evidence that the Wekiu bug capture rate in disturbed areas was greater than the capture rate in undisturbed areas. The odds of finding a Wekiu bug disturbed habitat was estimated to be 2.7 times greater than finding a Wekiu bug in an undisturbed habitat. However, the foraging area of the Wekiu bug is unknown, and it is possible that the bug survives in less disturbed areas and forages on disturbed substrates.

Species richness in the buffer zone areas was similar to that found in the summit area. A few species were exclusively found in one or the other of the two areas. The species richness of the summit area did not appear to be diminished by the presence of observatory structures. The quantity of aeolian waifs (the lowland arthropods carried up the mountain on wind) was also comparable in both the summit and buffer areas. This wind-borne material provides the major food resource for the resident animals.

Several species never before collected were found within the MKSR. Two small non-native spiders have invaded the MKSR since 1982. One is a sheet web spider from Europe, *Lepthyphantes tenuis*, which may be competing with the native sheet-web spiders. The other, *Meriola arcifera*, is a hunting spider that doesn't build a web but actively hunts on the ground. It may be having a negative effect on the Wekiu bug population.

The changes in the biotic community within the MKSR since the 1982 study indicate that active management of the habitat should be initiated. A comprehensive monitoring program is strongly recommended to track changes over time and to provide the necessary information to develop appropriate management practices to protect the natural systems. The major elements of a monitoring program are described. Other management recommendations include development and implementation of protocols to minimize introduction of non-native species; to minimize disturbance of habitats; to control dust; to collect and contain waste; to restrict access to sensitive areas; to limit skiing and playing in snow; and to expand public outreach and educational programs.

III. INTRODUCTION

After a series of observational reports listing invertebrates collected from the summit areas of the highest volcanoes in Hawai'i (Guppy 1897, Bryan 1916, Bryan 1923, 1926, Swezey and Williams 1932, Wentworth et al. 1935, Beardsley 1966, Gagné 1971), the existence of a resident community of native Hawaiian arthropods living near the Summit of Mauna Kea on the Island of Hawai'i was identified in 1980 (Howarth and Montgomery 1980). The resident species seemed to be able to cope with the stressful environments above 4,000 m (ca. 13,000 ft.). One long-legged, black, nearly wingless true bug, of the genus *Nysius* received substantial interest and was given the common name "Wekiu bug", *wekiu* being Hawaiian for summit or highest (Mull and Mull 1980). The Wekiu bug was one of several species new to science that were collected from the Mauna Kea summit area.

The discovery of this high-elevation, resident arthropod community generated considerable interest among biologists because of the scientific value of comparative studies in ecology, ethology, physiology, and morphology between high elevation aeolian organisms and their lowland relatives (Mull and Mull 1980, Papp 1981, Anonymous 1981, Gagné and Howarth 1982, Howarth and Stone 1982, Edwards 1987, Dumand and Montgomery 1991). Additionally, the discovery raised concerns about the impact of telescope construction in the summit area within the Mauna Kea Science Reserve (MKSR) to this newly described native ecosystem (Mull 1980).

In 1982 the Institute for Astronomy (IfA) funded a team of scientists to conduct an assessment of the arthropod fauna and aeolian ecosystems near the summit of Mauna Kea (Howarth and Stone 1982). The scientific team collected a large number of arthropod species. At least eleven of these species were native to Hawai'i and do not occur outside of the Hawaiian island chain. Enough information was gathered about two endemic species, the Wekiu bug and a lycosid spider (Lycosa sp.), to draw distribution maps. A large number of species captured were considered transient, aeolian waifs, blown upslope by the daily mountain winds. These latter species were thought to be a food source for the resident species.

Since the 1982 study, several biologists have collected arthropods from the summit of Mauna Kea. However, no organized, systematic sampling has occurred, and little information was available about the distribution of the species that were thought to be restricted to the summit area. Concurrent with its mission of astronomical exploration and research, the IfA recognizes a responsibility for the protection of native flora and fauna and the maintenance of native biological integrity within the MKSR. The IfA has initiated a program to gather the information necessary for effective and efficient management of the MKSR, and thereby help fulfill management goals by supplying the scientific justification for natural resource management activity.

In order to determine the current status of resident arthropod species within the MKSR, the IfA contracted for a new study of the summit area. Six core tasks were included in the 1997 IfA *Request for Proposals (RfP)*. These tasks were as follows:

Task 1. For all areas included in the Bishop Museum study, assess current arthropod capture rates relative to those found in the 1982 study.

Task 2. Within a representative subset of these areas, investigate seasonal fluctuations in Wekiu bug populations and, where feasible, other arthropod populations.

Task 3. Identify areas of promising Wekiu habitat in the "buffer zone" areas (i.e., that part of the MKSR outside those areas identified for possible telescope development in the Complex Development Plan).

Task 4. To the extent feasible, replicate the 1982 Bishop Museum study in a sample of promising Wekiu habitat within the buffer zone areas.

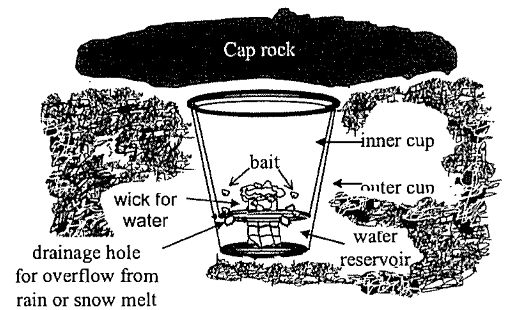
Task 5. Use data from Tasks 1 and 4 to compare arthropod diversity within the 1982 Bishop Museum study area with that in the selected buffer zone areas.

Task 6. Based on Tasks 1 through 5, recommend an arthropod management plan for the telescope development areas.

Field work began in April 1997 with the testing of new trap designs. The 1982 Bishop Museum study employed traps that killed all specimens collected. The best approach to the study of rare and sensitive invertebrate species is nondestructive

sampling. Live capture and release is the best method for measuring Wekiu bug activity rates. This method assures that the research procedures have minimal effect on the rare summit-resident arthropods of the MKSR.

In an effort to reduce the impact of sampling on Wekiu bugs, three different live traps were designed and tested for effectiveness in capturing Wekiu bugs, survival of the trapped Wekiu bugs, and comparability to traps used in the 1982 study. After testing, a modified pitfall trap was selected as the most efficient design comparable to traps used in the 1982 study. Further modifications, including the addition of a water reservoir, were made to the new pitfall trap design to increase Wekiu bug survival. The trap design used is shown in Figure III-1.



Wekiu bug Pit Fall Trap

Figure III-1

After two reconnaissance trips in June and July 1997, a sampling plan was statistically designed to adequately sample all areas of interest, and to allow for valid comparisons to the 1982 study. Sampling began in August 1997, at the summit areas of Pu'u Wekiu and Pu'u Hau'Oki and ended in September 1998, with a final reconnaissance and sampling of buffer areas.

A total of 44 days (179 person days) were spent in the field for sampling and reconnaissance. Several more person days were spent in the laboratory sorting and identifying specimens. Preliminary reports for each task were submitted to the IfA. In March 1999, principal investigators Frank Howarth and Greg Brenner met with Dr. Robert McLaren of the IfA and George Atta of Group 70 to discuss management strategies for the protection of summit-dwelling arthropod species.

This document represents the final report of all activities undertaken in 1997-98 to assess the status of arthropods occurring within the MKSR.

IV. TASK 1. A COMPARISON OF 1982 AND 1997-98 ARTHROPOD CAPTURE RATES

Task 1 of the IfA *Request for Proposals* (*RfP*) asked for a comparison of current arthropod capture rates to those found in the 1982 study. While there is interest in the capture rates for all arthropods within the MKSR, quantitative analysis was limited to the Wekiu bug, *Nysius wekiuicola*, the only arthropod for which enough historic information was available for comparison. Other resident arthropods captured in pitfall traps within the MKSR occurred in small numbers, making inferences about their capture rates impossible.

Questions Of Interest:

1. Is there a difference between 1982 and 1997-98 Wekiu bug capture rates in the areas sampled during the 1982 Bishop Museum arthropod assessment of the MKSR? What is the trend?

2. Is there a difference between 1982 and 1997-98 captures of arthropods other than the Wekiu bug in the areas sampled during the 1982 Bishop Museum arthropod assessment of the MKSR?

Methods:

Field Methodology:

The methods are described in detail in Appendix A: Documentation of Methodology. The traps were set along transects as follows.

Wekiu Crater Transects (Map 1):

1) Summit Ridge: 5 traps placed along the ridge.
2) Inner Crater Talus Slopes: 5 traps placed about 1/3 the distance down the slope longitudinally along the slope.
3) Col: 5 traps placed along the col from the road to the summit ridge.
4) Upper Crater Floor: 5 traps placed across surface of the upper crater floor.

Hau'Oki Crater Transects (Map 2):

1) Crater Floor: 5 traps placed at random across the crater floor.
2) Undisturbed Inner Slope: A vertical transect on undisturbed talus slope with 5 traps.
3) Disturbed Inner Slope: A vertical transect on disturbed talus slope with 5 traps.
4) Outer North Slope: 5 traps placed longitudinally across the outer north slope of Hau'Oki crater.
5) Outer East Slope: 5 traps placed longitudinally across the outer east slope of Hau'Oki crater.

North Plateau Road (Map 3):

1) Talus: 5 traps were placed in zones of gently sloping talus selected at random.
2) Blocky Lava: 5 traps were placed in zones of blocky lava selected at random. Blocky lava was medium- to large-sized (10-40 cm) rocks in a mosaic of volcanic substrates.
3) Periglacial Pavement: 5 traps were placed in zones of periglacial pavement selected at random.
4) Ashy Periglacial Pavement: 5 traps were placed in zones of ashy periglacial pavement selected at random.
5) Caves: Traps were placed in 5 shelter caves selected at random.

The traps on Pu'u Wekiu were set along the same transects used in the 1982 study, and in some cases, set in the same location. All were set in sites comparable to the specific sites used in the 1982 study. Because of the construction of the Keck and Subaru telescopes on Pu'u Hau'Oki, it was not possible to duplicate the 1982 transects exactly. However, transect 3 above ("Hau'Oki Disturbed Inner Slope") was approximately along the same transect into the crater used in the 1982 study. Also, transect 4 ("Hau'Oki Outer North Slope") was in a comparable location and habitat to a few traps set there in 1982. The other transects on Pu'u Hau'Oki were chosen in an attempt to investigate the effects of recent disturbance on arthropod abundance.

Statistical Methodology:

Log-linear Poisson regression was used to model the relationship between the rate of Wekiu bug captures and the year the captures were made. Year, locality, and disturbance were tested for statistical significance as indicator explanatory variables in the regression model. The year indicator variable represented the 1982 and 1997-98 studies; the locality indicator variable represented 7 localities. Localities not sampled during both studies were not included. The disturbance indicator variable represented relatively disturbed and undisturbed localities.

Results:

A full model with all interactions was tested first, and non-significant explanatory variables were eliminated step-wise from the model. The final model was:

$$\mathrm{Log}(\mu) = \beta_0 + \beta_1 \text{ year} + \beta_2 \text{ locality} + \beta_3 \text{ disturbance}$$

Regression Summary:

Coefficients	Value	Std. Error	t value
(Intercept)	3.41	0.044	76.80
year	-6.64	0.38	-17.32
locality1	-0.44	0.076	-5.81
locality2	0.098	0.03	3.19
locality3	-0.82	0.03	-23.86
locality4	-0.21	0.04	-4.99
locality5	0.05	0.01	3.36
locality6	-0.21	0.03	-7.24
locality7	0.29	0.0	38.94
disturbed	1.12	0.45	2.50

Deviance Residuals:

Min	1Q	Median	3Q	Max
-21.20893	-0.8559877	-0.3044401	-0.08634431	32.87128

Null Deviance: 14057.1 on 202 degrees of freedom
Residual Deviance: 3211.176 on 193 degrees of freedom

Over all localities, the average capture rate of Wekiu bugs during the 1982 study was 60 bugs per 3 days of sampling. The average capture rate of Wekiu bugs during the 1997-98 study was 0.16 bugs per 3 days of sampling (Table III-1). There was strong evidence that the Wekiu bug capture rate during the 1982 study was significantly greater than the Wekiu bug capture rate during the 1997-98 study (p-value < 0.0001).

The capture rates for 3 days of sampling in various localities are presented in Table III-1 along with standardized 3 day capture rates of the 1982 study for comparison. While the capture rates were significantly lower for each locality during the 1997-98 study, it is interesting to note the relative ranks of localities for each year. In 1982, the upper crater of Pu'u Wekiu had the greatest Wekiu bug capture rate. This locality fell dramatically to the 6th ranked locality in 1997-98. All other localities held their approximate relative rank.

Locality	1982	1982 rank	1997-98	1997-98 rank
WEKIU UPPER CRATER BOTTOM	644.48	1	0.07	6
WEKIU SUMMIT RIDGE	225.04	2	0.23	2
HAU'OKI INNER TALUS SLOPES	105.61	3	0.36	1
HAU'OKI OUTER S-E SLOPE	92.25	4	0.17	3
BOTTOM OF HAU'OKI CRATER	44.48	5	0.14	4
WEKIU COL TRAIL	35.24	6	0.05	7
HAU'OKI OUTER N SLOPE	10.92	7	0.13	5
WEKIU NORTH RIDGE	6.55	8	0.00	9
NORTH PLATEAU	2.85	9	0.04	8
MEAN 3-DAY CAPTURE RATES	60.09		0.16	

Table III-1. 1982 and 1997-98 3-day capture rates for the Wekiu bug. Table III-1 displays the standardized 3-day capture rate for Wekiu bugs in pitfall traps for the 1982 and 1997-98 studies. The table also contains the rank of the locality for Wekiu bug capture rate for each study.

There was strong evidence that the Wekiu bug capture rate in disturbed areas was greater than the capture rate in undisturbed areas (p-value < 0.0005). For a discussion of this result see Chapter VII. Task 4 (Page 26).

Discussion:

Significantly fewer Wekiu bugs were captured in the 1997-98 pitfall study than during the 1982 study. The cause of the difference could be due to any of several factors. For example, live traps were in place for only three days in 1997-98, compared to death

traps set for more than three weeks in 1982. Because of the shorter period they are in place, live traps are less likely to reflect arthropod response to variations in weather. Additionally, live traps may not have been as attractive as death traps to animals that make their living scavenging on recently dead or dying animals. Although our tests showed that the Wekiu bug could not escape once inside the trap, other trapped arthropods may have escaped from the live traps, thus reducing the total catch. Furthermore, the 1982 study was conducted during a period of exceptional snowfall that may have favored Wekiu bug activity. A change in the Wekiu bug population due to climate, introduced species, or habitat disturbance is difficult to determine without more frequent monitoring.

Several factors can affect pitfall trap capture rates. First, the rim of the trap can create a barrier to foraging insects. To prevent this from happening, pitfall traps were carefully buried so that their rims were flush with or even a little below the surface. In periglacial environments, such as on Mauna Kea, frost can push the trap upwards, or wind, rain, and frost can remove surface material surrounding the trap. These processes can expose the rim and compromise trap effectiveness. A cap rock was used to minimize this problem, and the condition of each trap was noted for additional disturbance information when visited for capture counting and release. No trap during this study experienced significant disturbance.

Second, the size of the trap can affect the capture rate. Size is usually considered to be the average diameter, because it is the trap width that is presented to an approaching insect. Baits may offset the size effect, because the range of attractiveness of the bait is thought to be more important than trap size. In both the 1982 and 1997-98 studies, the traps were baited with shrimp or fish paste.

Third, captured animals can attract or repel additional animals approaching a trap. Thus, the length of time the trap is left in place may affect the capture rate. Leaving traps open for several weeks during the 1982 study allowed for a buildup of dead insects in the traps, which may have been an additional attractant to scavenging Wekiu bugs.

It is important to note that pitfall traps measure activity rates of foraging animals. Although for many insect species the percentage of the population that are foraging may be roughly constant over time, in general the size of animal populations can only be determined from additional studies such as mark-and-recapture experiments.

The 1982 study captured a sufficient number of lycosid spiders to determine spatial distribution information on the summit. Capture rates in the 1997-1998 study were lower, but this seems most likely due to the shorter times that the traps were in place. The behavior of lycosid spiders suggests that a higher percentage of traps would contain spiders the longer the traps were in place. Once trapped, some lycosid spiders may escape the traps if they attached silk drag-lines as they fell into the trap. Observational data collected during the 1997-1998 study suggest that the lycosid spider population is comparable to what it was in 1982.

The endemic moth, *Agrotis* sp. has expanded its range since 1982, perhaps resulting from the different climatic conditions or additional food. The 1982 trap data and direct observations suggested that the moth larvae were most common on blocky lava substrates and that they fed on lichens. In the current study, we captured a few larvae in traps on the summit ridges far from blocky substrate and known lichen growths. On the summit, the larvae were feeding on dead arthropod remains, and in the buffer area, we found them feeding on the skin of a mummified sheep.

V. TASK 2. AN ASSESSMENT OF ARTHROPOD SEASONAL FLUCTUATION

Task 2 required an investigation into the seasonal fluctuations, over one full year, of the population of the Wekiu bug, *Nysius wekiuicola*, in a representative subset of the areas assessed for arthropods in the 1982 Bishop Museum study. The *RfP* also targeted for investigation, where feasible, the seasonal fluctuations of other arthropod populations. The field assessments were to include at a minimum, the late spring, early summer, and one winter/early spring snow melt. Four sampling periods were subsequently identified for assessment of seasonal fluctuations of arthropod activity. These sampling periods were summer melt, fall drought, winter melt, and spring melt.

We hypothesized that the seasonal activity of arthropods resident within the MKSR is influenced by weather factors, such as the amount of snow, moisture, and wind. While is it difficult to assess the direct impact of these factors on arthropod activity, changes that occur seasonally may be correlated with weather factors.

While there is interest in the seasonal activity of all arthropods within the MKSR, the study was limited to the Wekiu bug, *Nysius wekiuicola*, and the resident lycosid spider, *Lycosa* sp. The other resident arthropods captured in pitfall traps within the MKSR occurred in small numbers, making inferences about their activity difficult. Future studies should use sampling methodologies designed specifically for these other species.

Questions Of Interest:

1. Does Wekiu bug activity change seasonally?
2. Does the activity of lycosid spiders change seasonally?
3. Is there a correlation between the amount of snow and/or moisture and arthropod activity within the MKSR?
4. Is activity during the period of Fall drought different than that in other seasons?
5. Can any of the differences found in arthropod activity be attributed to Fall drought conditions?

6. Is there a trend in the population of Wekiu bug or in arthropod activity since the1982 Bishop Museum study?

Methods:

Field Methodology:

The methods are described in detail in Appendix A: Documentation of Methodology. Sampling was restricted to the summit areas, excluding the North Plateau. Transect design was similar to that discussed in Task 1, but repeated over time. Sampling was conducted in May and August of 1997 and January, April, and July of 1998.

Statistical Methodology:

Seasonal fluctuations were investigated using statistical tools developed for binomial (presence/absence) responses (Ramsey and Schafer 1997). The analysis of data composed of binomial responses (proportions) requires statistical tools different from normal distribution tools such as t-tests, analysis of variance, or least-squares regression. We tested differences between seasons of proportions of traps with Wekiu bugs. Statistical analysis of binomial responses leads to conclusions about population proportions and probabilities, which may be stated as inferences about odds ratios, such as the relative odds of a Wekiu bug occurring in a particular habitat.

Results for Task 2 are reported here in a time series graph to better illustrate seasonal variation in Wekiu bug activity. This type of reporting will be useful when comparisons are made to future sampling results.

Results:

The total number of Wekiu bugs captured varied only marginally with season (Figure V-1). The proportion of traps with Wekiu bugs on Pu'u Wekiu during the 1997-98 study was not significantly different across all seasons (p-values > 0.27). On Pu'u Hau'Oki, there was a significant difference in the proportion of traps with Wekiu bugs only between the May, 1997 and August, 1997 seasons (p-value = 0.0025). No other seasonal differences were statistically significant. Trap captures on Pu'u Wekiu was very low compared to Pu'u Hau'Oki, never exceeding more than 3 bugs. On Pu'u Hau'Oki

the number of Wekiu bugs captured was much larger in the May, 1997 and July, 1998 sampling periods than any other period.

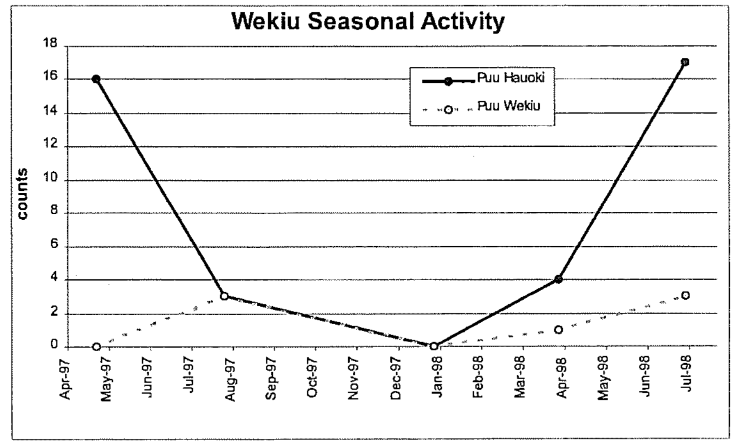


Figure V-1. Wekiu Bug Seasonal Activity. The graph shows the number of Wekiu bugs captured in Pu'u Wekiu and Pu'u Hau'Oki for five sampling periods in 1997 and 1998.

Lycosid spider activity did not vary significantly with season (p-values > 0.13) (Figure V-2). When snow was present, May 1997 and January 1998, lycosids were not active. Peak lycosid activity was not associated with peak Wekiu bug activity. Peak captures of the two species did not occur on the same sampling dates, nor was a significant lag period detected.

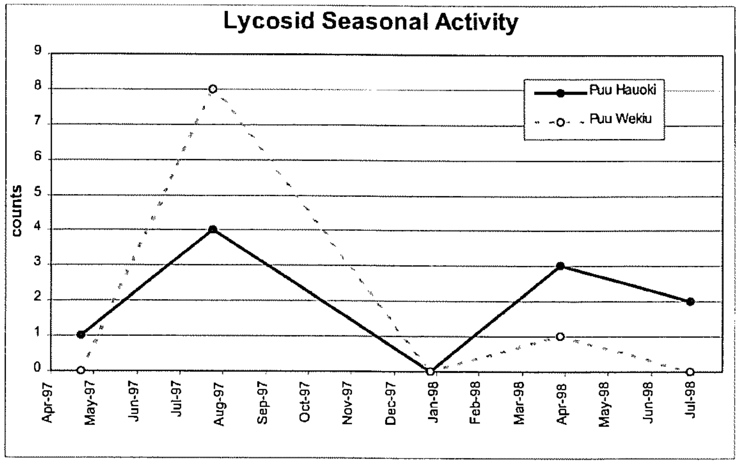


Table V-2. Lycosid Seasonal Activity. The graph shows the number of lycosid captured in Pu'u Wekiu and Pu'u Hau'Oki for five sampling periods in 1997 and 1998.

Discussion:

The capture rate of Wekiu bugs did not vary significantly with season. It is difficult to detect seasonal trends with a limited number of sampling dates and low capture rates. We collected data for only five sampling periods, which was insufficient to detect seasonal or other long-term population changes. Many insect populations exhibit abundance cycles over long periods of time. These long-term cycles can mask seasonal population changes.

The seasonal trends for both the Wekiu bugs and lycosid spiders may be associated with activity of aeolian prey species, or with substrate temperature. The abundance of aeolian prey species was not quantified, and substrate temperature was not measured. During the January sampling period, the water reservoirs in most traps froze, and the number of all arthropods captured was low. Possibly the bait also froze or remained fresh and less attractive to scavenging arthropods. That is, arthropods may

have been present but were not as attracted to the traps as when the temperatures were warmer.

Inactive lycosid spiders were found within their silken nests beneath large rocks frequently during cold periods, and occasionally at other seasons. This may indicate that they avoid harsh climatic conditions by seeking and remaining in sheltered habitats. The contemporaneous presence of different age classes of spiders during most of the sampling periods may indicate that reproduction is not synchronized with the seasons.

A hypothesis generated from 1982 study was that Wekiu bugs are adapted to exploit the margins of melting snow patches, and therefore, their activity and populations should be expected to be strongly correlated with seasonal and climatic events. The current study did not find evidence to support that hypothesis. The peak of Wekiu bug activity occurred in May 1997. At this time melting snowfields were present. Wekiu bug activity also reached a similar peak in July 1998, a time when no snow was present at the summit of Mauna Kea, and reached a low in January 1998, when snow was present. This evidence suggests that some factor other than the presence of snow may be influencing Wekiu bug activity. However, the conflicting results may reflect differences in the magnitude of snowfall during the two studies.

The 1982 study was conducted in the summer months. Snowfall had been heavy, and large patches still occurred on the summit throughout the entire sampling period. Further, 1982 followed several years of greater than average snowfall. Snowfall on Mauna Kea has been relatively light since about 1990, and the 1997-98-winter season was one of the lightest snowfall years in recent memory. Either no snow or only ephemeral patches were present during the 1997-1998 study. In the winter of 1982, most of the known Wekiu bug habitat near the summit was under a meter or more of snow. It is likely that the bugs were inactive when their habitat was snow-covered, but they emerged as the snow retreated and the substrate warmed. Thus in both the 1982 and 1997-1998 studies the bugs were active during the warmer spring and summer months. The current study found only suggestive evidence that they were less active during the both colder winter and drier autumn periods.

The life history of the Wekiu bug is poorly documented. We hypothesize that their development is slow in the cold Mauna Kea climate, and that the animals may be long-lived. All age classes of individuals, as well as mating pairs, were relatively abundant during the 1982 study, which was conducted in the summer months. Only adults, including a few mating pairs, were found during the May 1997 reconnaissance survey. Both nymphs and adults were found in the summer and fall sampling of this study, but the numbers were too low to compare age distributions with those of the earlier study.

The small numbers of Wekiu bugs found during this study did not allow us to make further observations on their activity or biology in the field. In the laboratory, we found that Wekiu bug nymphs would feed on small flies (Mull pers. com.). Wekiu bugs are sucking insects and can feed only upon live or recently deceased prey.

It is important to note that this survey measured arthropod activity, and the results cannot be used as a measure of the population size. It is unfortunate that in this study we failed to find a local population of bugs with the activity we found on both Pu'u Wekiu and Pu'u Hau'Oki in 1982. We had hoped to conduct mark-recapture experiments to determine the proportion of active/inactive bugs, and thereby determine relative population size. In a mark-recapture study, the insects are captured, marked with a nontoxic marker, and released. The proportion of marked to unmarked individuals caught subsequently can be used to determine a number of biological traits, including dispersal ability, longevity, and population size.

A long-term monitoring program would be useful in characterizing Wekiu bug life history. A comprehensive monitoring program, with repeated sampling over many seasons and years, would yield the information necessary to determine seasonal and long-term trends in Wekiu bug activity. Properly designed, a monitoring program would also supply new information about the impact of management, construction, and restoration activities.

VI. TASK 3. IDENTIFICATION OF PROMISING WEKIU "BUFFER ZONE" HABITAT

Task 3 required a reconnaissance of the "buffer zone" areas; that is, the part of the MKSR outside of those areas identified for possible telescope development in the Complex Development Plan. The reconnaissance helped us identify locations of suitable Wekiu bug substrates for detailed sampling. Potential Wekiu bug habitats were visually assessed along preplanned routes throughout the MKSR. The results of the reconnaissance were presented to the IfA, and specific localities were selected for comparisons to the summit area of Mauna Kea, as required in Task 4.

Question of Interest:

1. What is the distribution of promising Wekiu bug habitat in the "buffer zone" areas within the Mauna Kea Science Reserve?

Methods:

Two substrates types were specified in the *RfP* for assessment: "Type 2", (tephra ridges and slopes with scoria or lapilli deposits), and "Type 5", (talus slopes and highly fractured rock outcrops). These two substrate types were hypothesized to be the most suitable Wekiu bug habitats. Factors that might affect the suitability of these substrates for Wekiu bugs were noted. These factors include slope, size of the area, grain size, porosity, moisture content, presence of other arthropods, aeolian food resources, and elevation. In spite of the relatively dry weather, moisture was present at most sites, especially within the sandy ash layers.

Results:

A total of eight cones were surveyed and about 16 kilometers of transects were traversed (Map 4). Several Type 2 and Type 5 habitats were located (Table VI-1), and the larger and more accessible of these areas were selected for Task 4 sampling (Table IV-2). No Wekiu bugs were observed during the Task 3 reconnaissance. Lycosid spiders and noctuid moths were relatively common, as were linyphiid and clubionid spiders.

Table VI-1. Potential Wekiu bug habitats (i.e., Type 1 and Type 2) within the buffer areas of the Mauna Kea Science Reserve.

Talus Habitats:

1. **North Slope:** An accessible area of talus habitat lies near the end of the road along the north base of Pu'u Hau'Oki and Pu'u Kea. This habitat is composed of two areas about 300 meters apart more or less connected by a series of discontinuous islands of talus on blocky lava outcrops. These blocky ridges are narrowly separated by an irregular patchwork of periglacial pavements. The first talus area is on the ridge from Pu'u Kea, and the second area is downslope from the first area and west of Pu'u Mahoe. It was not possible to measure the size of the talus habitat directly, but the two areas probably total about 20 hectares of which about 25% is suitable habitat. The blocky lava flow continues eastward downslope about 2 kilometers, but the outcrops of talus are relatively small and modified by glaciers.

2. **South Slope:** A relatively large area of good talus habitat occurs between the Summit Road and Pu'u Lilinoe. The talus habitat connects with broken lava habitat on the south face of Pu'u Wekiu and continues downslope nearly to the access road to the VLBA facility. The total area of the blocky outcrop is about 29 hectares of which between 40 to 50% appear to be suitable talus habitat. Blocky lava flows and glacial till make up the remaining substrate. The talus habitat also connects with the excellent scoria (cinder) habitat on Pu'u Lilinoe.

3. **West Slope:** The south facing cliff of the northwest lava plateau has many small but good patches of talus along nearly its entire length from Pu'u Poliahu west to near the edge of the Science Reserve. Crevices in the blocky lava increase the connectivity among these patches. About one half of the upper part lies within the Ice Age NAR and outside the study area. The talus near the upper end connects with the scoria habitat on the northwest slope of Pu'u Poliahu. The cliff is 10 to 30 meters high and about 1.5 kilometers long. Most of the habitat is nearly vertical, and it was not possible to measure its area from the aerial photograph or map.

4. **Other Talus Deposits:** Smaller patches of talus habitat occur as islands in the blocky lava flows, especially on the northwest plateau, near the unnamed cone south of the VLBA facility, and on the slopes between the scoria cones. Some of these may be suitable, especially if interconnected by crevices in the broken lava. In many places, glaciers have modified these, and glacial till fills many of the cracks probably making them less suitable for the bug.

Scoria Habitats:

The scoria cones are described geologically (Wolfe and Morris 1996) as follows:

> "Scoria cones of Hawaiite or mugerite (unit 1c) and benmoreilte (unit 1bc) consist mostly of vesicular lapilli with lesser amounts of ash and bombs; agglutinated spatter occurs locally. Cones are generally dark gray to red where freshly exposed and yellowish brown where weathered; however, interiors that have been hydrothermally altered are grayish orange to yellowish and weakly cemented. Cones are locally mantled by unmapped fine-grained deposits of acolian or tephra-fall origin."

1. **Pu'u Lilinoe:** The scoria habitat on Pu'u Lilinoe covers about 40 hectares. Greater than 50% of the surface is composed of fist-sized vesicular scoria and appears to represent good to excellent habitat for the Wekiu bug. The scoria on the northern and western outer slopes is larger and is probably better habitat than the eastern and southern outer slopes.

2. **Pu'u Mahoe:** The outer slopes of the more accessible southern portion of this cone have deep deposits of fist-sized scoria and appear excellent for Wekiu bug habitat. The southern-most crater also contains excellent habitat. Approximately 50% of the remaining surface of Pu'u Mahoe also appears to be good to excellent bug habitat, but the more northern portion is too remote for efficient sampling. The total area of the cone is about 62 hectares.

3. **"VLBA Cone":** The unnamed cone south of the VLBA facility is composed of finer material with a shallow surface layer of larger scoria. The total area of scoria covers about 32.5 hectares. The cone itself is relatively small and steep, but a large area of scoria continues downslope between deposits of glacial moraines. There is a breached crater and many blocky lava outcrops at the summit. About 40% of the steeper main cone is promising bug habitat, especially the lower portion of the east slope and portions of the summit ridge.

4. **"Southeast Boundary Cone**:" The unnamed cone along the southeast boundary of the reserve is composed of a very loose deposit of fist-size scoria with scattered blocks deposited by the glacier. The floor of the summit crater is an undisturbed periglacial pavement of scoria and glacial blocks on moist sandy ash. Most of the cone appears to be excellent Wekiu bug habitat, and the site would be a good location to test the lower limit of bug distribution within the Science Reserve. The total area is 18 hectares of which about half are within the Science Reserve.

5. **Pu'u Poliahu:** Most of Pu'u Pollahu cinder cone is composed of weathered yellowish sandy ash with rocky outcrops and a thin surface layer of scoria. These ashy deposits are generally poor Wekiu bug habitat. The total area is about 112 hectares. On the lower northwest outer slopes is a deep deposit of fist-size scoria which appears to be excellent habitat, but it is a small area, about 4 hectares in extent. The scoria connects with the valley bottom of periglacial pavement made up of fallen scoria and weathered tephra. The pavement habitat is fair and covers about 3.4 hectares.

6. **"Lilinoe Iki":** This small (about 15 hectares) unnamed cone between Pu'u Lilinoe and the VLBA facility has more compact scoria than on Pu'u Lilinoe, but deep deposits of loose scoria occur in patches as solifluction lobes. About 50% of the cone is promising Wekiu bug habitat. The summit has no crater and the subsurface sandy ash layer on the narrow summit ridge is dry. However, lycosid and linyphiid spiders were seen on the slopes and summit area.

7. **"West Boundary Cone":** The large cinder cone downstope and west of Pu'u Pohaku is unnamed. Most of the slopes are too remote and steep to safely survey, but large areas appear to be promising Wekiu bug habitat. There are accessible promising areas on the upper slope, but they are still remote by foot. The total area is estimated to be about 150 hectares, of which more one half (the lower slopes) has an unknown composition. Up to 50 hectares may be suitable Wekiu bug habitat. Approximately 25 hectares of the eastern slopes between the blocky lava flows below Pu'u Pohaku and the rim of the crater is covered with a loose fine tephra deposit that is probably not suitable for Wekiu bugs. However, it may harbor other species, as it is one of the largest areas of this habitat type on the mountain.

8. **Pu'u Makanaka:** Pu'u Makanaka is one of the largest cinder cones on the mountain covering about 83 hectares. The west and southwest facing portions of the cone are composed largely of loose scoria, which is probably suitable bug habitat. The north facing slope appears to be covered with finer material and less suitable. The distinct crater covers just over 12 hectares. The summit rim and western half of the crater slope are covered mostly with ash, although numerous lava bombs and spatter deposits may provide refuge habitat. Most of the eastern half of the slope into the crater is composed of a loose deposit of large scoria blocks. This is a unique habitat type within the MKSR.

9. **Pu'u Poepoe:** A brief reconnaissance was made of this small cone, which covers about 24 hectares. The outer slopes are covered with sandy ash with scattered scoria channels. The small summit area and crater are covered with deposits of loose scoria, some of which appear to offer good bug habitat.

Because of their remoteness, the following cinder cones were not visited during this survey. From the aerial photographs, geologic maps (Wolfe et al. 1997), and inspection from a distance, they probably have significant scoria deposits and promising Wekiu bug habitat. However, they are at lower altitudes.

1. **Pu'u Hoaka:** Pu'u Hoaka is on the northeast boundary of the Science Reserve and north west of Pu'u Makanaka. The area could not be determined accurately from the aerial photographs, but it is approximately 30 hectares. The substrate type is unknown, but it is indicated to be a scoria cone on the geologic map, and its appearance from a distance suggests that it contains some good Wekiu habitat.

2. **Pu'u Ala:** Pu'u Ala is between Pu'u Makanaka and Pu'u Mahoe and covers about 68 hectares. We had good views of the western outer slopes during our transect across Pu'u Mahoe and believe the cone contains promising bug habitat. Also, according to the geologic map (Wolfe and Morris 1996), the north slope of Pu'u Ala consists of blocky lava.

3. **"Unnamed North Boundary Cone":** This is a small scoria cone downslope (north) of Pu'u Mahoe. It is remote, and its habitat characteristics are unknown, although like its neighbors, it possibly has suitable Wekiu bug habitat.

Other Habitats:

Other habitats seen in the buffer areas during the survey include blocky lava flows, aeolian deposits, glacial till, and moraines (Wolfe and Morris 1996). These often occur together in a mosaic or patchwork of ridges of lava flows interspersed with wind, water, or ice deposited material. The base substrate is usually blocky lava flows which occur as solid ridges of more massive flows of Hawaiite or the surface is more irregular and more 'a'a like. These flows nearly circle the summit cones being obscured by glacial till on the east. On the north slope they extend down to about 12,900 feet; on the west to 12,800 feet and the south to nearly 12,000 feet in places. The largest recognizable single flow is the northwest plateau, which covers about 270 hectares in area.

The lower slopes have been modified by the glacier, with the surface rocks either swept away or deposited in a jumble. Areas with glacially deposited material usually have the crevices filled with a fine-grained material. From our survey and confirmed by the maps (Wolfe and Morris 1996) and photographs, most of the east and north slopes between the scoria cones is covered with glacial till with large to small irregular boulders loosely held in a mixture of finer grained material. Because the pore spaces are mostly filled, the habitat appears poorly suited for the Wekiu bug, but there may be patches of suitable habitat there, or there may be important refuges. Some plants were widely scattered growing in crevices. During our reconnaissance, we saw several lycosid spiders, and they appeared to be locally common on this habitat.

Patches of smaller material usually are sorted by frost into layered size classes, and depending on degree of slope, these patches can creep downslope as solifluction lobes. These pavements of sorted material and lobes are characteristic of periglacial environments. Several small irregular gray colored areas are conspicuous on the aerial photographs of the northwest plateau. We planned our traverse to the west slope to inspect these as they possibly represented an unrecognized habitat type. However, they appear to be weathered fine-grained deposits similar in composition to sandy ash deposits elsewhere on the mountain. The largest gray area is about 1.2 hectares in size, and the total area covered is between three to four hectares.

Table VI-2. Wekiu bug habitats selected for intensive survey.

Talus Habitats:

1. North Slope near Pu'u Mahoe
2. South Slope near Pu'u Lilinoe
3. West Slope Near Pu'u Poliahu

Scoria Habitats:

1. Pu'u Lilinoe
2. Pu'u Mahoe
3. Northwest slope of Pu'u Poliahu

Discussion:

The type of substrate may dictate the presence of other parameters important for the bug. Hypothetically, slope provides arthropods the opportunity to move vertically within the substrate to find optimal microclimatic conditions. Larger pore spaces may allow greater range of movement and more hiding or resting spaces. Abundant, interconnected, interstitial spaces may allow the arthropods to migrate and exploit resources without being exposed to surface weather conditions and surface predators.

The presence of organic aeolian debris and moisture are necessary to support life in this stone desert. Generally, in spite of the dry weather, we found moist substrates at most sites, especially within the sandy ash layer below the surface scoria.

Except for one collection at 12,075 feet in Pu'u Makanaka Crater, the Wekiu bug has been found only at summit areas above about 12,800 feet. Potentially suitable habitat was noted at the lower boundary of the MKSR, at about 11,800 feet. We recommended that these areas be sampled to determine the lower limits of the Wekiu bugs. The lycosid spider, noctuid moth, some species of linyphiid spiders, and the recently invading clubionid spider were found at many sites down to the reserve boundary. We did not observe any Wekiu bugs during this reconnaissance, but found one Wekiu bug in Pu'u Makanaka Crater in September 1998.

We recommended a range of sites within the buffer zone where Type 2 and Type 5 habitat were found, that could be used for summit area and buffer zone Wekiu bug capture rate comparisons. We consulted with the IfA to determine which of the sites would be sampled. Sites chosen for detailed sampling appear in Table VI-2.

VII. TASK 4. A COMPARISON OF WEKIU BUG OCCURRENCE BETWEEN SUMMIT AND BUFFER HABITATS

Task 4 called for an assessment of Wekiu bug habitats and arthropod populations in selected areas of the "buffer zone" areas within the MSKR, along with a comparison of the status of arthropod populations between the summit areas and buffer zone areas.

Questions of Interest:

1. Is there a difference between Wekiu bug activity and abundance in the summit area and surrounding selected "buffer areas" within the MKSR? How abundant are Wekiu bugs in selected "buffer areas"?

2. Is there a difference between lycosid spider activity and abundance in the summit area and surrounding selected "buffer areas" within the MKSR? How abundant are lycosid spiders in selected "buffer areas"?

3. Is there suitable habitat for native arthropods beyond the summit area in the MKSR?

An additional question of interest was added during the planning phase of the study.

4. Is there a difference between disturbed and undisturbed sites within the summit areas?

Methods:

Field Methods:

Promising Wekiu bug habitats were identified in Task 3, and prospective sampling sites within the buffer zone were determined in consultation with the IfA. The sites were sampled for arthropod presence and diversity in July and September, 1998. Two Type 2 habitats, (Pu'u Mahoe and Pu'u Lilinoe), and two Type 5 habitats, (talus deposits near the bases of these two cinder cones), were sampled using the same live pitfall trapping method used in the summit area. In addition, a visual reconnaissance was conducted in Type 2 and Type 5 habitats at the northwest base of Pu'u Poliahu, the western slopes and summits of Pu'u Poepoe, and Pu'u Makanaka.

To improve the comparisons, trapping was conducted contemporaneously during the summer sampling period, 15-25 July, 1998, in the summit areas of Pu'u Hau'Oki

(Map 2), Wekiu Crater (Map 1), and North Plateau Road (Map 3) and buffer areas of Pu'u Mahoe transects (Map 5) and Northwest Pu`u Kea Talus Ridge (Map 6). Inclement weather made some trap collecting impossible, and traps set along Pu`u Wekiu col and summit ridge were retrieved after winds and fog subsided. These traps were open for 9 days, and trap catches were standardized accordingly. A visual survey of the talus and cinder areas on and near Pu'u Lilinoe was conducted in July 1998. Trapping in the buffer areas of Pu'u Lilinoe (Map 7) and visual surveys of the base of Pu'u Poliahu, the west slope, and Pu'u Makanaka occurred during the fall sampling period, 24-27 September 1998.

We planned to conduct the Wekiu bug assessment of the selected buffer zone and summit habitats during periods of snowmelt when we hypothesized the bugs to be active. However, the low snowfall of the 1997-98 season made that objective impossible to attain.

Statistical Analysis Methodology:

The data collected in Task 4 were binary (presence/absence) and required statistical procedures similar to those used in Task 2. Only the July 1998 trapping data were used in the statistical analysis. This is because both summit and buffer areas were sampled contemporaneously, allowing direct comparisons to be made.

Because habitat types (i.e. summit and buffer) were not assigned at random, the study design for Wekiu bugs and other arthropods in their habitats is called retrospective sampling of observational data. Calculation and reporting of odds is an appropriate analytical tool for this type of data. Fisher's Exact Test is a randomization test that computes the probability values for every permutation of the responses and gives the exact probability of the observed case to occur. This test provides inference about population parameters with random samples from binary observational sampling (Ramsey and Schafer 1997).

Statistical analysis of binary responses leads to conclusions about population proportions and probabilities, which may be stated as inferences about odds, such as the odds of a Wekiu bug occurring in a pitfall trap in a particular habitat. When the question becomes one of interpreting the difference between two habitats, the inference is properly reported as an odds ratio; for example, reporting the odds of finding a Wekiu bug in the summit area as some multiple of the odds of finding a Wekiu bug in the buffer areas. The odds ratio is the only statistic appropriate for comparing two groups of binary responses from observational studies.

Results:

Wekiu bug:

Only six Wekiu bugs were seen during the survey of the buffer zone areas; five were captured in 15 pitfall traps on Pu'u Mahoe, and one was observed in Pu'u Makanaka Crater. All were in Type 2 habitat. The lycosid spider was widespread but not abundant. A few were seen but rarely trapped in every area sampled. The endemic moth, *Agrotis* sp., was also widespread in the buffer zone, but was not as common as the lycosid spider. Other resident native arthropod species were only rarely observed.

The number of traps in which a Wekiu bug occurred are tabulated for summit and buffer areas (Table VII-1).

Location	present	absent
Summit Area	14	26
Buffer Area	3	22

Table VII-1. Wekiu bug occurrence in pitfall traps during the 15-25 July 1998 sampling period.

There was convincing evidence that Wekiu bugs are more likely to occur in the summit area than in the sampled buffer areas (p-value = 0.001). The odds of finding a Wekiu bug in a summit area pitfall trap was estimated to be 4.0 times greater than finding a Wekiu bug in a buffer area pitfall trap (95% C.I. 1.3 to 15.5).

Lycosid wolf spider:

The number of traps in which lycosid spiders occurred are tabulated for summit and buffer areas (Table VII-2).

Location	present	absent
Summit Area	2	38
Buffer Area	2	23

Table VII-2. Lycosid spider occurrence in pitfall traps during the 15-25 July 1998 sampling period.

There was no evidence that lycosid spiders are more likely to occur in the summit area than in the sampled buffer areas (p-value = 0.69).

Disturbed vs Undisturbed:

The average capture rate of Wekiu bugs in disturbed areas was 0.27 bugs per 3 day sampling period. The average capture rate of Wekiu bugs in apparently undisturbed areas was 0.11 bugs per 3 day sampling period. There was strong evidence that the Wekiu bug capture rate in disturbed areas was greater than the capture rate in undisturbed areas (p-value < 0.0005).

Location	present	absent
Disturbed	18	52
Undisturbed	9	71

Table VII-3. Wekiu bug occurrence in disturbed and undisturbed Pu'u Hau'Oki habitats during the 1997-98 study.

The odds of finding a Wekiu bug disturbed habitat was estimated to be 2.7 times greater than finding a Wekiu bug in an undisturbed habitat (95% C.I.: 1.1 to 6.6).

Discussion:

Wekiu bugs appear to be rare in the buffer zone surrounding the summit area. Only six Wekiu bugs were collected throughout all of the sampling periods from buffer areas, five from Pu'u Mahoe and one from Pu'u Makanaka. No other collectors have found Wekiu bugs below the immediate vicinity of the summit area (Ashlock and Gagné 1983). During the 1982 Bishop Museum study, the mean adult/trap/day capture rate ranged from 0.01 to 1.10 below 4,100 m (13,450 ft) but averaged 16.2 adults/trap/day above 4,100 m. In 1982, Wekiu bugs occurred in highest abundance above 4,100 m on Pu'u Wekiu and Pu'u Hau'Oki, with capture rates as high as 95.22 adult bugs per 3 days of trapping in some localities.

The evidence does not support the hypothesis that substrate factors are more important to Wekiu bug distribution than elevation. Significantly fewer Wekiu bugs were collected in Type 2 and Type 5 habitats in the buffer areas than were collected in the same habitat types in the summit area.

It has been hypothesized that Wekiu bugs have some obligatory association with snow and/or permafrost (Ashlock and Gagné 1983). Retreating snow fields were thought to be a source of food for Wekiu bugs, which have been observed feeding on frozen insects that melt out of the margins of snow fields (Howarth and Montgomery 1980). Snow patches remaining after long snowy periods contain abundant trapped food, and these remnant patches survive in nearly identical areas each year. This makes the resource predictable for scavenging arthropods (Ashlock and Gagné 1983). Limited seasonal data collected during this study did not support this hypothesis, but snowfall during the current study was exceptionally low compared to 1982. Permafrost was believed be a source of moisture critical to the easily dehydrated Wekiu bug. Ashlock and Gagné (1983) pointed out that the abdomens of Wekiu bugs are physogastric (swollen) after feeding, and collapse on almost all dry-mounted museum specimens. An adequate supply of moisture may be necessary for Wekiu bug survival; however, no literature is available that suggested permafrost is restricted to summit areas.

Food resources probably do not account for the differences in Wekiu bug occurrences between summit and buffer areas. Arthropod species richness was approximately the same in summit areas and buffer areas, (see Task 5). In captivity, Wekiu bugs survive nicely when fed small flies (W.P. Mull pers. com.). Small flies (Phoridae, Muscidae, Sciaridae, Sepsidae, and Sphaeroceridae) were abundant in both areas. Further study is needed to determine the factors that limit Wekiu bugs to the

summit area. Generally, these flies and other weak flying aeolian waifs, which are carried wind currents, may be more common near ridge crests and other areas where wind eddies tend to drop their particulate load. Snowfields chill and trap alighting insects and preserve these for foraging resident scavengers. In the absence of snow, wind-deposited insects can remain active on warm days and possibly avoid scavenging species such as the Wekiu bug.

Lycosid spiders appear to inhabit both summit and buffer areas. There was no statistically significant difference in lycosid occurrence between the areas, (Table VII-2). The capture rates were so low in both areas that statistical comparisons may not reveal true differences. Since lycosids generally feed on active prey, hypothetically they are not as tied to snow fields as the Wekiu bug is thought to be.

The current level of overall arthropod activity is significantly less than that measured in the 1982 Bishop Museum study. The cause of this decline in activity remains unknown. In 1982, and during brief visits in the few years following, Wekiu bugs could be easily observed on Pu'u Wekiu. More recent observations found Wekiu bug activity in decline. Possible causes for the decline include changing weather patterns, habitat disturbances, presence of harmful alien species, and long-term population cycles.

In all but one case, arthropod activity on Pu'u Hau'Oki was greater than or equal to that found on Pu'u Wekiu. Pu'u Wekiu is supposedly less disturbed, although substrate disturbance was evident, apparently caused by the greatly increased foot traffic along the ridge and within the crater since the 1982 study. Trap capture rates for Wekiu bugs were significantly higher in disturbed areas than in undisturbed areas. The highest trap capture rates occurred in Pu'u Hau'Oki, where inner crater walls and the crater bottom have been modified by observatory construction activity. These results raise the possibility that observatory construction and other human activities have not impacted Wekiu bug or lycosid spider distributions at the summit, outside of the immediate vicinity of the paved and covered areas. It has been hypothesized that Wekiu bugs prefer habitat with loose tephra over ashy substrate (Howarth and Stone 1982). Earth-moving activity may create these conditions in some cases. It should be, understood however, that cause-and-effect inferences cannot be reached in this case because the data are observational. Valid cause-and-effect inferences can only be made with properly designed experiments, in which disturbance levels are assigned at random to experimental units.

The preference of the Wekiu bug for the summit area has important implications for MKSR management. A statistically sound monitoring plan should be designed and implemented. Monitoring, including designed experiments, is required to determine factors influencing Wekiu bug distributions and population changes, and the effectiveness of protection efforts.

VIII. TASK 5. A COMPARISON OF ARTHROPOD DIVERSITY BETWEEN SUMMIT AND BUFFER ZONE HABITATS

Task 5 called for a comparison of arthropod diversity between the summit area and selected sites in the surrounding buffer area within the MKSR. The effort was important, not only to determine where Wekiu bugs and lycosid spiders occurred outside the immediate summit area, but also to ascertain the general distribution of other arthropods in the summit and buffer areas. These other arthropods may be important predators or prey of the Wekiu bug and the lycosid spider.

Questions of Interest:

1. Is there a difference between arthropod diversity in the summit area and surrounding selected "buffer areas" within the MKSR?

2. Is there a sufficient food base for Wekiu bugs and other endemic summit-dwelling arthropods in the buffer zones below the summit area?

Methods:

The arthropods were collected in the same traps used to assess Wekiu bug and lycosid spider activity in Tasks 1, 2, and 4. We identified all specimens to the lowest taxon possible, and compared the species richness in each area. Details of the analysis can be found in the Appendix A. Documentation of Methodology Final Report.

Results:

The results are presented in Table VIII-1. The table is arranged taxonomically by Class, Order, Family, Genus and Species. Information is given about the regional status. Endemic species live only in Hawai'i. Arthropods that were released purposefully for biological control are designated purposeful. Arthropods that arrived in Hawai'i by other means are designated adventive. The residence status is also provided. Arthropods that

Table VIII-1. Checklist of Arthropods Species Collected Within The MKSR During 1997-98. Summit Type 2 habitats (scoria habitats) include Pu'u Wekiu and Pu'u Hau'Oki; Summit Type 5 habitats (talus habitats) include the Northslope Plateau. Buffer zone Type 2 habitats include Pu'u Mahoe and Pu'u Lilinoe; Buffer zone Type 5 habitats include North Pu'u Kea Ridge to Pu'u Mahoe and the base of Pu'u Lilinoe.

TAXON	**REGIONAL**	**RESIDENCE**	**HABITAT OCCURRENCE**			
FAMILY	**STATUS**	**STATUS**	**TYPE 2**		**TYPE 5**	
SPECIES			**SUMMIT**	**BUFFER**	**SUMMIT**	**BUFFER**
Acari						
Bdellidae						
Undetermined species	unknown	resident	X			
Acaranae						
Clubionidae						
Meriola arcifera	adventive	resident	X	X	?	?
Linyphiidae						
Lepthyphantes tenuis (Blackwall)	adventive	resident	X		X	
More than one undetermined species	unknown	resdent	X	X	?	?
Lycosidae						
Lycosa sp.	endemic	resident	X	X	X	X
Salticidae						
One undetermined species	adventive	unknown	X			
Collembola						
Entomobryidae						
More than one undetermined species	endemic?	resident?	X	X	X	X

live and reproduce in the MKSR are designated resident. Species transported to the MKSR by winds are designated aeolian. An "X" was placed in the Habitat Occurrence column if that species was collected or observed in that habitat.

TAXON FAMILY SPECIES	REGIONAL STATUS	RESIDENCE STATUS	HABITAT OCCURRENCE TYPE 2 SUMMIT	TYPE 2 BUFFER	TYPE 5 SUMMIT	TYPE 5 BUFFER
Chironomidae						
One undetermined species	unknown	aeolian			X	
Drosophilidae						
Drosophila suzukii complex	adventive	aeolian	X	X	X	X
Drosophila sp.	adventive	aeolian	X		X	
Ephydridae						
Hydrellia tritici Coquillett	adventive	aeolian	X	X	X	X
Hydrelia sp.	endemic	unknown		X	X	
Lonchopteridae						
Lonchoptera furcata (Fallen)	adventive	aeolian	X	X	X	X
Muscidae						
Atherogona orientalis Schiner	adventive	aeolian	X	X	X	X
Haematobia irritans (L.)	adventive	aeolian	X	X	X	
Stomoxys calcitrans L.	adventive	aeolian		X		
Muscoidea						
One undetermined species	unknown	aeolian		X	X	
Mycetophilidae						
Leia sp.	adventive	aeolian			X	
Phoridae						
More than one undetermined species	unknown	unknown	X	X	X	X
Psychodidae						
Psychoda sp.	unknown	unknown	X	X	X	
Sarcophagidae						
More than one undetermined species	adventive	aeolian	X	X	X	

TAXON FAMILY SPECIES	REGIONAL STATUS	RESIDENCE STATUS	HABITAT OCCURRENCE TYPE 2 SUMMIT	TYPE 2 BUFFER	TYPE 5 SUMMIT	TYPE 5 BUFFER
Coleoptera						
Chrysomelidae						
Altica torquata LeConte	adventive	aeolian	X	X	X	
Cleridae						
Necrobia rufipes (DeGeer)	adventive	aeolian	X		X	
Coccinellidae						
Coccinella septempunctata (L.)	purposeful	aeolian	X	X	X	
Iharmonia conformis (Blaisduval)	purposeful	aeolian			X	
Hippodamia convergens Guerin-Meneville	purposeful	aeolian	X	X		X
Curculionidae						
One undetermined species	adventive	aeolian	X			
Hydrophilidae						
One undetermined species	unknown	unknown			X	
Scarabaeidae						
One undetermined species	purposeful	aeolian		X		
Staphylinidae						
More than one undetermined species	unknown	unknown	X	X	X	X
Diptera						
Calliphoridae						
Lucilia cuprina (Wiedermann)	adventive	aeolian	X	X	X	X
Calliphora vomitoria (L.)	adventive	unknown	X	X	X	X
At least 3 undetermined species	unknown	aeolian	X	X	X	X
Ceratopogonidae						
Forcipomyia sp.	endemic	aeolian			X	X

TAXON / FAMILY / SPECIES	REGIONAL STATUS	RESIDENCE STATUS	HABITAT OCCURRENCE TYPE 2 SUMMIT	TYPE 2 BUFFER	TYPE 5 SUMMIT	TYPE 5 BUFFER
Nabidae						
Nabis capsiformis Gemar	adventive	aeolian	X			
Homoptera						
Aphidae						
Aphis sp.	adventive	aeolian	X			
Delphacidae						
One undetermined species	adventive	aeolian	X			
Psyllidae						
One undetermined species	unknown	aeolian	X	X	X	X
Hymenoptera						
Braconidae						
Apanteles sp	purposeful	aeolian?	X	X	X	X
Chalcidoidea						
One undetermined species	purposeful	aeolian	X			
Ichneumonidae						
Diadegma blackburni (Cresson)	adventive	aeolian	X			
Ichneumon cupitus Cresson	adventive	aeolian	X	X	X	
Trathala flavoorbitalis (Cameron)	adventive	aeolian	X			
More than one undetermined species	unknown	aeolian	X			
Undetermined micro-Hymenoptera	unknown	unknown	X	X	X	
Vespidae						
Vespula pensylvanica Saissure	adventive	aeolian	X			

TAXON / FAMILY / SPECIES	REGIONAL STATUS	RESIDENCE STATUS	HABITAT OCCURRENCE TYPE 2 SUMMIT	TYPE 2 BUFFER	TYPE 5 SUMMIT	TYPE 5 BUFFER
Sciaridae						
Bradysia (?) species 1	unknown	aeolian	X	X	X	
Bradysia (?) species 2	unknown	aeolian	X	X		
Sciara sp.	unknown	unknown		X	X	
Sepsidae						
Sepsis thoracica (Robineau-Devoidy)	adventive	aeolian	X	X	X	X
Sepsis species 1	adventive	aeolian	X	X	X	X
Sepsis species 2	adventive	aeolian	X	X	X	X
Sphaeroceridae						
Copromyza equina	adventive	aeolian	X	X	X	X
Leptocera spp.	unknown	aeolian	X	X	X	X
More than one undetermined species			X	X	X	X
Syrphidae						
Allograpta species	purposeful	aeolian	X	X	X	
Tachinidae						
Gonia pallens Stal	adventive	aeolian	X	X	X	X
Phasiormia pallida Townsend	adventive	aeolian			X	
Heteroptera						
Anthocoridae						
Lasiochilus sp.	purposeful	aeolian	X			
Lygaeidae						
Geocoris pallens Stal	adventive	resident	X	X		X
Neacoryphus bicrucis Say	adventive	aeolian	X			
Nysius wekiucola Ashlock & Gagné	endemic	resident	X	X	X	
Nysius (more than one undetermined species)	endemic ?	aeolian	X		X	

TAXON / FAMILY / SPECIES	REGIONAL STATUS	RESIDENCE STATUS	HABITAT OCCURRENCE TYPE 2		TYPE 5	
			SUMMIT	BUFFER	SUMMIT	BUFFER
Lepidoptera						
Noctuidae						
Agrotis undescribed species	endemic	resident	X	X		X
Oechophoridae						
Agonopterix ulicetella	purposeful	aeolian	X			
Psocoptera						
Ectopsocidae						
Ectopsocus sp.	endemic	aeolian			X	
Elipsocidae						
Palistreptus inconstans (Perkins)	endemic	unknown		X		
Lisposcelidae						
Liposcelis divinatorius (Mulleer)	adventive	unknown			X	
Thysanoptera						
Thripidae						
Thrips sp.	endemic	aeolian			X	

Discussion:

We found the species richness in the buffer zone areas to be similar to that found in the summit area. A few species were exclusively found in one or the other of the two areas; however, these species were not abundant. The uneven pattern of their distribution may be an artifact of the sampling methodology, or, because these species are aeolian waifs, their uneven distribution within the MKSR may have been influenced by prevailing winds and wind patterns caused by observatory structures, cinder cones, lava ridges, and the general geomorphology of the physical environment. The species richness of the summit area did not appear to be diminished by the presence of observatory structures. Hau'Oki Crater, surrounded by large observatories, contained most of the species collected in Wekiu Crater, which appears to be less influenced by neighboring observatories, and potential prey species for both the Wekiu bug and lycosid spiders were abundant in both craters.

We observed that wind-dispersed arthropods were more abundant at the top of Pu'u Lilinoe than at its base. Wind swirling around the summit of this cone could be expected to drop passively carried arthropods near the summit. There are three physical reasons to support this conjecture: (1) winds from different directions converge at summits, and most fallout occurs at convergence zones; (2) removed from their energy source, upwardly moving currents caused by the warming ground surface are slowed above summits; and (3) surface irregularities such as ridges and summits cause eddy currents that may increase localized fallout.

Two new, presumably resident spider species were collected in the current study, and hoth appear to be recently introduced alien species. The first, and most common, is an alien linyphiid sheet-web spider, *Lepthyphantes tenuis* (Blackwall), native to Europe. Three presumahly native linyphiid spiders, *Erigone* spp., were collected in 1982, but were not found in 1997-98 study. Not all the recently collected arthropods have as yet been identified to species, so some native linyphiid spiders may have been found in the current study. For reasons noted in earlier chapters, not finding native sheet-web spiders in 1997-1998 may be related to the limitations of pitfall trapping, rather than absence from the MKSR.

The other alien spider species found may have more impact on Wekiu bugs. It is *Meriola arcifera* (Simon), a ground hunting spider (family Clubionidae), native to Chile, Bolivia, and Argentina. Like the lycosid spiders, it does not build a web, but actively hunts on the ground surface. *Meriola arcifera* was first collected in Hawai'i in 1995. It has been found only from upper elevations on the Saddle Road to the summit of Mauna Kea. Within the MKSR, it may be common enough to be preying upon and reducing populations of the smaller native arthropod species, including the Wekiu bug.

IX. NEW QUESTIONS OF INTEREST

New questions of interest have been developed during the course of this study. As data were analyzed, and old hypotheses tested, new hypotheses were generated to explain the distribution and abundance of resident arthropod populations. These new questions of interest may point the way for future work.

We compared the current captured rates of Wekiu bugs to those measured during the 1982 study, and found that Wekiu bug populations have dramatically dropped over the last 17 years. Our study was the first attempt since 1982, to investigate population changes of those arthropods. More frequent and sustained monitoring is necessary to fully document the long-term population fluctuations. Long-term monitoring may also reveal weather, habitat, and ecological changes associated with Wekiu bug population decline and/or increase.

In this study, we tested the hypothesis that Wekiu bug activity has seasonal fluctuations. Although we found no significant seasonal differences, our sample size was small. Our study covered only one and one-half years. With more information collected through long-term monitoring, we may discover significant seasonal patterns.

We surveyed the buffer zone and found habitats similar to those at the summit where the Wekiu bug occurs. Potential habitats were wide-spread throughout the buffer zone. We compared Wekiu bug activity in the summit area to activity in surrounding buffer areas, and discovered significantly more Wekiu bugs at the summit. This finding leads to questions about the conditions that limit the Wekiu bug to the summit. We hypothesized that food resources and predator populations may be different between the two areas. Arthropod collections in the two areas showed that prey diversity was not different. Our trapping methods were specifically designed for Wekiu bugs. These methods may not be as effective at capturing endemic and alien Wekiu bug predators, like lycosid and clubionid spiders. Future studies could be designed to characterize the spatial distributions of potential predators, and compare these to Wekiu bug distributions.

More detailed analysis of microhabitats may also reveal factors influencing Wekiu bug distributions. The Wekiu bug is extremely sensitive to heat. Sub-surface temperature fluctuations thus may be associated with preferred habitat. Wekiu bugs may require loose tephra or similar deposits for refuge, but may actively forage in neighboring habitats. The significantly different capture rates between disturbed and undisturbed habitats may have resulted from the greater efficiency of traps set in ash compared to those set in blocky tephra. Low levels of snow occurring during our study may also be associated with spatial distribution, and apparent population decline. Long-term studies could be useful in characterizing the optimal temperature and moisture regimes, as well as habitat-trap efficiency.

Alien species have been hypothesized to have significant impacts on Wekiu bug populations. Several parasitoid species have been released for biological control of pests in lowland areas, and some of these species were common in our trap collections. We found in our diversity studies that alien species occur in both the summit and buffer areas. New traps, specifically designed to capture alien arthropods, should be developed, and studies implemented to answer questions about alien and predator populations.

A species closely related to the Wekiu bug lives near the summit of Mauna Loa. A reconnaissance of the northern slopes of Mauna Loa during 1998 found the Mauna Loa bug, *Nysius aa* Polhemus (1998), to be apparently much more abundant than its relative on Mauna Kea. The factors causing the decline of the Wekiu bug population on Mauna Kea may not have occurred on Mauna Loa. There is a need to concurrently study Mauna Loa arthropods to determine population changes of the Mauna Loa bug, and differences between Mauna Loa and Mauna Kea habitats. The invasive alien predator *Meriola arcifera* (family Clubionidae), first collected on Mauna Kea in 1995 (Beatty et al. in press), is now abundant within the MKSR and may be impacting native species populations. If these spiders have been not yet invaded Mauna Loa, this may be evidence that alien predator species are associated with Wekiu bug decline. This type of information could be gathered with a properly designed and implemented long-term environmental monitoring program.

X. MANAGEMENT RECOMMENDATIONS

Task 6 required the development of management recommendations for the MKSR to preserve and protect the resident arthropod populations. We offer the following recommendations for consideration.

1. Mitigation of Construction Activity:

a. Minimize introductions of alien species:

Boxes, crates, vehicles, and other containers should be inspected before entry into the summit area. Many alien species are introduced to Hawai'i every year. The growing number of non-indigenous species impacts native arthropod populations. The introduction of the wrong alien arthropod may decimate the populations of one or more of the sensitive, endemic, summit-dwelling species. Standard inspection techniques exist and can be put in place in staging areas, before shipping up the mountain. Efforts to eliminate pests can also be made at the port of origin. These techniques should be researched, and a plan for the control of non-indigenous species introductions be developed.

b. Minimize disturbance to habitat:

Construction and construction-related activities should be restricted to approved sites. Areas identified as Wekiu bug habitat should be avoided whenever possible.

c. Garbage collection and containment:

Garbage containers should be covered, and remain covered, while they are within the summit area. We observed open refuse containers during the course of this study. Debris from these containers can easily escape during periods of high wind, which occur almost daily. Collection of escaped debris is of great concern. Habitats are easily disturbed and debris removal may actually do more harm than the actual debris. Techniques for appropriate garbage control and removal should be planned and applied.

d. Dust control:

Strict dust control measures should be initiated and enforced. Ash and other dust are easily moved and distributed by wind. These substances are most likely to be deposited in the same protected pockets in which most of the aeolian food resources for resident arthropod species are found. Excessive dust may reduce the structure and porosity of the scoria habitat used by arthropods

2. Mitigation of Visitor activity:

a. Restricted access:

Areas where Wekiu bug populations are the highest, or where they occur during periods of extremely low population levels, should be placed off-limits to visitors to the MKSR. These areas should be clearly marked and delineated. These areas should include, in the summit area, portions of the outer scoria slopes of Pu`u Hauoki and Pu`u Wekiu and, in the buffer area, Pu'u Mahoe and Pu`u Makanaka.

b. Limit Skiing activity on Mauna Kea:

Skiing and snow play on Mauna Kea should be discouraged and/or restricted to specific sites and times when the snow is deep and impacts would be minimal. Wekiu bug activity is hypothesized to be linked to availability of snow patches. Disturbance of snow-patch habitats during periods of bug high activity, including mating and foraging may be detrimental to the survival of the Wekiu bug.

c. Public outreach:

Efforts should be made to educate the public about the sensitivity of these unique species to disturbance and how the public can contribute to their protection. IfA representatives should participate in more public outreach and education about their efforts to manage the natural resources of the MKSR. News releases of the findings of this and other studies can be helpful in building an image of cooperation and caring for the IfA. Outreach may also include news releases about efforts to protect the summit flora and fauna.

d. Educational signs:

More signs should be placed in sensitive areas to educate visitors about the impact they may be having on sensitive summit-dwelling species. Information about the fauna and flora of the summit and buffer areas should be thoroughly displayed at the Visitors Center.

3. Habitat restoration:

a. Testing of new habitat restoration methodology:

Studies should be conducted to establish methods for habitat restoration. This may include techniques for constructing islands of Wekiu bug habitat with rubble screened to remove dust.

b. Methods should be investigated for captive rearing and release of Wekiu bugs to enhance populations.

c. All habitat restoration efforts should be planned and implemented as designed experiments. Only designed experiments, with randomization, replication, treatment controls, and control of confounding factors, can yield new knowledge about the direct causes of population increase or decline.

4. A comprehensive monitoring program:

Environmental monitoring is the investigation of the changes in environmental functions, attributes, and characteristics that happen over time. Monitoring provides the information necessary for adaptive management of natural systems, biogeographical areas, and their biotic components. The knowledge gained through a properly designed monitoring program will provide the IfA with inferences about ecological changes and the impacts of its management strategies on MKSR natural resources. The ultimate goal of monitoring is to aid in good stewardship and conservation of the natural world. A Long Term Environmental Monitoring Program (LTEMP) should be designed to collect the best scientific information available, and will ensure the IfA's compliance with all applicable laws and directives.

Clarity of purpose is important in planning a monitoring program. While the most general purposes of monitoring are to learn about environmental changes and to increase understanding of the impacts of management activities on native systems, the IfA may have one or more of the following specific purposes for monitoring natural resources within the MKSR:

- To provide historical records of environmental phenomena, attributes, and characteristics.
- To detect threshold events, or critical levels of environmental phenomena, attributes, and characteristics.
- To detect hazards and risks to valued ecosystem attributes and functions.
- To detect specific changes in the environment.
- To detect trends and/or patterns in those changes.
- To correlate auxiliary attributes and characteristics with trends and patterns of change.
- To predict future changes in environmental functions, attributes, and characteristics.
- To evaluate management activities and provide information useful in modifying management actions.

All these monitoring purposes apply to management and conservation of the natural resources within the MKSR. The MKSR has a unique environment with rare endemic plants and animals. Like most Pacific islands, Hawaiian ecosystems have sustained significant impact from human beings over the last few centuries. These impacts have resulted in alterations, extinctions, and introductions of populations of plants and animals. Detection, prediction, and modification of these environmental changes is vitally important to long-term management of Hawaiian natural resources.

The IfA's management of natural resources needs to be an iterative process of monitoring and management actions on a continuous basis. Observational monitoring, and monitoring of experimental treatments, will increase understanding of ecosystem dynamics and the effects of management actions. Monitoring will serve as a feedback mechanism to promote better integration of conservation efforts. As knowledge accumulates, management strategies will be adjusted, and management will become more effective at achieving their goals. Because of this adaptive benefit, monitoring of long-

term ecosystem changes has been recommended as an integral component of conservation-oriented management on most state and federally controlled resource land.

Monitoring change within the MKSR natural areas is complicated by habitat fragmentation, invasion of alien species, development near area boundaries, commercial and recreational use, and natural disturbances. The IfA needs scientifically detailed and reliable information about species within its management jurisdiction, about the impacts of management decisions to those species, and about changes in populations of those species over time.

The difficulties in planning for complex, multi-resource monitoring are mitigated by employing a systematic planning process. The following is a seven-step process for planning of long-term monitoring:

1. Prepare clear statements of the questions of interest.
2. Design the sampling systems
3. Develop sampling protocols for data collection
4. Prepare the data management systems
5. Plan the analysis and interpretation systems
6. Develop a reporting system
7. Develop a monitoring sustainability plan

Each of these seven steps must be undertaken and completed to develop a successful monitoring plan. Furthermore, the steps must be undertaken in a comprehensive manner. Planning decisions made in any one stage affect decisions at all the other stages.

1. Prepare clear statements of the questions of interest.

The first step in developing a monitoring plan requires clearly defining the questions of interest. Key questions are those with answers that can be efficiently estimated, and that yield the information necessary for management decision-making. The monitoring program depends upon identifying the important issues and concerns, and reducing general problems to questions of specific, measurable attributes. Identifying issues of concern will require interviews with IfA personnel, Hawaiian biologists, the University of Hawai'i, concerned environmental groups, and local citizens. Much effort will be spent investigating the key monitoring questions. Therefore, they must be well-considered and carefully elucidated.

2. Design the sampling systems

The second step in monitoring planning is designing the sampling systems. It is expected that several quantifiable questions of interest will be elucidated in the first stage. Each key question must then be evaluated for utility and efficiency. Proposed questions of interest must be prioritized, based on the projected costs to collect the data and the projected value of the knowledge to be gained. The effort expended to answer each question must lead to useful gains in knowledge and remain within budgetary and logistical constraints. Some questions are simply too expensive to answer efficiently. Some questions cannot be answered without controlled experimentation. Designed experiments, based on expected operational activities, should be incorporated into the sampling system.

Expertise in statistics, biometrics, and cost/benefit analysis are required for sampling system design. Some of the design techniques which should be applied are power analysis, cost allocation analysis, sampling structure determinations, sample size determinations, scale evaluations, randomization, replication, blocking, and covariate determinations. Schedules of sampling efforts must also be developed. Monitoring is the investigation of change over time, so timing and frequency of sampling are essential elements in sampling system design.

3. Develop sampling protocols for data collection

The third step in monitoring planning is to develop the data collection system(s). Sampling protocols are necessary to standardize data collection. Data gathered in the future must be comparable to data gathered today in order to statistically detect significant environmental changes. Protocols should include specific methods to be used for every habitat and each animal or plant type, descriptions of the tools necessary for data collection, and randomization schemes for determining trap placement, quadrat size,

or measurement device location. Protocols should be field-tested to assure feasibility and efficiency. Field data collection crews should then be trained and tested in the use of the sampling protocols.

4. Prepare the data management systems

The fourth step in monitoring planning is the preparation of a data management plan. The data collected in each sampling exercise must be checked for errors and corrected. Data sets must be entered into a database for easy access and retrieval. The database must be properly archived to be useful many years in the future. Monitoring requires comparisons of attributes over sometimes lengthy periods of time. It is important to recognize that data sets are expensive to obtain, and hence have significant monetary value. Not only will the archived data contribute information for future management decisions on Mauna Kea, they will also provide information potentially useful for management elsewhere in Hawai'i and the Pacific. Locational data should be incorporated into the existing IfA GIS.

5. Plan the analysis and interpretation systems

The fifth step in monitoring planning is the development of an analysis and interpretation plan. Statistical analysis and scientific interpretation are necessary to produce logical inferences and new knowledge from monitoring data. The sampling design and the statistical structure of the data must be accounted for in the analysis plan. Techniques of Exploratory Data Analysis (EDA), graphics, statistical distribution tests, data transformations, and modeling should be developed in the plan. Much of the inference gained through monitoring will be evaluated by means of mathematical models. Such models include time trend analysis, survival analysis, growth and mortality models, and population change models. The appropriate model forms should be specified in the planning process. Failure to specify analytical forms could cause gaps and inefficiencies in sampling design and data collection. Prior planning for analysis will help ensure completeness and timeliness of the sampling and prevent wasteful effort.

6. Develop of a reporting system

The sixth step in monitoring planning is the development of a plan for the reporting the results. The new knowledge acquired through monitoring should be communicated to responsible IfA personnel and interested agencies for use in determining management decisions. Charts, tables, and maps may be the immediate products of analysis but do not stand alone. Reports should be carefully planned and clearly written with consideration of the intended audience and the appropriate application of the findings. The reports should clearly explain the results of data analysis and the implications to natural resource management. Monitoring reports need to be produced on time and updated on a regular schedule.

7. Develop a monitoring sustainability plan

The seventh step in monitoring planning is development of a monitoring sustainability plan. Institutional commitment must be developed to secure annual budgetary planning for future monitoring efforts. Monitoring happens in the context of time. Environmental changes, and trends in those changes, are often detected only after several years of data collection. The IfA must consider the LTEMP to be a permanent part of it management strategy. Involving other stakeholders will help to build community commitment to the LTEMP. Planning for sustainability and commitment is a necessary element in long-term environmental monitoring.

In summary, monitoring of ecosystems and natural resources within the MKSR should be comprehensive, cost-effective, statistically designed, executed with analytical integrity, presented to decision makers by way of meaningful reports, charts, and maps, and updated regularly over many decades. Consideration and application of the seven steps will improve efficiency and effectiveness of knowledge acquisition and guarantee managers, regulators, scientists, and citizens useful information on which rational management decisions may be based. Conscientious planning and implementation of a properly designed monitoring plan will provide the IfA the necessary prerequisites for continued good stewardship of its properties.

XI. ACKNOWLEDGEMENTS

We thank Dan Polhemus, Smithsonian Institution, Washington; Ron Englund, B. P. Bishop Museum, Honolulu; Pete Oboyski, USGS/BRD, Volcano; Fred Stone, Hawai'i Community College, Hilo; and Steve Montgomery, Waipahu, for their assistance in the field, project design, and interpretation of the results, Matt Kweskin, USGS/BRD, Volcano, and Mike Richardson, USFWS, Honolulu, also assisted in the field work. We thank Mike Dubrasich, of Pacific Analytics, for his biometrical assistance and editorial comments. We further thank Teresa Leon, UH, Manoa, and Joe Beatty, Southern Illinois University, Carbondale, for assistance in identifying the spiders, and Sabina Swift, Gordon Nishida, and Keith Arakaki of Bishop Museum for assistance with curation of the specimens and especially Tracie Mackenzie and Ipo Santos-Bear for administrative support. This study was made possible through a contract with the Institute for Astronomy, to whom we offer our sincere appreciation for their contributions to the study of the resident arthropod community within the Mauna Kea Science Reserve. The cover illustration of *Nysius wekiuicola* was drawn by Mr. C. Sanchez, University of the Philippines, and is from Ashlock and Gagné (1983).

Contribution No. 1999-006 to the Hawai'i Biological Survey.

XII. LITERATURE CITED

Anonymous. 1981. Oceans: Life on lava flows. Oryx 16:24-25.

Ashlock, P.D. and W.C. Gagné. 1983. A remarkable new micropterous *Nysius* species from the aeolian zone of Mauna Kea, Hawai'i Island (Hemiptera: Heteroptera:Lygaeidae). International Journal of Entomology 25(1):47-55.

Beatty, J. A., J. W. and E. R. Berry. (in press). Additions and corrections to the spider fauna of Hawai'i. HBS Records. Occ. Papers Bishop Museum.

Beardsley, J.W. 1966. Investigations on *Nysius* spp. and other insects at Haleakala, Maui during 1964 and 1965. Proceedings of the Hawaiian Entomological Society 19:187-200.

Bryan, E.H. 1923. Insects from the summit of Mauna Kea. Proceedings of the Hawaiian Entomological Society 5:287-288.

Bryan, E.H. 1926. Additional notes on the insects occurring on Mauna Kea and Mauna Loa. Proceedings of the Hawaiian Entomological Society 6:280-282.

Bryan, W.A. 1916. Mauna Loa insects. Proceedings of the Hawaiian Entomological Society 3:295.

Duman, J.G. and S.L. Montgomery. 1991. Subzero temperature adaptations in arthropods from the summit of Mauna Kea, Hawai'i. Journal of Experimental Zoology 259:409-412.

Edwards, J.S. 1987. Arthropods of aeolian ecosystems. Annual Review of Entomology 32:163-179.

Eldridge, L.G. and S.E. Miller. 1995. How many species are there in Hawai'i? Bishop Museum Occasional Papers 41:3-18.

Gagné, W.C. 1971. Notes and exhibitions: *Psylla uncatoides* (Ferris and Klyver). Proceedings of the Hawaiian Entomological Society 21:25.

Gagné, W.C. and F.G. Howarth. 1982. On Mauna Kea 'desert' entomologists discover new life. Ka'Elele, Bishop Museum Newsletter 9(2):1, 6.

Guppy, H. 1897. The summit of Mauna Loa. Nature 57:20-21.

Howarth, F.G. 1997. *An Arthropod Assessment within Selected Areas of the Mauna Kea Science Reserve.* A proposal for work submitted to the Institute for Astronomy. B.P. Bishop Museum, Honolulu, Hawai'i.

Howarth, F.G., G.J. Brenner, and D.J. Preston. 1997. Potential Habitats on Mauna Kea Summit Science Reserve. Task 3 Preliminary Report. Submitted to the Institute for Astronomy, 2 December 1997.

Howarth, F.G. and S.L. Montgomery. 1980. Notes on the ecology of the high altitude aeolian zone on Mauna Kea. 'Elepaio, Journal of the Hawaiian Audubon Society 41(3):21-22.

Howarth, F.G. and F.D. Stone. 1982. An assessment of the arthropod fauna and aeolan ecosystem near the summit of Mauna Kea, Hawaii. Submitted to Group 70, Honolulu, Hawai'i. 18 pp.

Institute for Astronomy. 1997. Request for Proposals. A request for proposals for work to be completed within the Mauna Kea Science Reserve. University of Hawai'i, Honolulu.

Mull, M.E. 1980. Conservation and Mauna Kea. 'Elepaio, Journal of the Hawaiian Audubon Society 41(11):156.

Mull, M.E. and W.P. Mull. 1980. Perspective: The marvelous mountain. Hawaiian Tribune-Herald. Sunday, Jan. 27; Section B 5.

Papp, R.P. 1981. High altitude aeolian ecosystems in the Hawaiian Islands. Proceedings of the 3rd Conference of Natural Sciences, Volcanoes National Park, Cooperative National Park Resources Studies Unit. University of Hawaii, Manoa. Pages 259-264.

Ramsey, F.L. and D.W. Schafer. 1997. The Statistical Sleuth. Duxbury Press, Belmont, CA. 735 pages.

Southwood, T.R.E., 1971. Ecological Methods. Chapman and Hall, New York. 524 pp.

Swezey, O.H. and F.X. Williams. 1932. Insects from the summit of Mauna Kea. Proceedings of the Hawaiian Entomological Society 8:191-192.

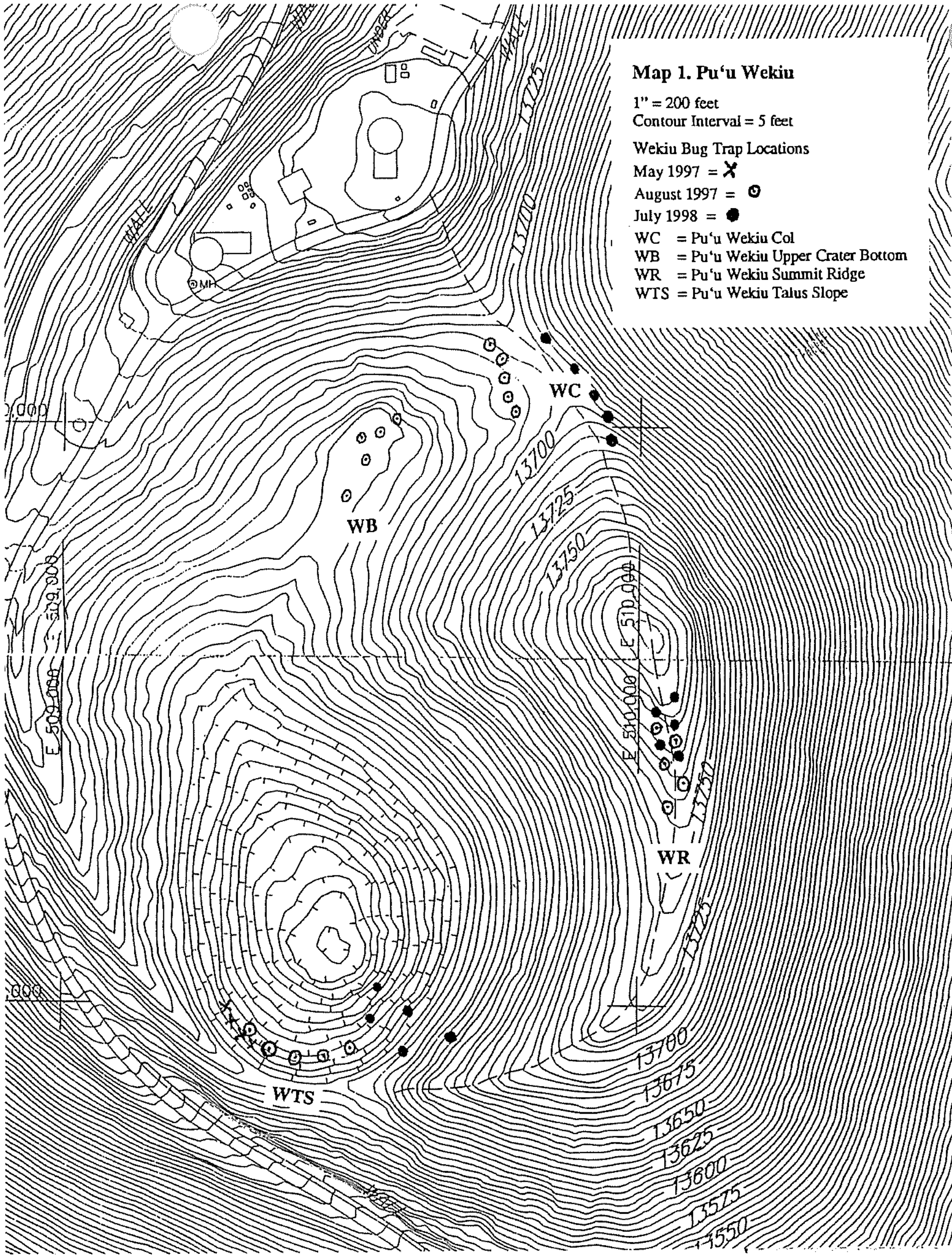
U.S. Congress, Office of Technology Assessment. 1993. Harmful Non-Indigenous Species in the United States. OTA-F-565. U.S. Government Printing Office, Washington, D.C. 391 pages.

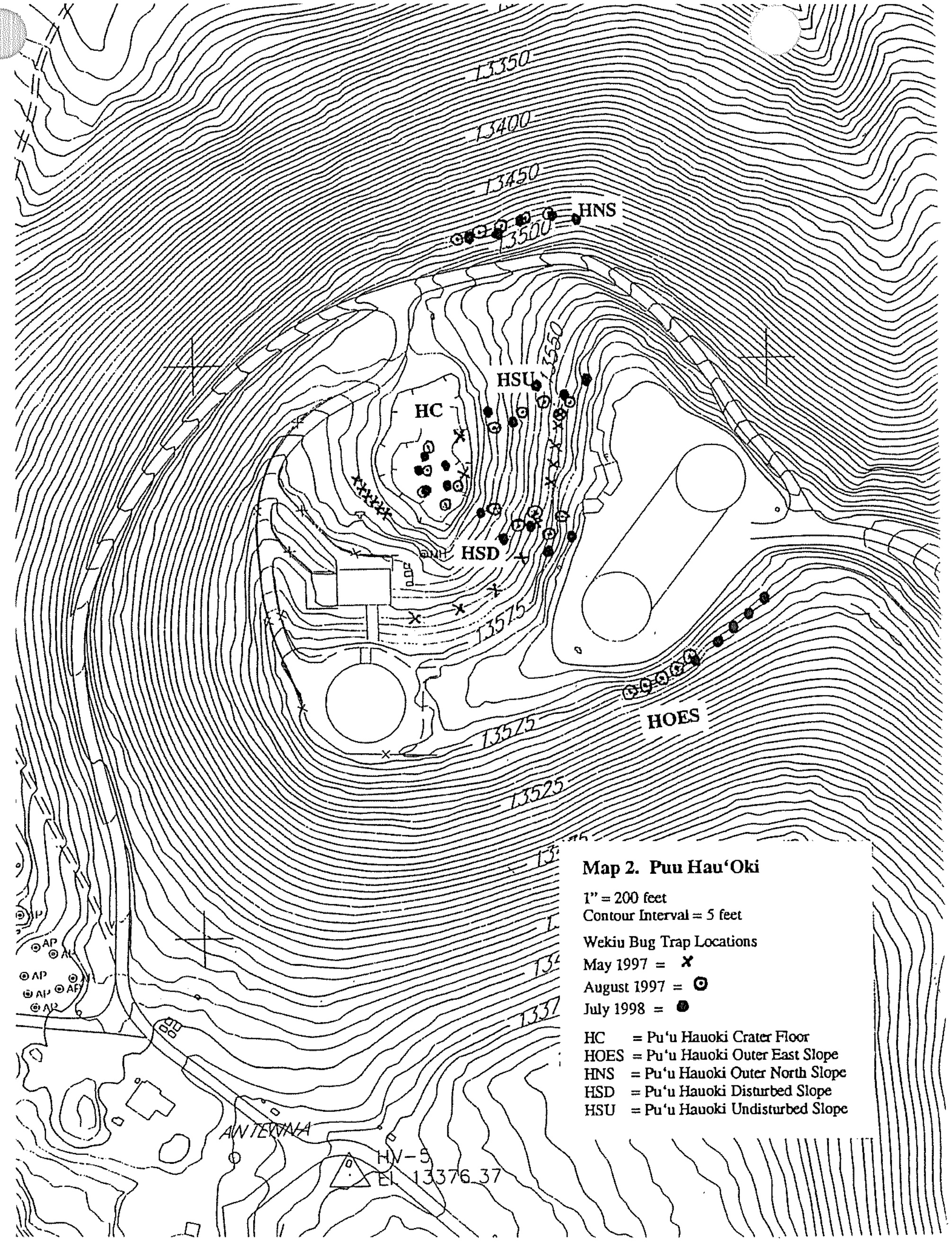
Wentworth. C.K., J.W. Coulter, and C.E. Hartt. 1935. The Mauna Kea expedition of 1935. Hawaii Academy of Science, 95 page MS located at B.P. Bishop Museum library.

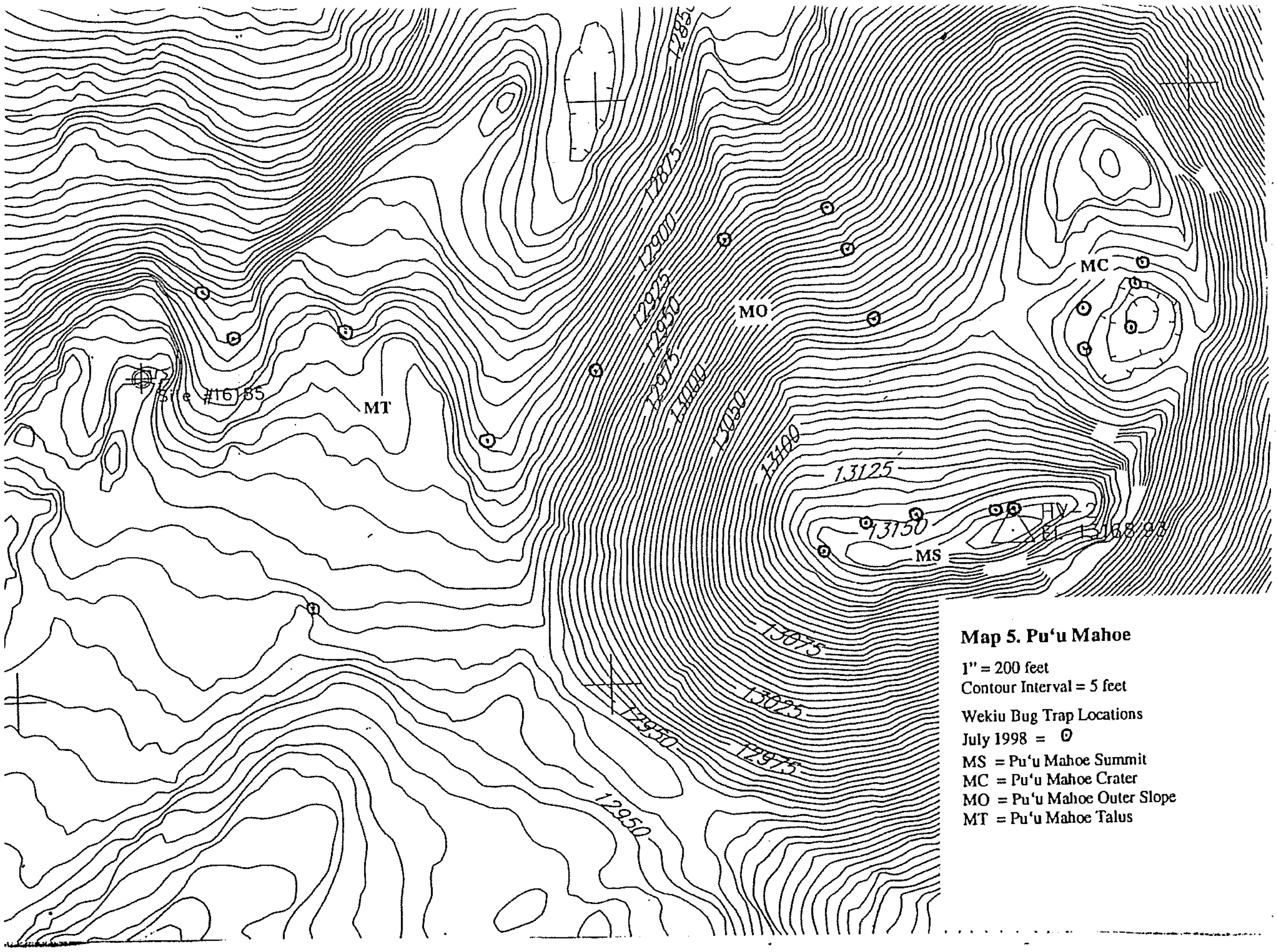
Wolfe, E.W. and J. Morris. 1996. Geologic map of the island of Hawaii. USDI, U.S. Geological Survey Miscellaneous Investigations Series Map I2524-A. 1996.

Wolfe, E. W., W. S. Wise, and G. B. Dalrymple. 1997. The Geology and petrology of Mauna Kea Volcano, Hawaii --- A study of postshield vulcanism. U.S. G.S. Professional Paper 1557.

XIII. MAPS


Map 1. Pu'u Wekiu
1" = 200 feet
Contour Interval = 5 feet
Wekiu Bug Trap Locations
May 1997 =
August 1997 =
July 1998 =
WC = Pu'u Wekiu Col
WB = Pu'u Wekiu Upper Crater Bottom
WR = Pu'u Wekiu Summit Ridge
WTS = Pu'u Wekiu Talus Slope
WC
WB
WR
WTS
13700
13725
13750
13675
13650
13625
13600
13575
13550
E 510,000
E 509,000
WALL

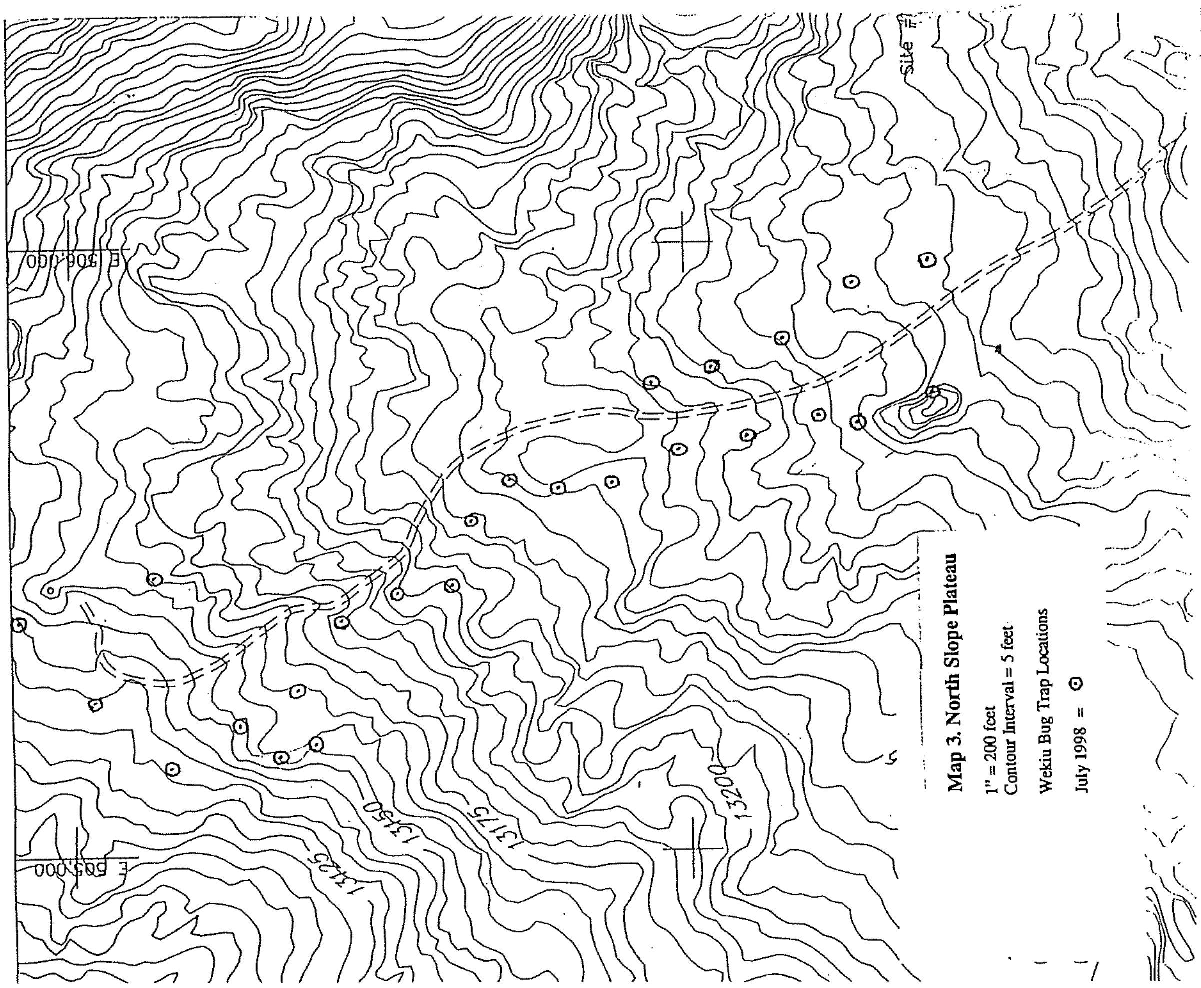

Map 2. Puu Hau'Oki
1" = 200 feet
Contour Interval = 5 feet
Wekiu Bug Trap Locations
May 1997 =
August 1997 =
July 1998 =
HC = Pu'u Hauoki Crater Floor
HOES = Pu'u Hauoki Outer East Slope
HNS = Pu'u Hauoki Outer North Slope
HSD = Pu'u Hauoki Disturbed Slope
HSU = Pu'u Hauoki Undisturbed Slope
HNS
HSU
HC
HSD
HOES
13350
13400
13450
13500
13550
13575
13525
ANTENNA
HV-5
EL 13376.37



Map 5. Pu'u Mahoe

1" = 200 feet
Contour Interval = 5 feet

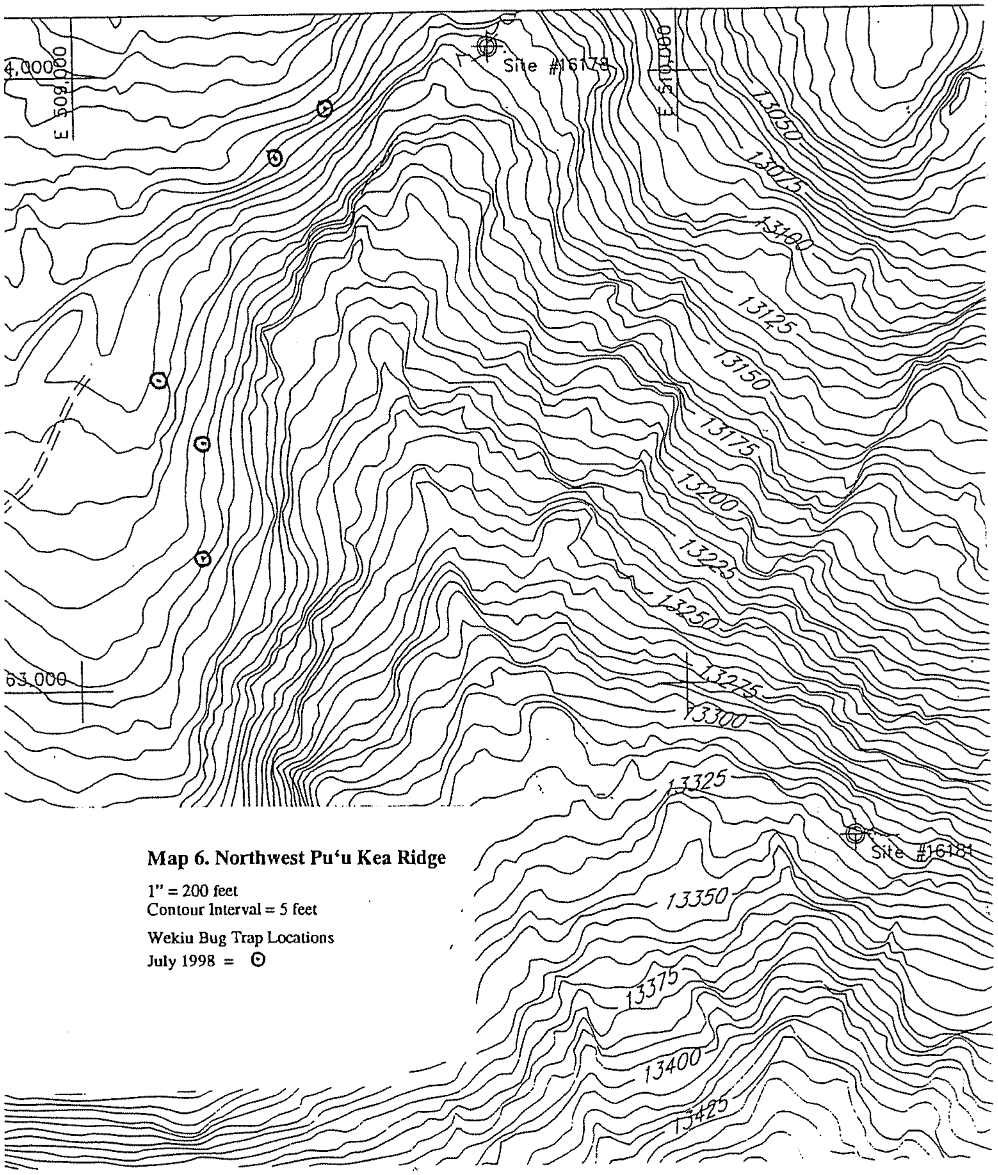
Wekiu Bug Trap Locations
July 1998 = ⊙
MS = Pu'u Mahoe Summit
MC = Pu'u Mahoe Crater
MO = Pu'u Mahoe Outer Slope
MT = Pu'u Mahoe Talus



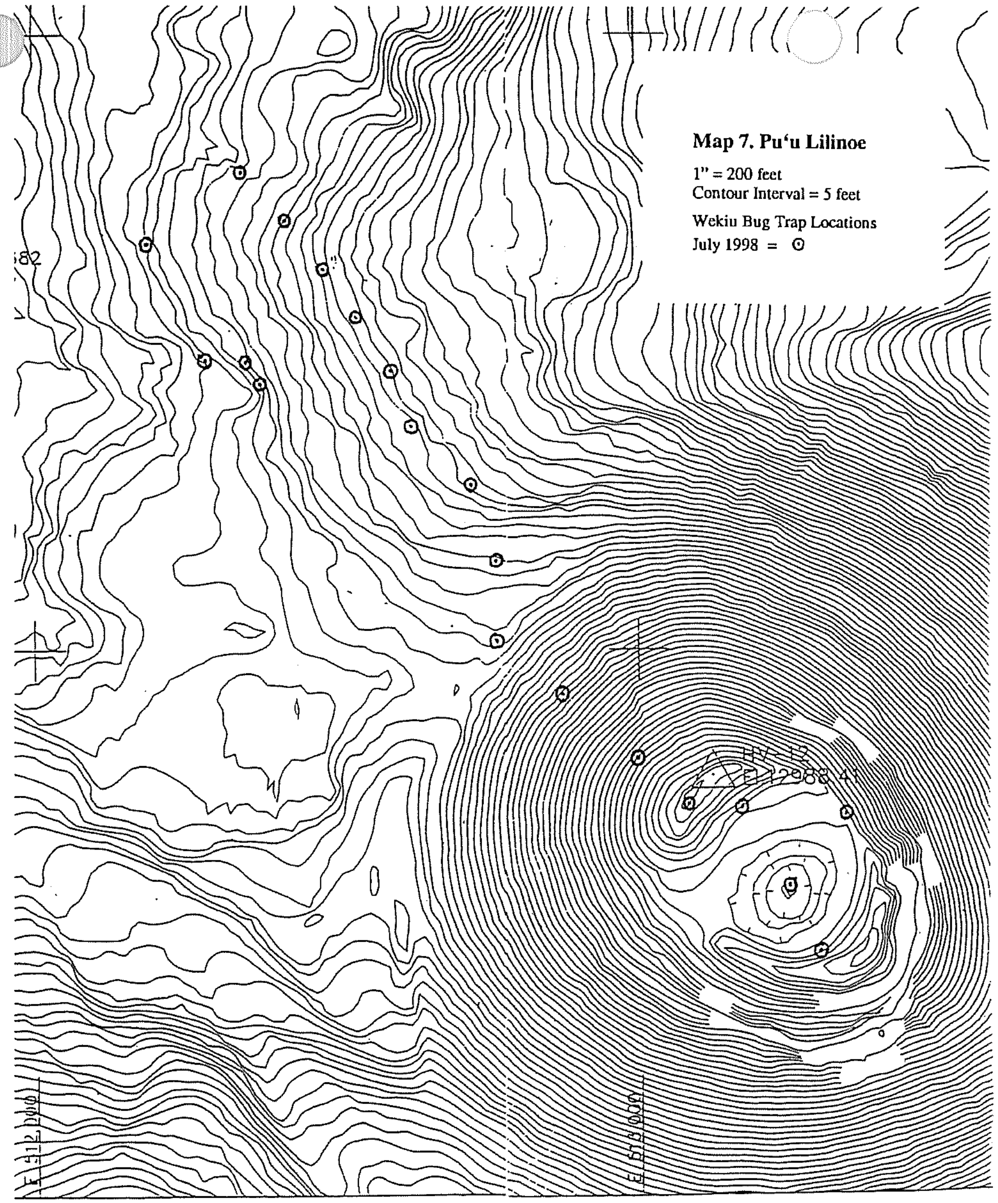
Map 3. North Slope Plateau

1" = 200 feet
Contour Interval = 5 feet

Wekiu Bug Trap Locations
July 1998 = ⊙



Map 6. Northwest Pu'u Kea Ridge



Map 7. Pu'u Lilinoe

MAUNA KEA SCIENCE RESERVE
MASTER PLAN

APPENDIX K

Mauna Kea Science Reserve Archaeological Site Inventory: Formal, Functional, and Spatial Attributes

Mauna Kea Science Reserve Site Descriptions – DRAFT
(122 pages – Available upon Request)

Patrick McCoy

1999

MARCH 2000

MAUNA KEA SCIENCE RESERVE ARCHAEOLOGICAL SITE INVENTORY: FORMAL, FUNCTIONAL, AND SPATIAL ATTRIBUTES

Patrick C. McCoy
State Historic Preservation Division
February, 1999.

INTRODUCTION

Archaeological surveys undertaken between 1975 and 1997 in the Mauna Kea Science Reserve have identified a total of 93 sites (McCoy 1975, 1977, 1982, 1990; in press; McCoy et al in preparation; Hammatt and Borthwick 1988) in an area encompassing some 3000 acres, which represents almost 27% of the 11, 215 acre Reserve (Fig. 1 and Table 1). Sites have been found in all of the areas surveyed to date, except for Area A and Area B (Fig. 1). The survey of Area B, which encompasses a cinder cone called Pu`u Poepoe, was limited, however, to the base of the cone. Two previously identified sites (16183 and 11078) were deleted from the inventory during the work undertaken by the State Historic Presevation Division in 1995. A reassessment of Site 16183, recorded in 1982 as an open-air shelter with modern rubbish on the floor (McCoy 1982), convinced us that the walls are also modern. Site 11078, a rock overhang recorded during the survey of the Very Long Base Array (VLBA) observatory site in 1988 (Hammatt and Borthwick 1988), was removed from the inventory because there is no evidence of human use.

Five of the 93 sites are of unknown function. The other 88 sites include: (1) 76 shrines; (2) 4 adze manufacturing workshops; (3) 1 positively identified burial site and 4 possible burial sites with an unknown number of interments at each site, and (4) 3 cairns that appear to be markers built either by surveyors or visitors to commemorate a visit (Table 1). Each class of sites is briefly described below in terms of its defining characteristics and spatial distribution patterns. Functional inferences are based on formal attributes, locational context, and comparative data (ethnographic and archaeological) from Hawai`i and other areas of East Polynesia.

The following formal and functional terms, some of which have already been used above, are employed in this report:

Cairn--A pile or heap of stones of generally circular to oval shape at the base; there are two varieties in the survey area--loosely constructed pyramidal forms with no facings that tend to be of nearly equal diameter and height, and well-constructed cylindrical piles with facings

Mound--A pile or heap of stones that is more irregular in construction and form than a cairn; the linear variety has sloping sides and a generally irregular upper surface

Pavement--A roughly flat to level surface of placed stones that may vary considerably in size, form and compaction; a term commonly applied to the upper surfaces of platforms and terraces; can also occur alone

Platform--A free-standing stone structure two or more courses high and with faced sides; the fill can be made up of stone and/or soil; usually rectangular or square in shape

Wall--A free-standing linear arrangement of stones that is longer than it is wide and at least two stones high; the sides and top are normally level in contrast to linear mounds

Upright --An archaeological term for what are inferred to be god stones that the Hawaiians called *'eho* or *pohaku 'eho*; this same term was also used for stone boundary markers and bird cooking stones (cf. Pukui and Elbert 1971; Buck 1957; Emory 1938; McCoy 1991); most of those on Mauna Kea are angular slabs set on end ("upright")

Lithic Scatter--A rarely used term in Hawaiian archaeology which means nothing more than all of the stone tool residues found at a given locality; these may include tools or implements, unfinished tools, manufacturing waste and hammerstones or some combination of all of these; lithic scatters are activity areas where one or more of the following activities may have taken place-- tool manufacture, tool use, tool discard

Enclosure --An area partially or fully circumscribed by a wall or an alignment of stones; often free-standing, but one or more sides may be bedrock

Shrine--In common usage a place of worship; the distinction, if one existed in the past, between shrines and temples (*heiau*) is not altogether clear and the present study follows

Buck (1957:527-528), who defined a shrine as "a convenient term to designate a simple altar without a prepared court. They were made by individuals or small family groups who conducted a short ritual which required no priest."

Workshop--The functional equivalent of a lithic scatter where there is evidence of tool manufacture and/or use; though rarely defined in the literature, this term normally implies in the case of reduction technologies, such as stone tool manufacture, a coherent structure amongst the various by-products of work [cores, waste flakes, rejected tools, etc.] that constitute this category of archaeological remains

Burial--A deliberate or intentional interment of human remains; all of the known and suspected burials in the Science Reserve are located in cairns situated on the tops of cinder cones

Marker--A general term applied to cairns believed to have been built by either surveyors to visitors for the purpose of commemorating

Unknown Function--Applies to remains where the function cannot be determined on available evidence

No excavations have been undertaken at any of the 93 sites, which are thus undated. The prospect of dating any of the sites seems remote at the present time since none of them appear to contain organic deposits or datable material of any kind. The only sites where artifacts have been found on the surface are the four adze manufacturing workshops.

FUNCTIONAL SITE CLASSES

SHRINES

Defining Characteristics and Terminology

Of the 93 sites identified in the Science Reserve 76 or 81.72% are classified as shrines. An additional 8 shrines are present on four adze manufacturing workshops, one each on Sites 11079, 16203, and 21211 and five on Site 16204. The total number of shrines recorded to date within the boundaries of the Science Reserve is thus 84.

The quintessential characteristic of all the remains identified as shrines is the presence of one or more upright stones. A number of shrines consist of just a single upright, while others are characterized by multiple uprights arranged in different patterns on a variety of different kinds of foundations. Kenneth Emory, who was the first one to describe the shrines on Mauna Kea and note their East Polynesian affinities, was of the opinion that the uprights represented or symbolized separate gods. Emory made the following comments about the shrines he saw in the nearby adze quarry, during a brief reconnaissance of the main quarry area in 1937:

> The adze makers, clinging to the ancient form of shrine at which to approach their patron gods, have preserved a most important link with their ancestral home. Each upright stone at a shrine probably stood for a separate god. The Hawaiian dictionary describes *'eho* as "a collection of stone gods" and this is the term which the Tuamotuans, the neighbors of the Tahitians, used to designate the alignment of upright stones on the low and narrow platform at their maraes, or sacred places. (Emory 1938:22)

The word *`eho* has various other meanings, some of which point to the need to exercise some caution in assuming that all upright stones were shrines. According to Mary Kawena Pukui and Samuel H. Elbert (1971:35) *'eho* is a term for a single stone image as well as a stone pile, particularly of the kind used to mark land boundaries. The latter information may have come from Samuel M. Kamakau, who noted that "Boundary markers (*kukulu 'eho'eho*) of tall stones (*oeoe pohaku*) were set up to identify the boundaries." (Kamakau 1976:7). The use of a stone to represent a god and mark a land boundary are not necessarily incompatible, however, since the construction of religious structures in Polynesia was a common way of making a claim to a piece of land (Handy 1927; Emory 1947:10). Elsewhere, McCoy has suggested that some of the upright stones found in both the Mauna Kea adze quarry and in the Pu`u Moiwi adze quarry on Kaho`olawe may have been *kapu* markers of the kind called *lahui* (McCoy 1990, 1993). The primary reason for thinking that most, if not all, of the single uprights in the Science Reserve are shrines is their locational context and association with rows of upright stones that are unquestionably shrines, based on ethnographic information for similar structures throughout East Polynesia (e.g. Emory 1933, 1947, 1970).

In addition to uprights, some sites have other elements that are widely found on religious stone structures (variously called by such names as *marae, ahu* or some cognate term) throughout East Polynesia. The ethnographies and archaeological survey reports written in the early to mid part of the century for many areas of East Polynesia commonly referred to these elements as "parts" (e.g. Emory 1933). The present report uses the same basic approach in describing the shrines in the Science Reserve in order to facilitate comparison with the religious structures in Hawai`i and elsewhere in East Polynesia described by Emory and others. The Mauna Kea shrines include one or more of the following elements or "parts": (1) uprights, (2) pavements, and (3) prepared courts. Significant variability exists in the presence/absence of pavements, courts, and artifacts, and in attributes such as , the number of uprights and manner in which they were set and arranged. Whether or not all of the observed variability can or should be subsumed by the term "shrine," as it is commonly understood, is a thorny issue that needs to be briefly addressed.

In an earlier report on the archaeological sites of the Mauna Kea summit region McCoy (1982) followed Sir Peter Buck in referring to the architecturally simpler and generally smaller structures as shrines (*kuahu*), which Buck (1957:527) considered "a convenient term to designate a simple altar without a prepared court." Some of the larger, more complex structures, including those with courts, McCoy called *marae* , following Emory, who had used this term to describe structures on the island of Necker that he believed bore close resemblances to the so-called "inland" type of Tahitian *marae* (Emory 1921, 1928, 1933, 1943, 1970). Though some of the stone remains in the Hawaiian Islands, including those on Necker and Mauna Kea, do in fact appear to more closely resemble some of the simpler forms of *marae* in Tahiti and the Tuamotus than any known form of Hawaiian *heiau*, it is probably best to discontinue using the term *marae*, which has no cognate in the Hawaiian language.

If one accepts the distinction that Buck (1957) made between shrines and temples, then the sites with prepared courts should be called temples. This report uses the generic term "shrine" to describe all of the religious structures that exist in the summit region of Mauna Kea, including both the Science Reserve and the adze quarry. Some may object and argue that they should instead be called *heiau*, but a review of the literature indicates that there is no agreement on what that term included and excluded in the past and how it should be used today. Kamakau (1964:33), for example, is very clear in saying that the *Pohaku o Kane* were family shrines and not a kind of *heiau* , whereas some archaeologists, such as Patrick Kirch (1985: 260), hold to the view that the *Pohaku o Kane* was a *heiau*.

Topographic Location and Orientation

The vast majority of shrines are conspicously sighted in the landscape, either on a ridgetop, or at a break in the slope, which generally seems to correspond to either a lava flow margin or a change in the slope of a glacial moraine. The few exceptions are located in an area of low relief on the southeast flank of Pu`u Lilinoe. The preference for prominent locations with commanding views of the landscape mirrors the pattern described by Gilbert McAllister and Buck for *heiau*. They made the following observations about *heiau* location and orientation:

> Heiaus were usually built on some commanding site, such as a hill top, the seaward end of a range, or a promontory of higher land which overlooked valleys, villages, or the sea. According to McAllister (1933a, p. 9) the orientation depended only upon the slope of the land. Heiaus face in all directions of the compass, the only generalization being that most of them face the sea. (Buck 1957:516)

While *heiau* may be found on hilltops elsewhere, there are no known shrines in the Science Reserve located on top of a cinder cone. Some could be found in the future, but on current evidence the tops of cinder cones were reserved for burial (see discussion of burial sites below).

McAllister and Buck were not the first to recognize the relationship between topographic location and site orientation in Hawaiian *heiau*. John Stokes came to similar conclusions even earlier, at the turn of the century. His observation about sites that seem to be oriented to cardinal points fits the Mauna Kea shrines perfectly:

> Orientation of the *heiau* platform was controlled by the situation. If situated on the shore, the temple lay parallel or at right angles to the immediate shoreline (not the overall lay of the coast). If slightly inland, the orientation would seem to depend primarily on the contour of the ground and secondarily on the lay of the coast; however, on the account of the form of the volcanic islands, either factor would seem to produce the same result. Farther inland, it would be only the contour of the ground which would be considered. I could find no evidence in the foundations of the orientation to cardinal points. It is true that some of them did lie almost true north-south or east-west, but this was because the situation required it. (Stokes 1991:35-36)

Shrines located on lava flows (ridges) are generally oriented parallel to the long axis of the flow, rather than perpendicular to it.

Uprights

As already noted, there is good reason to believe that each upright on a shrine stood for a separate god . Ethnographic information indicates that stones such as these provided a place for the gods to inhabit when they were needed. Adrienne Kaeppler has written, for example, that:

> Gods could be invoked in the abstract or they could be called to natural or fabricated objects, which in turn acquired power and served as suitable places into which the gods might be lured when next needed. These objects retained residual mana and power, which might be passed on from generation to generation. (Kaeppler 1982:83)

Ethnographic data also indicate that the interaction between humans and gods took many forms. The gods were not worshipped as images or icons, however.

Raw Material Type, Form and Size

There are two general classes of uprights: (1) angular slabs and (2) rounded boulders of generally elongated form. The latter are uncommon, occurring on sites where slab material does not seem to have been readily available. The vast majority of uprights are naturally occurring, unaltered slabs of tabular rock of long-narrow shape that were universally set on end (i.e., the long axis of the stone is vertical). The origins of these slabs and their abundance in some places is noted in this description of the glaciated areas on Mauna Kea:

> Over the glaciated area of Mauna Kea the wedge-work of ice is conspicous. The bed rock has been shattered, and spalls and slabs by thousands are strewn over the surface. In addition to the little-weathered, light gray fragments transported by glacial ice, large quantities of broken rock talus lie at the bases of cliff ledges, and, in many places stand in great stacks of flat or curved slabs only little removed from the bedrock itself. Some of the frost slabs are chunky or roughly columnar in form. Especially at the sides and downslope ends of thick lava flow or tube masses, the rock has spalled off in straight or slightly curved slabs, one to several inches thick and several square feet in area. (Gregory and Wentworth 1937:1738)

The lateral edges of a few of the slab uprights bear flake scars, but with a couple of isolated exceptions these appear to be generally of natural rather than human origin. The use of unmodified or minimally worked stones to represent gods appears to have been more common in Hawaii (Cox and Davenport 1988:25) than some other areas of East Polynesia where stone sculpture was more developed (e.g. Easter Island and the Marquesas). This could vary, though, as Buck noted in this description of Hawaiian stone gods:

> However, stone was used a good deal to represent family or craft gods (*`aumakua*). Some individuals were content to use pieces of unworked stone, whereas others made rough representations of the human figure. It should be remembered that it was not the workmanship but the prayers and offerings which gave a material object power (*mana*) and converted it into a god, no matter what the form. (Buck 1964:495)

While most of the uprights are unworked, the attribute data on form and size indicate that the procurement of slabs to be used as god stones (*`eho)* was not arbitrary or random (that not just any slab was picked up off the surface). If it had been then the slabs used in shrine construction should be representative of the wide range of shapes and sizes found in the source areas. They are not. The data demonstrate, rather, that the procurement process was deliberative and characterized by a conscious search for slabs of certain shapes and sizes that fall within a range that is much narrower than what exists in the environment as a whole. In a culture with a long tradition of using stones for various purposes and in which there was apparently a good deal of individual freedom of expression, the selection process was presumably more habitual than rule-bound.

Most uprights range between 50 and 70 cm in length or height. A few are over 1 meter high. Width normally ranges between 15 cm and 35 cm, and thickness between 5 cm and 20 cm. Cross-sections are commonly either triangular or rectangular since most of the uprights are tabular pieces of rock. The vast majority of uprights taper from the bottom to the top to end in a point (see Fig.11 for an example), or less commonly an angled surface. One variety of pointed slabs resembles a gabled roof (see Fig. 18 for an example). Less common are slabs with parallel sides from top to bottom that are flat, angled, or notched on top. Even less common are slabs that are narrower at the bottom than the top, which in most instances is flat or slightly angled (see Fig. 18 for an example). Some uprights when viewed in profile are more curved than straight-sided. As already noted, some of the non-slab uprights have rounded contours.

Ethnographic evidence suggests that these different upright forms or shapes are likely to be manifestations of the attributes of different gods or classes of gods, such as male and female. Things in nature that are high and straight, for example, were believed to be manifestations of the god Ku's virility. Sexual symbolism of this kind was widespread throughout Polynesia, including Hawai`i. Martha Beckwith noted, for example, that in Hawai`i:

> A slab-shaped or pointed stone (pohaku) which stands upright is called male, pohaku-o-Kane; a flat (papa) or rounded stone is called female, papa-o-Hina or pohaku-o-Hina, and the two are believed to produce stone children. So the upright breadfruit (ulu) tree is male and is called ulu-ku; the low, spreading tree whose branches lean over is ulu-ha-papa and is regarded as female. These distinctions arise from the analogy, in the shape of the breadfruit blossom and of the rock forms, with the sexual organs, an analogy from which Hawaiian symbolism largely derives and the male expression of which is doubtless to be recognized in the conception of the creator god, Kane." (Beckwith 1970:13)
>
> Rocks have sex: the solid rock, columnar in shape, is male; the porous rock, loaf-shaped or split by a hollow, female. Chiefs and priests worshipped these rocks and poured awa over them as representatives of the god. If a stone of each sex was selected, a small pebble would be found beside them which increased in size and was finally taken to the heiau to be made a god. (Beckwith 1970:88)

Based on information such as this McCoy (in press) has suggested that the pointed uprights might represent male gods and the flat-topped uprights, female gods.

Settings or Foundations

The method or manner in which uprights were set varies considerably, sometimes even within the same site where, for example, some uprights may be found resting on bedrock and others on a platform. Five different kinds of settings or foundations have been distinguished (Table 2). They include both natural surfaces (bedrock and boulders) and constructed foundations (mounds, cairns and platforms). The general characteristics, frequency of occurrence, and spatial distribution patterns for each variety is briefly described below, along with the numbers for sites with multiple kinds of foundations.

(1) *Bedrock*--The most common method was to simply set the uprights on top of an outcrop and brace them with a few stones. In many instances the uprights were set into a crack in the bedrock. There are 48 sites (57.83% of the total) in this category, which is predictably widespread.

(2) *Boulder*--The next most common method was to set the uprights on top of a boulder. In some instances the upright was braced by other stones; in other cases it appears that an upright might have been set into a heap of stones. There are 16 sites (19.27% of the total) where a boulder surface was used as an upright foundation. The majority of these are located on the north and east slopes where there appears to be a larger number of naturally occurring boulders of the right size. They constitute a distinctive class of remains that for comparative purposes could be called "boulder shrines."

(3) *Mound*--On 12 sites (14.45% of the total) the uprights are set into a low rubble heap or pile of stones. In the case of some of the smaller heaps, which are low and circular to oval in shape, it may be that the mound was built up around the uprights. The larger mounds are linear and are found on sites with a larger number of uprights. Sites in this category occur over a large area on the north, east and south sides of the Science Reserve.

(4) *Cairn*--There are only 4 sites (4.81% of the total) where the time was taken to build a cairn on which to set an upright. The cairns were made using cobble to small boulder size stones of generally sub-rounded to rounded shape. Three of the four sites (16170, 16175 and 21421) are located on the north slope close to the 13,000 ft elevation. The fourth site (16203) is an adze manufacturing workshop located on the south flank of the summit (Fig.1).

(5) *Platform*--There are 14 sites (16.86% of the total)) where a low, rectangular platform was constructed to seat one or more uprights. The platforms are made of the same kinds of stones used in the cairns. On some sites there are two platforms and thus two groups of uprights. Shrines with platforms are found in various areas (Fig.2), but the only areas with more than one are located: (1) on the south flank of the summit in the midst of a large cluster of sites; (2) in the adze quarry workshop and ritual complex designated Site 16204, and (3) the south side of Pu`u Lilinoe where there are two sites

(11077 and 21213). The latter has adze manufacturing debitage on the surface and like Site 16204 is a part of the adze quarry site complex.

(6) Multiple Settings--Of the 83 sites there are 9 (10.84% of the total) with uprights set on more than one kind of foundation or base (Table 2).

Location on the Structure

On some of the more complex sites uprights are found in locations that correspond to what are generally referred to as the "altar" and the "court" in much of the earlier literature on East Polynesian religious structures (e.g. Emory 1933, 1947). Ethnographic information indicates that the meaning of the uprights varied with their location. Emory had the following to say about the uprights on Society Island *marae*:

> The *marae* of the Society Islands follow a pattern of a rectangular court with a stone platform (*ahu*) at the head serving as a raised seat for the gods. Stone uprights designate the position of the worshippers on the court. When they occur on the *ahu*, they seem to designate the position of gods invoked. (Emory 1970:91)

It is probably reasonable to assume that this same distinction held true for the shrines on Mauna Kea, though there is no known firsthand knowledge of it as far as we know.

Number

In some cases it is difficult to accurately determine the number of uprights on a shrine because of (1) the effects of natural processes, such as erosion and perhaps windshear, that have might have resulted in breakage and the displacement of the stone from its original position, and (2) uncertainty regarding whether a particular stone had been utilized as an upright, a bracing stone or a paving stone. Given a situation such as this, where there are different degrees of confidence, a decision was made to present minimum and maximum numbers (see Table2). The numerical frequency calculations that follow is based on 83 rather than 84 shrines because of uncertainty about the presence of an upright on the shrine on one of the adze manufacturing workshops (Site 11079).

The number of uprights on a shrine varies from 1 to 24 and possibly 25, but 54 of the 83 shrines (65.07%) have just 1 to 3 uprights. Single upright shrines are the most common (30 or 36.14% of the total) and in fact constitute a separate category or type (see the discussion of grounplan below). Pairs of uprights are also common (13) making up 15.66% of the total. Almost as common are shrines with three uprights (11 or 13.25%). Shrines with four or more uprights number 29 (34.93% of the total).

Shrines with 2 Uprights

Pairs of uprights are quite common, with a total of 13 having been identified (15.66% of the total shrines). They occur in all areas of the Science Reserve, but nowhere is there any cluster of them (Fig.3).

Pairs of uprights appear to be widespread, though not necessarily common, in the Hawaiian Islands. It is possible that they might represent an emic type that heretofore has not been described, though there are numerous ethnographic accounts relating to pairs of gods, such as Ku and Hina, which are widely recognized as symbolizing the male and female principles:

> Ku and Hina, as well as their varied aspects, function as man and wife in daily rites performed by the populace. With his sister-wife Hina (whose name means "prostrate"), Ku ("upright") united the people into a single stock, for Ku and Hina represented the male and female reproductive principles. Ku also symbolized the east, sunrise, and the right hand; Hina the west, sunset, and the left. Such antithesis was common. (Luomala 1987:217)

This pair of gods (male-female or husband-wife) has in fact been identified archaeologically at least at one location where the stones are of different lithology, color and size:

> Stokes...has recorded two upright stones connected with, though not on, a *koa* at Pearl Harbor, Oahu. One is a dark stone, 4.5 feet high, representing Kuula, a patron of fishermen, the other a coral stone slab 2.5 feet high, representing his wife, Hina. (Emory 1928:107)

A pair of rounded upright stones have been identified as the gods Kane and Kanaloa in a photograph included in the revised edition of *Ruling Chiefs* (Kamakau 1992). Pairs of pointed upright stones occur on some of the Mauna Kea shrines and are inferred to symbolize two male gods.

<u>Shrines with 3 uprights</u>

Shrines with three uprights occur in almost the same numbers as pairs (11 sites; 13.25% of the total), but the distribution pattern is much more restricted. There are in fact only two general areas of occurence--on the north slope at and just below the 13, 000 ft elevation, and on the south flank of the summit above Pu`u Lilinoe (Fig.4).

<u>Shrines with 4 or more uprights</u>

The 29 sites that fall into this category (34.93% of the total) are found in all sectors of the Science Reserve (Fig.5). A closer examination of the distribution map shows several areas with clusters of these sites, including the north slope, the northeast slope, the south flank of the summit and the adze workshop-ritual complex (Site 16204).

Pavements

There are 16 shrines (Table 2) with crude pavements comprised of one to two courses of irregular and poorly fitted stones. The upper surface of most of them also tends to be irregular, as does the shape or form of the pavement in planview. The size (area) is likewise highly variable. The largest pavements are found on shrines with courts (Sites 16168, 16204, 21214, 21420, and 21431), and indeed the pavement is commonly the best indicator of a court. Smaller pavements are a feature of some of the small "boulder shrines" (e.g. Site 21418) which is a category defined by multiple, dispersed uprights located on top of a boulder and on the ground surface below. The ground level uprights in such cases frequently rest on the pavement.

The small number of shrines with pavements (19.27%) indicates that they were not a common feature. They are widely distributed (Fig.6), but the only places where they occur with any frequency are: (1) on the north flank of the mountain ; (2) on the south flank of the summit; and (3) in the adze workshop/ritual complex (Site 16204). This distribution pattern is similar in many respects to the "platform shrines" discussed above.

The function or uses of these pavements is unknown, but based on what is known about the function of stone pavements found on *heiau* it is reasonable to suggest that they were probably built as a place to lay offerings as indicated in this account by Buck:

> Stone pavements termed *kipapa* were laid in front of the images on the floor of the court...According to Malo (1951, p. 162), the temple offerings (*mohai)* were placed upon the offering pavements temporarily, until the priest was ready to go through the ceremony of presenting them to the gods. Some pavements were made in the space between two images for a similar purpose. (Buck 1957:522)

Courts

There are only seven sites (8.43% of the total shrines) with courts (Table2), which as previously noted are oftentimes identified by the presence of a crude pavement to one side of a row of uprights. Not all of the sites with courts have pavements, however (see Table 2). In cases such as this, it is the presence of one or more uprights on a flat area opposite a row of "altar" uprights that defines the court. None of these courts, which may have been called *kahua* like those on *heiau* (Buck 1957:516), are enclosed, but in several instances the court area is clearly demarcated by the local topography (lava flow margins or ledges).

The location of the court at Sites 16168, 16190, 21214, 21420 and 21431 indicates that the approach to the shrine was from the uphill side, so that the back of the celebrants would have been to the mountain (i.e., the sites faced the sea). Site 16184, which consists of two parallel rows of uprights and a possible intermediate upright at the uphill end between the rows, is an exception. Another exception is shrine 4 of Site 16204, where the court is located on the downhill side of a raised platform, so that the celebrants would have been facing the top of the mountain when performing rituals. A possible explanation for this unusual orientation is given elsewhere (McCoy in press).

Sites with courts occur in all sectors of the Science Reserve, except for the southwest quadrant where the surveyed area is limited to just one transect, however (Fig. 7). The seven sites with courts are structurally and visually among the most impressive religious structures in the summit region. If one accepts the distinction Buck made between shrines and temples, these seven sites should be classified as small temples that according to Buck would have been made by a family group or lesser chief (Buck 1957:516). There are several more sites with courts in the adze quarry, where the functional association is clearly linked to occupational specialization.

Groundplan

The ultimate expression of variability is in the groundplan or layout. The following five "categories" are provisionally recognized: (1) single upright; (2) a single row of aligned uprights; (3) a row of uprights and one or more off-set uprights; (4) multiple rows of uprights, and (5) dispersed uprights. The frequency of each category is summarized in Table 3.

Table 3--Summary of Groundplan Category Characteristics

Category	Defining Characteristics	No.	% Total
1	single upright	30	36.14
2	single row of two or more uprights	33	39.76
3	row of uprights and off-set uprights	10	12.05
4	multiple rows of uprights	6	7.23
5	group of dispersed uprights	4	4.82

There is a general progression in structural complexity from simple to complex in in the move from one category to the next. There is no indication, however, that this is necessarily an evolutionary sequence, with the more complex shrines developing from the simpler ones and dating to a later time period. It is highly likely that the various groundplans all existed at the same time, and that the differences are to be explained in social terms.

Category 1

The simplest or most elementary kind of shrine, but at the same time the most problematical for reasons outlined above, is the single upright stone. A total of 30 or 36.14% of the shrines in the Science Reserve fall into this category (Table 3). In 16 or 53.33 % of the cases the upright was set on bedrock, either in a crack or on the surface, and supported by bracing stones. As nothing more than a point, a simple mark on the landscape, shrines such as these clearly have no ground plan. There are 9 sites (30% of the total) where the upright was set on top of a boulder. Rarely, was the time taken to construct a mound, cairn, or platform for a single upright (Table 2). One of the few examples is Site 16202, which has an unusual crescent-shaped upright set on a small platform (Fig. 9). It is located at the 13,006 ft elevation amongst a group of shrines on the south flank of the summit.

Though small, it is unlikely that the boundaries of these simple shrines were defined by the upright alone. How large of an area would have been regarded as a "sacred precinct" is difficult to know.

Single upright shrines have been found everywhere, except for Transect 2, where no shrines were found at all (Fig. 8). Elsewhere these simple shrines are widespread, but the distribution is uneven. The largest number are found on the north slope, including Transect 3. There is one loose grouping of 5 sites (16171, 16172, 21199, 21200 and 21198) on the northwest slope centered around the 13,000 ft elevation Five single upright shrines were found in Transect 3, two of which (21421 and 21428) are in close proximity, forming one of the paired groupings mentioned above. The second largest number of single upright shrines are found on the northeast-east slope, south and east of Pu`u Mahoe. A total of eight sites were found in this general area. Further south, there are two clusters, each comprised of three sites, located in the general environs of Pu`u Lilinoe. The cluster on the northwest side of Pu`u Lilinoe includes Sites 16202,16197 and 16199). The three sites in this category on the southeastern side of Pu`u Lilinoe are 11077, 21210 and 21213.

Category 2

The most common category of shrines in the Science Reserve are those consisting of a series of uprights aligned in a single row. There are 33 sites in this category, which makes up 39.73% of the total shrines (Table 3). There is considerable variability within this category in terms of both (1) the number of uprights that form the rows, and (2) the spacing between the uprights. The simplest and most common kind of row is a pair of uprights (see discussion above). The data have not been completely analyzed, but one could recognize, for example, small, medium and long rows. A good example of a long row is Site 16194, which has a total of 12 and possibly 14 uprights (Figs.10 and 11). It is located at t he 12,673 ft elevation on the east slope.

Single row shrines are widely but unevenly distributed, and were found in all of the survey areas, except for Transect 2. Their distribution is more restricted than the Category 1 shrines (Fig. 12). There are only two on the northwest slope, for example (Sites 16165 and 16169). The largest number are found on the north and northeast slopes to the west and south of Pu`u Mahoe. Further south, there is a sizable loose cluster of 5 sites (16176, 16185, 16180, 16179 and 21202) on the northwest side of Pu`u Mahoe and three more (Sites 21211, 21212 and 21214) on the south flank of that prominent cinder cone. Three of the shrines (1, 2 and 5) that are found on Site 16204, the site located on the eastern fringe of the Mauna Kea adze quarry (McCoy in press) , fall into this category.

Category 3

The defining characteristic of this category of shrines, which distinguishes it from Category 2, is the presence of additional uprights located on one side of the primary row. There are 10 sites in this category (12.05% of the total, Table 3). In some cases these uprights are located on a clearly defined court and can, following the established practice in describing East Polynesian *marae*, be called "court uprights." The probable function of these uprights as backrests for persons of honor has been noted above in the discussion of upright locations. A good example of a site in this category with uprights on the court is Site 16190 (Figs.13 and 14) which is located on the east slope at the 12,956 ft elevation. In other cases there is no clearly defined court. It could be argued, however, that because the they occupy a different space than the row ("altar") uprights, they are essentially the same thing as "court uprights."

Shrines comprised of a row of uprights and other, presumably secondary uprights to one side of the row, are less numerous and of more restricted distribution than either Categories 1 and 2. None were found in Transects 1 and 2 (Fig. 15). There is, however, one site in this category (Site 16168) on the southern border of Transect 2, where it adjoins the Natural Area Reserve on Pu`u Pohaku (Fig. 15). Most of the sites in this category are found on the north and east slopes close to the 13,000 ft elevation. One notable fact about the Category 3 sites on the northwest, north and eastern slopes is that they are roughly equidistant from one another (Fig.15). Three more sites in this category are located on the south side of the summit, above Pu`u Lilinoe.

Category 4

There are only 6 sites (16166, 16184, 16198, 16204-3, 16204-4 and 21420) in this category, which includes shrines with more than one row of uprights. Though small in number (7.23% of the total, Table 3) there is considerable variability in the plan or layout. In some cases, such as shrines 3 and 4 on Site 16204, the rows parallel one another. On Site 21420 the rows intersect to form two sides of a structure that has the general appearance of an enclosure, though the other two sides are natural boulders and cobbles. Many of the sites in this category have pavements and/or courts.

One of the two sites located in the southern half of the Science Reserve is located on the northwest side of Pu`u Lilinoe (Site 16198). The other two examples in this area, shrines 3 (see Figs. 16, 17 and 18) and 4 on Site 16204, are located on a long whaleback ridge that includes a number of other remains related to the Mauna Kea adze quarry (McCoy in press). Two of the four are found in the northern half of the Science Reserve, one (Site 16166) on the western flank of Pu`u Hau Oki and the second just below Pu`u Mahoe (Fig.19).

Category 5

This is a rare form of shrine with only 4 examples (4.82% of the total, Table 3). The defining characteristic is a small number of uprights that do not appear to be aligned in any obvious way, but are rather dispersed.

All four sites (16173, 16174, 16175 and 16180) are located in a relatively small area on the north flank of the mountain at or near the 13,000 ft elevation (Fig. 20). The localization to just one area is highly unusual. It is possible that all of them may have been made by one small family group or related families.

Offerings

Apart from a single *`opihi* shell of questionable age on shrine 2 of Site 16204 and the adze rejects found on the shrines at the adze manufacturing workshops associated with the quarry (Sites 11079, 16203, 16204, and 21211) no other obvious offerings of any kind--coral, shell, bone, stone, have been found on the shrines in the Science Reserve. It is hard to imagine that nothing was offered to the gods, thus leading to the obvious supposition that the offerings must have all been perishable materials, such as strips of pandanus that might, for example, have been tied around the uprights.

An account of a shrine and associated remains dedicated to Pele at a place called Puu o Umi on Mauna Loa (see Emory 1943; 1970) indicates that the uprights themselves should perhaps be considered offerings:

> An old road of Umi's from his heiau between the mountains in Kona to Kau, is mentioned in the article "Ahua a Umi" in the 1917 Annual. A most interesting discovery of another section of this road was made by Professor Jaggar on visiting the source of the 1919 lava low. Near the source of the flow were many small horse-shoe shaped stone shelters at different parts of the trail, and one large stone platform with long stones erected at the back, and further along a smaller stone platform. It has been learned from the Hawaiians that these platforms were for the priests, and the upright stones were offerings erected whenever there was a flow in this especially Pele-ridden section of Mauna Loa, to avert disaster. The shelters were against the prevailing wind, and would hold from one to several men, sheltering quite a company in all." (Baker 1920: 85)

It may never be possible to corroborate this statement, but the idea that a stone erected for the purpose of averting a disaster is regarded as an offering to the god Pele makes sense and is not inconsistent with the generally accepted view that uprights and other material objects were places for the gods to inhabit when they were needed.

Functional Variability and Use

On current evidence there are at the minimum two functional classes of shrines represented in the 84 shrines located in the Science Reserve---(1) the 8 occupational specialist shrines that are part of the adze quarry, and (2) all the others, which on current evidence appear to be "non-occupational." Morphologically, there is nothing to distinguish these two classes, each of which exhibits considerable variability in groundplan, number of uprights, etc. The Mauna Kea shrines are in this regard no different from Hawaiian shrines in general. According to Buck, "Shrines varied considerably in construction, and similar forms were distinguished merely by their function." (Buck 1957:528). The only thing that distinguishes the occupational shrines from all the others are the associated lithic scatters that represent the remains of specialized workshops, and the adze manufacturing byproducts (offerings) found on the surfaces of these shrines.

In the report on the 1982 survey of the central summit area and north slope McCoy (1982) suggested the possibility of variability in the function and use of the non-occupational shrines. The contrast between the simple shrines with a small number of uprights and the more complex structures with courts and larger numbers of uprights (called *marae* in the 1982 report) led to the conclusion that the former were probably made by one or a few individuals and the latter by a larger kin group.

To expand and refine the earlier speculation, it now seems likely that the simple shrines were built and used by small family groups as originally thought, but that the larger, more complex structures were built and maintained by a priesthood. There are two initial reasons for thinking this may be the case. First, on the assumption that each upright stands for a separate god, the larger number of uprights on these sites points to a larger pantheon of gods (major and minor gods) that probably most Hawaiians would not have known. Second, many of the sites in this category are isolated from the main areas of worship (see Fig. 7). The separation has to have been deliberate. It implies, as physical separation often does, a meaningful social boundary and, in this case, status differences.

We will never know what kind of rites were conducted at any of the shrines or the names of the gods that were invoked. The uprights on the larger, more complex sites, those which are inferred to have been built and used by priests instead of the heads of small family groups, may have possibly functioned in a way similar to that described by Raymond Firth for the stone symbols on the *marae* of Tikopia:

> The material symbols also gave a kind of chart for navigation in ritual behaviour. The ritual of Marae Lasi in Uta had an intricate ground plan, and by reference to the stone symbols of the gods the performers could constantly orient themselves for assembly and individual action. The stones were also of great importance as mnemonics, serving to remind generation after generation of what had to be done, where and for whom. (Firth 1970:126)

Age

As noted in the Introduction, none of the shrines have been dated and it is unlikely that any ever will be unless some organic material is found buried beneath an upright or paving stone, or some new dating technique is developed in the future. Some of the shrines are potentially quite early, and may even date to the early colonization period, if McCoy's theory about the meaning and origins of the summit region shrine complex is true.

McCoy (1982, 1990) has interpreted the shrine complex in the summit region as the remains of an historically undocumented and apparently unknown pattern of pilgrimage to worship the snow goddess, Poliahu, and other mountain gods and goddesses. In a paper on the adze quarry, he commented briefly on the probable origins of the pilgrimage process (McCoy 1990:113-114):

> A large shrine complex located above the quarry suggests that the earliest activity on the top of the mountain was related to the worship of local gods and goddesses. This complex, which is interpreted as a 'pilgrimage center', is inferred to have had its origins in what would have been for the first colonists from east Polynesia a natural history anomaly--snow--which because it was 'matter out of place' must have been regarded as mystically dangerous. As Lewis (1976:109) points out, 'anomalies are always situational and relative, never or very rarely absolute.' The shrine complex, though undated, suggests that this anomaly was not avoided, but rather than it was quickly given a place in the local cosmology (Douglas 1966:38).

While a few shrines could date to perhaps as early as AD 700-800, most were probably constructed at a later time, coinciding with the rise in population and intensification of adze manufacture in the adze quarry circa AD 1400-1600. It is important to note in this regard that the shrines in the Science Reserve and those in the adze quarry are stylistically indistinguishable. A good number of shrines are therefore probably coeval with the quarry industry, which is roughly dated to circa AD 1100 to AD 1800 (McCoy 1990).

ADZE MANUFACTURING WORKSHOPS

There are four sites in the Science Reserve (11079, 16203, 16204 and 21211) that are classified as adze manufacturing "workshops " based on the presence of one or more of the following kinds of manufacturing byproducts---flakes, cores, adze rejects, and hammerstones. These are "workshops" of a different kind that those found in the adze quarry, however. First of all, there is no naturally occurring stone-tool quality raw material on any of these sites, which means that all of them are located outside of the quarry proper. Both the raw material used for the manufacture of adzes and the tools (hammerstones) employed in the manufacturing process had to have been brought from the quarry. Second, there seems to be a disproportionate number of adze rejects compared to the number of flakes, thus pointing to the high probability that some of the adzes were flaked elsewhere and/or transported to these localities at a later stage in the manufacturing process. This, combined with the small size of the assemblages, suggest that these were not ordinary workshops. Site 16204 differs from the others in the presence of a number of small open-air enclosures (Fig.21).

Associated with each of these workshops is one or more shrines. All of them have one or more uprights, with the possible exception of Site 11079 where there is reason to believe that one existed but was removed before the site was recorded. What is inferred to have been the shrine at this site is a large boulder with a number of cobble-size rocks and one adze reject on top (Hammatt and Borthwick 1988). The rocks would have supported at least one upright and the adze is in a location that suggests it was an offering because of the deliberate placement on a boulder. Adze rejects , flakes and occasionally other manufacturing byproducts were found on the shrines at the other three sites. These assemblages, like those found on many shrines in the quarry, are interpreted as offerings to the tutelary gods of adze making (Malo 1951 McCoy 1990, in press).

All of these sites, but Site 16204 in particular, are highly significant for the information they convey about the quarry as a social process. McCoy (in press) has interpreted this site as the locus of initiation rites for apprentice adze makers.

BURIALS AND POSSIBLE BURIALS

There are numerous references to human burials on the northern and eastern slopes of Mauna Kea, some at elevations that would fall within the boundaries of the Science Reserve (see discussion in McEldowney 1982). The practice of burying the dead in remote, high elevation areas may have been a common practice, based on the information collected by Thomas Thrum:

> The use of the craters within Haleakala as burial places, far removed from places of habitation, is quite in keeping with ancient Hawaiian practice. Distances and difficulties were no bar to faithful execution in carrying out the instruction of a dying relative or friend. (Thrum 1921:258)

One reason, but undoubtedly not the only one, for taking the dead to remote areas was the fear that the bones might be used to make fishhooks. A person named Nainoa gave such an explanation in testimony before the Boundary Commission:

> In old times, if anyone died, could not wail, but people come and steal shin bones for fishhooks, so used to carry body secretly and bury in mountains (quoted in McEldowney 1982:1.9)

To date the only positively identified human remains found in the Science Reserve are located at Site 16248 on the summit of Pu`u Makanaka (Fig. 1). Jerome Kilmartin, a surveyor with the United States Geological Survey, noted the presence of human remains on this prominent cinder cone in 1925. A popular account of his experiences on the mountain, written many years later, contains some interesting information regarding this site:

> To set up Camp Four at 12,400 feet near Puu Makanaka, we had difficulty finding a small flat area for the tents. Makanaka is the largest and most perfectly formed cone in the summit area, 1,500 feet in diameter at the rim and 300 feet deep, while the base is more than 600 feet below the rim at one point. On the rim I found a partially uncovered grave, eroded by high winds, with an incomplete human skeleton. This was unknown, as far as I could discover, to anyone familiar with the area. The name Puu Makanaka means "Hill crowded with many people" and the grave must have been ancient. (Kilmartin 1974:15)

In 1991 Patrick McCoy, Holly McEldowney, and Marc Smith made an effort to record the burials at this site, but the onset of cold, rainy weather prevented them from accomplishing the task. Human bones were observed at that time within several cairns (Fig.22) on the southern rim. Several other spatially discrete groups of cairns, each comprised of two to three individual cairns, were found on the southern and eastern rim. On current evidence Kilmartin probably only saw one part of this site. The reference to an incomplete skeleton is potentially quite significant. Without more information one can only speculate, but it is possible, if not highly likely, that the remains represent a secondary burial.

There are four other sites in the surveyed areas of the Science Reserve that have been identified as possible burials (Sites 16195, 21413, 21414 and 21416). In each case there are compelling reasons to believe that the the site is indeed a burial, but because human remains were not seen at the time the site was recorded it has been called a possible burial.

There are several reasons for thinking that the four sites in question are burials. First, the cairns are morphologically similar to those on Pu`u Makanaka and at the well known burial center at Kanakaleonui and unlike other cairns, such as the one at Site 21412, which is more cyclindrical in shape. It is also possible that these cairns are another form of shrine, one without an upright. A common practice is for visitors to such remote and generally inaccessible places is to build a cairn to commemorate a visit, to record the ascent of a peak. While it is possible that all of these possible burial cairns may be markers erected to commemorate a visit to the top of a cinder cone, it is significant that they are all located, like those on Pu`u Makanaka, on the eastern and/or southern rim of each cone. The same is true of a small group of cairns on the eastern rim of Pu`u Waiau that are also believed to be burials. The probability that all visitors would construct the same kinds of cairns at the same locations on a cinder cone seems remote. In summary, the morphological characteristics, and locational setting of these cairns suggest that they are more likely to be burials than markers.

Site 16195 consists of two adjacent cairns located on the eastern rim of Pu`u Lilinoe. The site was initially recorded in 1975 during McCoy's research project in the adze quarry. At that time some doubt existed as to whether the cairns were historic or modern, partly because a piece of milled wood was found in one of them. The wood suggested that they might be surveyor markers. Both cairns were in poor condition at that time and appear to have been disturbed. After seeing the cairns on Pu`u Makanaka and at Kanakaleonui and reviewing the historic period literature on Mauna Kea, there is good reason to suspect that these may be the graves that W.D. Alexander's surveying party saw on the top of Pu`u Lilinoe in 1892. Alexander wrote:

> The same afternoon [July 25, 1892] the surveyors occupied the summit of Lilinoe, a high rocky crater, a mile southeast of the central hills [the 'summit'] and a little over 13,00 feet in elevation. Here, as at other places on the plateau, ancient graves are to be found. In olden times, it was a common practice of the natives in the surrounding region to carry up the bones of their deceased relatives to the summit plateau for burial. (Alexander 1892)

If the cairns that were recorded in 1975 were in fact the same graves, the remains had been removed sometime prior because no human bone was visible at that time.

Sites 21413, 21414 and 21416 are located on the southern and eastern rim of a large unnamed cinder cone on the northwestern edge of the Science Reserve ((Fig. 1). They were found during the survey in 1997. Each consists of a single cairn, that unlike the two cairns on Pu`u Lilinoe, appear to be undisturbed. There appear to be a few more cairns of the same kind on the eastern rim.

There is good reason to expect that more burials are to be found in the Science Reserve on the tops of cinder cones, either in cairns or in a small rockshelter or overhang. The basis for this prediction is that all of the known and suspected burial sites on the summit plateau are located on the tops of cinder cones and, more particularly, on the southern and eastern sides. No burials have been found on the sides or at the base of a cone, or on a ridgetop amongst any of the shrines. There in fact appears to be a clear separation between burial locations and shrine locations.

The apparent restriction of the higher elevation burials to the apex of cinder cones is in sharp contrast to many of the burials found at Kanakaleonui, a well-known burial center located not too far outside of the Science Reserve, just below Pu`u Makanaka and the summit plateau, which is the lower boundary of the proposed Mauna Kea Summit Historic District. Reconnaissance of this area indicates that there are a indeed a great number of structural remains at this locality. There are platforms on the top of the cone and a great number of smaller cairns at the base. On current evidence there are more burials in the general environs of Kanakaleonui than probably exist higher on the mountain, possibly on all of the summit plateau. The disproportionate number of burials in the environs of Kanakaleonui suggests that the edge of the plateau might have been a major social boundary, with the area below reserved for commoners and the plateau for persons of higher social status (chiefs and priests). If the very top of the cones were reserved for higher status individuals and the ground below for commoners, then Kanankaleonui must have both.

MARKERS

Three sites (21411, 21412, and 21423) are classified as either survey markers or markers left by unknown visitors. Sites 21411 and 21412 are cairns and Site 21423 a less formal pile of rocks on top of a boulder. The cairns are quite unlike those which have been interpreted as burials (compare with Fig. 22). The cairn at Site 21412, for example, is more cylindrical in shape and faced (Fig.23).

The first mention of a cairn on Mauna Kea was made by the Rev. Goodrich, who found one on the summit in 1823 (Goodrich 1826). This site, which appears to have been either destroyed or extensively modified over time, has been designated Site 21209 because of its obvious importance as the first mentioned historic site on the mountain. The function is presently listed as unknown (Table 1). It is possible that it could have been a shrine, a burial, or a memorial to some unknown event or person.

There are other references to cairns on the summit, including one by Jarves in 1844, one by Alexander in 1892 and another one that was published in the Mid-Pacific Magazine in 1911:

> My companions, not having seen the snow, disbelieved the guide's statement the evening previous, and started themselves to seek the summit. Having ascended the hill which the guide had pointed out, they found another arising two hundred or more feet above that, which, after great labor, they scaled. These hills are composed of loose sand, into which one slips knee deep at every step. The second one was frozen hard. This was found to be the highest point; it was covered with slag, lava, and gravel. The snow, or rather ice, lay in chasms, in a few spots, in masses ten feet deep, fourteen wide, and three hundred long...Having piled a cairn, as a memorial of their success, they returned in all haste to the camp. (Jarves 1844: 228)

> On Monday, the 25th, the thermometer stood at 20 deg. at sunrise. Messrs. Muir and Alexander ascended the second highest peak on the northwest, overlooking Waimea, 13645 feet height to continue their survey. In the cairn on the summit a tin can was found, which contains brief records of the visits of five different parties from 1870 to the present time, to which we added our own. A party of eight girls from Hilo, "personally conducted" by Dr. Wetmore and D.H. Hitchcock, Esq., in 1976, must have been a merry one. Cpt. Long of H.B.M.'s Ship Fantome had visited this spot in 1876, and Dr. Arning with several Kohala residents in 1885. (Alexander 1892)

> At the highest point, an elevation of 13,825 feet, a mound of rocks is built, and in this a can lines that contained lists of the names of those who, in recent years, had climbed the mountain, and deposits of silver money made toward a fund for a monument there, and divers [sic] articles, the leaving of which had suited the taste and fancy of the depositor. One had left a small compass, another a bunch of sulphur matches, another a brass button, another a penny.

> We copied the names of those who had been there before us, and left our own and gave each of a bit of silver the Summit Monument. Then we be-though ourselves that as the sum in the can had reached the amount of $4.05, it was time some steps were taken looking to the carrying out of the purposes of the contributors. And so we then and there perfected the organization of the Mauna Kea Association, Limited, and elected Joseph G. Pratt, president, Eben P. Low secretary and collector, and A.L.C. Atkinson treasurer. The amount of the collection was turned over to the treasurer, and it was determined that any person who has made the ascent of Mauna Kea, the highest point in the Hawaiian Islands, shall be eligible for membership upon proof that he has been on top of the mountain, and that each member contributing to the monument fund shall receive a certificate stating the date of his ascent and acknowledging the amount of his contribution. (Anonymous, Mid-Pacific Magazine 1911:408)

Some things that could possibly be interpreted as markers have been built in modern times. Jerome Kilmartin, who was in charge of the topographic mapping of the Lake Waiau quadrangle for the United States Geological Survey, in 1925, mentions building an *ahu* to retard the wind (Kilmartin 1974:15).

One would expect that there would be more markers in the summit area of the mountain than this, and it is indeed possible that some of the simple stacked-stone constructions that we thought were of modern age, may be memorials of the kind described by Thomas Thrum in Haleakala:

> It was a recognized custom of Hawaiians to erect stone piles--pile is one meaning of the word ahu--as way marks, memorials of parties traveling or resting, division points of survey, and also guides to most accessible routes of travel. One such marks the safest of three ridges leading from the rim of the crater to the district of Nuu. That some ahu mark burial places is in accord with the present practice in certain districts of Maui and of Hawaii, and perhaps elsewhere. Most, if not all, of the ahus of three stones, one upon the other, are tributes to the deity of the locality and are designed by travelers to assure safety in their journey. (Thrum 1921:259)

The number of markers could thus change with a closer examination of the survey data.

UNKNOWN FUNCTION

There are five sites of uncertain or unknown function, including the summit cairn (Site 21209) that was just mentioned above. Three of the other sites (21204, 21417, and

21434) are either cairns or piles of rocks that could be markers. Site 21427 is a terrace with a possible upright; it may be an unfinished shrine.

MACRO-LEVEL SITE DISTRIBUTION PATTERNS

Archaeological sites have been found in all areas that have been surveyed to date (totalling some 3000 acres). There are significant differences, however, in the number, types, and density of sites in given areas and on different landforms. (Fig. 1). Burials, for example, have been found nowhere else than on the tops of cinder cones and never together with shrines. Some of the other more obvious differences in site distribution patterns and the implications these have for understanding the development of the Mauna Kea summit region into a ritual center are discussed below. A more detailed analysis of the spatial data will undoubtedly change and refine some of the conclusions that have been reached at this time.

Summit Cones

The most important observation to be made about the summit (Kukahauula) is the meager evidence of human activity prior to the historic period. Indeed, with the single exception of the cairn (Site 21209) that the Rev. Goodrich found in 1823, there are no other known sites on the series of cinder cones that comprise the "summit" of Mauna Kea. While no archaeological surveys were conducted prior to the construction of the summit road in 1965, there is no indication that any archaeological sites on the "summit" were destroyed at that time, or at any time thereafter in the construction of the existing observatories. The "summit" cairn is, moreover, the only site mentioned in the historic literature and publications of early scientific expeditions.

The virtual absence of archaeological sites on the very top of the mountain may mean different things and is potentially open to a number of different interpretations. In the early to mid-19th century the opinion seems to have been that Hawaiians avoided the top of the mountain because of the cold environment and superstitious beliefs. The following accounts provide an indication of the thinking at that time:

> The natives have no passion for high mountains, or cold weather. (Jarves 1844:222)
>
> Rev. Joseph Goodrich, who, on this occasion, was unfortunately laid up with mountain sickness, had on 26th August, 1823, reached the summit of Mauna Kea. This is the first recorded instance of the ascent of this mountain, although Mr. Goodrich mentions that on reaching the top of one of the terminal cones that encircle the main plateau of Mauna Kea, he discovered a heap of stones, probably erected by some former visitor. Who this former visitor was is unknown, but he was probably one of the white men that in the early years of the nineteenth century got a living by shooting wild bullocks that roved on the side of Maunt Kea. It is very unlikely that any native had reached the top of the terminal cones on the summit, owing to being unprovided with warm clothing to resist the great cold and also to the fact that the natives had a superstitious dread of the mountain spirits or gods. About six months after the date of the first ascent of Mauna Kea by Mr. Goodrich the peak was scaled by Dr. Abraham Blatchley and Mr. Samuel Ruggle, both connected with the American Mission. (Macrae 1922:55)
>
> The snow on the summit of the mountain, in all probability, induced the natives to call it Mouna-Kea, (mountain white), or, as we should say, white mountain. They have numerous fabulous tales relative to its being the abode of the gods, and none ever approach the summit---as, they say, some who have gone there have been turned to stone. We do not know that any have been frozen to death; but neither Mr. Goodrich, nor Dr. Blatchely and his companion, could persuade the natives, whom they engaged as guides up the side of the mountain, to go near its summit. (Ellis 1979:292)

The lack of warm clothing was clearly not a deterrent to reaching the top of the mountain, as the numerous shrines located only a few hundred feet below the summit demonstrate. The repeated references to the top of the mountain being the "abode of the gods" and to the fear of these mountain gods indicate why the early expeditions could not persuade their Hawaiian guides to go all the way to the suumit. The top of the mountain was clearly a sacred precinct that must, moreover, have been under a *kapu* and accessible to only the highest chiefs or priests. The virtual absence of sites on the summit cones suggests that the same belief system had been adhered to and strictly enforced in the more remote past.

Northern and Eastern Slopes

The primary concentrations of sites in the Science Reserve are found on the northern and eastern slopes just above and below the 13,000 ft elevation (Fig.1). This pattern, which was discussed at some length in the report on the 1982 survey (McCoy 1982) suggests that most of those who journeyed to the summit area came from the Hamakua and Hilo sides of the mountain. The sizable number of sites found in the Transect 3 survey add more support to this interpretation. More sites were seen in the distance outside of the transect.

While there appear to be many more sites on the northern flank of the mountain, the same would not seem to hold true for the eastern slope. Reconnaissance of the area south of Pu`u Poepoe and Pu`u Makanaka, suggests that there there is a sharp drop off in the number of sites below the 12,500 ft elevation.

Western and Southwestern Slopes

Few sites of any kind have been found on the western and southwestern slopes, which have not been as thoroughly surveyed as the other areas, however. Only five shrines were found in the survey of Transect 1 and none in the survey of Transect 2 (Fig.1). The focal point of human activity in this area may have been the use of the large cinder cone located below the Natural Area Reserve for burial.

While the small number of shrines on this side of the mountain suggest the possibility of people coming from the Kona and South Kohala districts, the number would appear to have never been high. The implications are quite interesting. It suggests that while the mountain may have been viewed from a distance by people from everywhere on the island as a sacred mountain, in practice those who made the journey and worhsipped there did not represent an even cross-section of the island populace. The implication is that access to the summit region was under the political control of the east Hawaii chiefdoms, a conclusion that is consistent with all of the other data.

Southeastern Slope

The site distribution map (Fig. 1) shows several discrete clusters of sites on the southeastern slope. The largest and, inferrentially most important cluster, is located directly below the summit, which is not visible from this locality, however. The number of sites at this one locality suggests that it was a specific destination point for large numbers of people over a lengthy period of time, and in fact this location is about as close as one can get to the summit without actually climbing the side of the cinder cone. Contained within this cluster is one adze manufacturing workshop (Site 16203), thus pointing to the possibility that some of the other shrines in this area may have been built by adze makers.

A second, smaller cluster of sites, also with adze manufacturing debris, is located on the lower side of Pu`u Lilinoe. The third obvious cluster, which is well separated from all the others, is the Site 16204 complex that has been previously described (Fig. 1).

REFERENCES CITED

Alexander, W.D.
1892 The Ascent of Mauna Kea, Hawaii. *The Hawaiian Gazette* 27(38):7.

Anonymous,
1911 Mauna Kea: The Highest of Island Peaks [illustrated by Alonzo Gartley]. *The Mid-Pacific Magazine* 11(5):403-411.

Baker, Albert S.
1911 The Kona Coast. *Hawaiian Annual for 1921*, pp. 80-85.

Beckwith, Martha
1940 *Hawaiian Mythology.*University of Hawaii Press, Honolulu.

Buck, Sir Peter
1957 *Arts and Crafts of Hawaii.* Bernice P. Bishop Museum Special Publication 45. Honolulu.

Cox, J. Halley and William H. Davenport
1988 *Hawaiian Sculpture* (Revised Edition). University of Hawaii Press. Honolulu.

Douglas, Mary.
1966 *Purity and Danger: An Analysis of the Concepts of Pollution and Taboo.* Routledge and Kegan Paul, London.

Ellis, William
1979 *Journal of William Ellis: Narrative of a Tour of Hawaii ,or Owwhyee; with Remarks on the History, Traditions Manners, Customs, and Language of the Inhabitants of the Sandwich Islands..* Charles E. Tuttle Company, Inc. Rutland, Vermont.

Emory, Kenneth P.
1921 *An Archaeological Survey of of Haleakala.* Bernice P. Bishop Museum Occasional Papers 7(11):237-259. Honolulu.
1928 *Archaeology of Nihoa and Necker Islands*. Bernice P. Bishop Museum Bulletin 53. Honolulu.
1933 *Stone Remains in the Society Islands.* Bernice P. Bishop Museum Bulletin 116. Honolulu.
1938 The Adz Makers of Mauna Kea. *Paradise of the Pacific* 50 (4):21-22.
1943 Polynesian Stone Remains. In *Studies in the Anthropology of Oceania and Asia*, edited by Carleton S. Coon and James M. Andrews, IV, pp. 9-21. Papers of the Peabody Museum of American Archaeology and Ethnology 20. Harvard University. Cambridge.
1970 A Re-examination of East-Polynesian Marae: Many Marae Later. In *Studies in Oceanic Culture History, Volume 1*, edited by R.C. Green and M. Kelly, pp. 73-92. Pacific Anthropological Records 11. Department of Anthropology, Bishop Museum. Honolulu.

Firth, Raymond
1970 *Rank and Religion in Tikopia..* George Allen and Unwin, London.

Goodrich, Joseph
1826 Notice of the Volcanic Character of the Islands of Hawaii. *American Journal of Science*, Series 1, 11:2-7.

Gregory, Herbert E. and Chester K. Wentworth
1937 General Features and Glacial Geology of Mauna Kea. *Bulletin of the Geological Society of America* 48: 1719-1742.

Jarves, James
1844 Scenes and Scenery in the Sandwich Islands, and a Trip Through Central America. James Munroe and Company. Boston.

Hammatt, Hallett and Douglas Borthwick
1988 Archaeological Reconnaissance of Two Proposed Antenna Sites for the National Radio Astronomy Observatory, Mauna Kea, Hawaii.

Kamakau, Samuel M.
1964 *Ka Po` Kahiko (The People of Old)* Bishop Museum Special Publication 51. Honolulu.
1992 *Ruling Chiefs of Hawaii* (Revised Edition). Kamehameha Schools Press. Honolulu.

Kaeppler, Adrienne
1982 Genealogy and Disrespect: A Study of Symbolism in Hawaiian Images. *Res* 3:82-107.

Kilmartin, Jerome
1974 Na Mea o Mauna Kea (Things About Mauna Kea). *Explorers Journal* 52(1): 12-16.

Kirch, Patrick V.
1985 *Feathred Gods and Fishhooks: An Introduction to Hawaiian Archaeology and Prehistory*. University of Hawaii Press, Honolulu.

Lewis, I.M.
1976 *Religion in Context: Cults and Charisma.* Cambridge University Press. Cambridge.

Luomala, Katherine
1987 Hawaiian Religion. In *The Encyclopedia of Religion*, Edited by Mircea Eliade, 6: 214-219.

Macrae, James
1922 *With Lord Byron at the Sandwich Islands*, Edited by W.F. Wilson. Honolulu.

Malo, David
1951 *Hawaiian Antiquities.* Bishop Museum Special Publication 2. Honolulu.

McAllister, J. Gilbert
1933 *Archaeology of Oahu* Bernice P. Bishop Museum Bulletin 104. Honolulu.

McCoy, Patrick C.

1977 The Mauna Kea Adz Quarry Project: A Summary of the 1975 Field Investigations. *Journal of the Polynesian Society* 86(2):233-244.

1981 Stones for the Gods: Ritualism in the Mauna Kea Adz Quarry Industry, Hawaii. Paper presented at the 46th Annual Meeting, Society for American Archaeology, San Diego, California.

1982 Archaeological Reconnaissance Survey, In Patrick C. McCoy and Holly McEldowney, Cultural Resources Reconnaissance of the Mauna Kea Summit Region. Department of Anthropology, Bishop Museum.

1990 Subsistence in a "Non-Subsistence" Environment: Factors of Production in a Hawaiian Alpine Desert Adze Quarry. In *Pacific Production Systems: Approaches to Economic Prehistory*, edited by D.E. Yen and J.M.J. Mummery, pp. 85-119. Occasional Papers in Prehistory, No. 18, Department of Prehistory, Research School of Pacific Studies, Australian National University, Canberra.

1991 Survey and Test Excavations of the Pu`u Kalepeamoa Site, Mauna Kea, Hawai`i. Prepared for Facilities Planning and Management Office, University of Hawaii. Ms. on file in the Department of Anthropology, Bernice P. Bishop Museum. Honolulu.

in press Neither Here Nor There: A Rites of Passage Site on the Eastern Fringes of the Mauna Kea Adze Quarry, Hawai`i. *Journal of Hawaiian Archaeology*, Vol. 7.

McCoy, Patrick C. and Richard A. Gould

1977 Alpine Archaeology in Hawaii. *Archaeology* 30(4):234-243.

McCoy, Patrick C., Akihiko Sinoto and Atwood Makanani

1993 *Archaeological Investigations of the Pu`u Moiwi Adze Quarry Complex, Kaho`olawe*. Kaho`olawe Island Conveyance Commission Consultant Report No. 14.

McCoy, Patrick C., Holly McEldowney, Eric Komori and Marc Smith

in prep. Historic Preservation Plan for the Mauna Kea Science Reserve.

McEldowney, Holly

1982 Ethnographic Background of the Mauna Kea Summit Region. Report 1 In *Cultural Resources Reconnaissance of the Mauna Kea Summit Region*. Bishop Museum Department of Anthropology ms.

Pukui, Mary Kawena and Samuel Elbert

1971 *Hawaiian Dictionary*. University Press of Hawaii. Honolulu.

Stokes, J.F.G. and Tom Dye (Ed.)

1991 *Heiau of the Island of Hawai`i.: A Historic Survey of Native Hawaiian Temple Sites.* Bishop Museum Bulletin in Anthropology 2. Honolulu.

Thrum, Thomas G.

1921 Note. In Kenneth P. Emory, *An Archaeological Survey of of Haleakala.* Bernice P. Bishop Museum Occasional Papers 7(11):237-259. Honolulu.

DRAFT

Table 1
LIST OF ARCHAEOLOGICAL SITES LOCATED IN THE MAUNA KEA SCIENCE RESERVE

State Site No.	Elevation (ft. asl)	Description	Function
11077	12320	single upright	shrine
11079	12313	lithic scatter of adze manufacturing byproducts and 2 associated cairns	"workshop" and possible shrine
16163	12880	platform/pavement with 14 uprights	shrine
16164	13397	3 to 5 uprights on platform and 1 isolated upright	shrine
16165	13362	single row of 2 uprights	shrine
16166	13422	2 rows of uprights, 8 to possibly 9 total	shrine
16167	13395	single row of 2 uprights	shrine
16168	13098	semi-enclosure with 21 to possibly 25 uprights	shrine
16169	13210	single row of 2 uprights	shrine
16170	13139	2 cairns with 3 to possibly 4 uprights	shrine
16171	13087	single upright	shrine
16172	13218	single upright	shrine
16173	13009	7 dispersed uprights	shrine
16174	13075	boulder with 1 to possibly 8 uprights on the side	shrine
16175		5 cairns with 1 upright each	shrine
16176	13078	single row of 3 uprights	shrine
16177	13118	platform with 3 uprights	shrine
16178	13236	single upright	shrine
16179	13122	single row of 3 uprights	shrine
16180	13086	boulder with 3 uprights	shrine
16181	13401	single upright	shrine
16182	13155	3 to 5 uprights	shrine
16184	13072	semi-enclosure with 24 uprights	shrine
16185	13008	single row of 3 uprights	shrine
16186	13076	single row of 2 and possibly 3 uprights	shrine
16187	12775	single row of 9 uprights	shrine
16188	12857	single upright	shrine
16189	12902	single row of 3 and possibly 4 uprights	shrine
16190	12956	single row of 10 uprights and off-set uprights	shrine
16191	12889	single row of 4 uprights	shrine
16192	12842	2 sets of uprights, 6 total	shrine

Table 1, continued
LIST OF ARCHAEOLOGICAL SITES LOCATED IN THE MAUNA KEA SCIENCE RESERVE

State Site No.	Elevation (ft. asl)	Description	Function
16193	12843	single upright	shrine
16194	12673	single row of 12-14 uprights	shrine
16195		2 cairns	possible burial
16196	12953	single row of 2 uprights	shrine
16197	12953	single upright	shrine
16198	12930	2-tiered platform with 7 uprights	shrine
16199	12991	1 and possibly 4 uprights	shrine
16200	12975	single row of 5 and possibly 6 uprights	shrine
16201	12990	single row of 3 uprights	shrine
16202	13006	single upright	shrine
16203	13145	single row of 2 and possibly 3 uprights and a lithic scatter of adze manufacturing byproducts	adze "workshop"and shrine
16204	12332	5 shrines, 26 stone-walled enclosures and a lithic scatter of adze manufacturing byproducts	adze "workshop" and shrine complex
16248		series of cairns	burial
18682	12955	single row of 3 uprights	shrine
18683	13012	single row of 2 uprights	shrine
21197	13052	2 platforms with a total of 5 uprights	shrine
21198	13043	single upright	shrine
21199	12876	single upright	shrine
21200	13165	single upright	shrine
21201	13087	single row of 2 uprights	shrine
21202	13048	single row of 6 to posssibly 7 uprights	shrine
21203	13034	single row of 2 uprights	shrine
21204	12925	3 areas of stacked rock	unknown
21205	13484	single upright	shrine
21206	12754	single upright	shrine
21207	12787	single upright	shrine
21208	12799	1 to 2 uprights on a boulder	shrine
21209		cairn on summit	unknown
21210	12233	single upright	shrine
21211	12275	single row of 2 uprights on a platform and a lithic scatter of adze manufacturing byproducts	adze "workshop" and shrine
21212	12385	single row of 2 uprights	shrine
21213	12249	3 piles of rocks with 1 upright	shrine

Table 1, continued
LIST OF ARCHAEOLOGICAL SITES LOCATED IN THE MAUNA KEA SCIENCE RESERVE

State Site No.	Elevation (ft. asl)	Description	Function
21214	12241	single row of 5 and possibly 7 uprights	shrine
21406		single upright	shrine
21407	12952	single row of 2 uprights	shrine
21408	12913	single upright	shrine
21409	12984	single upright	shrine
21410	12801	single row of 5 uprights	shrine
21411	12815	cairn	marker?
21412		cairn	marker?
21413		cairn	possible burial
21414		cairn	possible burial
21415	13130	cairn on a boulder	unknown
21416	12792	cairn	possible burial
21417	12974	cairn	unknown
21418	12889	3 and possibly 4 uprights on top and to the side of a boulder	shrine
21419	12495	single upright	shrine
21420	12152	enclosure with 11 and possibly 12 uprights and a nearby stone platform	shrine
21421	12731	2 cairns, one with a possible upright and an isolated upright	shrine
21422	12847	single upright	shrine
21423		stones on boulder	marker?
21424	12320	4 to 5 uprights on a platform and boulder	shrine
21425	12523	single upright	shrine
21426	12568	single row of 4 uprights	shrine
21427	12635	terrace with possible upright	unknown
21428	12720	single upright	shrine
21429	12719	single upright	shrine
21430	13111	single row of 3 uprights	shrine
21431	12532	semi-enclosure with 7 to 10 uprights	shrine
21432	13044	single row of 2 uprights	shrine
21433	12579	single upright	shrine
21434	12551	8 stones on a boulder	unknown
21435	12564	cairn and boulder with 1 upright	shrine

Table 2 Shrine Attributes

SITE NO.	CATEGORY	NO. UPRIGHTS MIN	NO. UPRIGHTS MAX	UPRIGHT FOUNDATION BEDROCK	BOULDER	MOUND	CAIRN	PLATFORM	PAVEMENT	COURT
11077	1	1	1					+	+	-
16171	1	1	1	+					-	-
16172	1	1	1	+					-	-
16178	1	1	1	+					-	-
16181	1	1	1	+					-	-
16188	1	1	1	+					-	-
16193	1	1	1		+				-	-
16197	1	1	1			+			-	-
16199	1	1	4					+	-	-
16202	1	1	1					+	+	-
21198	1	1	1	+					-	-
21199	1	1	1	+					-	-
21200	1	1	1	+					-	-
21205	1	1	1	+					-	-
21206	1	1	1		+				-	-
21207	1	1	1		+				-	-
21208	1	1	2		+				-	-
21210	1	1	1		+				-	-
21213	1	1	1			+			-	-
21406	1	1	1	+					-	-
21408	1	1	1	+					-	-
21409	1	1	1	+					-	-
21419	1	1	1	+					-	-
21421	1	1	2	+			+		-	-
21422	1	1	1	+					-	-
21425	1	1	1		+				-	-
21428	1	1	1		+				-	-
21429	1	1	1		+				-	-
21433	1	1	1	+					-	-
21435	1	1	1		+				-	-
16165	2	2	2	+					-	-
16167	2	2	2	+					-	-
16169	2	2	2	+					-	-
16176	2	3	3	+					+	-

Table 2 Shrine Attributes

SITE NO.	CATEGORY	NO. UPRIGHTS MIN	NO. UPRIGHTS MAX	UPRIGHT FOUNDATION BEDROCK	BOULDER	MOUND	CAIRN	PLATFORM	PAVEMENT	COURT
16179	2	3	3	+					-	-
16185	2	3	3	+					-	-
16186	2	2	3			+			-	-
16187	2	9	9	+					-	-
16189	2	3	4	+					-	-
16191	2	4	4	+					-	-
16192	2	11	17	+					-	-
16194	2	12	14	+					-	-
16196	2	2	2			+			-	-
16201	2	3	3	+	+				-	-
16203	2	3	3				+		-	-
18682	2	3	3	+					-	-
18683	2	2	2			+			-	-
21201	2	2	2	+					-	-
21202	2	6	7			+			-	-
21203	2	2	2	+					-	-
21211	2	2	2					+	-	-
21212	2	2	2		+				-	-
21214	2	5	7			+			+	+
21407	2	2	2	+					-	-
21410	2	5	5		+				-	-
21424	2	5	5		+			+	-	-
21426	2	4	4	+	+				-	-
21430	2	3	3	+					-	-
21431	2	7	10	+					+	+
21432	2	2	2	+					-	-
16204-1	2	9	9	+					-	-
16204-2	2	6	7			+			-	-
16204-5	2	2	2	+					-	-
16163	3	14	14	+		+		+	+	-
16164	3	4	6	+				+	+	-
16168	3	22	25			+			+	+
16170	3	4	4				+		-	-
16177	3	3	4					+	+	-

Table 2 Shrine Attributes

SITE NO.	CATEGORY	NO. UPRIGHTS MIN	NO. UPRIGHTS MAX	UPRIGHT FOUNDATION BEDROCK	UPRIGHT FOUNDATION BOULDER	UPRIGHT FOUNDATION MOUND	UPRIGHT FOUNDATION CAIRN	UPRIGHT FOUNDATION PLATFORM	PAVEMENT	COURT
16182	3	4	5	+					+	-
16190	3	10	10					+	-	+
16200	3	5	6					+	-	-
21197	3	5	5					+	-	-
21418	3	3	4	+	+				+	-
16166	4	8	9	+					+	-
16184	4	24	24	+					-	+
16198	4	7	7					+	+	-
21420	4	11	12			+			+	+
16204-3	4	8	10	+				+	+	-
16204-4	4	14	15	+				+	+	+
16173	5	7	7	+					-	-
16174	5	8	8	+					-	-
16175	5	6	6				+		-	-
16180	5	3	3		+				-	-

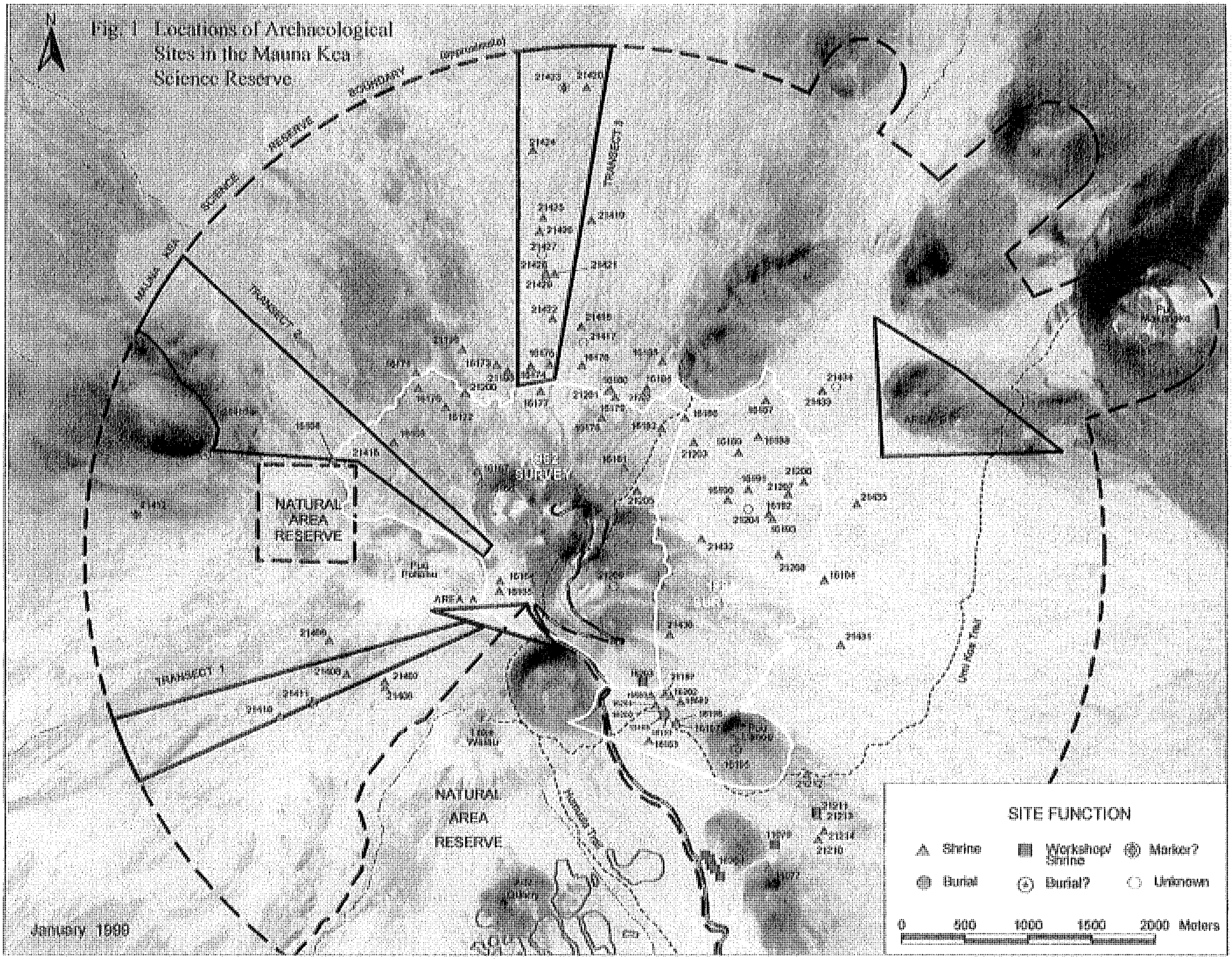
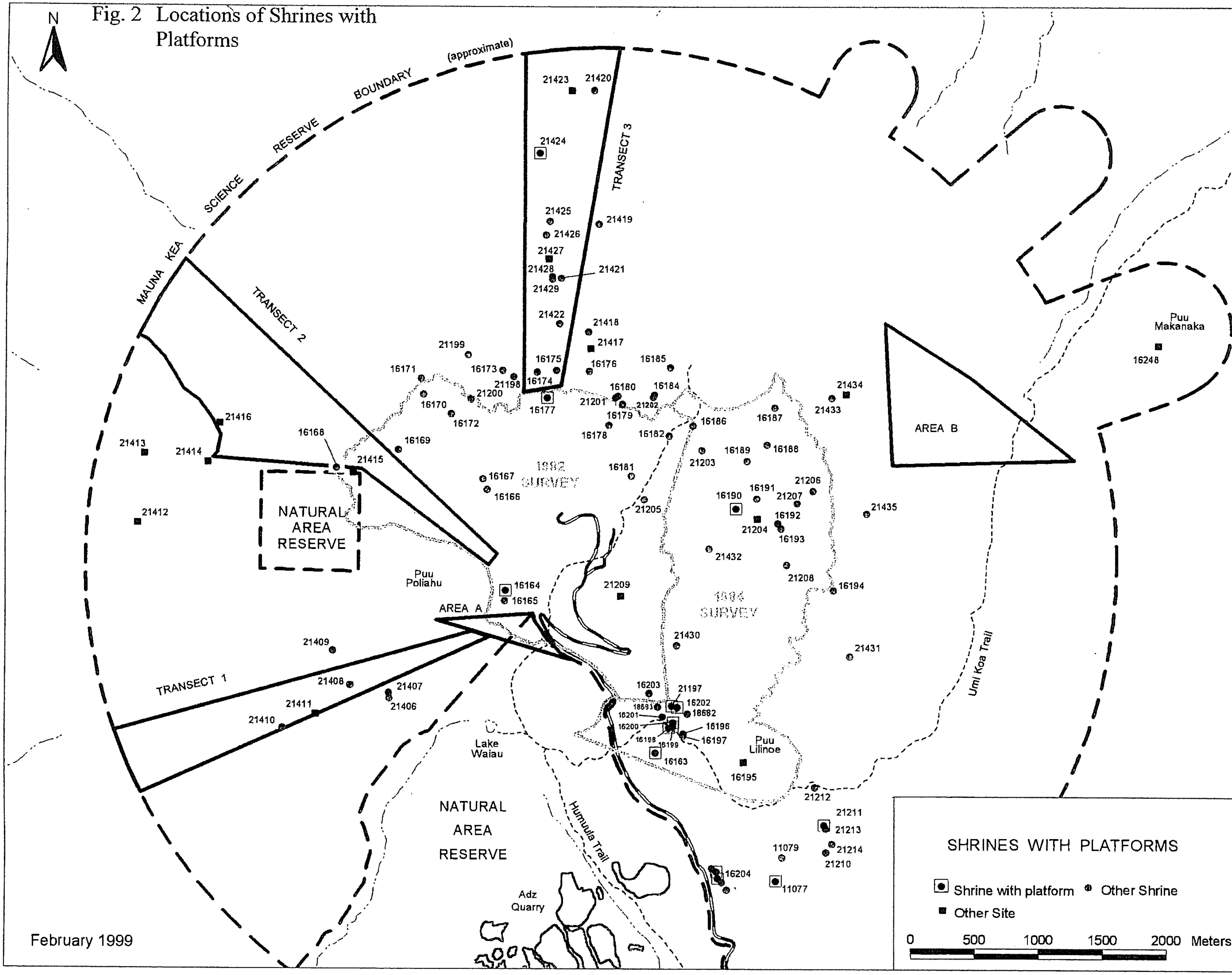


Fig. 1 Locations of Archaeological Sites in the Mauna Kea Science Reserve
MAUNA KEA SCIENCE RESERVE BOUNDARY (approximate)
TRANSECT 1
TRANSECT 2
TRANSECT 3
AREA A
1982 SURVEY
NATURAL AREA RESERVE
NATURAL AREA RESERVE
SITE FUNCTION
Shrine
Workshop/ Shrine
Marker?
Burial
Burial?
Unknown
0 500 1000 1500 2000 Meters
January 1999

Fig. 2 Locations of Shrines with Platforms



February 1999

Fig. 3 Locations of Shrines with 2 Uprights

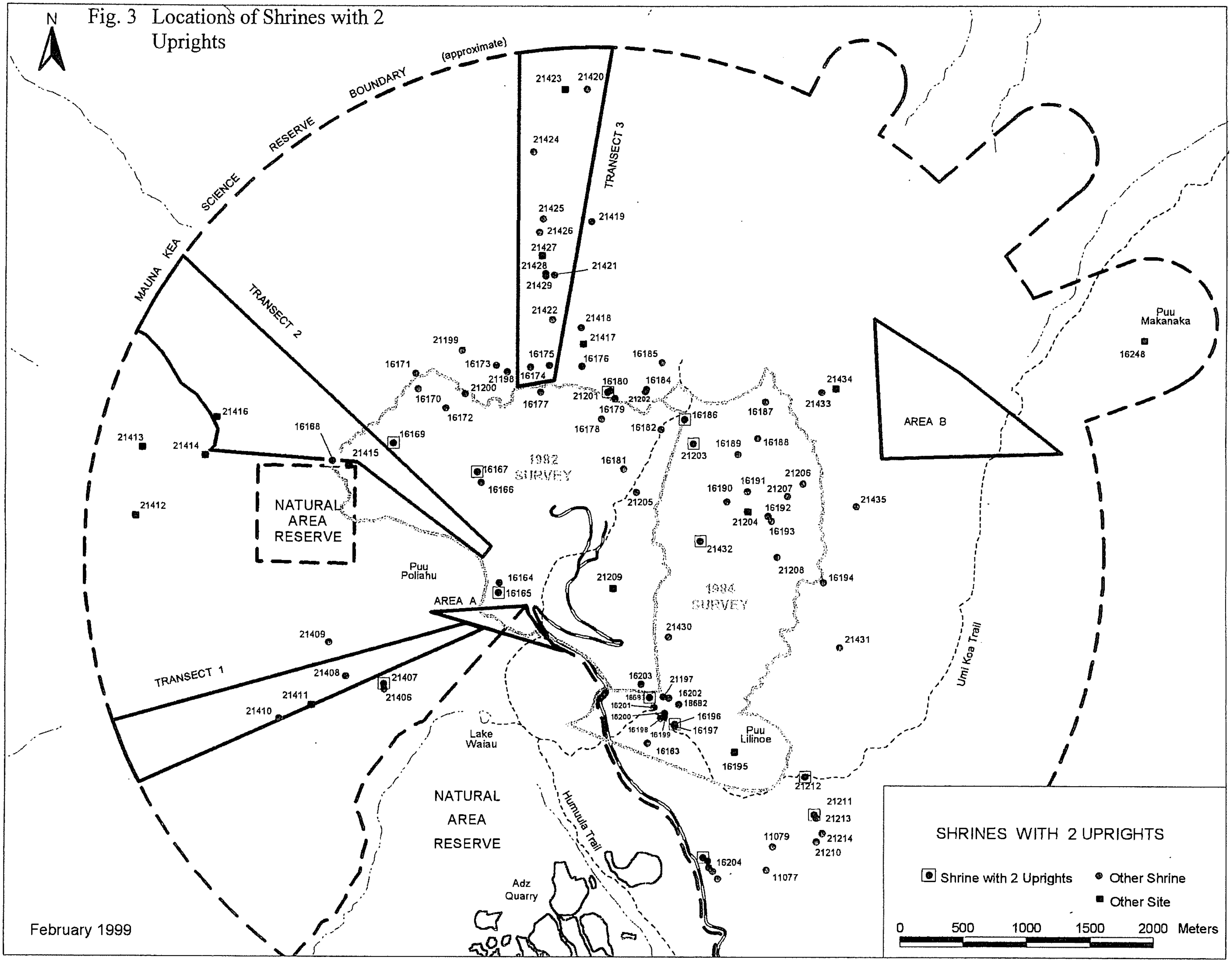


Fig. 4 Locations of Shrines with 3 Upright

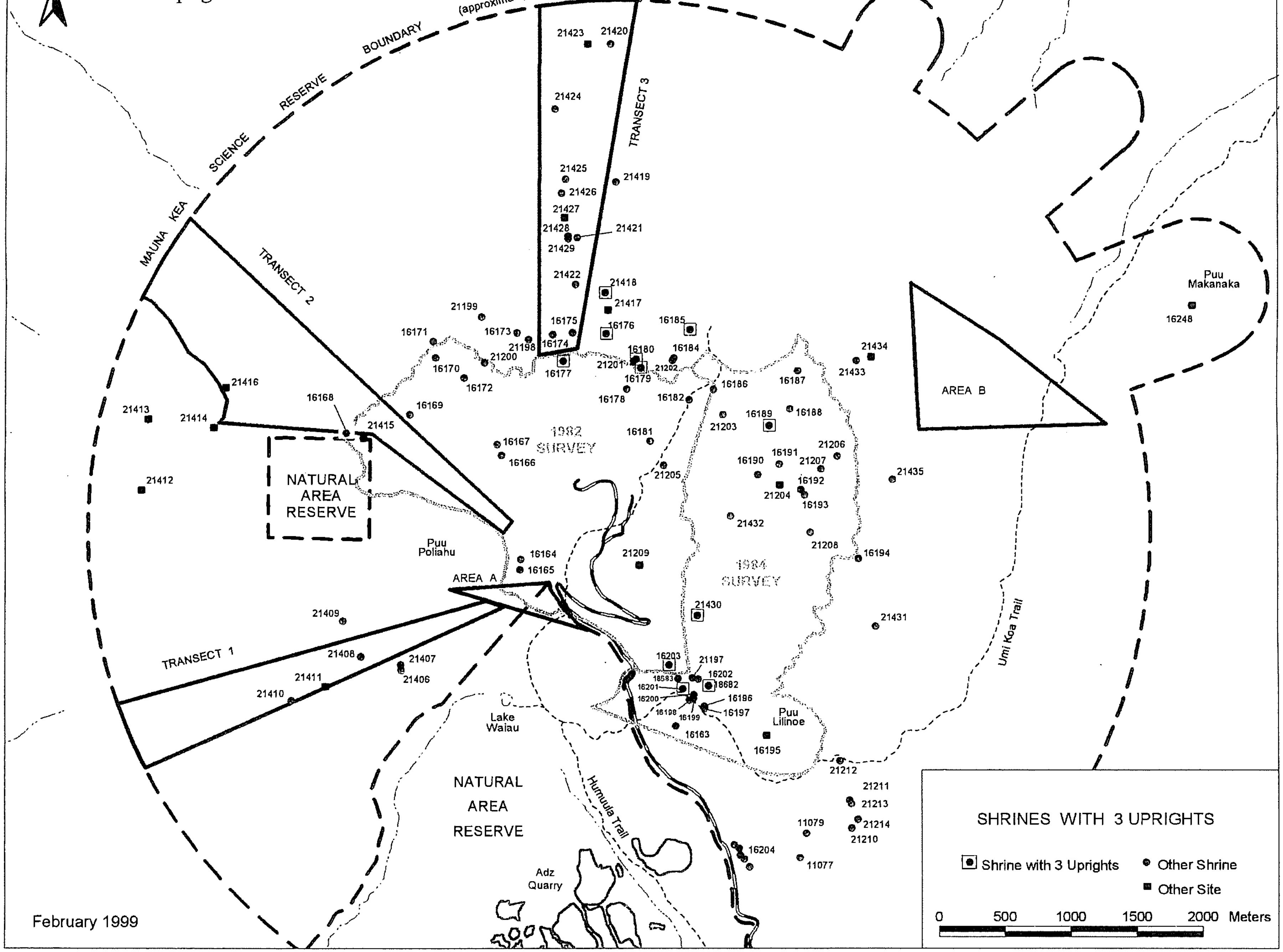


Fig. 5 Locations of Shrines with 4 or more Uprights

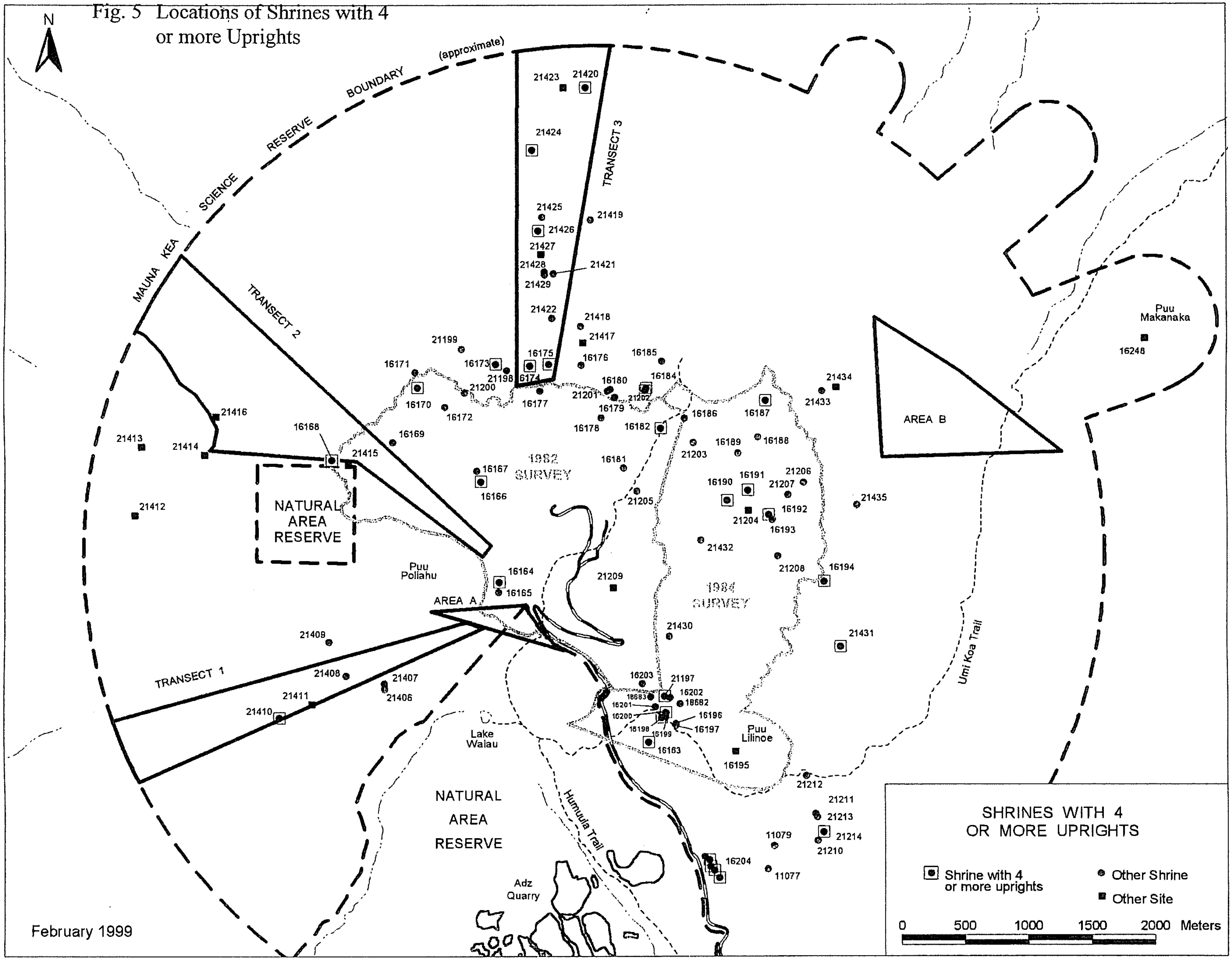


Fig. 6 Locations of Shrines with Pavements

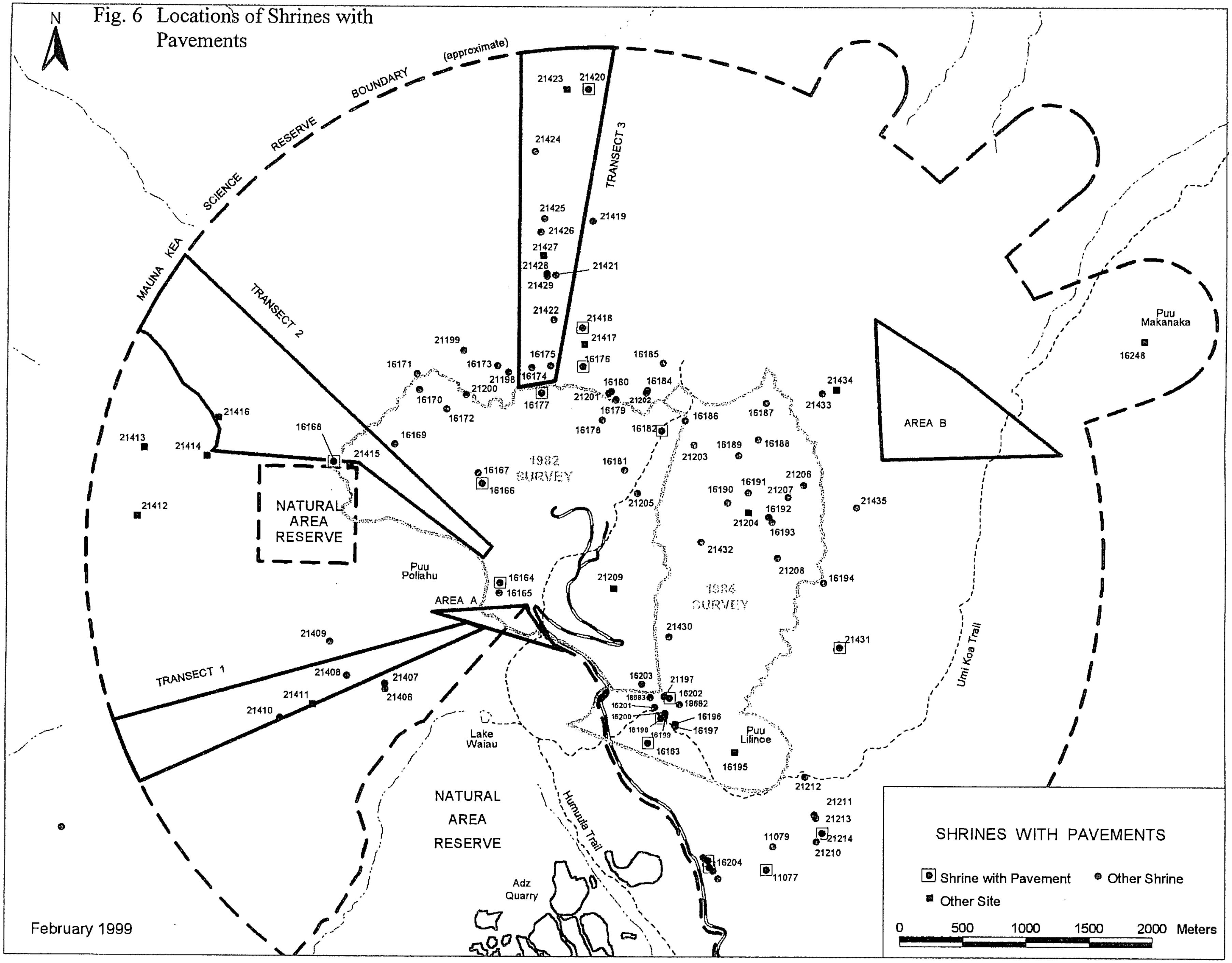


Fig. 7 Locations of Shrines with Courts

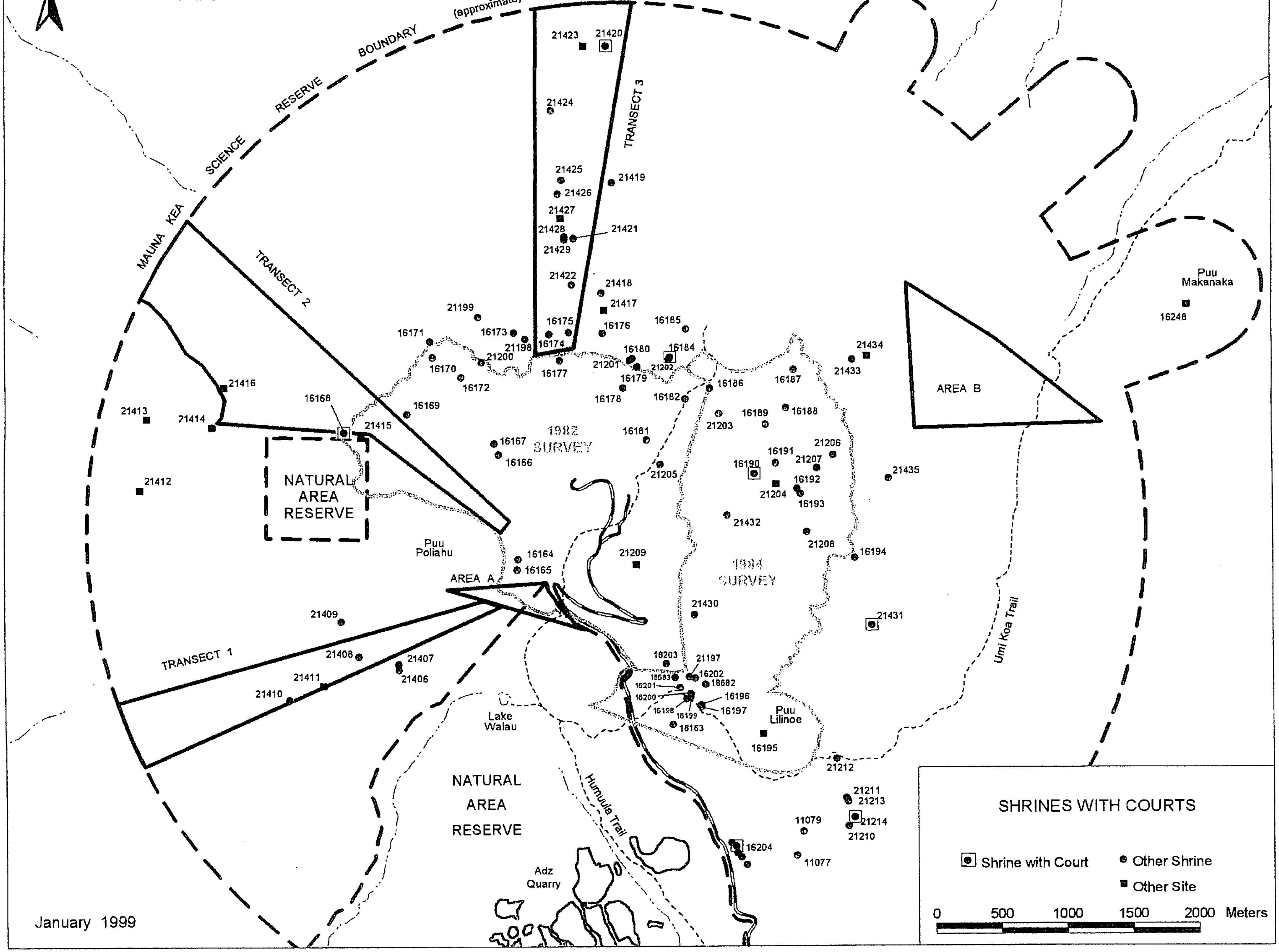
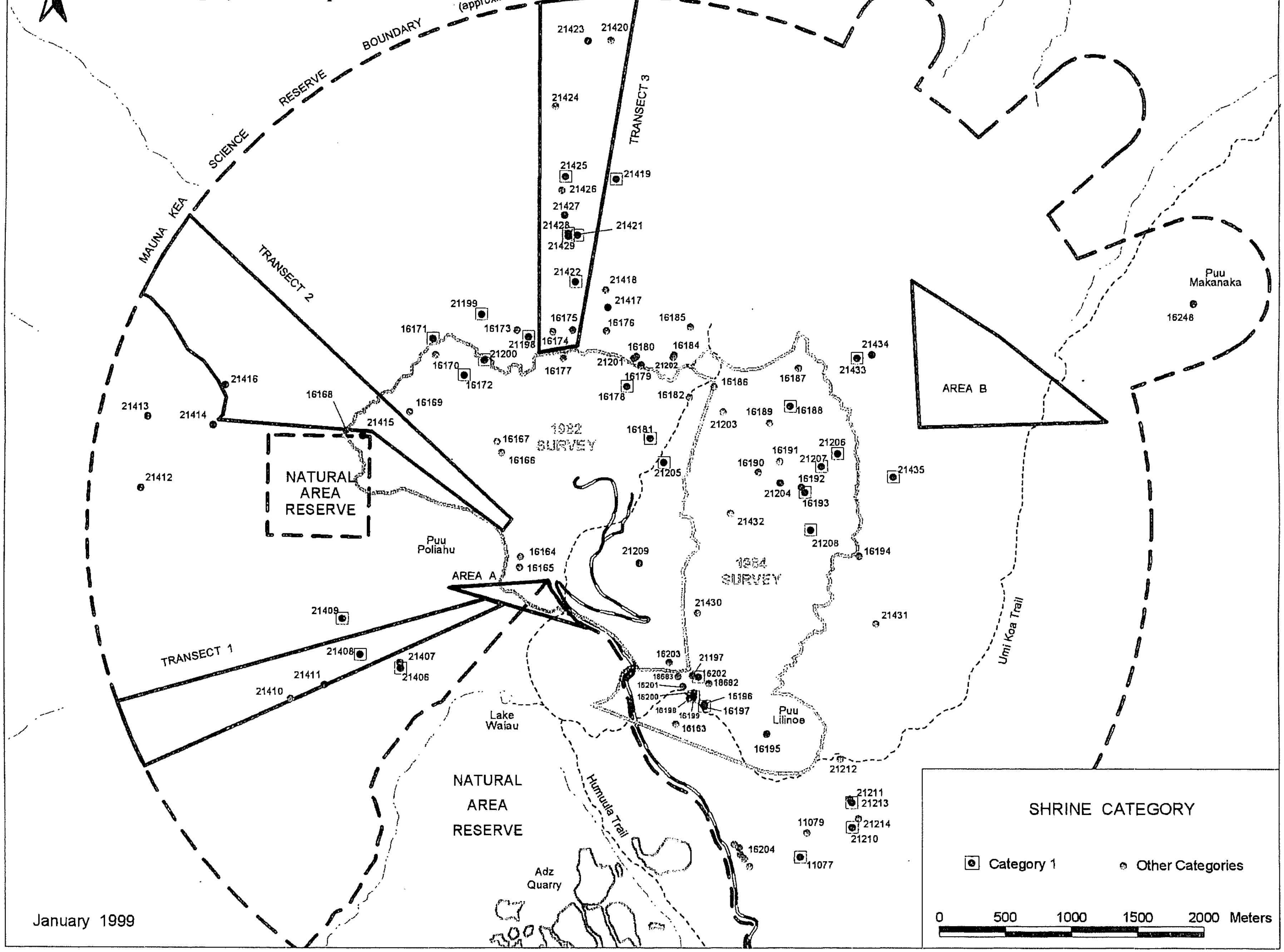


Fig. 8 Locations of Shrines with Category 1 Groundplans



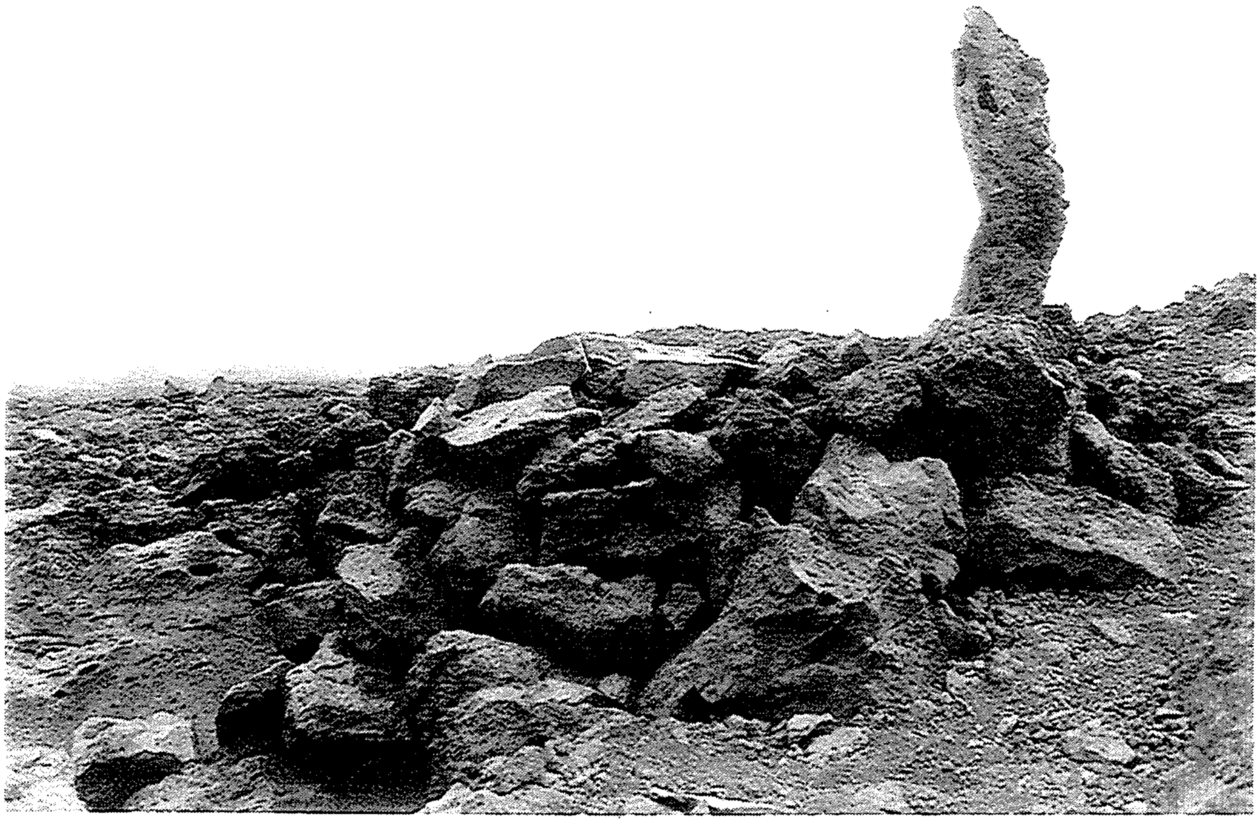


Fig. 9 Single Upright Shrine (Site 16202)

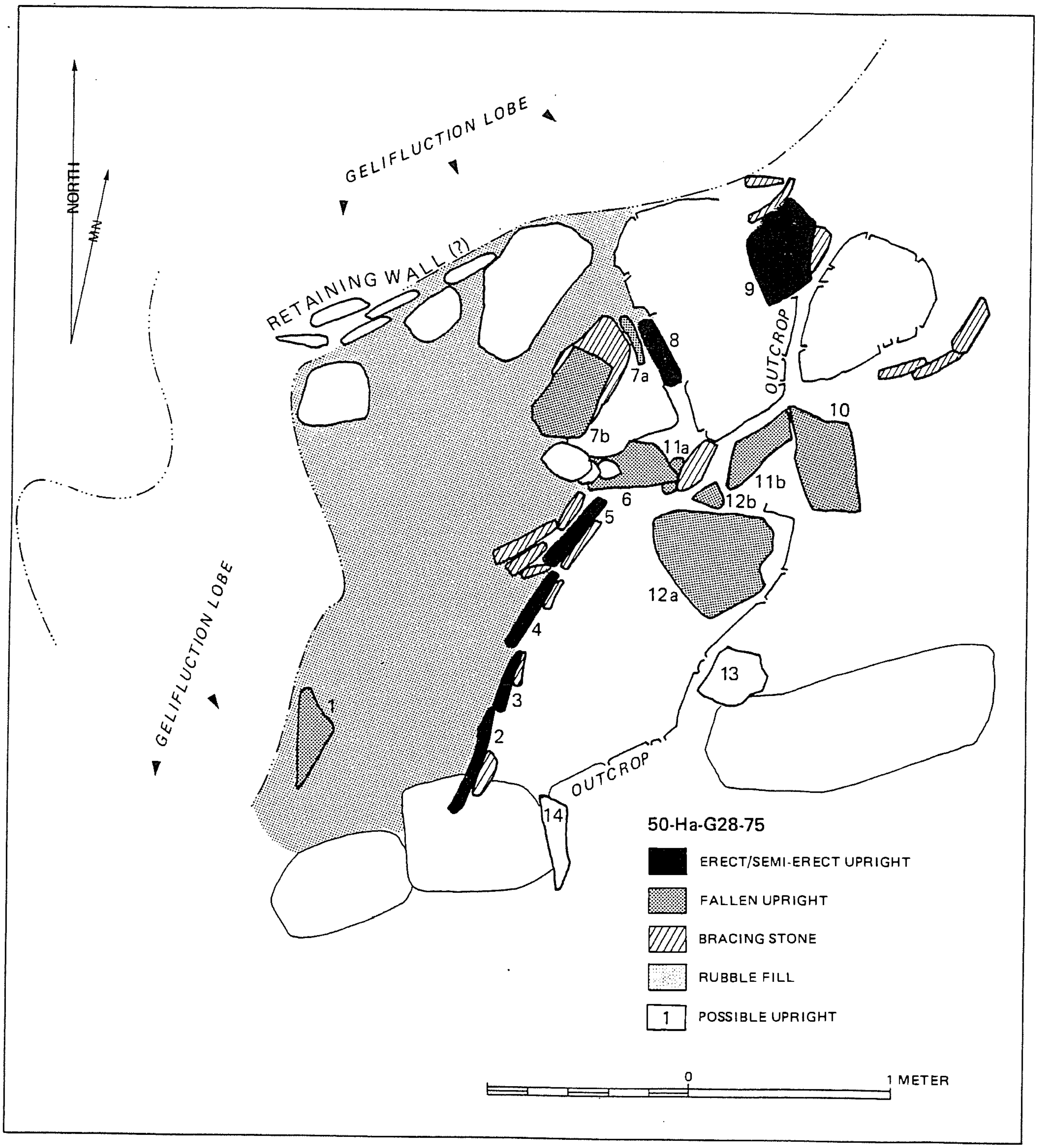
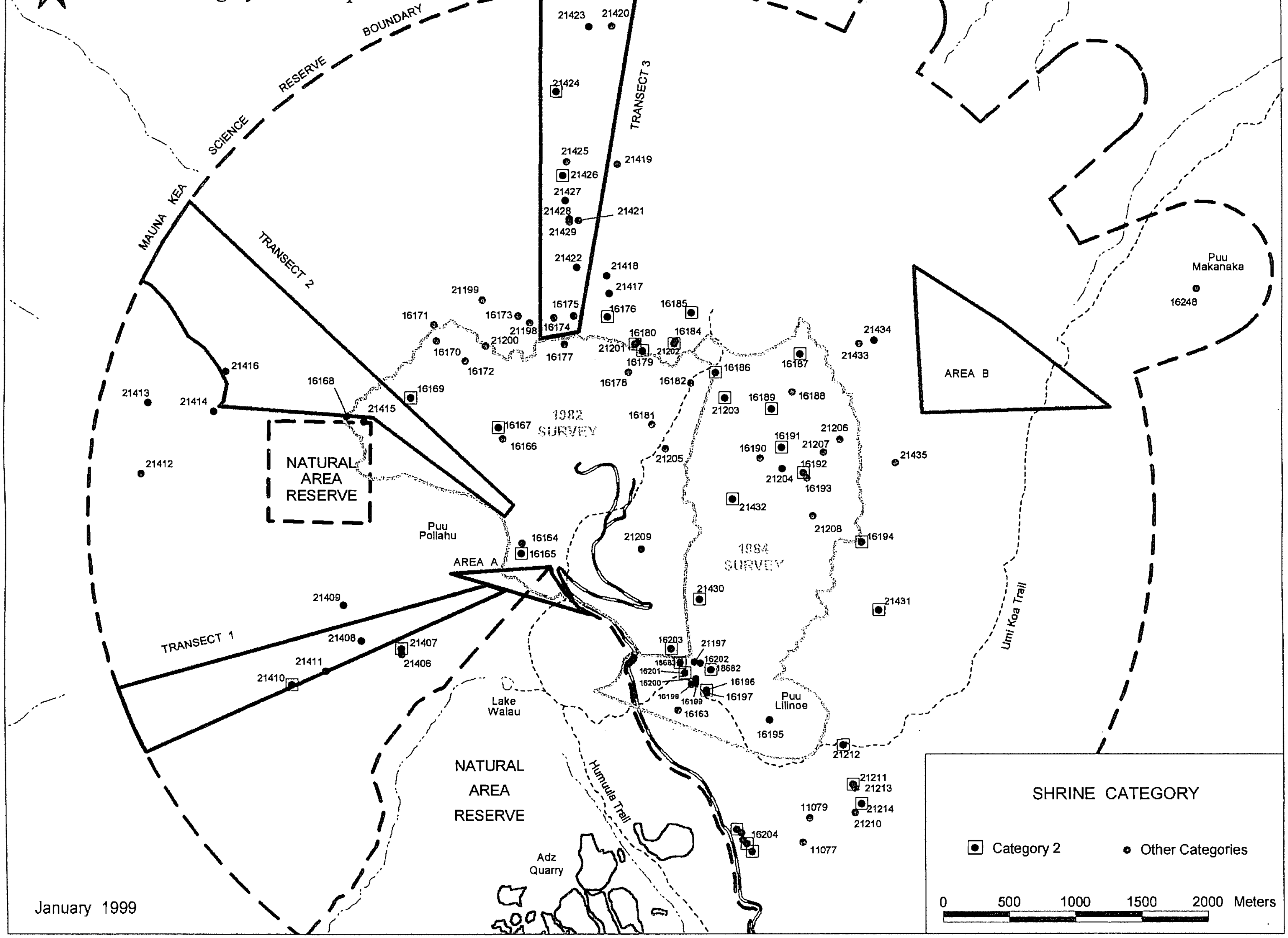


Fig. 10 Planview Map of Site 16194 (BPBM No. 50-Ha-G28-75)

Fig. 11   Front Side of Site16194 Looking West-Southwest toward the Summit

Fig. 12 Locations of Shrines with Category 2 Groundplans



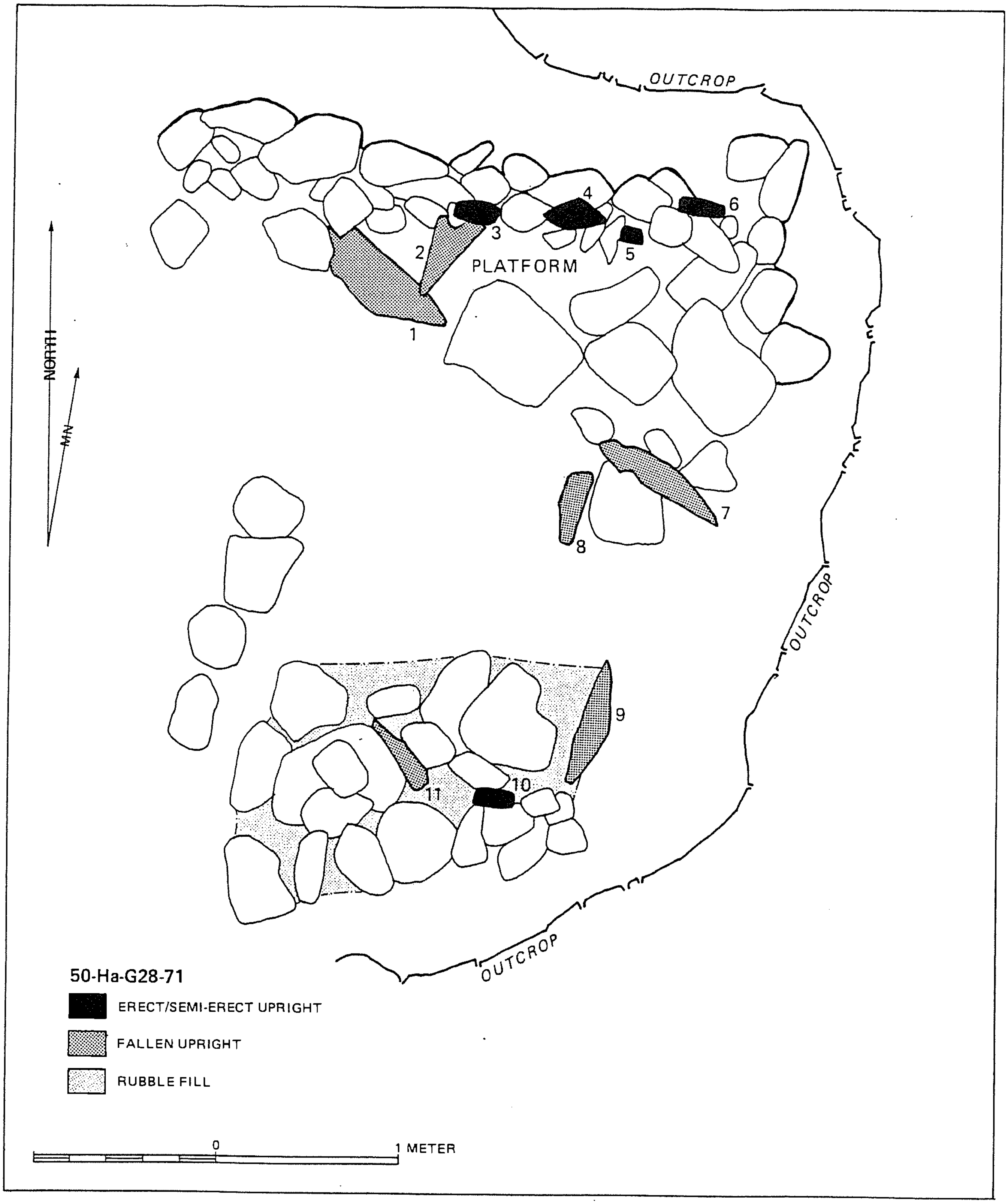
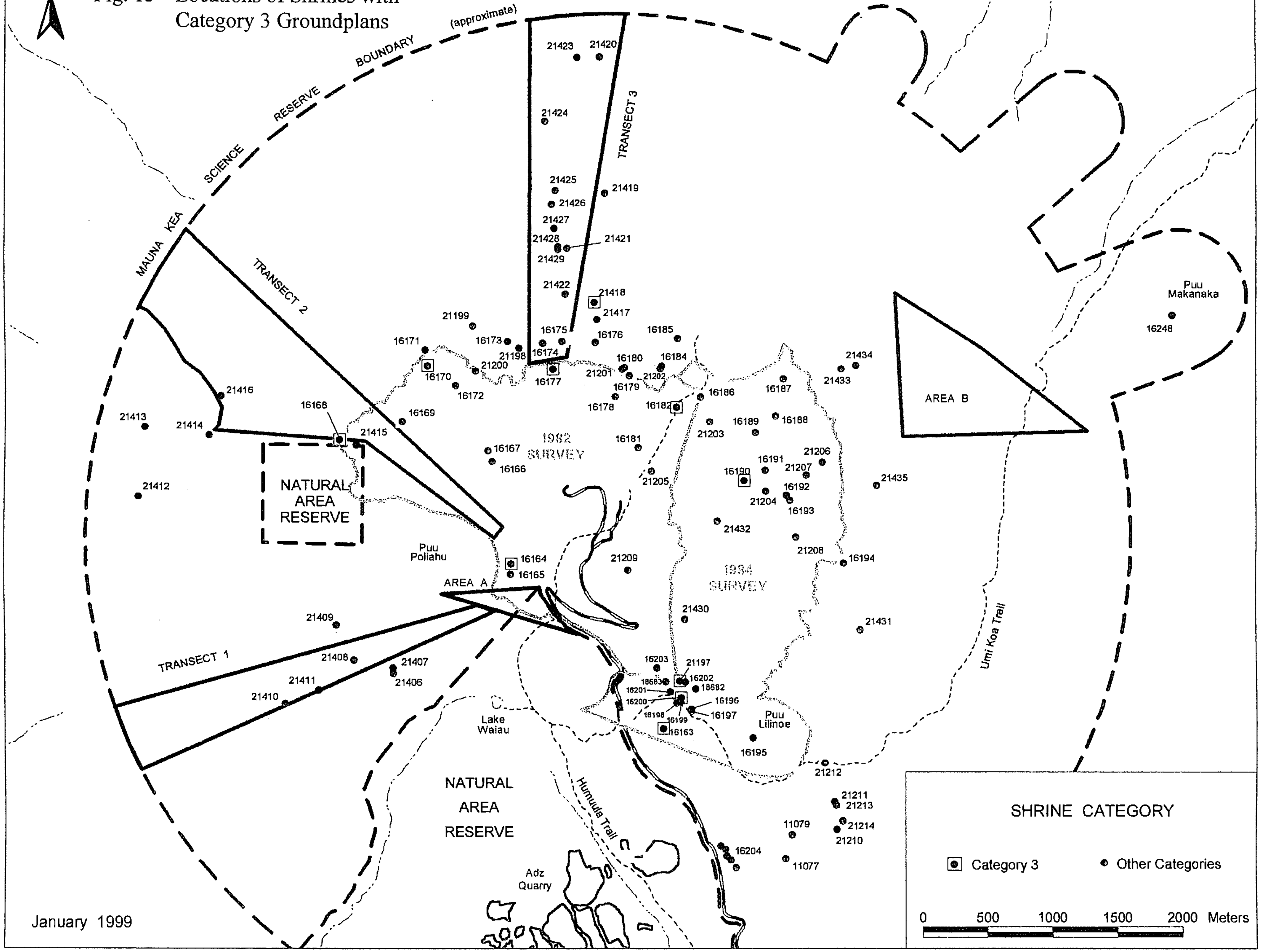


Fig. 13 Planview Map of Site16190 (BPBM No. 50-Ha-G28-71).

Fig. 14 Site 16190 Looking North toward Pu`u Mahoe [Judy McCoy is standing on the court]

Fig. 15 Locations of Shrines with Category 3 Groundplans



January 1999

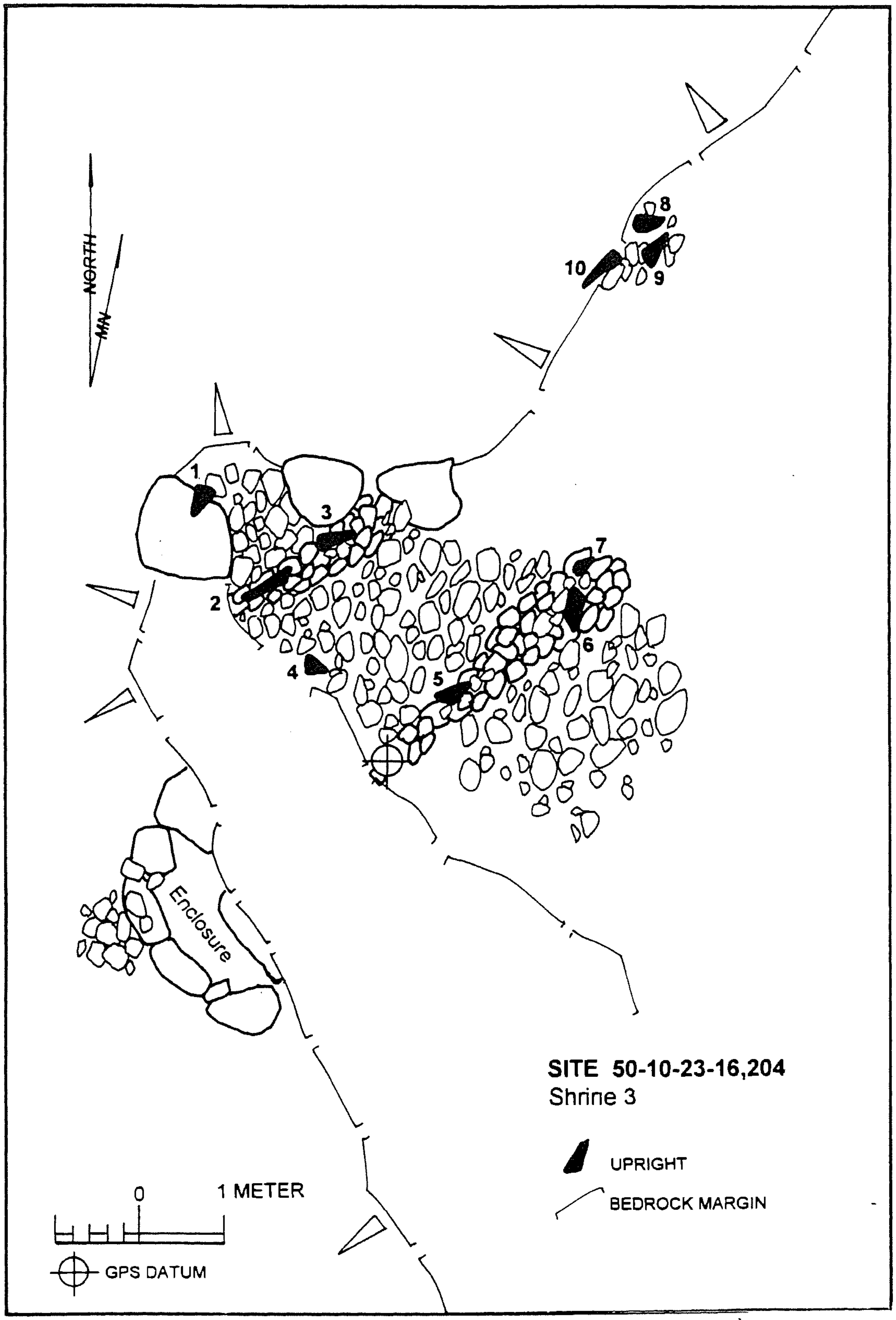
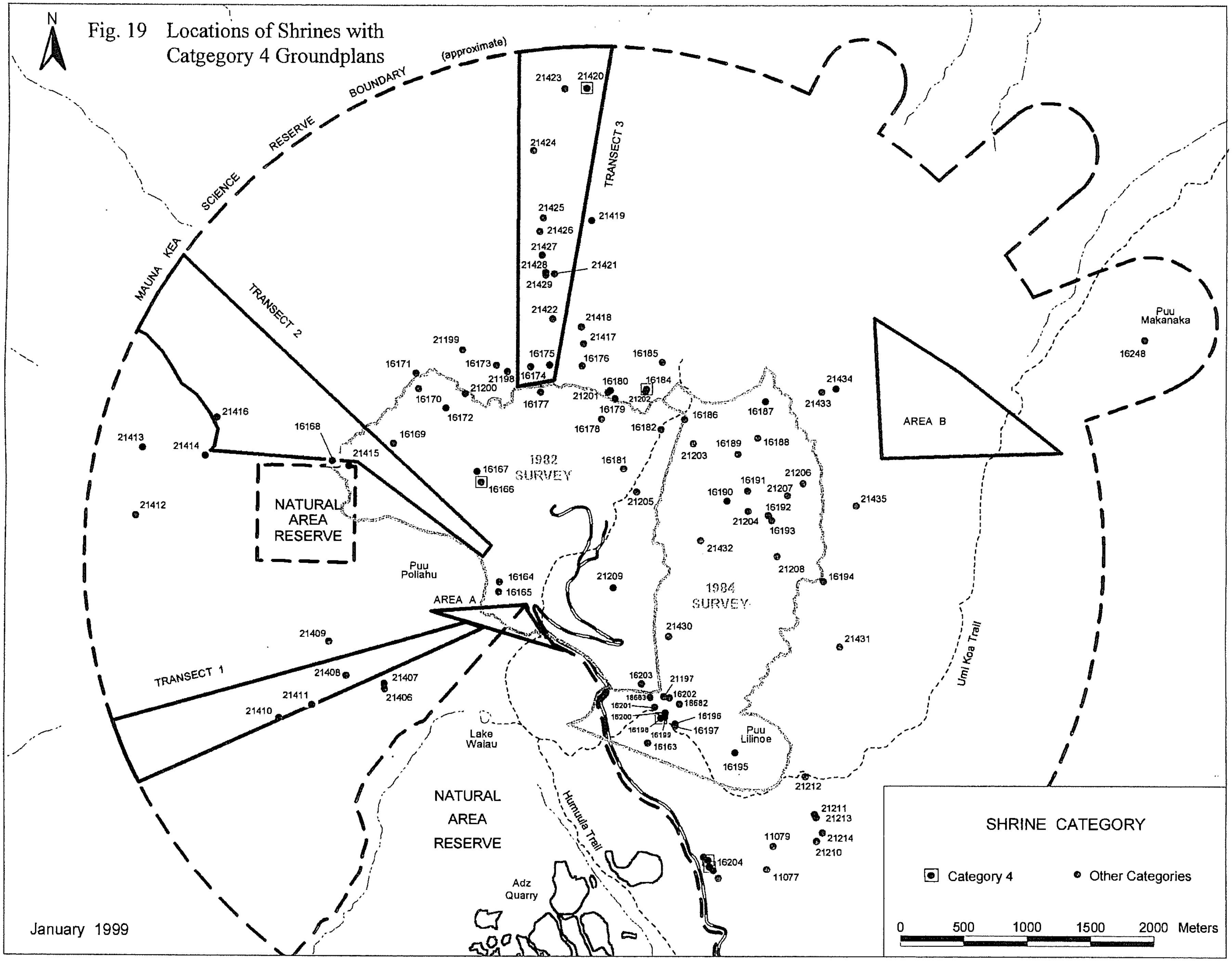


Fig. 16 Planview Map of Site 16204, Shrine 3

Fig. 17 View of Site 16204, Shrine 3 Looking South Toward the Adze Quarry

Fig. 18 Closeup of Uprights 2 (gabled) and 3 (flat to slightly angled top) on Site 16204, Shrine 3



N
Fig. 19 Locations of Shrines with
Catgegory 4 Groundplans
MAUNA KEA SCIENCE RESERVE BOUNDARY (approximate)
TRANSECT 1
TRANSECT 2
TRANSECT 3
AREA A
AREA B
NATURAL AREA RESERVE
NATURAL AREA RESERVE
1982 SURVEY
1984 SURVEY
Puu Poliahu
Puu Makanaka
Puu Lilinoe
Lake Waiau
Adz Quarry
Umi Koa Trail
Humuula Trail
21423
21420
21424
21425
21419
21426
21427
21428
21421
21429
21422
21418
21417
21199
16175
16176
16185
16171
16173
16174
21198
21200
16180
16184
16170
16177
21201
21202
16172
16179
16186
16187
21434
21433
16178
16182
21416
16168
16169
21413
21414
21415
16167
16166
16181
21203
16189
16188
21206
16191
21207
16190
21435
21205
16192
21204
16193
21412
21432
21208
16164
16165
21209
16194
21430
21431
21409
21408
21407
21406
21411
21410
16203
21197
18683
16202
18682
16201
16200
16196
16198
16199
16197
16163
16195
21212
21211
21213
11079
21214
21210
16204
11077
16248
SHRINE CATEGORY
Category 4
Other Categories
0
500
1000
1500
2000
Meters
January 1999

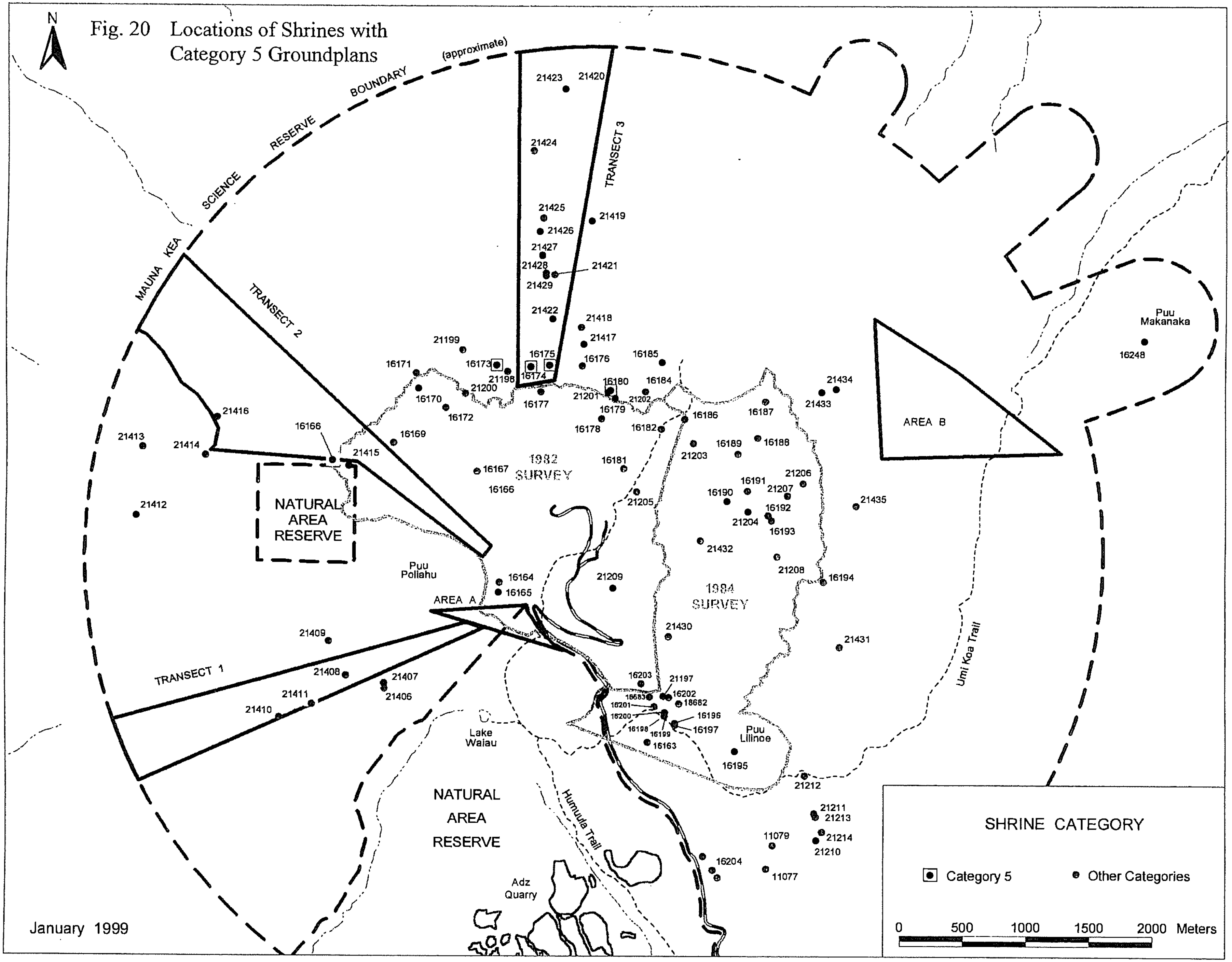


Fig. 20 Locations of Shrines with Category 5 Groundplans

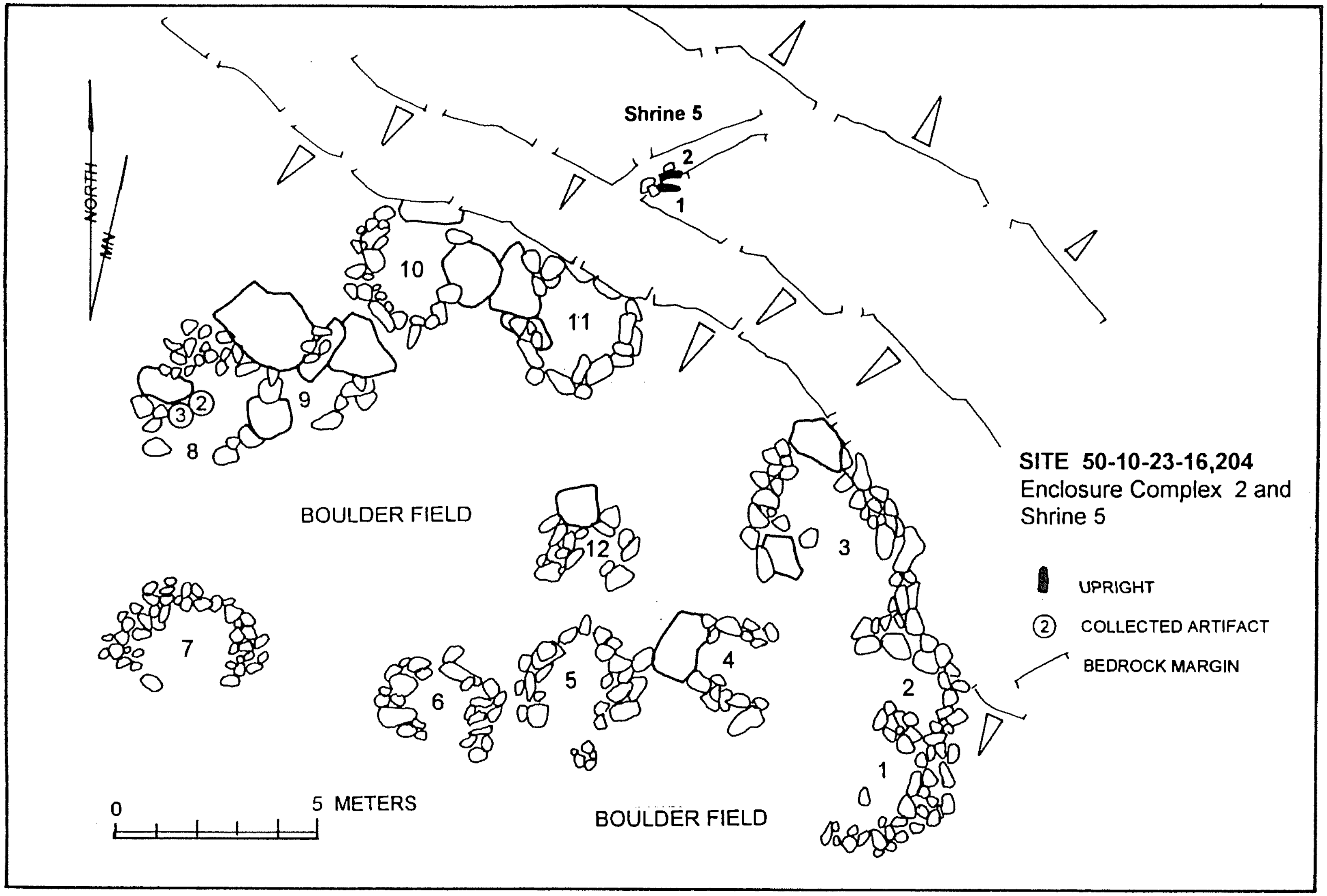


Fig. 21 Planview Map of Some of the Open-Air Enclosures on Site 16204

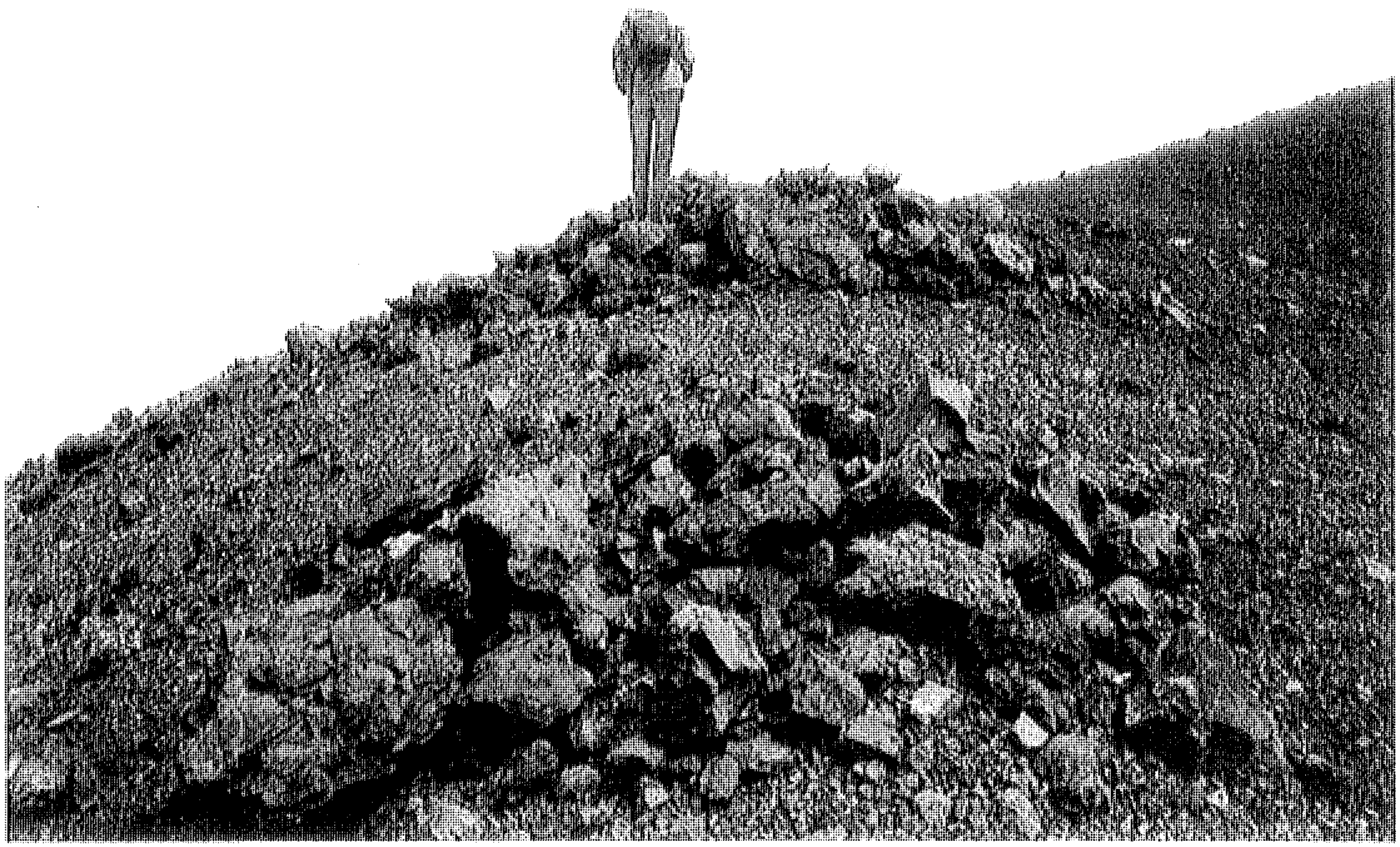


Fig. 22 Burial Cairn (Site 16248) on the top of Pu`u Makanaka

Fig. 23   Site 21412 Looking West-Southwest

Mauna Kea Science Reserve Site Descriptions – DRAFT
(122 pages – Available upon Request)

Patrick McCoy

June 29, 1999

MAUNA KEA SCIENCE RESERVE
MASTER PLAN

APPENDIX L

Mauna Kea Complex Development Plan Update: Roadway and Utilities Report

Sam O. Hirota, Inc.

July, 1999

MARCH 2000

Mauna Kea

Complex Development Plan Update

Roadway and Utilities Report

Prepared For:
Group 70 International

Sam O. Hirota, Inc.
Engineers & Surveyors
Honolulu, Hawaii 96813

July, 1999

Table of Contents

Table of Figures

1.1 Introduction

This report is a study of the existing roadways and utilities which service the University of Hawaii Management Areas located on MaunaKea. Included in the study is an assessment of future demands for the proposed "Conventional Optical/IR" and "Optical Interferometer & SMA Expansion" sites (see Figure 1).

2.1 Roadways

2.1.1 Existing Roadway Facilities

The roadway from Saddle Road to Hale Pohaku is an asphaltic-concrete paved roadway approximately 20 feet in width. This stretch of roadway is from approximately 6,700 ft to 9.200 ft in elevation, and is approximately 6 miles in length. The pavement structure consists of approximately 7 inches of asphaltic concrete over a compacted subgrade. There is no base course layer within the pavement structure. Currently the roadway is in fairly stable condition (Ref. 2). The existing roadway has shoulders on both sides.

At the time of the 1983 Complex Development Plan, the existing roadway from Hale Pohaku to the summit was approximately 15 feet in width, and a gravel material. The 8.3 mile stretch was considered dangerous and difficult to maintain. Several studies were completed to analyze the design process necessary to pave a roadway to the summit (Ref. 3).

In 1985, the State of Hawaii Department of Transportation started the design process on a 20-ft wide roadway beginning at Hale Pohaku and looping around the summit facilities. The design was broken up into six (6) phases (see Figure 2). They are as follows:

Phase I	Access Road from Sta 0+00 to 52+37.19 Spurs 1 (1050 ft), 2 (2850 ft) , 3 (2120 ft), & 4 (575 ft)
Phase II-A	Access Road (2.5 mi) from the end of Phase I (elev 13,240) to elev 11,800. Includes construction of 2 parking areas; Parking area 2 (elev 12,800) with 22 stalls, and Parking area 4 (elev 11,855) with 12 stalls
Phase II-B	Access Road (1.1 mi) from end of Phase II-A (elev 11,800) to elev 11,100. Includes construction of 2 parking areas; Parking area 5 (elev 11,390) with 18 stalls, and Parking area 1 (elev 13,240, located off Spur 3) with 50 stalls
Phase III-A	Access Road (4,700 ft) from end of Phase II-B (elev 11,100) to elev 10,690
Phase III-B	Access Road (1.7 mi) from end of Phase III-A (elev 10,690) to elev 9,870. Includes a runaway truck ramp
Phase III-C	Access Road (1,550 ft) from end of Phase III-C (elev 9,870) to Hale Pohaku. Includes a runaway truck ramp

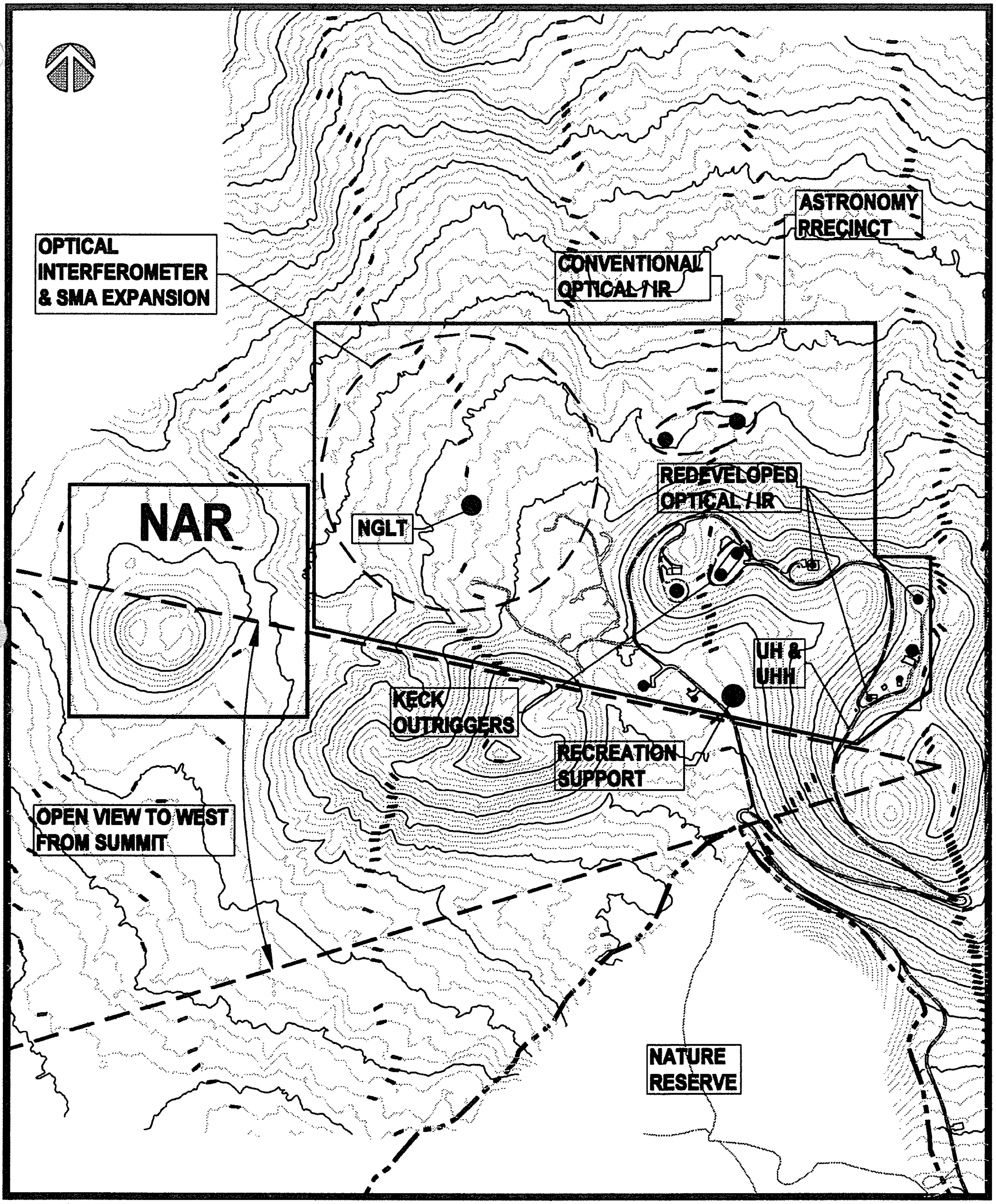


FIGURE 1:
PROPOSED EXPANSION

PREPARED BY: SAM O. HIROTA, INC.

SOURCE: USGS MAUNAKEA & PUU OO QUADRANGLE MAPS

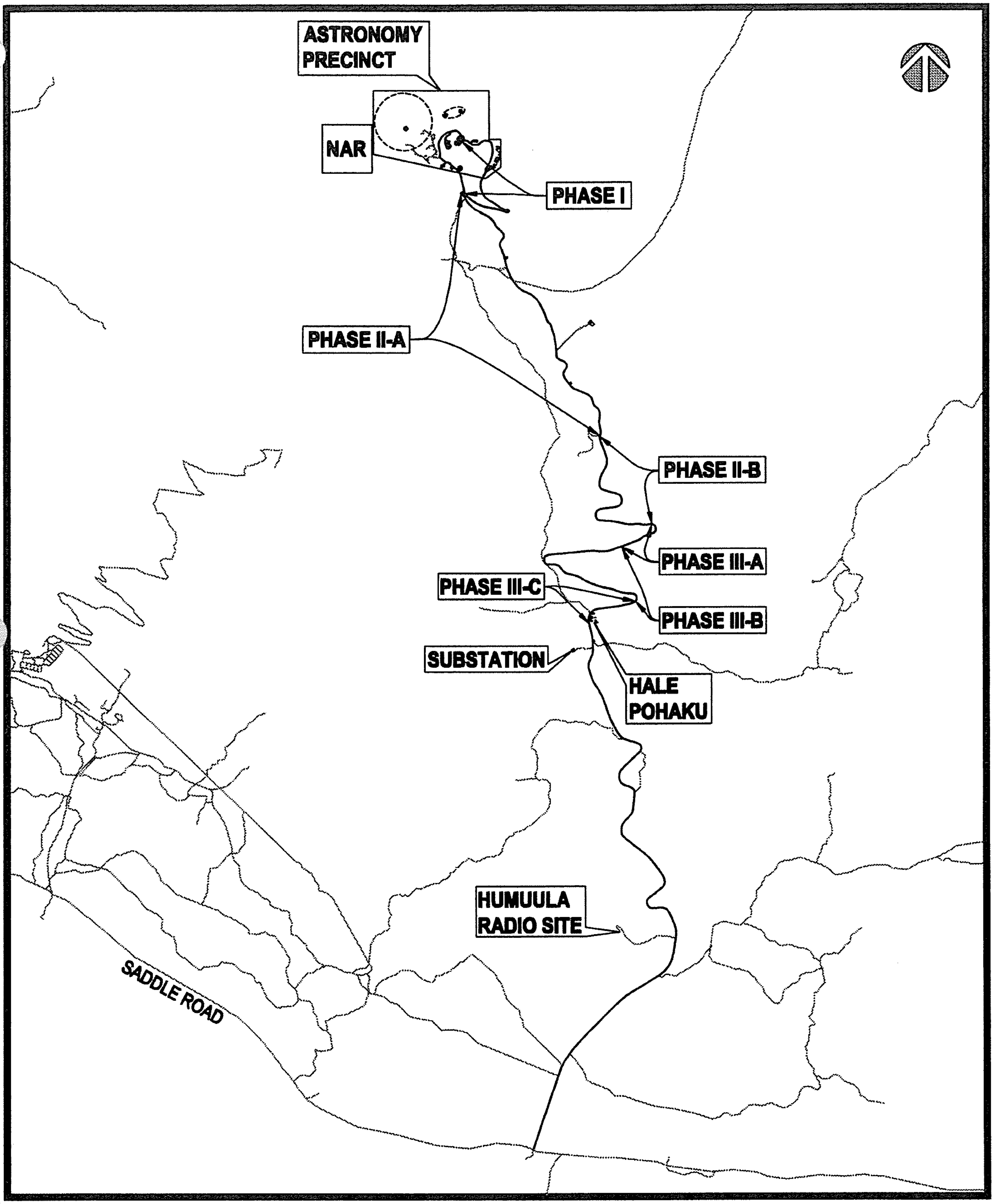


FIGURE 2:
ROADWAY FACILITIES

PREPARED BY: SAM O. HIROTA, INC.

SOURCE: USGS MAUNAKEA & PUU OO QUADRANGLE MAPS

Phase I of construction has been completed. This paved roadway makes a complete loop at the summit, with the exception of a portion of gravel roadway between Keck and JNLT telescopes. The roadway is 20 feet in width, and is approximately 7 inches of asphaltic concrete over a compacted subgrade. A prime coat was applied to the surface of the subgrade and a tack coat was applied to the surface of the a.c. pavement.

Other roadway improvements were also made within the loop at the summit. Shoulders are prevalent on the roadway, either consisting of base course material or a.c. pavement. The shoulders vary in width from 4 feet to 9 feet. Asphaltic concrete and concrete gutters have been installed. The concrete gutters are 5 feet in width with side slopes of 2:1. While the a.c. gutters are also 5 feet in width, the side slopes are 6:1 and 2:1, making them shallower than the concrete gutter. Along most of the outer edges of the roadway, standard metal guardrails have been installed to prevent cars from leaving the road. Portions of the roadway were cut into the existing slope of the summit, which required the construction of retaining walls along portions of the roadway. A majority of the retaining walls are located along the access road, where grades had previously fluctuated.

Phase II-A of construction has also been completed. This portion of roadway is from the end of Phase I, exiting the loop, to an elevation of 11,800. The roadway is similar to the summit, with a 20-foot wide a.c. travelway, shoulders, gutters and standard metal guardrail. The pavement structure is the same as Phase I, with 7 inches of a.c. pavement over compacted subgrade, with a primecoat and tackcoat.

Currently, these pavements are in good condition. No evidence has been seen to show deterioration of the pavement structure. Considering the pavement is less than 12 years old, the current conditions are to be expected.

Currently the roadway, between elevations 11, 800 and Hale Pohaku, is approximately 20 feet in width and a cinder material. There are six (6) culvert crossings, in which the width allows only one (1) car to traverse at a time. Signage warns drivers of the crossings and sharp turns (Ref. 2).

2.1.2 Proposed Roadway Construction

Phases II-B to III-C have not been constructed at this time. It is anticipated that construction will begin, as funding becomes available. Once these phases are complete, a paved roadway will exist from Saddle Road to the Summit, including the Summit loop.

It is anticipated that as the future “Conventional Optical/IR” and “Optical Interferometer & SMA Expansion” sites are developed outside of the existing Summit Loop, the existing unpaved roadways will be utilized. Over a period of time, it is anticipated that the unpaved roadways will deteriorate due to increased vehicular traffic and natural erosion. In the future may be necessary to pave these roadways to continue to permit safe passage to these proposed sites.

2.2 Parking Areas

Near Hale Pohaku, there are a series of parking areas. The Visitor's Information Station has an asphaltic concrete paved parking lot with approximately 20 stalls and is open to the public. At the main building of Hale Pohaku, there are two (2) a.c. paved parking areas, restricted to official vehicles, which have 35 and 23 stalls. In addition, there is another parking area near the construction camp. This is a gravel lot with approximately 20 stalls. The parking in this lot is not designated, and is often used by visitors during nightly stargazing trips (Ref. 2).

During the construction of Phases I and IIA, two parking areas were constructed. Parking area 2 (elev 12,800) consists of 22, 90 degree parking stalls. Parking area 4 (elev 11, 855) has 12 stalls. The pavement structure of each parking area is 6-1/2 inches of a.c. pavement over a compacted subgrade, including a prime coat and a tack coat.

As mentioned earlier, during the construction of Phase II-B, it is proposed to add two (2) additional parking areas along the access road, providing approximately 68 additional parking stalls.

2.3 Utilities

2.3.1 Water Supply

Water supply for Hale Pohaku and the summit is trucked from Hilo. Two-40,000 gallon water tanks are located at Hale Pohaku. Currently, 25,000 gallons per week are trucked to the mid-level facility (Ref. 1). The water is brought to Hale Pohaku and the summit by means of 5,000 gallon capacity tanker trucks. The loads are delivered during regular business hours, Monday through Friday (Ref. 4).

An additional 15,000 gallons per week are trucked to the summit to supply the various facilities. Each of the telescope facilities have a water tank, and the loads are distributed based on the demand of each facility (Ref. 4).

These quantities have remained fairly consistent throughout the development of the telescope facilities. However, during heavy construction periods, the construction crews consumed additional water.

As new facilities are constructed, expansion would require new water tanks to be installed at each additional facility. Water would be delivered to the site in a similar means as for the existing sites. It would be anticipated that demands would be greatest during the construction periods due to the increased number of personnel on the summit.

2.3.2 Sewerage

At this time all sewer disposal and treatment is handled by individual wastewater systems (cesspools and septic tank/leaching field) servicing each facility. There is no plan for construction of a sewer collection system to serve the summit area (Ref. 1).

Future development would require new individual wastewater systems to be constructed at each new site. Past Complex Development Plans have gone into great discussion about the feasibility of adding new systems, and determined it a safe means of wastewater treatment for Mauna Kea.

2.3.3 Drainage

Erosion has been a major concern on Mauna Kea and was expressed within the 1983 Complex Development Plan. Stormwater runoff has caused extensive erosion, including the creation of gullies within the existing gravel roadways. The extent of the drainage facilities a.c. and concrete gutters and roadway culverts.

The existing gravel road from Hale Pohaku to elevation 11,800 has six (6) culverts within 4.5 miles of roadway. These culverts divert water from areas surrounding the roadway and carry it to a lower elevation.

The new a.c. roadway construction in Phases I and II-A has 11 culverts that were installed, two(2) located on Spur 3 and nine(9) located on the access road. In most cases, water is collected within the gutters and enters an intake located above the roadway. The culvert pipe carries the water underneath the roadway and outlets it below the surface of the roadway. Riprap was used as a dissipation device.

2.3.4 Proposed Drainage Improvements

During the construction Phases II-B through III-C, the six (6) existing culverts located between Hale Pohaku and elevation 11,800 would be replaced with 25 new culverts. The water would be directed into a.c. and concrete gutters and would flow into inlet structures. The outlet structure would be located below the road surface. To prevent erosion, riprap would be installed at the outlet to dissipate the stormwater runoff.

2.3.5 Existing Electrical Power Facilities

The 1983 Complex Development Plan went into great detail to discuss the power requirements for the summit and its future development. Over the past 15 years, many improvements have been made to provide adequate power to the summit and Hale Pohaku (see figure 3).

The first phase of bringing power to the summit bean in 1985 with the construction of a 69KV overhead system from the Humuula Radio Site to the mid-level facilities. The decision was made to construct the overhead system because of the increased expense and the lack of experience of HECo in installing 69KV lines underground. Another consideration was the increased maintenance expense associated with an underground system. Due to the selected routing, visibility of the wooden poles would be kept at a minimum (Ref. 3).

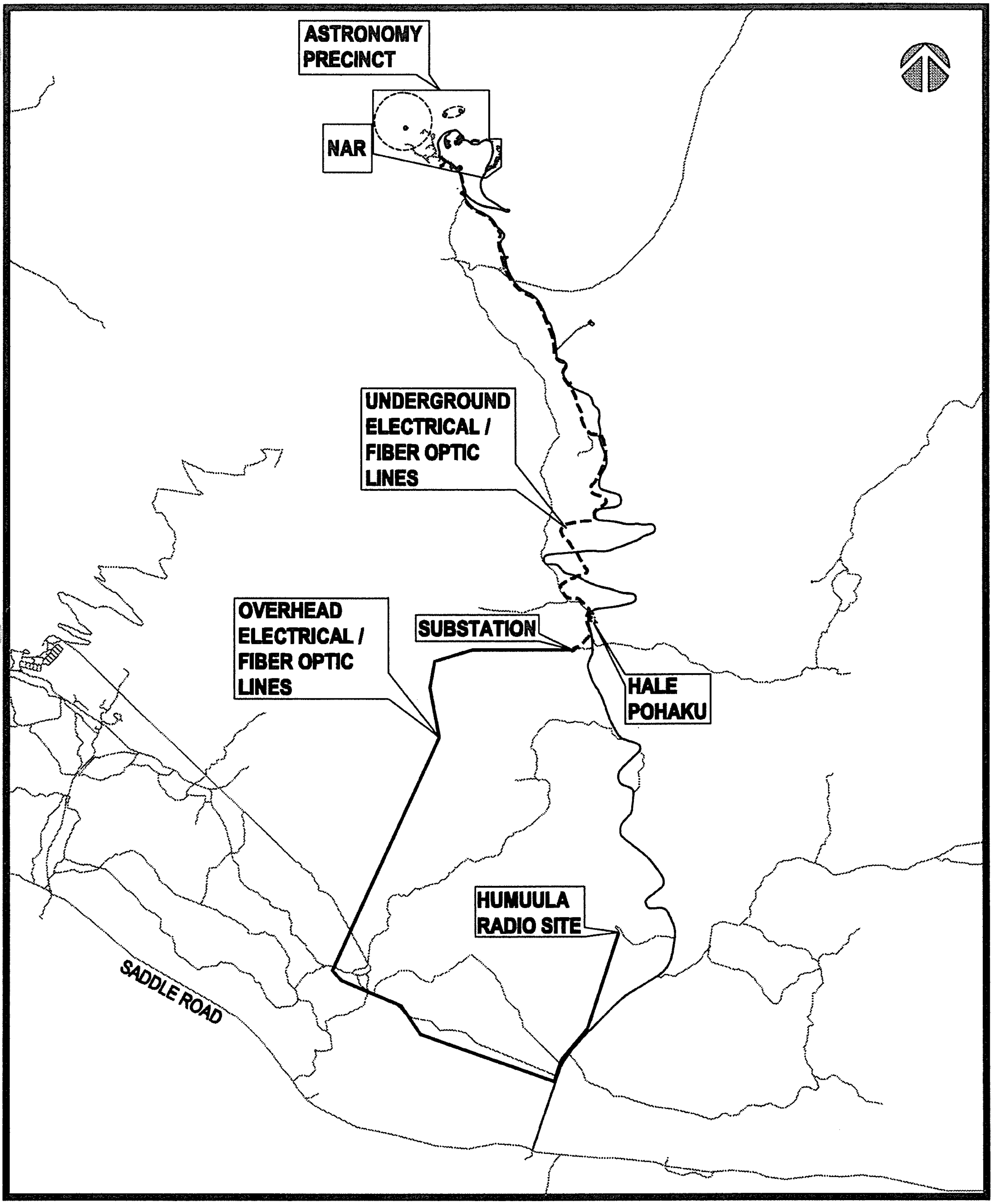


FIGURE 3:
POWER / COMMUNICATIONS

PREPARED BY: SAM O. HIROTA, INC.

SOURCE: USGS MAUNAKEA & PUU OO QUADRANGLE MAPS

0' 3000' 6000' 9000'
GRAPHIC SCALE

Once power reached a substation located just below the mid-level facilities, the voltage was reduced to 12.47KV, and the system was constructed in an underground distribution system up to the summit. The decision was made to construct distribution system to the summit underground because of the following considerations: the weather conditions at the summit and limited vegetation to cover the sight of wooden poles. By reducing the voltage, the construction and maintenance of the distribution system became more feasible in terms of cost. Once the distribution system was constructed at the summit, transformers were installed at each telescope facility. This electrical distribution system construction was completed in 1988.

In 1995, an upgrade of the electrical system, from HH 1 to HH24, began. This upgrade completed the loop at the summit, providing new service to JNTL. The upgrade was completed in 1998.

The Mauna Kea Summit is presently fed via a 69KV overhead radial feed system to the Hale Pohaku Substation. This substation consists of two 3000 KVA transformers, for a total capacity of **6000 KVA**. From this substation, there is an underground 12.47KV, dual-radial-radial feed system which essentially loops around the Mauna Kea Summit. The existing demand load at this substation is approximately **1100 KVA**, which essentially leaves approximately **4900 KVA** of spare capacity. For comparison purposes, the existing worst case demand load of a single telescope is from the KECK telescope site, which registers approximately **428 KVA** at peak demand.

2.3.6 Proposed Electrical Power Expansion

Based on the above data received from HELCo, the site has sufficient spare capacity to accommodate the proposed sites, assuming the loads of the new sites reflect that of a typical telescope facility presently at Mauna Kea.

The probable HELCo connection point to serve the proposed facilities would be at a primary switch (PME 9) located at the vicinity of the Smithsonian Site (see Figure 4). The existing underground system would be intercepted and extended to the proposed sites, and terminated at new HELCo transformers at each site.

Summary of Load at Hale Pohaku Substation

Total Substation Capacity	6000 KVA
Total Existing Demand Load	**1253 KVA**
Available Spare Capacity	4747 KVA

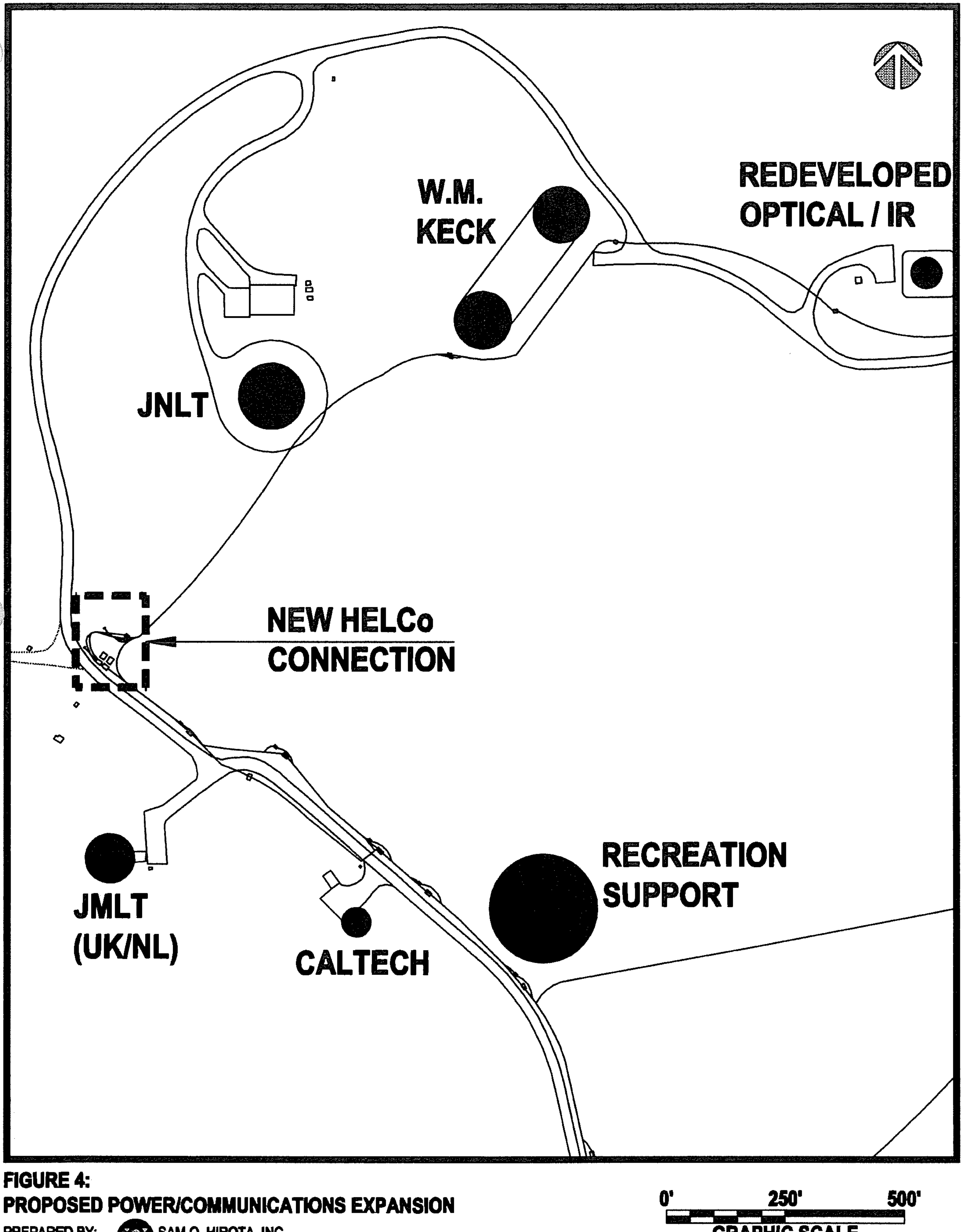


FIGURE 4:
PROPOSED POWER/COMMUNICATIONS EXPANSION

PREPARED BY: SAM O. HIROTA, INC.

SOURCE: USGS MAUNAKEA & PUU OO QUADRANGLE MAPS

2.3.7 Communications

The addition of the communications system took many phases of construction to complete. The first phase began during the construction of the underground power distribution system. Two (2) additional empty PVC conduits were installed along with the other three (3) conduits for the power system to prepare for the addition of a communications system. The addition of summit communications system continued into the 1990's, with the installation of fiber optic lines.

In 1995, the project to add fiber optic lines to the existing 69KV overhead power system began. The lines were added to the existing system of poles from the Humuula Radio Site to the substation near Hale Pohaku.

One final phase of construction was necessary to complete the fiber optics system on Mauna Kea. During the initial phase of the underground power distribution system, a series of the two (2) empty PVC conduits was omitted between the substation below Hale Pohaku (at elevation 9225) and an existing handhole located at an approximate elevation of 9325. In 1996, the construction began to complete the final phase of the fiber optics communication system. This work was completed in 1998.

Future expansion at the"Conventional Optical/IR" and "Optical Interferometer & SMA Expansion" sites are would require the communications system to be extended to the new sites. This extension would most likely begin near the Smithsonian site and run parallel to the electrical power extension. It is not anticipated that new upgrades to the communications system would be required to adequately service the new sites.

References

1. B. McLaren, Institute for Astronomy, meeting and personal conversation, December 1998.

2. R. Koehler, Mauna Kea Support Services, personal conversation, December 30, 1998.

3. "Mauna Kea Science Reserve Complex Development Plan", Group 70, September 1983.

4. G. Forbes, Mauna Kea Support Services, personal conversation, January 20, 1999.

MAUNA KEA SCIENCE RESERVE
MASTER PLAN

APPENDIX M

Economic Impact of Mauna Kea Observatories, Hawai'i County, State of Hawai'i.

SMS Research and Marketing, Inc.

July, 1999

MARCH 2000

Consulting
Database Marketing
Economic & Social Impact Studies
Research
Training

SMS
1042 Fort Street Mall
Suite 200
Honolulu, HI 96813
Ph: (808) 537-3356
Fax: (808) 537-2686
E-mail: info@smshawaii.com
Website: www.smshawaii.com

Beyond Information. Intelligence.

ECONOMIC IMPACT OF MAUNA KEA OBSERVATORIES, HAWAIʻI COUNTY, STATE OF HAWAIʻI

July 1999

Prepared for:

Group 70 International

Research Corporation of the University of Hawaiʻi

***SMS** affiliations:*

Allan Barker Associates
Customer Insight Company
International Survey Research
Simmons Market Research Bureau, Inc.
Strategic Mapping, Inc.

CONTENTS

EXHIBITS

1: INTRODUCTION

Mauna Kea is home to the most powerful collection of astronomical observatories on the surface of the earth. The summit offers an exceptional basis for astronomy – so much so that planning is needed to be sure that space is allocated appropriately to respond to scientific demand, to follow environmental safeguards, and to make culturally sensitive land use of some or all of the summit area possible.

The University of Hawai'i's Institute for Astronomy is the scientific landlord for the summit on behalf of the State of Hawai'i. Currently, a master plan process is under way, to develop scientifically, ecologically and culturally appropriate ways to use the summit and lower parts of Mauna Kea. Group 70 International is serving as professional planners for this effort.

In support of the planning process, Group 70 contracted with SMS Research & Marketing Services, Inc. to conduct an economic impact study of the Mauna Kea observatories and prepare this memo.

1.1 SCOPE OF STUDY

For this study, SMS Research conducted a survey of the observatories and collected secondary data. SMS used its version of the Hawai'i Input-Output Model, which incorporates the 1992 transaction table developed by the State Department of Business, Economic Development and Tourism's Research and Economic Analysis Division (1997) to identify indirect and induced impacts of astronomy on Mauna Kea at the statewide level. SMS further adapted the Input-Output model, adapting the County level multipliers (based on data from the US Bureau of Economic Analysis) in line with the difference between the corresponding multipliers in the DBEDT and BEA state models.

The observatories have both quantifiable and more general impacts on the Big Island and State economies. In this short report, attention is paid first to the specific impacts that can be estimated using the Input-Output model. Other current impacts are then discussed.

Future impacts possible under the Master Plan are discussed in the third section of the memo. That analysis identifies low and high growth projections, sketching out the range of impacts that could occur.

1.2 ASTRONOMY AS AN INDUSTRY IN HAWAI'I

Astronomy has blossomed on the Big Island of Hawai'i because Mauna Kea offers exceptionally clear viewing conditions. The State and County have protected those conditions through management of the summit of Mauna Kea and concern over changes in land use (e.g., urban lighting) that could affect viewing.

Astronomers and scientific organizations throughout the world have responded by investing in observatories on the summit. In addition, the University of Hawai'i developed a strong graduate program at Manoa and the ability to create scientific instruments for viewing.

As an industry, astronomy begins with a renewable natural resource. It then draws on several distinct sorts of physical and human resources. Physical resources include:

- *Telescopes*: These vary greatly in size and in the type of light they capture. The smallest of the optical telescopes on Mauna Kea has a mirror with a 0.6 meter diameter, while the largest are over eight meters in diameter. The new Smithsonian Submillimeter Array will consist of eight installations gathering data together. Even more complex is the Very Long Baseline Array, with one installation on Mauna Kea and nine others on the Mainland United States and in the Caribbean. (In this document, SMS follows the convention of treating telescope arrays as single instruments, since the difference does not affect the economic issues under study.) The Mauna Kea telescopes have been erected over a thirty-year period, from 1969 to the present.

- *Instrumentation*: Instruments are lenses and similar equipment used to gather the light collected in the telescopes. The Mauna Kea telescopes all have more than one instrument, allowing different kinds of observations to be made in response to scientific interest. Moreover, while the telescopes cannot easily be changed, instrument-making can take advantage of ongoing technical developments, and increase the value of particular telescopes. Because instrument-making is a continuing activity of the observatories, capital investment does not end with the erection of a telescope.

- *Summit buildings and infrastructure*: Telescopes need solid housing, to protect equipment and minimize changes in wind, heat and other conditions that could disrupt viewing. The infrastructure has been developing over the past decades, to include roads, power, and communications systems. Housing for astronomers is provided at Hale Pohaku, at the 9,200-foot level.

- *Facilities in Hilo and Waimea*: These are increasingly complex. Several observatories have headquarters with much office space, machine shops, and computing resources which allow astronomers to analyze great amounts of data away from their home institutions. New facilities are being planned for the UH Institute for Astronomy and the Smithsonian observatory.

The human capital needed includes astronomers, a wide range of engineers and engineering technicians (mechanical, electrical, and electronic), software programmers, staff able to maintain and direct equipment under the extremely difficult conditions of the summit, and administrative personnel.

Some 400 full-time positions in Hawai'i will be supported by Mauna Kea observatories astronomy as of 2000. These are continuing jobs, since the observatories need skilled personnel to maintain and use the telescopes, and make the most of the data gathered. In addition, the observatories attract visiting astronomers. A few are on rotation in Hawai'i for months or a few years. Most are in Hawai'i to conduct observations for a few days. They come to the Big Island, acclimatize for a day or so, and use the telescopes. Many then stay for a few more days to review the data and conduct preliminary analyses.

With the development of sophisticated controls off the mountain and improving communications from the summit to the Big Island towns and overseas, it is often possible for astronomers to direct and analyze their observations away from the summit. At least one observatory will encourage many astronomers to stay home, and monitor their observation runs by teleconference. Arguably, the result will be more efficient scheduling of observations, and hence greater productivity. As a by-product, growth in the number of visitors attracted to the Big Island to conduct experiments will likely slow.

Astronomy is an export industry. It produces observations for further use by the global scientific community. Because it is funded by government institutes, it minimizes reliance on monetary values in allocating its scarcest resource -- viewing time on the telescopes. Viewing time is typically allocated on the basis of scientific review of proposals. The observatories do not explicitly place a dollar value on viewing time, much less identify profitability levels in economic terms. Still, they strive to maintain their standing as sites where research of high quality is conducted, and invest new resources to keep or increase market share, much like other industries.

2: IMPACTS OF ASTRONOMY, TO 1999

2.1 TERMINOLOGY

Major economic impacts of any industry consist of employment, output and income. All of these can be estimated both as direct impacts – changes in the people and cash flows directly associated with the operation of the industry – and in terms of indirect and induced impacts. Indirect impacts are brought about as firms buy goods and services from other firms in the region. Induced impacts are due to spending by the workforce. Direct and indirect spending support jobs. Workers in those jobs in turn spend their pay locally, patronizing stores and paying local taxes.

Indirect and induced impacts can be estimated for any region, given information about the goods and services created and used in the local economy. In Hawai'i, the Input-Output Model used by the State is based on local and national studies of the relations among local industries.

The SMS version of the model uses software developed by the Minnesota Implan Group. The original version included county and state models based on data supplied by the US Bureau of Economic Analysis. The State's model is in many respects more accurate than the BEA version, so SMS has imported the DBEDT estimates of transactions among industries. County models can be adjusted in proportion to the difference in the BEA and DBEDT State models, either using global weights or specific adjustments for particular coefficients and multipliers. For the present study, SMS has taken the latter course.

This study focuses on the economics of astronomy on Mauna Kea in 1999-2000. The "current" situation is defined in the near future because three major telescopes – the Subaru, the Gemini Northern telescope, and the Smithsonian Astronomical Observatory – will soon be operational. Development of these and existing telescopes can be seen as a full-scale realization of earlier Mauna Kea Science Reserve plans, as distinct from the plan revision now being considered.

2.2 QUANTITATIVE IMPACTS

2.2.1 Direct Impacts

The thirteen observatories constitute a medium-size industry. The continuing development of new telescopes provides a conservative indicator of growth, shown in Exhibit 1. (It is conservative because the observatories built in recent years have had larger staffing and budgets than the older ones.)

Exhibit 1: NUMBER OF TELESCOPES ON MAUNA KEA, BY YEAR

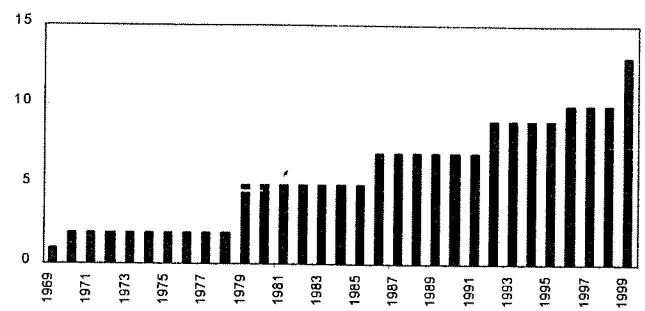


Exhibit 2: DIRECT IMPACTS, ASTRONOMY ON MAUNA KEA

Operating Budget (1)	$51.9 million
Workforce	397
Visiting researchers (Number of trips/year)	3,755
Visitor spending (minimum)	$0.7 million

NOTES: Summary by SMS, based on interviews and IfA reports.
(1) Excludes all capital improvement funds.

The totals shown in Exhibit 2 are conservative:

Budgets: These are for Hawai'i operations and Hawai'i-based personnel only. Separation of the Hawai'i budget from larger institutional budgets is sometimes difficult. The budgets do not include capital improvements spending, either on construction or on instrumentation.

Workforce: This total includes O'ahu personnel who work for the observatories. It excludes overseas staff of the observatories, Institute for Astronomy (IfA) personnel not tasked to a specific observatory, and, on the Big Island, Mauna Kea Support Services (MKSS) staff. (The last supplies the observatories with utilities, housing and such services as road clearing to the summit. It is treated here as a vendor to the observatories, not as a direct part of the industry.)

Visiting Researchers and Visitor Spending: Visitor spending is modest in relation to the number of researchers who visit, because much of the cost of researchers' stay is covered by the observatories.

A few come to Hawai'i for months at a time. Most come to conduct observations on a single telescope. They go to Hale Pohaku to become acclimatized, then stay on the mountain for a few days. Some then stay on-island for the first analysis of their data (for "data reduction").

Visiting astronomers resemble tourists in bringing capital to Hawai'i to spend – but only when they move outside the facilities established for them. Researchers who stay in hotels while they review data are estimated here as spending about as much as the average tourist from their home area. (Average daily spending figures for 1997 for tourists from the United States, Japan and Europe were used to estimate spending by such researchers.) When on the mountain, or in the dormitory maintained by the Keck Observatory in Waimea, researchers have little chance to spend, and the cost of their lodging is already included in the observatory budgets. For researchers who spend nearly all their time on the mountain, a modest expenditure on food and souvenirs has been assumed.

Since the University of Hawai'i has rights to use the various telescopes, a significant portion of the visiting researchers consists of astronomers from Honolulu. Their travel costs are treated here as part of the Big Island astronomy industry.

The Mauna Kea observatories' direct spending is nearly all concentrated on the Big Island. Exhibit 3 shows in detail the allocation of jobs and spending.

Exhibit 3: DIRECT ECONOMIC IMPACTS, HAWAI'I COUNTY AND STATE OF HAWAI'I

	Hawaii County	State of Hawaii
Direct Impacts, Mauna Kea Observatories		
Spending		
Annual Operations Spending (1)	$51.0	$51.9
Annual Share, Construction Spending (2)	$9.4	$9.4
Annual Spending on Instruments in Hawaii (3)	$0.0	$1.0
Visitor Spending (4)	$0.7	$0.7
Total	$61.1	$63.0
Employment		
Research Operations	383	397
Construction (5)	73	73
Instruments (3)	-	10
Visitor Spending (6)	7	7
Total	463	487
Personal Income		
Research Operations (7)	$24.4	$25.3
Construction (8)	$3.7	$3.7
Instruments (3)	$0.0	$0.3
Visitor Spending (6)	$0.2	$0.2
Total	$28.2	$29.4

NOTES All dollar values are in millions of dollars.
(1) State figure from Exhibit 2. County figure reached by separating out payroll costs for Oahu-based employees.
(2) Based on observatory construction costs from 1979 to present. Earlier dollar figures were adjusted to current dollars using the Consumer Price Index for Honolulu for the year construction was finished. Costs were averaged over a 22-year period -- 1978 through 1999. After discussion of examples with observatory personnel, SMS took 25% of construction value as, on average, spent in Hawaii (on construction of buildings at the summit and at lower levels, on infrastructure, and on local transportation).
(3) Based on cost of four instruments now being developed, averaged over two years.
(4) State figure as shown in Exhibit 2. County figure is somewhat smaller, when half of interisland travel costs and of per-trip expenses for astronomers who only stay in research housing are treated as spent outside Hawaii County.
(5) Employment estimated on the basis of ratio between statewide construction jobcount and construction spending, 1997.
(6) Based on State estimates of jobs and personal income supported by visitor spending statewide, for 1997.
(7) From interviews.
(8) From statewide average wage, heavy construction, 1997.

2.2.2 Indirect and Induced Impacts

Total impacts of astronomy on Mauna Kea on output, employment and wages are estimated for Hawaii County and for the State in Exhibit 4.

Exhibit 4: DIRECT, INDIRECT AND INDUCED ECONOMIC IMPACTS, HAWAI'I COUNTY AND STATE OF HAWAI'I

	Hawaii County	State of Hawaii
Output		
Research Operations	$110.8	$118.8
Construction	$18.7	$19.7
Instruments	$0.0	$1.7
Visitor Spending	$1.3	$1.5
Total	$130.9	$141.7
Employment		
Research Operations	582	619
Construction	158	173
Instruments	-.	15
Visitor Spending	12	13
Total	753	820
Personal Income		
Research Operations	$37.5	$41.4
Construction	$6.6	$7.0
Instruments	$0.0	$0.5
Visitor Spending	$0.4	$0.4
Total	$44.5	$49.3

NOTES:

Multipliers (Type II) from SMS ImPlan Pro Input Output models, using both model based on DBEDT transaction table for 1992 and State and County models based on Bureau of Economic Analysis estimates. The DBEDT model was taken as the best available, and the BEA County multipliers were adjusted in proportion to the differences between the DBEDT and BEA State multipliers. Visitor spending multipliers were developed for this study, based on average of hotel, eating and drink and miscellaneous retail multipliers. Instrument-making was classed as miscellaneous manufacture.

State

	Output	Jobs	Income
Research	2.29	1.56	1.64
Construction	2.10	2.37	1.91
Instruments	1.69	1.49	1.71
Visitor Spending	2.05	1.76	1.93

County

	Output	Jobs	Income
Research	2.17	1.52	1.54
Construction	1.99	2.17	1.81
Visitor Spending	1.95	1.70	1.81

The Hawai'i County jobs listed in Exhibit 4 amount to 1.5% of the total jobcount in the county. The total wages amount to 3.6% of the wages of Hawai'i County employees. The income level is higher than the jobcount, since many of these jobs pay above the average wage in Hawai'i County.

The multiplier effects for the highly specialized activities – research and instrument making – are not particularly large. However, the County-level multipliers for research are nearly as large as the State ones. These industries purchase less from other local firms than do less specialized industries, but pay their workers well, leading to strong spending in the local consumer economy. In other words, astronomy has fairly low indirect effects, but high induced effects.

2.2.3 Emerging Trends

The historical trend shown in Exhibit 1 is for continuing growth in the number of telescopes on Mauna Kea. The likely economic trend is, then, for continuing growth in spending on astronomy on the Big Island. However, three issues deserve note:

First, telescopes do not automatically bring a large workforce and continuing spending – observatories do. The distinction is obvious in the case of the VLBA, for which Mauna Kea is simply an outlying part – and the local staff is small. The newest telescopes now being finished all are backed by Hawai'i personnel and equipment. The Big Island is becoming an important site for scientific work, not just a field outpost from which data is collected. The administrative center of the Gemini project is in Hilo – operation of its second telescope (in Chile) will be supervised from, and could be fully directed from Hawai'i.

It makes good sense to locate a headquarters near the best viewing site, in Hawai'i. But the technology involved is changing quickly, making it far from certain that Hawai'i will continue to attract well-staffed observatories.

Secondly, changes in telecommunications, that have allowed much of the control of the telescopes to be done from Hilo and Waimea, can make it less and less necessary for researchers to come to the Big Island at all.

Third, the role of University of Hawai'i could change. Its telescopes are the oldest on the summit, and leading candidates for replacement. If those sites are ceded to others, the University would have viewing rights on all telescopes, but exclusive rights to none. Perhaps a more important trend arises with IfA's work on instrumentation. IfA personnel are developing devices for the new telescopes, and could continue to be well placed to modify and adjust instruments. (The

actual manufacture of instrument parts largely takes place outside Hawai'i , even for IfA.) The economic impact of these trends would be growth in the overall effects of astronomy in Hawai'i .

2.3 FURTHER IMPACTS

The economic impacts of an industry are evidently greater than those measured in an input-output model. An industry can create a climate in which others – in related industries or very different ones – can flourish. This may be because it provides a crucial source of sales or personnel. Alternatively, it may provide free resources for the other industry.

2.3.1 Impacts on Industry

For this study, attention was paid to indications that astronomy had affected four other industries. Anecdotal information about impacts on the communities surrounding Mauna Kea was also noted. Our tentative finding is that astronomy does not have a large enough presence to support specialized vendors. Its impact on higher education is strong, but its consequences for tourism have not yet been developed to a significant extent.

Computer Services. Observatory personnel were asked about the availability of computer parts and services. While some use Hawai'i suppliers and service personnel, most depended on staff resources and US Mainland suppliers far more than on Hawai'i firms.

Machine shops. Again, since the observatories need custom-made equipment, we asked whether machinists and similar services were available. Observatory personnel were positive about the skills of staff – mostly local hires from the Big Island – but did not mention local vendors as important.

Education. The observatories have extensive impacts on education. They provide speakers for schools and the University of Hawai'i at Hilo. They have sponsored courses in Waimea. Work-study students from local high schools and interns from UH Hilo gain experience in the observatories, and may go on to permanent jobs in them.

While these local impacts are important, the larger impact is on astronomy as an educational and research activity, in Hawai'i and across the world. In Hawai'i, the development of telescopes on Mauna Kea has given UH astronomers preferential access to a wide range of telescopes. The Institute for Astronomy, founded in 1967, now has some 46 faculty members, four post-doctoral researchers, and 23 graduate students. It is one of the few research departments at the University generally recognized as of high quality.

Tourism. Hundreds of tourists visit Hale Pohaku or the Keck headquarters, and the Gemini headquarters includes an entry area that will be welcoming to visitors. Some 30,000 to 50,000 visitors come to Hale Pohaku annually. This tourist traffic is, however, very modest in comparison to the Big Island's total visitor count (1.2 million visitors annually; on average, about 20,000 visitors on island daily). Special events such as eclipses bring many more visitors to the island.

With construction of the Subaru telescope, for the National Astronomical Observatory of Japan, there has been speculation that large numbers of Japanese tourists will come to Hilo to visit. It is simply too early to know whether there will be much impact.

Improvement of the Saddle Road over the next few years will make Hale Pohaku much more accessible for visitors. Currently, standard auto rental contracts bar use of the Saddle Road, so nearly all tourists cannot reach the mountain. When the road improves, it will become a major crossing, and Hale Pohaku will easily become part of the itinerary taken by tourists. Visitor counts could easily increase to the level seen at Lava Tree State Monument in Puna (143,000 counted in 1994) or the Lapakahi State Park Historical Site (336,000 in 1994).

Construction of new observatories has created events of interest to visitors, including opening ceremonies and First Light observations. These have attracted specialists and supporters to the Big Island.

Currently, a few tourism operators on the Big Island and Moloka'i promote skywatching as a visitor activity. Arizona has seen greater tourist activity, both at observatories and at resorts which provide telescopes and "star parties" for guests (DeVoss, 1998). Hawai'i can claim comparable viewing conditions, and hence can treat astronomy as not just an interest of tourists, but as an attraction that will bring a niche market to the islands.

2.2.3 Impact on Communities

The two towns most affected by astronomy on Mauna Kea are Hilo, long the center of government and commerce on the Big Island, and Waimea. Astronomy has had little evident effect in Hilo. In Waimea, the headquarters of the Canada-France-Hawai'i and Keck observatories have stood out as a new venture, quite different from the town's ranching past. Waimea has gained a reputation as a town with many professionals, who patronize its upscale restaurants and boutiques. Astronomers hardly form a large enough base for the retail economy.

Instead, their importance has been to contribute to the image of Waimea as more sophisticated than nearby communities.

Observatory staff contribute time to non-profit groups including the Chamber of Commerce, sports organizations, and charities. The impact goes beyond the towns of Hilo and Waimea. For example, an observatory employee developed websites for a cooperative and small businesses in South Hawai'i.

3: IMPACTS OF GROWTH ALLOWED UNDER THE MAUNA KEA MASTER PLAN, TO 2020

This section deals with economic impacts of changes anticipated under the Master Plan. Potential astronomy-related growth factors independent of the Master Plan are noted, then two scenarios – low and high growth estimates – for new development are studied. Education and management activities are estimated, along with astronomical research, since the Master Plan emphasizes the integration of astronomy into systematic management of Mauna Kea as a complex resource area.

3.1 POTENTIAL IMPACTS INDEPENDENT OF THE MASTER PLAN

Two trends may have much larger effects than seen to date:

- With continuing support of science education and internships, and continuing need for staff, the observatories will encourage a local pool of skilled technical personnel. The results could well include not only jobs with good pay for some residents, but also experience leading to similar jobs elsewhere for some, or the creation of start-up businesses by a few others.
- Tourism on the Big Island may draw more extensively on astronomy as a resource. East Hawai'i marketers are very much aware of the need for more and varied attractions (Visitor Industry Working Group, 1998). When and if astronomical work is shown at a site that can be integrated easily into the trips of many tourists, the tourist industry will explore ways to include astronomy, as a separate attraction or simply as part of the association between the Big Island and spectacular natural events.

A "Mauna Kea Center" Science Education Center is being planned for the UH Hilo University Park area. It could contribute to both trends, providing technical jobs and a convenient venue for displaying astronomy to visitors and Hawai'i residents.

3.2 DEVELOPMENT UNDER THE MASTER PLAN

The Master Plan discusses new development of three kinds:

- Access management (ranger station on road);

- Visitor facilities (expanded Visitor Information Station; use of cabins by groups); and
- Observatories.

For the purposes of this report, road access management is treated as mandated by the Plan, and new visitor facilities are viewed as programmed and likely to be built in the course of the 20-year Plan period. The Plan permits, but does not mandate, increases in the number of observatories. Replacement of existing observatories and construction of new ones will depend on scientific, funding and planning decisions. Two estimates of new activity are used here, to underline the fact that the extent of future development is uncertain.

Strictly speaking, the "Low Estimate" is a Low Growth estimate, anticipating new construction that may or may not occur. Again, the "High Estimate" is a high estimate within the framework of the Master Plan. Alternative scenarios, with more and faster expansion of scientific work, are conceptually possible but excluded as not in keeping with the Master Plan.

3.2.1 Construction

The construction that will most affect the human presence on Mauna Kea consists of new facilities for rangers near and at the Visitor Information Station (VIS), and expansion of the VIS. The Plan calls for continuous control of access to the upper elevations of the mountain, and increased educational activity, by rangers and by guides at the VIS.

The Master Plan directs observatories to plan new operations at the sites of older existing telescopes, in preference to new sites at the summit. Replacement of older telescopes will demand coordination among many parties, notably the operators of older telescopes and developers of new ones. The Low Estimate also allows for some construction at new sites, notably for the Next Generation Large Telescope. The size of that facility could vary, so cost and operations estimates under the Low Estimate are smaller than under the High Estimate. In both cases, this project is expected to involve a larger footprint, complex engineering issues, and hence a major construction effort.

Exhibit 5 lists construction on Mauna Kea under the Master Plan, for the entire period (to 2020). It is likely that construction would be spread out during the period, not concentrated in one or two years. As Exhibit 6 shows, the construction jobcount on the Big Island would average from 80 to 120 direct jobs annually.

Exhibit 5: POSSIBLE CONSTRUCTION UNDER MASTER PLAN, BY 2020

	Development Costs Total	HI (est.)
LOW ESTIMATE		
New management and visitor facilities	$2.0	$2.0
On-site replacement of older facilities (1)		
1 Instructional, UH 0.6	$0.1	$0.1
2 Optical/IR replacement	$120.0	$12.0
Expansion of existing observatories		
4 Auxiliaries, Keck	$20.0	$5.0
SMA (about 12 pads/6 new antennae)	$12.5	$3.1
New facilities		
1 New instructional telescope, UH Hilo	$0.5	$0.5
1 Optical/IR	$100.0	$25.0
1 Next generation large optical/IR telescope	$800.0	$160.0
Lower Estimate Total	$1,055.1	$207.7
HIGH ESTIMATE		
New management and visitor facilities	$2.0	$2.0
On-site replacement of older facilities (1)		
1 Instructional, UH 0.6	$0.1	$0.1
3 Optical/IR replacement	$180.0	$36.0
Expansion of existing observatories		
6 Auxiliaries, Keck	$30.0	$7.5
SMA (about 24 pads/12 new antennae)	$25.0	$6.3
New facilities		
1 New instructional telescope, UH Hilo	$0.5	$0.5
2 Optical/IR	$300.0	$60.0
1 Next generation large optical/IR telescope	$1,000.0	$200.0
Higher Estimate Total	$1,537.6	$312.4

NOTES: All estimates are in constant 1999 dollars. Estimates are based on plans for new construction discussed in the course of the Master Plan Update process. Low and high assumptions are generated to describe the range of development that could occur under the Master Plan Update. Construction would occur over the length of the Master Plan period.

(1) Development costs include removal of older telescopes.

The total construction employment impact – direct plus indirect and induced jobs – would amount to about 190 to 290 jobs statewide annually, on average. Of those jobs, some 175 to 265 would be located in Hawai'i County. (Exhibits 6 and 7 depend on ratios and multipliers used in Exhibits 3 and 4.)

Exhibit 6: CONSTRUCTION EMPLOYMENT IMPACTS OF POSSIBLE NEW DEVELOPMENT ON MAUNA KEA

	Low	High
Value, all Hawaii construction	$207.7	$312.4
Direct jobs	1,613	2,426
Average annual direct jobcount over 20 years	81	121
Indirect and Induced Jobs		
Statewide, over 20 years	2,210	3,323
Statewide, annual average	111	166
County, over 20 years	1,885	2,835
County, annual average	94	142

Direct construction income would likely range from $5.5 million to $8.3 million (1999 dollars) annually. Total income associated with construction – for direct, indirect and induced jobs -- would come to $10.6 million to $15.9 million annually.

3.2.2 Operations

At the end of the Master Plan period, most of the observatories now on the Big Island would be active, along with some future observatories. It is assumed here than no current observatory would simply close, without being replaced, since demand for viewing times is strong. Accordingly, Exhibit 7 estimates new operations staffing as follows:

- Management and rangers: A small Hilo-based management would work with rangers and VIS educational specialists on the mountain;
- Existing observatories: not shown, since Exhibit 7 covers new activities;
- Replacement telescopes: small growth in numbers over those currently staffing observatories where replacements will occur;
- Expansion (of Keck and SMA): small increases to handle additional capabilities;

- New observatories: new staffing, comparable to those of the Keck, Gemini, and Subaru observatories;

- Visiting researchers: the number of trips, and hence the amount of visitor spending, is estimated for the new operations based on current levels of activity; and

- Instrumentation: This is increasingly a Hawai'i specialty, with scientists from IfA developing new optics for the Mauna Kea telescopes. This is an opportunity that could be missed (as shown in the Low Estimate) or seized.

Exhibit 7: DIRECT OPERATIONS EMPLOYMENT IMPACTS OF POSSIBLE NEW ACTIVITIES ON MAUNA KEA

		Low	High
Management (Hilo)		2	2
Rangers (Mauna Kea)		3.5	6
Visitor Information Station		2	5
Direct Jobs for Observatories			
Replacement telescopes		2	15
Expansion		10	14
New observatories		117	172
Visiting Researcher Impacts			
Current level for viewing observatories (1)			
trips per observatory	469		
spending per observatory	$0.1		
Future level for new observatories			
Trips		939	1,408
Spending		$0.2	$0.3
Direct employment impact		2	3
Instrumentation (Statewide)		0	20
Total direct employment		138	237

NOTES: Operations jobs are estimated for end of Master Plan period. Development is expected to occur throughout the 20-year period. Based on construction estimates and current operations of observatories. Low and High estimates differ not only in number of observatories but in size of facilities and operations.
(1) Does not include observatories under development in 1999 (Subaru, Gemini, Smithsonian) and the remotely operated VLBA. Current data shown on left side of table used to calculate future impact (below and right).

Visitor spending is estimated only for researchers using new telescopes. It seems likely, however, that improvements at the VIS and the rangers' monitoring of the upper slopes will correlate with, and could even stimulate, increased visitor traffic on the mountain.

Exhibit 8 shows direct employment and income impacts for operations and operations-related activities under the two Master Plan scenarios. It combines current and anticipated impacts in order to indicate the size of Mauna Kea-related activities in the coming years. (Construction was considered separately, since construction jobs are short-term, while operations jobs are potentially permanent, continuing from year to year.)

Exhibit 9 goes on to estimate direct, indirect and induced impacts. The row dealing with management services is small, since it does not count the existing support services as direct inputs. Instead, these are treated (as they were for Exhibit 4) as indirect employment associated with research on the mountain. Indirect and induced impacts are shown for statewide impacts, not County (although there will likely be little change in the allocation of jobs in Hawai'i County vs. other parts of the state).

When construction and operations data are viewed together, it is likely that, at the end of the Master Plan period, the total direct jobs will be in the range of 650 to 800 jobs (including the average annual construction jobs as well as the full range of operational jobs developed in the course of the Master Plan period). Total direct, indirect and induced jobs would then come to about 1,050 to 1,300 jobs (combining jobs associated with annual construction with operations jobs under the Low and High scenarios).

Exhibit 8: DIRECT EMPLOYMENT AND INCOMES IN HAWAI'I ASSOCIATED WITH MAUNA KEA DEVELOPMENT, AS OF 2020

	Low	High
Employment		
Management, Rangers, VIS		
Existing (MKSS)	22	22
New	8	13
Subtotal	30	35
Observatories		
Existing	397	397
New	129	201
Subtotal	526	598
Visitor Spending		
Existing	7	7
New	2	3
Subtotal	9	10
Instrumentation (Statewide)		
Existing	10	10
New	-	20
Subtotal	10	30
TOTAL	574	673
Incomes (in millions of 1999 $s)		
Management, Rangers, VIS		
Existing (MKSS)	$0.8	$0.8
New	$0.3	$0.5
Subtotal	$1.0	$1.2
Observatories		
Existing	$25.3	$25.3
New	$8.2	$12.8
Subtotal	$33.5	$38.1
Visitor Spending		
Existing	$0.2	$0.2
New	$0.1	$0.1
Subtotal	$0.3	$0.3
Instrumentation (Statewide)		
Existing	$0.3	$0.3
New	$0.0	$0.6
Subtotal	$0.3	$0.9
TOTAL	$35.1	$40.5

NOTES: New incomes estimated from existing levels.

Exhibit 9: DIRECT, INDIRECT AND INDUCED EMPLOYMENT AND INCOME IMPACTS

	Low	High
Employment		
Management, Rangers, VIS		
Direct (1)	8	13
Indirect and Induced	4	8
Subtotal	12	21
Observatories		
Direct	526	598
Indirect and Induced	294	335
Subtotal	820	933
Visitor Spending		
Direct	9	10
Indirect and Induced	7	8
Subtotal	16	18
Instrumentation (Statewide)		
Direct	10	30
Indirect and Induced	5	15
Subtotal	15	45
TOTAL	863	1,016
Incomes (in millions of 1998 $s)		
Management, Rangers, VIS		
Direct	$ 1.0	$ 1.2
Indirect and Induced	$ 0.1	$ 0.2
Subtotal	$ 1.2	$ 1.5
Observatories		
Direct	$ 33.5	$ 38.1
Indirect and Induced	$ 21.4	$ 24.4
Subtotal	$ 54.9	$ 62.4
Visitor Spending		
Direct	$ 0.3	$ 0.3
Indirect and Induced	$ 0.2	$ 0.3
Subtotal	$ 0.5	$ 0.6
Instrumentation (Statewide)		
Direct	$ 0.3	$ 0.9
Indirect and Induced	$ 0.2	$ 0.6
Subtotal	$ 0.5	$ 1.5
TOTAL	$57.1	$66.0

NOTES: Existing support jobs on Mauna Kea are counted as indirect impacts of research on the mountain, and are excluded from the direct impact count in this table.

(1) Wages estimated from average Hawaii County State wages, 1997, and (for indirect and induced jobs) from statewide average wages for employment covered by State insurance.

3.2.3 Fiscal Impacts of Growth

The projected growth of Mauna Kea facilities will affect State and County revenues. State revenues will increase mainly due to:

- Taxes associated with construction in Hawai'i: These include excise taxes on construction spending, excise taxes on construction-related workers' spending of their disposable income, and income taxes on the construction-related workers' wages. Based on annual average construction spending, these would likely amount to $7.3 million to $10.9 million (1998 dollars) annually during the Master Plan period accruing to the State of Hawai'i. (Calculations are based on current tax law and the spending and income figures shown earlier.)

- Taxes associated with operations workforce incomes and spending: The State would similarly gain revenues from incomes and spending by direct, indirect and induced operations-related workers. The annual taxes associated with operations would amount to $4.9 million to $5.7 million (1998 dollars) by the end of the Master Plan period, when new operations are fully developed.

New State revenues would accordingly be at least $7 million annually and would grow to $12.2 million to $16.6 million (under the Low and High scenarios) at the end of the Master Plan period. (Some additional revenues would also be gathered through corporate income taxes and fees.)

County revenues are not easily estimated. The major source of County income, property taxes, would increase as operations workers invest in homes for their families. (Much or all of the direct construction for astronomy is for government and non-profit agencies and is dedicated to educational purposes – and accordingly is exempt from County property taxes.)

Some new jobs will be filled by in-migrants. With population growth, County and State spending is likely to grow. New spending associated with in-migrants will likely be small in relation to the new revenues discussed here.

3.2.4 Growth in Comparison to Historical Trends

Potential new activities during the Master Plan period can be compared to recent trends. Two major differences stand out:

- Average annual construction costs and jobcounts are somewhat higher than in the recent past (comparing the 73 direct construction jobs in Exhibit 3 with the 81 to 121 direct jobs during the Master Plan period). This is largely due to the NGLT project. If that project is smaller – or its Hawai'i construction share is

smaller – than estimated, the average costs and jobcounts could easily be smaller than in the last two decades.

- New astronomy operations employment amounts to 33% to 57% of current employment. The trend is, then, for much slower growth in the astronomy workforce than in the last two decades.

The picture that emerges is of a maturing local industry, with a significant local role but declining growth.

REFERENCES

DeVoss, D. "In Arizona, It's an All-Night Party for the Stars." *Smithsonian*, pp. 113-123. December, 1998.

Hawai'i State Department of Business, Economic Development and Tourism. *The 1992 Hawai'i State Input-Output Study.* Honolulu, HI, 1997.

Hawai'i State Department of Business, Economic Development and Tourism. *The State of Hawai'i Data Book 1997.* Honolulu, HI, 1998a.

Hawai'i State Department of Business, Economic Development and Tourism. *Science & Technology: The Key to Hawaii's Economic Future.* Honolulu, HI, 1998b.

Visitor Industry Working Group, East Hawai'i Governor's Office and Hawai'i Island Chamber of Commerce. *East Hawai'i's Visitor Industry: Opportunities at Hand.* Hilo, Hawai'i, 1998.

MAUNA KEA SCIENCE RESERVE
MASTER PLAN

APPENDIX N

Cultural Impact Assessment Study:
Native Hawaiian Cultural Practices, Features, and Beliefs Associated with the University of Hawai'i Mauna Kea Science Reserve Master Plan Project Area

PHRI, Inc.

August, 1999

MARCH 2000

Report 1876-040199

Cultural Impact Assessment Study

Native Hawaiian Cultural Practices, Features, and Beliefs Associated with the University of Hawai'i Mauna Kea Science Reserve Master Plan Project Area

University of Hawai'i Mauna Kea Science Reserve Master Plan
Mauna Kea Science Reserve and Hale Pōhaku

Lands of Ka'ohe (Hāmākua District) and
Humu'ula (Hilo District), Island of Hawai'i

Technical Report for Environmental Impact Study

PHRI
Paul H. Rosendahl, Ph.D., Inc.
Archaeological • Historical • Cultural Resource Management Studies & Services

Report 1876-040199

Cultural Impact Assessment Study

Native Hawaiian Cultural Practices, Features, and Beliefs Associated with the University of Hawai'i Mauna Kea Science Reserve Master Plan Project Area

University of Hawai'i Mauna Kea Science Reserve Master Plan
Mauna Kea Science Reserve and Hale Pōhaku

Lands of Ka'ohe (Hāmākua District) and
Humu'ula (Hilo District), Island of Hawai'i

Technical Report for Environmental Impact Study

PREPARED BY

PHRI
204 Waianuenue Avenue
Hilo, Hawai'i 96720

PREPARED FOR

University of Hawaii – Institute for Astronomy
c/o Group 70 International
925 Bethel Street, Fifth Floor
Honolulu, Hawai'i 96813-4307

AUGUST 1999

PHRI **Paul H. Rosendahl, Ph.D., Inc.**
Archaeological • Historical • Cultural Resource Management Studies & Services
HAWAII: 204 Waianuenue Avenue • Hilo, Hawaii 96720 • (808) 969-1763 • GUAM: P.O. Box 23305 • G.M.F., Guam 96921 • (671) 472-3117

SUMMARY

Consisting of the upper slopes and summit region of Mauna Kea, the University of Hawai'i Mauna Kea Science Reserve is an 11,288 acre parcel of land leased by the University from the State of Hawai'i since 1968 for development and use as a scientific complex devoted to astronomical research. This cultural impact assessment study has been prepared as a technical report for inclusion in the Environmental Impact Statement submitted by the University of Hawai'i in support of the University's Mauna Kea Science Reserve Master Plan. This new master plan is currently being prepared to provide guidance for the use and development of the Science Reserve into the next decades.

The overall objective of the present cultural impact assessment study was to identify any Native Hawaiian cultural practices, features, and beliefs currently associated with the Science Reserve Master Plan project area that might potentially be in some manner constrained, restricted, prohibited, or eliminated if the proposed Master Plan were to be approved. The nature of identified cultural practices addressed was not restricted; that is, claims for all three types of practices – traditional cultural property, traditional and customary cultural practices, and contemporary cultural practices – were identified and considered.

The principal source of information utilized by the present study was the oral history and consultation study carried out by Cultural Resources Specialist Kepâ Maly, who made extensive efforts to identify and contact individuals potentially knowledgeable of Mauna Kea with regard to traditional and customary cultural practices, traditional cultural properties, and contemporary cultural practices. He conducted a total of fifteen recorded interviews with twenty-two different informants, and in the process of carrying out his study consulted with more than 100 individuals, a great number of whom had knowledge about Mauna Kea and were able to provide information which supplemented that obtained during the recorded informant interviews.

The number and variety of individuals and groups contacted and consulted by Maly demonstrates an adequate, appropriate, and reasonable good-faith effort to identify the full range of native Hawaiian cultural practices, features, and beliefs currently associated with the Science Reserve Master Plan project area on Mauna Kea. This documented effort indicates it is likely that the full range of current cultural practices, features, and beliefs associated with the Science Reserve Master Plan project area has been identified, even though in many instances only the general nature of these practices, features, and beliefs has been determined but not documented in any great detail.

Based on an evaluation of the findings of the present cultural impact assessment study, it is believed that with minor exceptions, most of the native Hawaiian cultural practices, features, and beliefs identified as being currently associated with the Mauna Kea Science Reserve Master Plan project area can be considered to be culturally and historically significant. Most, if not all, of the identified practices and beliefs would seem to qualify as traditional and customary cultural practices, while the principal *pu'u* (Kukahau'ula, Lilinoe) and the shallow lake with adjacent *pu'u* (Waiau) would seem to satisfy the criteria for being regarded as legitimate traditional cultural properties. Finally, none of the identified practices and beliefs would seem to represent strictly contemporary cultural practices or beliefs lacking some measure of traditional connection.

Based on an evaluation of the Native Hawaiian cultural practices, features, and beliefs identified as currently associated with the Mauna Kea Science Reserve Master Plan project area, and a general consideration of the potentially adverse direct and indirect effects that might result from future development and use of the summit region, it is obvious that a comprehensive plan for both the short-term and long-term management of the Science Reserve Master Plan project area is vital for the protection and preservation of significant traditional cultural resources. The Master Plan minimizes potential direct and indirect impacts to cultural practices, features and beliefs through the careful limits set upon future development within the proposed Astronomy Precinct and restrictive design guidelines. The Management Plan proposes specific necessary actions to protect the cultural resources and traditional cultural access rights and uses.

Contents

Illustrations

Tables

INTRODUCTION

Consisting of the upper slopes and summit region of Mauna Kea, the Mauna Kea Science Reserve is an 11,288 acre parcel of land leased by the University of Hawai'i from the State of Hawai'i since 1968 for development and use as a scientific complex devoted to astronomical research. In 1983, the University of Hawai'i adopted a complex development plan, the Mauna Kea Science Reserve Complex Development Plan, which projected development to the year 2000 and which has provided guidance for the use and development of the science reserve up to the present. To provide guidance into the next decades, a new master plan is currently being prepared by the Honolulu firm of Group 70 International for the University of Hawai'i; the Mauna Kea Science Reserve Master Plan (1999) for continued complex development incorporates the major directions and recommendations proposed by the University of Hawai'i's Mauna Kea Advisory Committee and Group 70.

STUDY IDENTIFICATION

The present cultural impact assessment study has been prepared as a supporting technical report for an appropriate Environmental Impact Statement (EIS) (In prep.) being prepared by Group 70 for the University of Hawai'i in connection with the Master Plan in accordance with "Chapter 343 – Environmental Impact Statements" (Haw.Rev.Stat.) and "Title 11, Chapter 200 – Environmental Impact Statement Rules" (Haw.Admin. Rules, Dept. Health). The basic purposes of the EIS are two-fold: (a) to permit adequate consideration of the potential environmental, social, and economic consequences of the proposed project; and (b) to provide for public participation in the planning of the project (OEQC 1997a:4).

STUDY PURPOSE

General Purpose

The general purpose of the present cultural impact assessment study would be to assess the potential impacts of the proposed complex development plan of the University of Hawai'i Mauna Kea Science Reserve Master Plan upon the cultural resources of the upper slopes and summit region of Mauna Kea in accordance with general guidance provided by OEQC guidelines for cultural impact assessment (OEQC 1997b). Generally speaking, cultural resources include a broad range of often overlapping categories of cultural items – places, behaviors, values, beliefs, objects, records, stories, and so on. For the purpose of this cultural impact assessment study, cultural resources would be defined more specifically as the cultural practices, features, and beliefs of Native Hawaiians that are associated with the defined University of Hawai'i Mauna Kea Science Reserve Master Plan project area atop Mauna Kea on the Island of Hawai'i.

One specific type of cultural resource that falls within the purview of the historic preservation review process is called a "traditional cultural property" (TCP). A traditional cultural property is a historic property or place that is important because it possesses "traditional cultural significance":

> "Traditional" in this context refers to those beliefs, customs, and practices of a living community of people that have been passed down through the generations, usually orally or through practice. The traditional cultural significance of a historic property, then, is significance derived from the role the property plays in a community's historically rooted beliefs, customs, and practices. . . .

> A traditional cultural property, then, can be defined generally as one that is...[important/significant]. . . because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community (Parker and King 1990:1).

In addition, it is important to realize that sometimes a traditional cultural property may not have a visible physical manifestation:

> Although many traditional cultural properties have physical manifestations that anyone walking across the surface of the earth can see, others do not have this kind of visibility, and more important, the meaning, the historical importance of most traditional cultural properties can only be evaluated in terms of the oral history of the community (Sebastian 1993:22).

Two significant differences distinguish traditional cultural properties as a subset within the larger sphere of cultural resources. First, while cultural resources such as practices and beliefs may be spatially associated with general types of geographical areas, such as the upper slopes of Mauna Kea, a traditional cultural property is a specific physical entity or feature with a definable boundary, such as a specific cinder cone, or *pu'u*, situated on the upper slopes of Mauna Kea. Second, while cultural resources such as practices and beliefs can include general cultural behaviors such as the use of a general area for the collection of natural resources, meditation and ceremonial purposes, or the conduct of religious activities, a traditional cultural property is a specific place or feature directly associated with specific cultural behaviors, the continuity of which over time can be demonstrated.

Given these two significant distinctions, there are three types of practitioner claims relating to cultural practices, beliefs, and features that are likely to be encountered in the course of conducting a cultural impact assessment study. These claims can be referred to as (a) traditional cultural property claims, (b) traditional and customary cultural practice claims, and (c) contemporary (or neo-traditional) cultural practice claims.

Traditional cultural property claims would be those which lie within the purview of the historic preservation review process; that is, they are claims involving the traditional practices and beliefs of a local ethnic community or members of that community that (a) are associated with a definable physical property (and entity such as a site, building, structure, object, or district), (b) are founded in the history of the local community, (c) contribute to the maintenance of the cultural identity of the community, and (d) demonstrate a historical continuity of practice or belief up to the present – through either actual practice or historical documentation (including both written and oral historical sources). Furthermore, a potential traditional cultural property must have demonstrable historical significance in terms of established evaluation criteria, such as those of the National Register of Historic Places and/or the Hawai'i Register of Historic Places, to qualify as a legitimate traditional cultural property within the historic preservation context.

Traditional and customary cultural practice claims would be those which lie within the purview of Article XII, Section 7, of the Hawai'i State Constitution ("Traditional and Customary Rights"), and various other state laws and court rulings, particularly as reaffirmed in 1995 by the Hawai'i State Supreme Court in the decision commonly referred to as the "PASH decision," and as further clarified more recently in its 1998 decision in *State of Hawai'i v. Alapai Hanapi*. The notable points of the decisions in PASH and in *Hanapi* can be summarized as follows: (a) the reasonable exercise of ancient Native Hawaiian usage is entitled to protection under Article XII, Section 7, of the Hawai'i State Constitution; and (b) those persons claiming their conduct is constitutionally protected must prove that they are a Native Hawaiian as defined in PASH, that the claimed right is constitutionally protected as a traditional and customary Native Hawaiian practice, and that the exercise of the right is occurring on undeveloped or less than fully developed property.

While traditional cultural property claims, as defined above, would certainly fall within the general domain of traditional and customary cultural practice claims, not all traditional and customary cultural practice claims would necessarily qualify as traditional and customary cultural property claims. Traditional and customary cultural practice claims subsume a broad range of cultural practices and beliefs associated with a general geographical area or region, rather than a clearly definable property or site – for example, the gathering of various plant products from an upland or forest area for traditional subsistence or ceremonial purposes, in contrast to the gathering of a specific plant species for a specific use by current generation members of a family that had obtained the same plant from the same recognized site for several generations.

Contemporary, or "neo-traditional", cultural practice claims do not necessarily overlap with either traditional property claims or traditional and customary practice claims. Contemporary cultural practice claims would be those made by cultural practitioners relating to current practices or beliefs for which no clear specific basis in traditional culture can be clearly established or demonstrated – for example, the conducting of ritual ceremonies at sites or features for which no such prior traditional use and associated beliefs can be demonstrated. In some cases, however, it may be possible to demonstrate the reasonable evolutionary development of a contemporary practice from an earlier traditional practice.

Specific Purpose and Objectives

The specific purpose of the present cultural impact assessment study was to assess the potential effects of the proposed Complex Development Plan of the University of Hawai'i – Institute for Astronomy (UH-IfA) upon Native Hawaiian cultural practices (including features and beliefs) associated with the defined University of Hawai'i Mauna Kea Science Reserve Master Plan project area atop Mauna Kea on the Island of Hawai'i. To accomplish this purpose, the following specific objectives were established:

1. Identify any traditional Native Hawaiian cultural practices currently being conducted by individual cultural practitioners or groups;
2. Collect information sufficient to define and document the nature, location, and authenticity of identified traditional cultural practices and practitioners or groups;
3. Assess potential impacts of the current project upon identified traditional cultural practices; and
4. Recommend appropriate mitigation measures for any potentially adverse effects upon identified traditional cultural practices.

Thus, the overall goal or objective of the present cultural impact assessment study was to identify any Native Hawaiian cultural practices currently being conducted within the defined project area that might potentially be in some manner constrained, restricted, prohibited, or eliminated if the proposed UH-IfA project were to be approved. The nature of identified cultural practices would not be restricted; that is, claims for all three types practices – traditional cultural property, traditional and customary cultural practices, and contemporary cultural practices – would be identified and considered.

CULTURAL IMPACT ASSESSMENT AND OEQC GUIDELINES

Background

To understand the cultural impact assessment issue, particularly as it is addressed in the present study, a concise consideration of the intent and evolution of the OEQC guidelines is necessary. The guidelines evolved out of what are commonly referred to as "PASH/Kohanaiki" issues – issues relating to Native Hawaiian traditional and customary access and land use rights as they were reasserted by a State Supreme Court decision in August 1995 and further clarified in its 1998 decision in State v. Hanapi – and the need for appropriate means to address these issues within the State environmental impact review process. For a good discussion of the issues and options involved, the recently completed "Report on Native Hawaiian Traditional and Customary Practices Following the Opinion of the Supreme Court of the State of Hawai'i in Public Access Shoreline Hawai'i vs. Hawai'i County Planning Commission" prepared by the PASH/Kohanaiki Study Group (1998) should be consulted.

Initial attempts to address various issues relating to Native Hawaiian traditional and customary access and land use rights within the framework of the State environmental impact review process were made in the form of proposed changes to the State EIS law as contained in Chapter 343 (HRS). These attempts to require a formal cultural impact assessment failed to pass the State legislature in 1996 and 1997.

A subsequent, second attempt to address various issues relating to Native Hawaiian traditional and customary access and land use rights was made in the form of proposed changes in the "Administrative Rules" for compliance with Chapt. 343 (DOH Title 11, Chapt. 200). This attempt to require an explicitly defined cultural impact assessment also failed, as the governor declined to approve the proposed amendments.

The third attempt to address various issues relating to Native Hawaiian traditional and customary access and land use rights within the State environmental impact review process has resulted in the current OEQC "Guidelines for Assessing Cultural Impacts" (OEQC 1997b). Draft guidelines were initially issued for public review and comment on September 8, 1997. The guidelines in their final form were formally adopted by the Environmental Council on November 19, 1997.

The relationship of the OEQC guidelines to the State Supreme Court "PASH" decision was clearly stated on front page of the September 8, 1997 issue of the OEQC bulletin, *The Environmental Notice,* when the draft guidelines were first issued for public review and comment:

> For years, a controversy has simmered over developer's responsibility to perform a "Cultural Impact Study" prior to building a project. The recent Supreme Court "PASH" decision reaffirmed the state's duty to protect the gathering rights of Native Hawaiians. In light of these events, the Environmental Council has drafted a guidance document to provide clarity on when and how to assess a project's impacts on the cultural practices of host communities.

It should be noted that the guidelines for cultural impact assessment are meant to include consideration of all the different groups comprising the multi-ethnic community of Hawaii; however, this inclusiveness is generally understated, and the clear emphasis is meant to be upon aspects of Native Hawaiian culture.

More than 20 letters were received by OEQC in response to the publication of the draft guidelines, and relevant comments were said to have been incorporated into a final version of the guidelines (OEQC n.d.). The final guidelines (OEQC 1997b) were formally adopted by the Environmental Council on November 19, 1997. The final guidelines are virtually identical to the draft guidelines initially published on September 8, 1997, and the degree to which any of the received comments on the draft guidelines were considered prior to issuance of the final guidelines is uncertain. In fact, the overall process through which the guidelines were prepared and adopted brings out several important questions relating to such topics as (a) the source or basis utilized for the content of the guidelines, (b) the background and qualifications of the preparer(s) of the guidelines, (c) the criteria to be used for the adequacy of cultural impact assessment studies prepared in response to the guidelines, and (d) the legal question of how compliance can be required when the standards are guidelines.

According to the Chair's Report contained in The 1997 Annual Report of the Environmental Council, the guidelines were drafted by the Cultural Impacts Committee:

> The Committee drafted guidelines recommending a methodology to assess the impact of proposed actions on cultural resources, including Native Hawaiian cultural resources, values, and beliefs. The guidelines also specify the contents of a cultural impact assessment.
>
> To prepare the Guidelines, the Committee reviewed public testimony and solicited input from interested parties. Expertise from the DLNR's Historic Preservation Division as well as Federal regulations governing the "Protection of Historic Properties" were used to model the draft guidelines.
>
> The draft cultural impact guidelines were published for review and comment in the Sept. 8 Environmental Notice, and over 20 letters were received. Relevant comments were incorporated into a final draft versions of the guidelines, which were adopted as a policy document by the Environmental Council on November 19, 1997 (OEQC n.d.:5).

Direct inquiries to OEQC (Gary Gill, Director) and SHPD (Dr. Holly McEldowney, Staff Specialist in the History and Culture Branch) provided additional background information relating to the formulation of the cultural impact assessment guidelines. The principal author or compiler of the guidelines was Arnold Lum, Esq., a member of the Environmental Council's Cultural Impacts Committee, and also a staff attorney at the Native Hawaiian Legal Corporation. OEQC staff also assisted in the preparation of the guidelines. Several internal drafts were prepared, reviewed, and revised. Preparation of the guidelines relied to some degree upon National Register Bulletin No. 38, "Guidelines for Evaluating and Documenting Traditional Cultural Properties" (Parker and King 1990) for basic content information. Other sources, including the SHPD draft rules for conducting ethnographic surveys and dealing with traditional cultural properties (DLNR n.d.), were consulted; in fact, a copy of the SHPD draft rules was provided to OEQC and the Cultural Impacts Committee by SHPD Administrator, Dr. Don Hibbard. Professional staff in the SHPD - History and Culture Branch took part in the preparation and review of the guidelines. Certainly the inclusion of such professional anthropological and historical expertise in the preparation of the guidelines was appropriate; however, much of the professional advice on the extent to which detailed expectations – regarding study scope, content, methodology, documentation, and impact assessment – should be explicitly addressed in the guidelines was apparently discounted.

Discussion

The OEQC guidelines consist of three basic sections. The first section is an introduction which notes the various statutory and other bases for addressing potential impacts upon cultural resources within the context of the environmental assessment review process, and "...encourages preparers of environmental assessments and environmental impact statements to analyze the impact of a proposed action on cultural practices and features associated with the project area" (OEQC 1997:1). The second section of the guidelines discusses methodological considerations for conducting cultural impact assessments, and presents a recommended six-step protocol to be followed by the assessment preparers. The third section of the guidelines outlines eleven topics or "matters" that a cultural assessment should address; these topics basically represent the proposed or desired content and organization of a cultural impact assessment report.

As "guidelines", the OEQC guidelines would seem to have neither the specific statutory authority of law, nor the regulatory authority of administrative rules. As guidelines, they should be regarded as providing general guidance; that is, they represent suggestions and recommendations as to how to approach the assessment of potential cultural impacts. The guidelines provide little or no guidance relative to many important questions, perhaps the most significant of which would be the following:

1. How would project-specific determinations be made as to whether or not a cultural impact assessment study might even be necessary or appropriate, given the specific nature and location of a proposed project;

2. If a cultural impact assessment study is to be conducted, how does one determine what would constitute an appropriate project-specific level of effort – that is, the general scope of work or objectives for the study, and the specific tasks or activities required to accomplish successfully the scope of work or objectives;

3. What criteria are to be used for determining the credibility and reliability of potential cultural information sources (generally referred to as "informants" or "knowledgeable individuals");

4. If specific cultural practices, beliefs, or features are definitely identified as being associated with a project area, what criteria are to be applied for evaluating (a) the descriptive adequacy and (b) the cultural authenticity of the identified practices, beliefs, or features;

5. If specific culturally authentic practices, beliefs, or features are definitely identified as being associated with a project area, what criteria are to be used for assessing the nature and extent of potential impacts of a proposed project on the identified practices, beliefs, or features – "no effect", "no adverse effect", and/or "adverse effect";

6. If a project were determined to have potentially adverse effects upon specific identified, culturally authentic practices, beliefs, or features, what criteria are to be used for evaluating the adequacy and appropriateness of alternative potential mitigation actions;

7. The review and acceptance or rejection of a completed cultural impact assessment study would legitimately fall within the purview of what regulatory office or agency; and

8. What standards or criteria are to be used to evaluate the overall adequacy or acceptability of a completed cultural impact assessment study?

Consideration of these questions, and their implicit implications, would have direct relevance to cultural impact assessment studies. These implications relate most importantly to (a) the level of study effort believed appropriate for the project-specific context, and (b) the rational adopted for both the study overall, as well as for the identification and evaluation of identified cultural practice claims, the assessment of potential project-specific impacts, and the formulation of any specific recommendations for further study or other actions.

PRESENT STUDY SCOPE

Level of Study Effort and Rationale for Approach

Determination of the level of study effort appropriate in any project- specific context should involve the consideration of several factors, including the following:

1. Probable significance and number of known or suspected traditional cultural properties, features, practices, or beliefs within or related to the specific project area;

2. Potential number of individuals (potential informants) knowledgeable of the specific project area;

3. Availability of historical and cultural information on the specific project area or immediately adjacent lands;

4. Size, configuration, and natural history of the specific project area; and

5. Potential effects of the project on known or expected traditional cultural properties, features, practices, or beliefs within or related to the specific project area.

In some instances, consideration of these factors within the specific nature and context of a project might indicate that the most appropriate level of study for an adequate assessment of potential cultural impacts would be that which could be characterized as an identification study. The distinctive characteristics of an identification study are that it would be limited to (a) the identification of Native Hawaiian cultural practices currently being conducted by individual cultural practitioners or groups, and (b) the collection of information minimally sufficient so as to define the general nature, location, and likely authenticity of identified cultural practices. An identification study is believed to comprise a reasonable approach for the assessment of potential cultural impacts when the potential for a project to result in adverse impacts upon any current Native Hawaiian cultural practices, beliefs, or features would seem likely to be minimal or indeterminate; that is, given the specific details of a proposed project, it would be very unlikely that the continued exercise of any current practices would be in any way restricted, constrained, prohibited, or eliminated.

An identification study would not involve the considerably greater level of effort – both calendar months and hours of labor – needed to carry out what could be characterized as a documentation study. The distinctive characteristics of the latter, more commonly be referred to as a full ethnographic or oral history study would be (a) the collection of detailed information regarding identified Native Hawaiian cultural practices by means of formal oral history interviews which are usually tape recorded and transcribed, and (b) the analysis and synthesis of all collected data – from interviews, as well as relevant historical documentary and archival research – within the general cultural-historical context of traditional Native Hawaiian culture and the defined specific geographical area of a specific project.

The overall rationale guiding the present study has been that the level of study effort should be commensurate with the potential of the proposed project for making any adverse impacts upon any Native Hawaiian cultural practices currently conducted by cultural practitioners within the Science Reserve Complex Development Plan project area. Because the proposed project was believed likely to have potentially adverse impacts, the level of study effort referred to as a documentation study, or a full ethnographic or oral history study, was determined to be appropriate. Proposed future development within the Science Reserve Complex Development Plan project area would involve construction and operation of substantial and widespread, or dispersed, astronomy facilities and related support facilities and infrastructure, and would appear to have significant potential for both direct and indirect effects of short-term and long-term duration on current Native Hawaiian cultural practices associated with the project area.

Therefore, intensive efforts were made to seek out and interview knowledgeable informants and cultural practitioners in an effort to identify and document traditional and customary practices, traditional cultural properties, and contemporary cultural practices associated with the project area so that adequate and appropriate mitigation measures might be developed to minimize or eliminate adverse effects upon existing Native Hawaiian cultural practices, features, and beliefs. Adequate identification and documentation for the present study entailed considerable efforts to interview knowledgeable informants and cultural practitioners in order to collect and record the details of identified cultural practices, features, and beliefs. The study did not, however, make any exhaustive efforts to evaluate the authenticity of identified cultural practices, or to determine whether such practices represented more recently established contemporary cultural practices rather than traditional and customary cultural practices. This position was taken for two reasons: (a) disagreement or argument with informants and practitioners as to the cultural authenticity of specific practices, features, or beliefs would seem to be both insensitive and presumptuous; and (b) efforts made to minimize or avoid potentially adverse effects upon identified Native Hawaiian cultural practices, features, and beliefs would seem to be the more productive and appropriate course of action.

Specific Scope and Work Tasks

While the specific purpose of the cultural impact assessment study was to assess the potential effects of the proposed Complex Development Plan of the University of Hawai'i - Institute for Astronomy (UH-IfA) upon Native Hawaiian cultural practices (including features and beliefs) associated with the defined University of Hawai'i Mauna Kea Science Reserve Master Plan project area, the specific scope and work tasks of the study were defined by several assumptions, constraints, and limitations. In order to accomplish the specific purpose and objectives outlined for the present study, the following specific tasks were formulated:

1. Review available historical documentary, traditional cultural property, and archaeological background research;

2. Review and evaluate available oral history informant interview summary and transcripts;

3. Prepare an appropriate cultural impact assessment report; and

4. Consult and coordinate with client and client representatives, regulatory agencies, advisory groups, and any other individuals or groups as necessary and/or appropriate.

Assumptions, Constraints, and Limitations

At the direction of the client and with the agreement of the SHPD, the present cultural impact assessment study was be carried out in accordance with two specific assumptions that would constrain and limit the scope of work and tasks. First, no additional or new historical documentary, traditional cultural property, and archaeological background research would be conducted. Background review would utilize only available materials, particularly recently prepared ones, including (a) an archival literature research overview and oral history report prepared for the present Complex Development Plan project by independent Cultural Resources Specialist Kepā Maly (Maly 1999), (b) a compilation of traditional cultural property and current cultural uses information prepared by SHPD History and Culture Specialist H. McEldowney, (c) an archaeological inventory survey report prepared by SHPD Staff Archaeologist P. McCoy, and (d) a comprehensive historic preservation plan for the Mauna Kea Science Reserve prepared by SHPD staff (DLNR In prep.). Secondly, no additional oral history informant interview work was to be conducted. Review and evaluation of local informant interviews would utilize the available summaries and transcripts of the oral history interviews recently completed by independent Cultural Resources Specialist Kepā Maly (Maly 1999).

As indicated by the recent audit report on the management of Mauna Kea and the Mauna Kea Science Reserve (Auditor 1998), the protection and management of the natural resources of Mauna Kea, including the cultural resources, has generally been less than adequate. While several more or less comprehensive plans and reports for management and development have been prepared over the years since 1977, implementation of proposed measures to protect and manage significant natural resources has generally been weak; more specifically, the audit determined that historical preservation concerns had been neglected, and cultural preservation concerns largely unrecognized (Auditor 1998:15-23).

During the period 1986-1993, numerous discussions apparently took place between the University of Hawai'i and DLNR regarding the preparation of a historic preservation plan for the identification, protection, and management of historic properties on Mauna Kea and in the Mauna Kea Science Reserve. A detailed scope of work for the preparation of a historic preservation management plan (DLNR 1993) was finally completed and approved in 1993, and archaeological survey field work related to the preparation of the plan was subsequently carried out between 1995 and 1997 (McCoy 1999).

In February 1999, the University of Hawai'i and DLNR executed a formal Memorandum of Agreement under which the University would provide financial support to DLNR for the preparation by SHPD of a historic preservation management plan for Mauna Kea. This agreement, which incorporated the approved 1993 scope of work, called for DLNR to complete and submit a final plan within nine months (i.e., by the end of October 1999), with draft versions of different component sections of the plan to be completed and submitted within six months (i.e., by the end of July 1999).

A detailed outline for the organization and content of the historic preservation plan had been previously prepared by SHPD and finalized in December 1998. This outline conceptualized a comprehensive plan consisting of two essential major components: (a) an information component which described the significant historic properties of Mauna Kea and the Mauna Kea Science Reserve, and (b) a management component which identified potential impacts of proposed development and appropriate measures through which potentially adverse effects could be avoided or mitigated.

The information component of the historic preservation plan was organized to address the following topics:

1. Introduction, including plan objectives and background, geographic areas to be covered, and operational jurisdictions (applicable State and Federal laws and policies);

2. Environmental Setting;

3. Cultural-Historical Background, including overview of social-political context, prehistoric and early historic land use patterns (to 1850) of the summit region and Hale Pōhaku/mid-elevation forest zone, and historic period land use patterns of the summit region and Hale Pōhaku (c. 1830s to 1960);

4. Historic Property Inventory, including history and extent of past archaeological survey coverage, and results (property types, distribution patterns, analysis, traditional cultural properties);

5. Evaluations and Eligibility for the National Register, including definition of a Summit Region Historic District, and discussions of Kalepamoa Area (Hale Pōhaku area) historic properties and the Mauna Kea Adze Quarry);

6. Land Uses, Potential Threats, and Regulated Activities; and

7. Jurisdictions.

The management component of the historic preservation plan was organized to address the following topics:

1. Plans for Specific Development Projects and Related Activities, including maintenance and routine operations, and proposed development and construction projects, in terms of potential direct and indirect adverse effects, and proposed mitigation measures to avoid or minimize adverse effects; and

2. Long-Term Management Plan for Historic Properties within the Science Reserve, including plans for interpretive development, monitoring, routine consultation with Native Hawaiian organizations and individuals, cultural uses, and continued inventory of historic properties.

In addition to a Reference section and a Glossary of terms used in the plan, the historic preservation plan was to incorporate five technical Appendices:

1. Report of Archaeological Surveys Conducted by DLNR (1995 to 1997), including survey methods, areas covered, relocation of previously identified sites, and survey results;

2. Catalogue of Historic Properties, including descriptions of all historic properties identified between 1982 and 1997;

3. Annotated Bibliography of Archaeological and Related Studies in the Mauna Kea Science Reserve and Mauna Kea, including all archaeological studies and related scientific studies;

4. Annotated Bibliography of Historic and Ethnographic References to Mauna Kea, including associated cultural references (myths, legends, and traditions), historic period accounts of the upper regions, and historic period land use records of areas; and

5. Annotated List of Applicable Historic Preservation Laws and Regulations.

The scope of work and level of preparation effort agreed upon for the present cultural impact assessment study were formulated with the understanding and assumption that draft versions of major substantive sections of the historic preservation plan being prepared by DLNR would be available and would be utilized extensively in the preparation of the present cultural impact assessment study. With the exception of a detailed content outline and partial draft discussion of the management component of the historic preservation plan, and a draft summary inventory of archaeological sites identified within the Science Reserve (including short descriptions of individual sites), these expectations had not been fulfilled as of early August 1999.

This situation has resulted in limitations to the present study report, which have been dealt with as follows. First, intended overview sections on cultural-historical background and archaeology have been replaced by a single cultural-historical-archaeological overview section that has been taken from, with minor changes, the *Mauna Kea Science Reserve Master Plan - Draft #3* (Group 70 International 1999:V-1 thru 10). Second, an intended section on the proposed Mauna Kea Summit Region Historic District has been replaced by a short summary prepared on the basis of discussions with SHPD staff, and two draft maps provided by SHPD staff.

While these limitations have altered somewhat the original intended scope of the present study report, they do not prevent an adequate identification and evaluation of Native Hawaiian cultural practices, features, and beliefs associated with the Mauna Kea Science Reserve Complex Development Plan project area. Information sufficient for such identification and evaluation is provided by the oral history study and archival literature research report conducted by Kepā Maly (1999), and supported by additional documentary sources.

STUDY METHODOLOGY

Guidance Documents

Several documentary references were consulted and utilized for general guidance in the preparation of the present cultural impact assessment study. The principal sources were the following:

1. The recently adopted OEQC "Guidelines for Assessing Cultural Impacts" (OEQC 1997);

2. The "Native Hawaiian Rights Handbook" (MacKenzie 1991), and more specifically the discussions of traditional and customary rights contained in the chapters on access rights (Lucas 1991a), gathering rights (Lucas 1991b), religious freedom (Kau and MacKenzie 1991), and burial rights (Ayau 1991);

3. The recently completed "Report on Native Hawaiian Traditional and Customary Practices Following the Opinion of the Supreme Court of the State of Hawai'i in Public Access Shoreline Hawai'i v. Hawai'i County Planning Commission" prepared by the PASH/Kohanaiki Study Group (1998);

4. The Federal regulations of the Advisory Council on Historic Preservation for the National Register of Historic Places (CFR 1981) and the "Protection of Historic Properties" (CFR 1986);

5. National Register Bulletin No. 38, "Guidelines for Evaluating and Documenting Traditional Cultural Properties" (Parker and King 1990); and

6. Recent versions of the State Historic Preservation Division (SHPD) draft administrative rules, including Chapter 275 – "Rules Governing Procedures for Historic Preservation Review for Governmental Projects Covered Under Sections 6E-7 and 6E-8, HRS" (DLNR 1998), and Chapter 284 – "Rules Governing Procedures for Ethnographic Inventory Surveys, Treatment of Traditional Cultural Properties, and Historical Data Recovery" (DLNR n.d.).

While the general nature and content of the first three referenced sources are self-explanatory, further comment should be made regarding the final three items. In the absence of any formally adopted administrative rules, the State Historic Preservation Division (SHPD) currently utilizes National Register Bulletin No. 38 (Parker and King 1990) as its principal source of guidance for reviewing and evaluating the adequacy and acceptability of traditional cultural property study reports prepared in connection with various permit applications for which SHPD regulatory review is required. Bulletin No. 38 provides detailed guidance for the assessment of traditional cultural properties within the framework of the National Register significance criteria evaluation process (NPS 1990).

The SHPD draft administrative rules relating to ethnographic surveys and traditional cultural properties (DLNR n.d.) have existed in finalized draft version since at least early 1997; however, they have never been circulated openly, much less formally provided for public review, comment, and eventual adoption by the Department of Land and Natural Resources. This situation is unfortunate because the draft rules go well beyond National Register Bulletin No. 38 in providing detailed guidance for conducting traditional cultural property studies, and more specifically for dealing with the identification, evaluation, and documentation of Native Hawaiian traditional cultural properties and their associated cultural practices and beliefs.

In the absence of any formally adopted administrative rules, SHPD can also be said to basically follow the Federal regulations of the Advisory Council on Historic Preservation for guidance in the evaluation of significance – as contained in Section 60.4 ("Criteria for evaluation") of the "National Register of Historic Places (CFR 1981), and for guidance in the assessment of potential effects – as contained in Section 800.9 ("Criteria of effect and adverse effect") of the "Protection of Historic Properties" (CFR 1986).

Information Sources

The principal source of information utilized by the present study was the oral history and consultation study carried out by Kepā Maly (1999). Maly made extensive efforts to identify and contact individuals potentially knowledgeable of Mauna Kea with regard to traditional and customary cultural practices, traditional cultural properties, and contemporary cultural practices. *Table 1* summarizes the background and qualifications of the knowledgeable informants and cultural practitioners whose interviews were used as the basis for Maly's report:

> In the period between September 25th to December 21st, 1998, Maly...conducted a total of fifteen tape recorded and supplemental interviews with twenty-two participants. The interviews were transcribed and returned to each of the interviewees and follow up discussions were conducted to review each of the typed draft-transcripts. The latter process resulted in the recording of additional narratives with several interviewees... Additionally, three historic interviews (recorded between 1956 to 1967) were translated from Hawaiian to English...and transcribed. With those interviews, representing three primary interweaves, the total number of interviewees represented in [Maly's] study is twenty-five (Maly 1999:ii).

*Table 1. Interviewee Background: Summary of Informants and Identified Cultural Practitioners **

Previously Recorded Interviews:

Name of Interviewee	*Ethnicity*	*Year Born*	*Birth Place*	*Male (M) Female (F)*	*Place of Residence*	*Comments*
Kaleohano Kalili	Hawaiian	ca. 1884	n/a	M	Honolulu	1956 participant in Bishop Museum interview.
James Kahalelaumāmane Lindsey	Hawaiian	1882	Waimea Hawai'i	M	Waimea	1966 participant in family interview.
Kalani Ka'apuni Phillips	Hawaiian	1902	Waimea Hawai'i	F	Waimea	1967 participant in family interview.

Interviews of 1998:

Name of Interviewee	*Ethnicity*	*Year Born*	*Birth Place*	*Male (M) Female (F)*	*Place of Residence*	*Comments*
Toshi Imoto	Japanese	1928	Pu'u 'Ō'ō	M	Pāpa'ikou	Retired Cowboy.
John Ah San	Chinese-Portuguese	1907	Laupāhoehoe	M	Laupāhoehoe	Retired Mauna Kea Forestry employee.
Coco Hind	Part Hawaiian	1923	Honolulu (Raised in Waimea)	F	Hōlualoa	Descendant of Hawaiian ranching family.

**from Maly (1999)*

Table 1. Interviewee Background (continued)

Name of Interviewee	Ethnicity	Year Born	Birth Place	Male (M) Female (F)	Place of Residence	Comments
Teddy Bell	Part Hawaiian	1923	Waimea	M	Waimea	Retired Cowboy and Construction worker.
Sonny Kaniho	Part Hawaiian	1922	Kawaihae uka	M	Waimea	Retired Cowboy.
Daniel Kaniho Sr.	Part Hawaiian	1932	Waimea	M	Waimea	Retired Cowboy.
Judge Martin Pence	Caucasian	1904	Kansas	M	Honolulu	Federal Judge; Mauna Kea Hunter.
Pete L'Orange	Part Hawaiian	1933	Waipahu	M	Waimea	Retired Parker Ranch/Humu'ula Manager; Land Use Planner.
Alika Lancaster	Part Hawaiian	1930	Hilo	M	Keaukaha	Mason; Hawai'i Loa Descendant; Hawaiian practi-tioner.
Anita (Kamaka'ala-Poli'ahu) Lancaster	Part Hawaiian	1942	Moloka'i	F	Keaukaha	Poli'ahu-Hawai'i Loa descendant.
Tita Spielman	Part Hawaiian	1924	Waiākea	F	'Ōuli	Parker-Low family descendant.
J.K. Spielman	Part Hawaiian	1959	Honolulu	M	'Ōuli	Son of Tita Spielman; fisher-man.
Hannah Kihalani Springer	Part Hawaiian	1952	Kona	F	Ka'ūpūlehu	Hawaiian Practi-tioner; historian; OHA Trustee.
Albert Kahiwahiwaokalani Haa Sr.	Hawaiian	1930	Kapoho	M	Waiākea	Retired from Military and State Corrections program; Hawaiian ranching family with ties to Mauna Kea.
Albert K. Haa Jr.	Part Hawaiian	1953	Honolulu	M	Waiākea	Son of A. Haa Sr.; Hawaiian Practi-tioner.
Lloyd Case	Part Hawaiian	1949	Waimea	M	Waimea	Construction worker; Hawaiian practitioner; and subsistence hunter.
Pualani Kanaka'ole-Kanahele	Hawaiian	1937	Hilo	F	Pana'ewa	Hawaiian Educator, cultural practi-tioner; Ho'opa'a Kumu Hula.
Irene Lindsey-Fergerstrom & Romona Ferger-strom-Kalalau and family members	Part Hawaiian	1932 1960	Waimea	F F	Waimea	Descendants of families with generations of practice on Mauna Kea.

In the course of conducting his oral history research, Maly attempted to contact and evaluate as many knowledgeable informants and cultural practitioners as possible:

> [D]uring the process of preparing for, and conducting the formal recorded interviews, [Maly] spoke with more than 100 individuals who were known to him, or were identified as: (1) having knowledge about Mauna Kea; (2) knowing someone who could be a potential interviewee; or (3) who represented Native Hawaiian organizations...with interest in Mauna Kea. Several of those contacts resulted in the recording of informal documentation regarding Mauna Kea, or generated written responses as formal communications (Maly 1999:ii-iii).

Other sources of information consulted were various historical documentary and cultural studies, archaeological reports, and management reports pertaining to Mauna Kea. The principal additional references consulted included *A Social Impact Assessment: Indigenous Hawaiian Cultural Values of the Proposed Saddle Road Alignments* (Kanahele and Kanahele n.d.), *Supplement to Archaeological, Historical, and Traditional Cultural Property Assessment for the Hawai'i Defense Access Road...and Saddle Road...Project* (Langlas 1998), *Mauna Kea* - Kuahiwi Ku Ha'o I Ka Malie: *A Report on Archival and Documentary Research* (Maly 1998), *Archaeological and Historical Literature Search and Research Design: Lava Flow Control Study, Hilo, Hawai'i* (McEldowney 1979), *Report 1. Ethnographic Background of the Mauna Kea Summit Region* (McEldowney 1982), *A Regional Synthesis of Hamakua District* (Cordy 1994), several archaeological paper and reports by P.C. McCoy (1977, 1978, 1981, 1982, 1984a, 1984b, 1986, 1990,1997, 1999a, 1999b, Ms.), *Revised Management Plan for the UH Management Areas on Mauna Kea* (DLNR and UH-IfA 1995), and *Mauna Kea Science Reserve Master Plan - Draft #3* (Group 70 International 1999).

UNIVERSITY OF HAWAI'I MAUNA KEA SCIENCE RESERVE MASTER PLAN

The following project description section summarizes project background and setting, and the major physical and master plan components of the University of Hawai'i Science Reserve Master Plan in connection with which the present cultural impact assessment study has been prepared. The principal source from which the following has been adapted is the *Mauna Kea Science Reserve Master Plan - Draft #3* (Group 70 International 1999).

PROJECT BACKGROUND

The Mauna Kea Science Reserve comprises the upper slopes and summit region of Mauna Kea. The Science Reserve is an 11,288 acre parcel of land leased by the University of Hawai'i from the State of Hawai'i since 1968 for development and use as a scientific complex devoted to astronomical research. The reserve was established by the Hawai'i State Board of Land and Natural Resources in 1968 when it approved a 65 year lease to the University of Hawai'i. Two summit region parcels excluded from the reserve are components of the Mauna Kea Ice Age Natural Area Reserve. Astronomy facility development has occurred primarily on the summit area above 13,200 feet elevation, while support facilities have developed downslope at Hale Pōhaku (9,800 feet elevation).

In 1983, the University of Hawai'i adopted a complex development plan, the Mauna Kea Science Reserve Complex Development Plan, which projected development to the year 2000 and which has provided guidance for the use and development of the science reserve up to the present. To provide guidance into the next decades, a new master plan is currently being prepared as an update to the Complex Development Plan by the Honolulu firm of Group 70 International for the University of Hawai'i. The Mauna Kea Science Reserve Master Plan (1999) for continued complex development incorporates the major directions and recommendations proposed by the University of Hawai'i's Mauna Kea Advisory Committee and Group 70.

PROJECT SETTING AND DESCRIPTION

Project Physical Components

The Complex Development Plan project area consists of four major physical components; the Mauna Kea Science Reserve, the Mid-Elevation Facilities at Hale Pōhaku, the Summit Road which provides access between Hale Pōhaku and the summit region, and the two Natural Area Reserve parcels *(Figure 1)*. While the latter are not technically under the management control of the University of Hawai'i, they must be considered as part of the project area because they contain significant archaeological and cultural resources (e.g., the Mauna Kea Adze Quarry Complex and Lake Waiau) which might potentially be effected by development, operational, and recreational activities within the areas under University management control.

The 11,288 acre Science Reserve itself contains the majority of significant archaeological and cultural sites that have been identified to date. Most of the archaeological sites are situated in a band that circles the actual summit area, while the existing astronomy facilities are concentrated in the immediate summit area. This distribution of archaeological sites and astronomy facilities are shown in *Figure 2*, which also shows the location of a recently proposed 525 acre Astronomy Precinct within which all future development atop Mauna Kea would be restricted. The remaining 10,760 acres surrounding the Astronomy Precinct would become the Natural and Cultural Preservation Area.

1876-040199

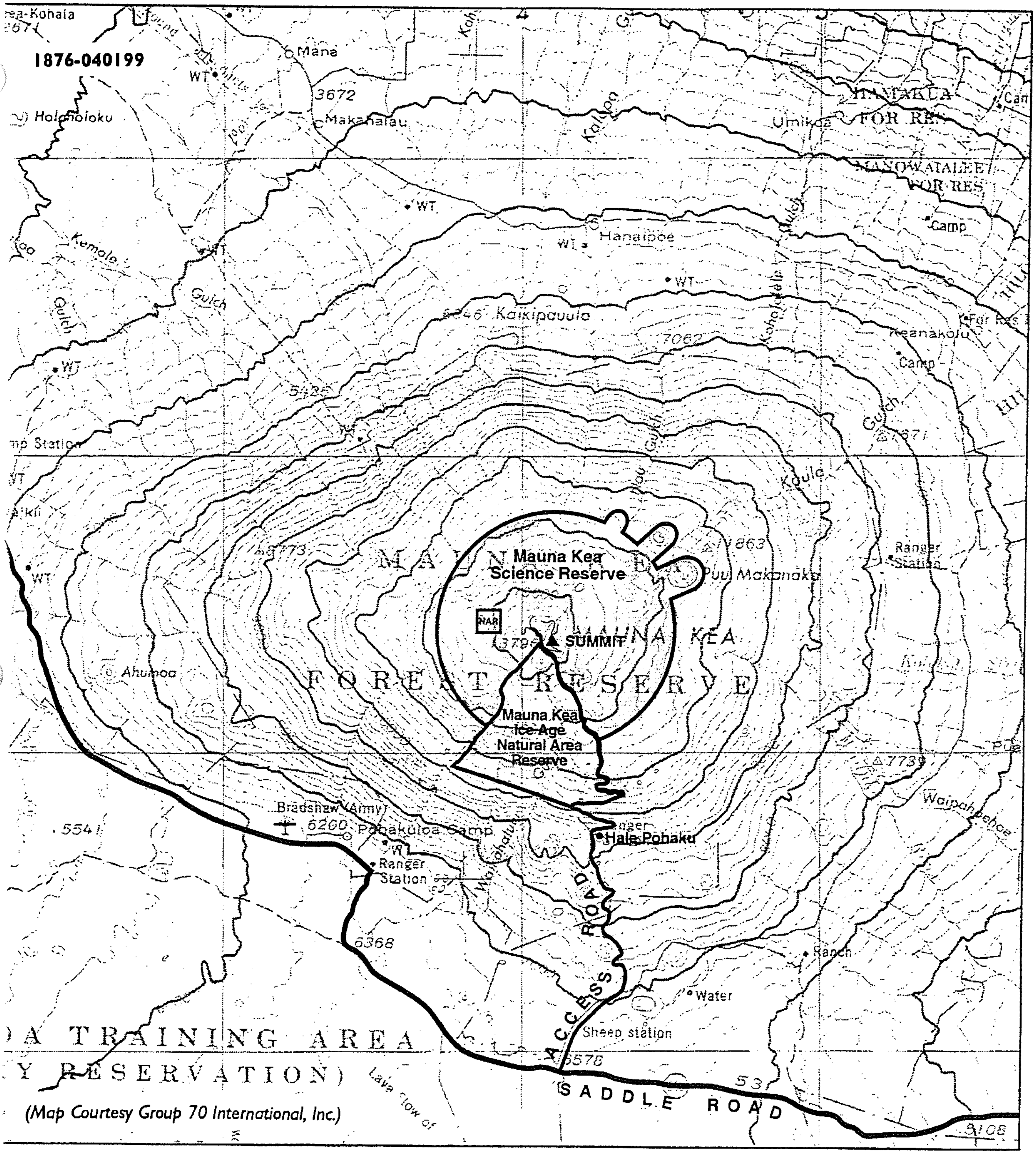
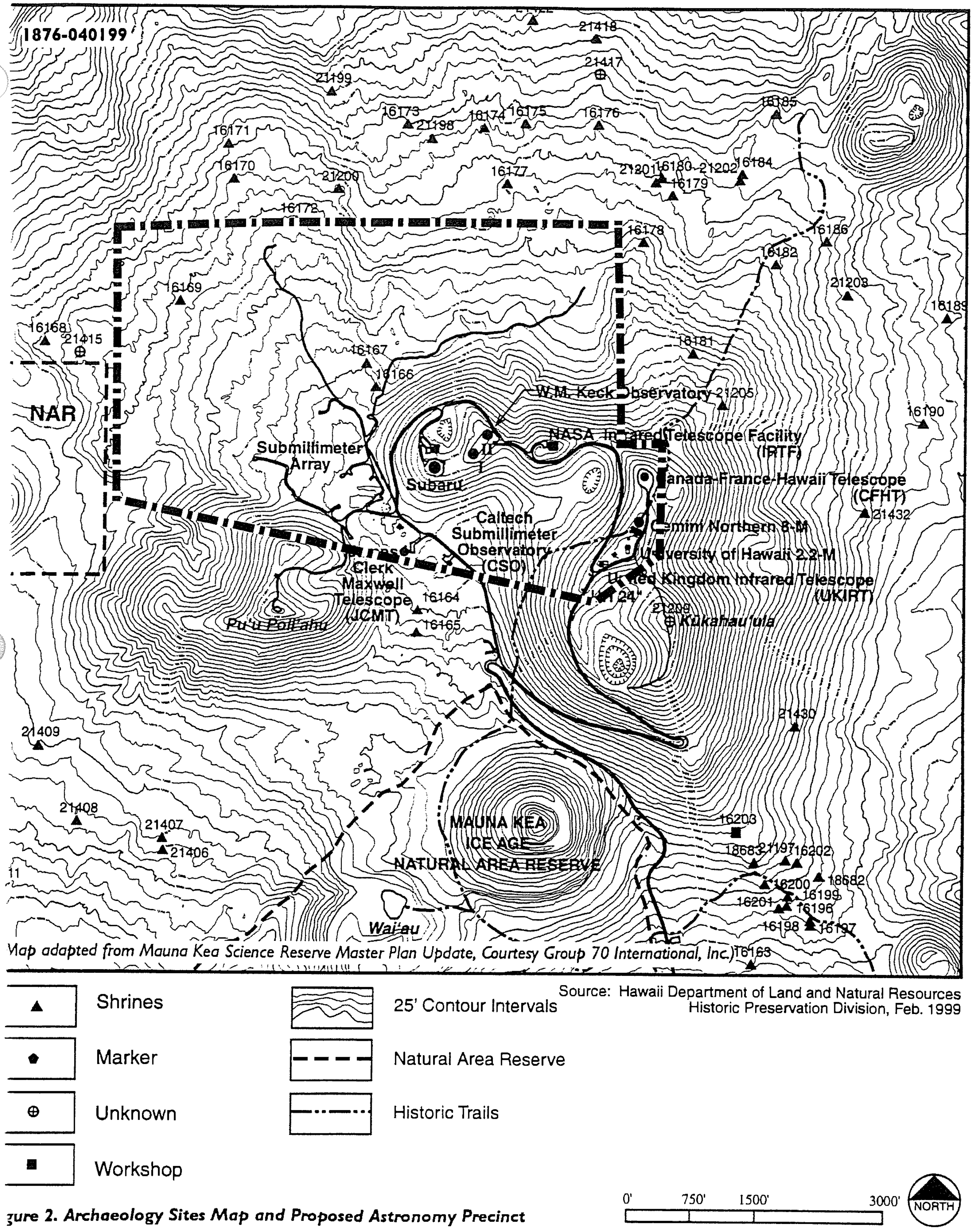


Figure 1. Mauna Kea Science Reserve and Hale Pohaku Project Area

0' 7500' 15000' 30000' NORTH



gure 2. Archaeology Sites Map and Proposed Astronomy Precinct

Project Master Plan

The Master Plan prepared by Group 70 International (1999) for the update of the Complex Development Plan is structured into three major integral sections. The first section establishes the direction and process for the Master Plan; it provides an introduction to the project, outlines the goals and objectives, and summarizes the methodology used. The second section describes the various components that comprise the existing physical environment and background to the human utilization of Mauna Kea: the natural environment – including geology, flora and fauna, and the historic period destruction of native vegetation; and the cultural setting – including Native Hawaiian cultural concepts, occupation, and resource utilization, and early historic period land use patterns, as known through historical, archaeological, and ethnographic research. The second section also contains a component which discusses the range of management and use issues and opportunities that pertain to Mauna Kea. The third section contains physical and management plans, based on the analysis and integration of all available information relating to future educational, research, cultural, and recreational use of Mauna Kea.

CULTURAL-HISTORICAL-ARCHAEOLOGICAL OVERVIEW

[Note: this overview section has been taken from, with minor changes, the *Mauna Kea Science Reserve Master Plan - Draft #3* (Group 70 International 1999:V-1 thru 10)]

The ancient saying *"Mauna Kea kuahiwi ku ha'o ika mālie"* (Mauna Kea is the astonishing mountain that stands in the calm) (Pukui 1983: No.2147), expresses the feeling that Hawaiians and non-Hawaiian alike have for this special place. Standing tall over the Island of Hawai'i, Mauna Kea is home to vast physical, natural, and cultural resources. From early adze makers to modern day astronomers, Mauna Kea has long been a special place for work, worship, and reflection.

THE FIRST ARRIVALS: NATIVE HAWAIIAN USES

In Hawaiian culture, natural and cultural resources are one and the same. Native traditions describe the formation of the Hawaiian Islands and the presence of life on and around them. All forms of the natural environment, from the skies and mountain peaks, to the valleys and plains, and to the shoreline and ocean depth are the embodiments of Hawaiian gods and deities. One Hawaiian genealogical account records that Wākea (the expanse of the sky) and Papa-hāna-moku (Papa – Earth mother who gave birth to the islands) and various gods and creative forces of nature gave birth to the islands. Hawai'i, the largest of the islands, was the first-born of these island children. The account continues that the same god-beings were also the parents of the first man (Hāloa) , and from this ancestor, all Hawaiian people are descended. In some genealogical chants, Mauna Kea is referred to as "Ka Mauna a Kea" (Wākea's Mountain), and it is likened to the first-born of the Island of Hawai'i (Maly 1999).

> Cultural attachment is demonstrated in the intimate relationship (developed over generations of experiences) that a people of a particular culture share with their landscape – for example, the geographic features, natural phenomena and resources, and traditional sites, etc., that make up their surroundings. This attachment to environment bears direct relationship to the beliefs, practices, cultural evolution, and identity of a people. In Hawai'i, Hawai'i cultural attachment is manifest in the very core of Hawaiian spirituality and attachment to landscape. The creative forces of nature which gave birth to the islands (e.g., Hawai'i), mountains (e.g. Mauna Kea) and all forms of nature, also gave birth to *nākānaka kānaka nā kānaka* (the people), thus in Hawaiian tradition, island and humankind share the same genealogy" (Maly, 1999, p. 27).

According to Kanahele and Kanahele (n.d.), the first Hawaiians landed on the island's shores between 25 BCE and 125 CE. Many more Polynesians voyaged to Hawai'i and settled over the next thousand years. During this settlement period, the early Hawaiians developed stable water and food sources and adapted to their new environment (Kanahele and Kanahele n.d.). Hawaiians first settled near the shore where there was ready access to the ocean's plentiful resources. The forests provided plants and animals for food, tools, and shelter. Flightless birds, knowing no predators before, became easy prey for Hawaiian hunters. The mountain tops, the highest points of the land, were considered sacred. Mauna Kea is among the most sacred of these high points.

As early as AD 1100, adze makers came in reverence to the Mauna Kea adze quarry, Keanakāko'i (most of which is located in the Mauna Kea Ice Age Natural Area Reserve), to craft tools from the unique dense basalt found here. As part of the ritual associated with quarrying, craftsman erected shrines to their gods. Adze makers came to the mountain for short periods of time to work on the basalt that formed from molten lava that erupted under the glacial ice cap. They chipped out chunks of basalt and then worked the stone to form refined tools in shelters and workshops they had built. Different areas were designated for chipping, rough-finishing, and fine-finishing. *Māmane* wood was preferred for adze handles. In addition to the quarrying of adze basalt, craftsmen also collected volcanic glass and dunnite/gabbro for cutting tools and octopus fishing gear sinkers (McCoy, various; and Maly 1999). Further down the mountain, near a spring, the adze makers erected shelters from which they would gather water, wood, and food to sustain them as they worked in the quarry (Langlas et al. 1999). Remnants of shelters, shrines, adze manufacturing, food and offerings remain today to tell of these early craftsmen. The adze makers are thought to have come from neighboring areas and the adzes they crafted were widely used. Keanakāko'i was an active place for hundreds of years, with intensive use after AD 1400 and eventual decline prior to Western contact.

Following the long period of initial settlement, an era of high culture ensued. The Hawaiian society advanced in all areas from the 1200s until the late 1700s. During this time political powers exerted their might and the structure of communities was refined (Kanahele and Kanahele n.d.). In the beginning of the 1600s, during the time of Umi, the Hawaiian Islands were divided into political regions. The larger islands (*mokupuni*) were divided into districts (*moku*). The *moku* were divided into *ahupua'a* and large *ahupua'a* were divided into *'ili*. *Ahupua'a* were often entire valleys spanning from the top of the mountain ridge to the ocean. The *konohiki* managed the day-to-day operations of the *ahupua'a* with the aid of *luna* who were experts in various fields such as planting and fishing. Each *ahupua'a* contained nearly all of the resources Hawaiians required for survival from fresh water, plants, and a variety of animals, and was managed so that these resources could be sustained over time.

The *ahupua'a* of Ka'ohe spans the summit of Mauna Kea and includes the Mauna Kea Science Reserve. The lower slopes of Mauna Kea reach into the *ahupua'a* of Humu'ula and Ka'ohe. Hawaiians hunted and gathered in Mauna Kea's *māmane* forests,which were rich with vegetation and native birds including the *'ua'u* (dark-rumped petrel), *nēnē*, and *palila*. So prized were the plump young *'ua'u* that they could be eaten only by the *ali'i*. Hawaiians came to the *koa* and *'ōhi'a 'ōhi'a* forest on the mountain's lower slopes to gather wood for canoe-making and to collect bird feathers. Above the *koa* forests was the open *māmane* forest where they may have hunted *'ua'u* and *nēnē*.

All aspects of Hawaiian life were steeped in ritual. For the Hawaiian people, spiritual beliefs, cultural practices and all facets of daily life were intricately bound to the natural landscape of the islands. The lake, Wai'au, was believed to contain pure water associated with the god Kāne and was used in healing and worship practices. Archaeologist Pat McCoy suggests that shrines located at the edge of the summit plateau may mark the transition to a spiritual zone associated with the summit of Mauna Kea (McEldowney and McCoy 1982). The shrines may be associated with the snow line and thus represent shrines to Poli'ahu and/or other deities. Hawaiians also buried the bones of their dead on the slopes of Mauna Kea.

ARCHAEOLOGY AND ETHNOGRAPHIC RESEARCH

What we know today of Mauna Kea's ancient use and meaning we have learned from the physical clues left behind on the mountain. Ethnographic research explores more recent human activity and the traditions that have been handed down within families over time. For the past two decades archaeologists have conducted extensive field work on the slopes of Mauna Kea, with access made much easier with the construction of a road to summit area. Approximately 3,000 acres, or 27 percent, of the Science Reserve has been surveyed to date (McCoy 1999). Much of this archaeological work has been undertaken by Dr. Patrick McCoy. Currently with the State Historic Preservation Division, McCoy and colleague Dr. Holly McEldowney are in the process of preparing a Historic Preservation Management Plan for Mauna Kea. As part of this plan, McCoy has inventoried and summarized the archaeological sites that provide a wealth of knowledge of past use of the mountain (McCoy 1999).

In addition to the archaeological field work, several individuals have recently conducted ethnographic studies concerning Mauna Kea. Their research is summarized here. Dr. Charles Langlas of the University of Hawai'i-Hilo worked with Paul H. Rosendahl, Ph.D., Inc. to prepare an Archaeological Inventory Survey and Historic and Traditional Cultural Assessment for the Hawai'i Defense Access Road A-AD-6(1) and Saddle Road (SR 200) Project (Langlas et al. 1999; Langlas 1998). Pualani and Edward Kanahele prepared a Social Impact Assessment of Indigenous Hawaiian Cultural Values for this same project (n.d.).

In association with the preparation of this Master Plan, cultural specialist Kepā Maly conducted an oral history interview and archival research effort in the later part of the 1998 to compile the thoughts and memories that those living today have of Mauna Kea (Maly 1999). Maly interviewed 22 individuals and structured his research into broad groupings that are helpful in organizing the often generalized feelings that individuals have toward Mauna Kea.

McCoy summarizes the most recent archaeological work within the Mauna Kea Science Reserve. Based on field work undertaken between 1975 and 1997, a total of 93 archaeological sites have been identified in surveys covering approximately 3,000 acres within the larger Science Reserve, including the immediate summit ridge areas. These sites tell us much about the history of man's association with Mauna Kea. Of the 93 sites, 76 are shrines, four are adze manufacturing workshops, and three are markers. One burial has been positively identified and four other possible burial sites exist. The function of five of the 93 sites is unknown (McCoy 1999).

Shrines

The term "shrine" is used by McCoy to describe all of the religious structures that exist in the summit region of Mauna Kea. The most common of the archaeological features on Mauna Kea, shrines are characterized by the presence of one or more upright stones. The shrines at Mauna Kea range from single uprights to more sophisticated complexes with pavements and prepared courts. The majority of shrines on Mauna Kea are located conspicuously on ridgetops or at breaks in the slope. It is not surprising that shrines were placed in prominent locations with commanding views of the landscape. Shrines have not been found on the tops of cinder cones.

McCoy suggests that each upright on a shrine may have stood for a separate god. The majority of uprights were made of angular slabs found in the glaciated area of Mauna Kea. These select stones were unmodified by their human gatherers and provided a place for the gods to inhabit when they were needed. Based on ethnographic information McCoy suggests that the pointed uprights might represent male gods and the flat-topped uprights, female gods. Stone uprights were typically set in a crack in the bedrock and braced with a few stones. In other shrines, most notably those in the north and east slopes, uprights were set on the top of a boulder. In shrines dispersed throughout the summit area, stone uprights were set into low rubble heaps or piles of stones. In only a few cases, cairns were built to support the stone upright. Platforms were also built to support one or more uprights.

McCoy suggests that the shrines on Mauna Kea were erected for one of two, and possibly more, functions. Though they are not distinguished from each other by physical characteristics, the shrines can be classified as occupational or non-occupational in function. The eight occupational shrines are identified by the remains of specialized workshops and adze manufacturing byproducts. The non-occupational shrines range in complexity from simple features with a small number of uprights to more complex structures with courts and larger numbers of uprights. Most of the shrines found on Mauna Kea have just 1 to 3 uprights, however, some have as many as 24 or 25 stone uprights. McCoy speculates that the simple shrines were built and used by small family groups and the larger, more complex structures were built and maintained by a priesthood. McCoy reasons that the larger number of uprights indicate a larger number of gods that most Hawaiians would probably not have known. In addition, many of these more complex sites are isolated from the main areas of worship. McCoy has interpreted the shrine complex in the summit region as evidence of an historically undocumented pattern of pilgrimage to worship the snow goddess, Poli'ahu, and other mountain gods and goddesses.

Adze Quarrying and Manufacturing

The main adze quarry, Keanakāko'i, is located within the Mauna Kea Ice Age Natural Area Reserve. The majority of the workshops and shrines associated with adze manufacturing are located near the main quarry. Four additional adze manufacturing workshops have been found in the Science Reserve across the Summit Access Road from the adze quarry. However, these workshops are of a different kind than those found in the adze quarry. Manufacturing byproducts such as flakes, cores, adze rejects, and hammerstones have been found at these workshops, however, no stone-tool quality raw material is found. Thus it is likely that adzes were flaked elsewhere and transported to these localities at a later stage of the manufacturing process. Each workshop has one or more shrines upon which adze byproducts were offered to the tutelary gods of adze making. McCoy has identified one of these workshops as the location of initiation rites for apprentice adze makers (McCoy 1999).

Several of those interviewed by Maly have heard of or visited the adze quarry areas on Mauna Kea:

> I went up once [to Mauna Kea], a long time ago, we went up to Lake Waiau. I remember feeling kind of weak when we got up there, and it was the thin air. I wasn't that old. We went up to Humu'ula and then we took horses. We rode horses up to Wai'au. I was with my father, my mother didn't go. My mother was afraid of horses, she wouldn't go near a horse."... "... we went up and dad showed us this...there were other people with us too, my uncle Allan and his son, and others. He showed us this place where there were *'ōpihi* shells all over and it was where daddy said that they used to rough cut the adzes and then bring them down and finish them up, down below..." (Florence La'i-ke-aloha-o- Kamālu "Coco" Vrendenburg-Hind, p. A-118 *in* Maly 1999).

Trails and Access

In pre-contact times, it is suspected that travel to Mauna Kea was guided by individual knowledge of the landscape rather than by any distinct trails. It is possible that ridges were followed or that sources of water were known and visited along the way. Individuals going up the mountain likely visited the shrines erected by their family members to their gods. No evidence of pre-contact trails has been documented. (McEldowney 1982)

Maly reports that by the later nineteenth and early twentieth centuries, trails were created and often traveled on horseback. The trails of Mauna Kea linked communities and cultural and natural resources together. To reach the summit, people left the near-shore and plains lands and traveled the mountain slopes to the summit. The trails ascend the slopes of Mauna Kea from nearly all of the major, and many of the smaller *ahupua'a* which lie upon Mauna Kea's slopes. Traditions pertaining to journeys on the mountain trails, and knowledge of Mauna Kea are still retained as important family history today. Mauna Kea's trails, as told of in the oral and written histories, are depicted on the annotated interview map (Maly 1999, Figure 2). Significantly, many of these trails converge at Wai'au, in the Natural Area Reserve.

Interviewees told Maly of their elders travelling to Mauna Kea to worship in the summit region, gather water from Wai'au for healing practices, procure stone for adze making, and take individuals' ash remains to the summit area or to Wai'au for their return to the Earth. Teddy Bell describes one of the mountain trails to Wai'au:

And then we also went from Waiki'i . . .You go so far from Pu'u Lā'au . . . There used to be one pine tree forest. And from that reserve, there's a clump of pine trees. That's where they've got a lot of cones. From that pine trees, you look at Mauna Kea, the two sides, it's almost like a *pali* but wide. And then you right up through that hollow there, and you come up to Lake Waiau. Almost to the end of the *pali* on Mauna Kea (Theodore "Teddy" Bell, Sr., p. A-128 *in* Maly 1999) (This trail is indicated as K Waiki'i-Waiau trail).

During the historic period, people have traveled the mountain for Territorial Forestry operations, ranching, hunting, and recreational activities. Lloyd Case describes game trails on the mountain:

You know one of the most amazing things, and I don't know if some of the old timers told you this. But a lot of these Hawaiian trails, a lot of them were used by the sheep, they became game trails after a while. The sheep would use some of these trails. Some of these trails we walked 'em, on the Kemole side, Pu'u Mali side. But a lot of them, they are still there, but you have to have a good trained eye to find 'em" (p. A-348 *in* Maly 1999).

Burials

As was mentioned earlier, no shrines have been identified on top of cinder cones in the Mauna Kea Science Reserve. McCoy believes that these high and remote places were reserved for burying the dead. Although there are references to human burials on Mauna Kea in oral histories, only one burial site has been positively identified in the mountain summit area. "To date the only positively identified human remains found in the Science Reserve are located at Site 16248 on the summit of Pu'u Makanaka (Fig. 1). Jerome Kilmartin, a surveyor with the United States Geological Survey, noted the presence of human remains on this prominent cinder cone in 1925" (McCoy 1999). Four other sites within the Science Reserve have been identified as possible burials by McCoy:

There are four other sites in the surveyed areas of the Science Reserve that have been identified as possible burials (Sites 16195, 21413, 21414, and 21416). In each case there are compelling reasons to believe that the site is indeed a burial, but because human remains were not seen at the time the site was recorded it has been called a possible burial (McCoy 1999).

Of these four possible burial sites one consists of two adjacent cairns located on the eastern rim of Pu'u Lilinoe. The other three are located on the southern and eastern rim of a large unnamed cinder cone on the northwestern edge of the Science Reserve.(McCoy 1999). McCoy notes that archaeological sites have been found in all areas that have been surveyed to date but the distribution and density of the various types of sites follows certain patterns. The one burial and four possible burials have been found only on the tops of cinder cones and never with shrines.

While none of the individuals interviewed by Maly reported knowing of specific locations of burials in the immediate area of the Mauna Kea summit, many spoke of *ilina* (burial sites) in cinder cones, and other natural features in the region extending from about the 12,000 down to the 7,000 foot elevation. In modern times several family members or close friends of interviewees have had their cremated remains taken to the summit of Mauna Kea for release.

Summit Area

A significant pattern is the virtual absence of archaeological sites at the very top of the mountain. McCoy states that the "top of the mountain was clearly a sacred precinct that must, moreover, have been under a *kapu* and accessible to only the highest chiefs or priests." Most of the shrines in the Science Reserve are found on the northern and eastern slopes just above and below the 13,000 foot elevation. This pattern suggest that most of those who journeyed to the summit area came from the Hāmākua and Hilo sides of the mountain. Discussing the scarcity of sites on the western and southwestern slopes, McCoy makes the following observations:

> While the small number of shrines on this side of the mountain suggest the possibility of people coming from the Kona and South Kohala districts, the number would appear to have never been high. The implications are quite interesting. It suggests that while the mountain may have been viewed from a distance by people from everywhere on the island as a sacred mountain, in practice those who made the journey and worshipped there did not represent an even cross-section of the island populace. The implication is that access to the summit region was under the political control of the east Hawaii chiefdoms, a conclusion that is consistent with all of the other data (McCoy 1999).

All of those interviewed by Maly attributed spirituality and healing qualities to being on Mauna Kea; and several recorded that they still go to Mauna Kea for prayer and restoration. One described Mauna Kea as a sanctuary in ancient times. The area above the forest line was so sacred that once in the upper region, your enemies could not pursue you (Maly 1999).

In addition to the sites identified within the Science Reserve, a wealth of physical evidence can be found in the Mauna Kea Ice Age Natural Area Reserve, outside of the Science Reserve. Within the Natural Area Reserve, the main adze quarry and numerous sites at Wai'au tell of the activity in this geologically and culturally unique area. Many of these sites have been inventoried but have yet to be fully analyzed and related to the other sites found on the mountain.

Cultural Landscape

The summit of Mauna Kea has been referred to as *wao akua* (region of the gods). The most common understanding of *wao akua* is that it was a remote desolate location where spirits, benevolent or malevolent, lived and people did not live. Usually these places were deep interior regions, inhospitable places such as high mountains, deserts and deep jungles. These areas were not necessarily *kapu* but were places generally avoided out of fear or respect. Different people and family had different protocols when they traveled through these remote regions (George Atta personal communication with Holly McEldowney and Pat McCoy, June 2, 1999):

> Perhaps as a result of its prominence, isolation, and extreme environmental conditions, Mauna Kea's place in the culture and history of the Hawaiian people is significant. This 'cultural significance' extends beyond a physical siting, sites or particular features which have been previously identified in archaeological site studies. Mauna Kea is a prominent feature on the cultural landscape of Hawai'i which has been and continues to be, viewed from afar, and to which spiritual and cultural significance is attributed (Maly 1999, p. 3).

The ancient saying "Mauna Kea kuahiwi ku ha'o i ka mālie" (Mauna Kea is the astonishing mountain that stands in the calm) (Pukui 1983: No. 2147), expresses the feeling that Mauna Kea is a source of awe and inspiration for the Hawaiian people. The mountain is a respected elder, a spiritual connection to one's gods.

Thus, the landscape can be interpreted as a significant facet of a Hawaiian's identify. Mauna Kea is the focal point of numerous traditional and historical Hawaiian practices and narratives recorded by both Native Hawaiians and foreign visitors.

A number of place names recorded for this mountain landscape are associated with Hawaiian gods. Other place names are descriptive of natural features and resources, or document events that occurred on the mountain." (Maly 1999) "Native families also retain names such as Maunakea, Poli'ahu, Lilinoe, and Wai'au, which in some cases are directly tied to the mountain landscape" (Maly 1999).

The Kanaheles (n.d.) tell of Mauna Kea as the *piko* or origin point for the island of Hawai'i, and specifically the northern half of the island. Mauna Kea is, therefore, a place of great *mana*. Kanahele has also said that the three *pu'u*, Poli'ahu, Līlīnoe, and Wai'au are named for three sister goddesses who are female forms of water. Poli'ahu is embodied in the snow, Līlīnoe in mist, and Wai'au in the lake. These *pu'u* are where the goddesses manifest themselves. Of these three landforms two, Poli'ahu and Līlīnoe, are located in the Science Reserve. Wai'au is located in the Natural Area Reserve.

Many of those interviewed by Kepā Maly expressed the significance Mauna Kea holds for them as Hawaiians and as individuals. John Speilman and Pualani Kanahele describe Mauna Kea in the context of the entire Island of Hawai'i and in Hawaiian ancestral history:

> And I think too, what is important to understand and for people to realize is that it is all connected. Although we are talking about Mauna Kea, Mauna Kea and Paniau are connected. When you go fishing from Paniau, you look up to Mauna Kea and you check out the weather. You look to the mountain and see what the weather patterns are doing. The Kohala mountains. So the fishermen use the mountains as visual aids to help them in their fishing. And perhaps, I don't this as much, but from the mountain side down, but I would imagine that the farmers and the people that lived higher, would look down to the ocean to see if the weather was changing, the cloud patterns on the ocean. It's all connected. It is not separate. But Mauna Kea, I think, is the focal point of this island. It is the *piko*, the breath . . . (John K. Spielman, p. A-282 *in* Maly 1999).
>
> Mauna Kea was always *kupuna* [an elder, ancestor] to us. Mauna Kea and Mauna Loa, the tips, they were always *kūpuna* [elders, ancestors]. and there was no wanting to go on top. You know, just to know that they were there was just satisfying to us. And so it was kind of a hallowed place that you know is there, and you don't need to go there. You don't need to bother it. But it is there, and it exists. And it was always reassuring because it was the foundation for our island (Pualani Kanaka'ole Kanahele, p. A-366 *in* Maly 1999).

Alexander Lancaster and Tita Spielman relay the significance of Mauna Kea to each of their families:

> Yes, my grandmother Alice. Her Hawaiian name is Kamahalo – she was named after her grandmother, my great, great, great grandmother. She said " When you go up there, you going feel the spirit." And you do feel the spirit (Alexander Kanani'alika Lancaster, p. A-234 *in* Maly 1999).

Regarding her family's relationship to Mauna Kea, Spielman explains:

> Well, it was through my mother, because of course, she grew up in Kohala and spent a lot of time there. And at Pu'u Wa'awa'a and Kiholo, and always loved Mauna Kea. She used to say 'That's my mountain.' And so we got to know it and love it as we do. ("Tita" Elizabeth Kauikeōlani Ruddle-Spielman, p. A-265 *in* Maly 1999)

Teddy Bell and Lloyd Case relay their own personal feelings about Mauna Kea:

> On the slopes of Mauna Kea, there is a ridge there called Pu'u Nānā. Pu'u Nānā, if it's a clear day, you can see all of this Waimea. So that's where I want my ashes to be scattered (Theodore "Teddy" Bell Sr., p. A-139 *in* Maly 1999).

> Because the one thing I loved about it was just going up there and sitting down under the tree and looking out at space. Looking at everything. That is the most rewarding thing that I ever can say happens to me. When I go up there, it just heals me. That is a place for healing. I come back a different person (Lloyd Case, p. A-353 *in* Maly 1999).

A gentleman interviewed by Langlas was taught by his great-grandparents that there were two sites of ritual importance on Mauna Kea, the summit peak and the lake and surrounding *pu'u* Wai'au. According to this individual, the summit peak was a place to go and pray to the gods for *mana*, to cleanse the person and give him health.

Wai'au is a place of tradition and a source of inspiration. Located outside the Science Reserve in the Natural Area Reserve, Wai'au is a focal point for many visitors to the mountain. Many of the individuals interviewed by Kepā Maly discussed their own visits or visits by family members to Wai'au:

> It [Mauna Kea] brings back memories, you know. But way back, people never used to go up there. They never did go to Mauna Kea except on horseback, and that was very few. And right at Lake Waiau, had a bottle there. Whoever went up, would write their name and the date, and put it in the bottle. . . Yeah. So, I don't know what happened to that bottle. My first trip to Mauna Kea was in 1934. And there were a few peoples names in that bottle already.(Theodore "Teddy" Bell Sr., p. A-123 *in* Maly 1999).

> [In response to Kepā Maly's statement that Waiau was a favorite place of her grandfather Eben Low] A very favorite place. Yes, and that's why his plaque was put there. Because that was one of his favorite places. Although, his ashes were scattered at the top, the plaque was put at Waiau" ("Tita" Elizabeth Kauikeōlani Ruddle-Spielman, p. A-270 *in* Maly 1999).

In addition to feelings of *aloha* expressed for the place, numerous oral traditions of the importance of Wai'au have been handed down through families:

> Kepā Maly, "So he [your father] would go *mauka* to Waiau and gather water there?" Anita Landcaster, "And he would bring it, and he had my mom and I drink that water. And if we had it for a week, it never went into the refrigerator, it stayed on the counter, but it was always cold. And that was the sweetest water. It was so pure. I thought nothing of it because I was so young. But as I grew older, I would always remember

> it because my dad always had this gallon hanging, you know when he didn't go hunt, the gallon was always hanging in the house. In fact, the last time I saw it was just before he died, and then I don't know what happened to the gallon..." (Anita Leilani (Kamaka'ala) Landcaster, p. 245 *in* Maly 1999).
>
> "The water they used...the *lā'au lapa'au*, the healers went to this particular place, and another place in the Kohala mountains, there is another spring up there which Papa Auwae uses." . . . "So, I've heard of the old ones getting water from Waiau to use for healing" (Lloyd Case, p. A-353 *in* Maly 1999).
>
> "And so here, within the Mauna a Wākea, sits this *'apu wai* [water container] which is Waiau. What they are calling Lake Waiau. And as it hasn't had a chance to come down to the rest of us, then it is sacred water, like the water that is in the piko of *lau kalo* [taro leaf], and the water that is found in the *'ohe* [bamboo – interpreted as the meaning of the *ahupua'a* name Ka'ohe, within which the summit of Mauna Kea and Waiau are situated]. And the water that is found also in the *niu* [coconut]. So you have all of these different, sacred waters, but to me, that water, Waiau, is the most sacred because it isn't the water that has been spilled, it is still up there in the realm of Wākea.". . . "The most sacred of all the waters." (Pualani Kanaka'ole Kanahele, p. A-368 *in* Maly 1999).

In ca. 1881, Dowager Queen Emma ascended Mauna Kea on a journey of spiritual and physical well-being. At the time, Queen Emma was in competition with David Kalākaua for the position of ruling chief for the Kingdom of Hawai'i. Each of the two embarked on journeys to prove their connection to the senior line and connect back to a *wahi pana* (a sacred physical place). Emma went to the top of Mauna Kea to bathe in the waters of Wai'au, and cleanse herself in the *piko* of the island (Kanahele and Kanahele 1997).

For some, Wai'au has a special family tie. "...Hawaiian members of the Lindsey family have a tradition of taking the *piko* of their children to Wai'au and the summit of Mauna Kea." "Other interviewees who had not heard of the practice of taking *piko* to Mauna Kea all felt that it was likely to have occurred, and they shared similar stories from their own families of the custom at various localities" (Maly 1999).

Kanahele explains the importance of this tradition of taking the *piko* to a particular place:

> I don't personally know any families [who took the *piko* to Waiau]. I know that people took *piko* there, I just don't know who. . . . Well, the *piko* is that part of the child that connected the child back to the past. Connected the child back to the mama. And the mama's *piko* is connected to her mama, and so on. So it takes it back, not only to the *wā kahiko* [ancient times], but all the way to *Kumu Lipo*. . . . So, it's not only the *piko*, but it is the extension of the whole family that is taken and put up in a particular place, that again connects to the whole family line. And it not only gives *mana* or life to the *piko* and that child, but life again to the whole family" (Pualani Kanaka'ole Kanahele, p. A-368, *in* Maly 1999).

THE FIRST EUROPEAN CONTACT TO THE ISLANDS

As evidenced by the archaeological evidence and though oral histories, Hawaiian adze-making and worship at Mauna Kea continued through the 1700s. In 1778, the first foreigner arrived in Hawai'i. In the decades that followed, life in Hawai'i changed dramatically with the introduction of new technologies, religion, diseases, animals, and industry. The population of Hawaiians was decimated by the effects of diseases that had never been seen before in the islands. Port towns such as Kailua, Kealakekua and Hilo developed into commercial centers accommodating Western ships. Adze quarrying on Mauna Kea ceased to exist as stone adzes were soon replaced by metal tools after European contact.

In the late 1700s and through the 1800s several Europeans led expeditions to Mauna Kea. The names Goodrich, Baldwin and Alexander are well-known to students of the mountain. Their maps and documents are the earliest written descriptions of Mauna Kea. Early in the 20th Century, the Board of Agriculture and Forestry designated the Mauna Kea Forest Reserve.

In 1793 the first cattle were brought to Hawai'i and offered by Captain George Vancouver to King Kamehameha. By the early 1800s more cattle had arrived and escaped to forested areas where, in the absence of natural predators, their populations multiplied (Juvik and Juvik 1984). In addition to wild cattle, sheep and goats thrived on the mountain. In 1809, John Palmer Parker settled in Hawai'i and became friends with King Kamehameha I. The king placed Parker in charge of the wild cattle. With a land grant from King Kamehameha III in 1845, Parker established a ranch, Parker Ranch, which has been in continuous operation until the present. Other ranches also operated in the mid-1800s, however, much of the cattle and sheep continued to run free on the mountain's slopes destroying the native vegetation. By this time, hunting had become a vital lifestyle for many island residents. Hunters continued to pursue the animals for their hides and meat which were consumed locally and bartered for goods from visiting ships.

After the decline in adze making on Mauna Kea, there was limited human activity on the mountain. On the lower portions of the mountain animals grazed and hunters pursued them. On the higher slopes a few Western explorers conducted expeditions up to the summit region. The next major phase of activity began in the early 1960s with the exploration of Mauna Kea as a potential site for astronomy observations.

The travel journals of the first Westerners to explore the mountain's summit region highlight some of the first information on the physical evidence of past activity. McCoy (1999) shares some of these earliest observations. The first documented trip to the summit of Mauna Kea was that of Reverend Joseph Goodrich in 1823. Later writings of this trip record some of the observations and thoughts about the summit region:

> Rev. Joseph Goodrich, who, on this occasion, was unfortunately laid up with mountain sickness, had on 26th August, 1823, reached the summit of Mauna Kea. This is the first recorded instance of the ascent of this mountain, although Mr. Goodrich mentions that on reaching the top of one of the terminal cones that encircle the main plateau of Mauna Kea, he discovered a heap of stones, probably erected by some former visitor. Who this former visitor was is unknown, but he was probably one of the white men that in the early years of the nineteenth century got a living by shooting wild bullocks that roved on the side of Mauna Kea. It is very unlikely that any native had reached the top to the terminal cones on the summit, owing to being unprovided with warm clothing to resist the great cold and also to the fact that the natives had a superstitious dread of the mountain spirits or gods (Macrae 1922).

An account of Alexander's journey in 1892 mentions the presence of a cairn at the top of a cinder cone:

> Messrs. Muir and Alexander ascended the second highest peak on the northwest, overlooking Waimea, 13,645 height to continue their survey. In the cairn on the summit a tin can was found, which contains brief records of the visits of five different parties from 1870 to the present time, to which we added our own (Alexander 1892).

Reflecting this notion, Ellis (1979) looked back to the travels of Goodrich and Blatchely, who ascended the peak about six months after Goodrich, and provided this description of Hawaiians' view of Mauna Kea:

> The snow on the summit of the mountain, in all probability, induced the natives to call it Mouna-Kea (mountain white), or, as we should say, white mountain. They have numerous fabulous tales relative to its being the abode of the gods, and none ever approach the summit – as, they say, some who have gone there have been turned to stone. We do not know that any have been frozen to death; but neither Mr. Goodrich, nor Dr. Blatchely and his companion, could persuade the natives, whom they engaged as guides up the side of the mountain, to go near its summit (Ellis 1979).

CULTURAL PRACTICE TODAY

In their ethnographic work Maly, Langlas, and Kanahele and Kanahele describe some of the practices that individuals and families conduct on Mauna Kea today. Several of the individuals interviewed by Maly stated that "they still go to Mauna Kea for prayer and restoration". All interviewees attributed spirituality and healing qualities to being on Mauna Kea (Maly 1999).

Dr. Langlas interviewed a woman of the Poli'ahu line, meaning that Poli'ahu is one of her family's *'aumakua*. This family has designated an individual as their *kahu* for worship of Poli'ahu. This individual has constructed a shrine on Mauna Kea to worship Poli'ahu and has incorporated a stone given to her by the family. She considers the whole mountain to be sacred and feels that it is appropriate to worship anyplace on the mountain if one is spiritually guided there. Thus, worship should not be limited to traditional sites. The shrine placed by this *kahu* is not located in a traditional site but rather in a place that she was guided to.

Maly's interviewees also report of the practice of taking ash remains to the summit of Mauna Kea for release. Two of the individuals interviewed by Maly have instructed that upon their deaths, their ashes are to be taken to specific places on the slopes of Mauna Kea.

While the ethnographic research provides few accounts of actual cultural practices on the mountain, other individuals and groups may visit the mountain for worship on special occasions or on a regular basis. Many more carry with them an esteem and respect for Mauna Kea:

> In both its genealogical associations and its physical presence on the island landscape, Mauna Kea is a source of awe and inspiration for the Hawaiian people. In Hawaiian practice elders are revered – they are the connection to one's past – and they are looked to for spiritual guidance. Because of its place in the Hawaiian genealogies, Mauna Kea, the landscape itself is a sacred ancestor (Maly 1999, p. D-25).

This is the spirit with which many view the mountain today.

PROPOSED MAUNA KEA SUMMIT REGION HISTORIC DISTRICT NATIONAL REGISTER NOMINATION

SHPD staff have recently indicated that they will be proposing a historic district designation for the summit region of Mauna Kea which they believe will meet the eligibility criteria for inclusion in both the Hawai'i State and the National Register of Historic Places. This historic district proposal has evolved in the course of reviewing historical, ethnographic, and archaeological information for the preparation of a historic preservation plan for the protection and management of historic properties and cultural resources on Mauna Kea. Within the historic preservation domain, a historic district is defined as a historic property that "...possesses a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development" (NPS 1990:5).

Figure 3 indicates the approximate boundary of the proposed district. Provisionally referred to as the "Mauna Kea Summit Region," the proposed historic district incorporates the virtually the entire Science Research summit area, extending beyond limits of the reserve, and also portions of the Natural Area Reserve. The district boundary has been tentatively set to correspond with the moraine fields and the incidence of topographic change which provides the general appearance of a summit plateau. The proposed district includes the total of 93 archaeological sites identified within the Science Reserve, three landscape features within the reserve believed to qualify as traditional cultural properties, and the Mauna Kea Adze Quarry Complex situated within the Natural Area Reserve. Of the 93 archaeological sites identified to date, 76 are shrines of varying complexity, four are adze manufacturing workshops, one is a confirmed burial, four are possible burials, three are marker cairns, and five are of undetermined function.

Figure 4 indicates the location and approximate boundaries of the three landscape features believed to qualify as traditional cultural properties on the basis of traditional Native Hawaiian cultural practices and beliefs associated with them. The boundaries of the properties have been set to coincide with the base of the component *pu'u*, or cinder cones. The largest of the three properties, "Kukahau'ula," refers to the cluster of three *pu'u* that merge and collectively make up the summit of Mauna Kea. The second property, "Waiau," refers to the small lake and adjacent *pu'u* situated southwest of the summit and within the Natural Area Reserve. The third property, "Lilinoe," refers to a *pu'u* situated southeast of the summit and within the Science Reserve.

To be considered eligible for inclusion in the National Register of Historic Places, a potential property, such as the proposed Mauna Kea Summit Region Historic District, must demonstrate its historical significance by meeting the "National Register Criteria for Evaluation" contained within the Code of Federal Regulations, Title 36, Part 60 (CFR 1981). Generally speaking, this is accomplished through (a) association with an important historic context, and (b) retaining historic integrity of those aspects or elements needed to communicate significance. More specifically, to be found eligible for inclusion in the National Register of Historic Places, an entity of purported historical significance must satisfy a five-fold sequential test of (a) being one of a recognized category of tangible physical property, (b) being associated with an important historic context, (c) meeting one or more of the four basic National Register Criteria, (d) determining whether an otherwise ineligible property meets any of seven National Register Criteria Considerations which would make the property eligible, and (e) having integrity – the ability to convey significance. It is assumed that SHPD staff, in preparing the National Register nomination for the Mauna Kea Summit Region Historic District that is intended to be included in their Historic Preservation Plan for the Mauna Kea Science Reserve (DLNR In prep.) will adequately address all of these areas in making their argument for National Register eligibility

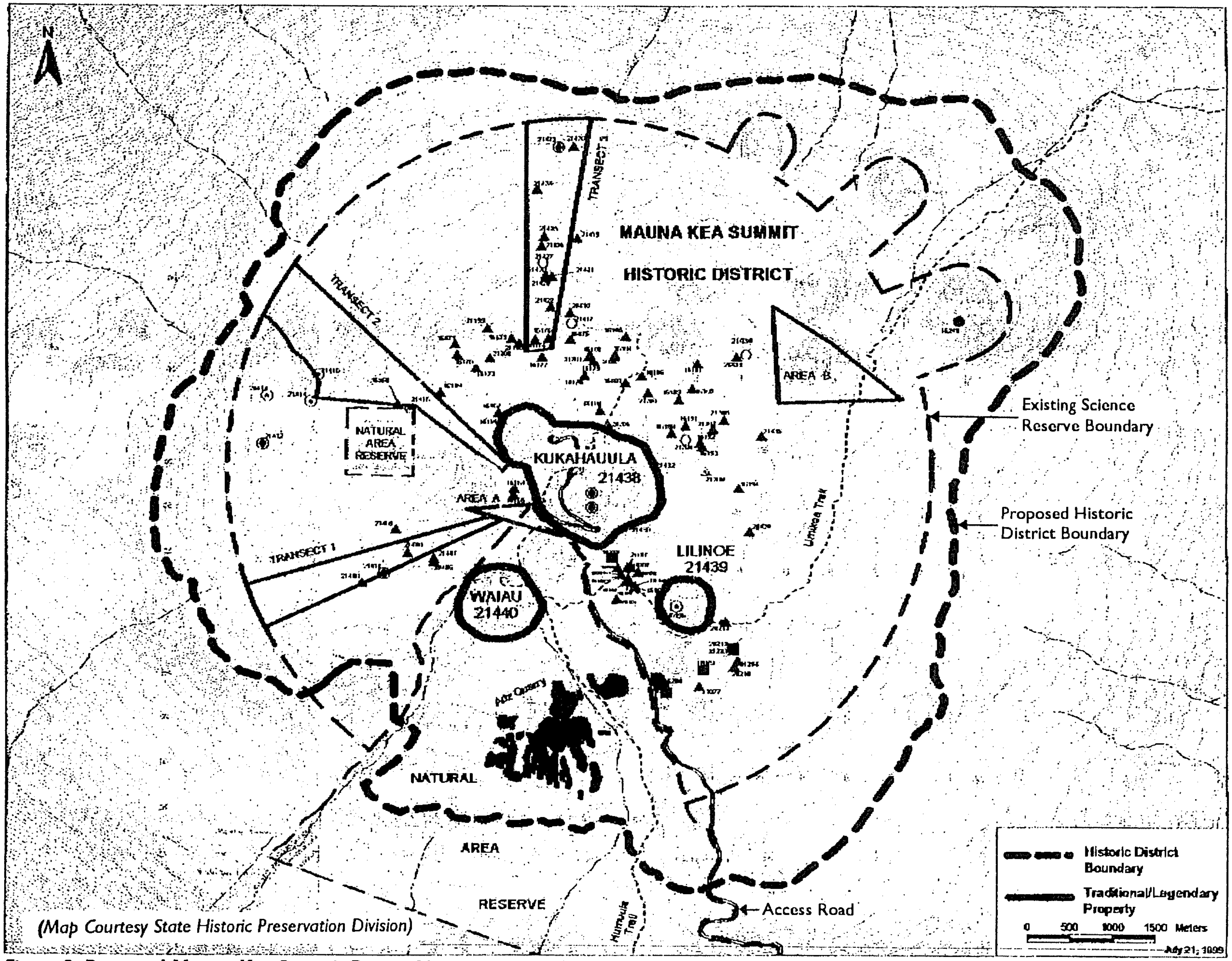
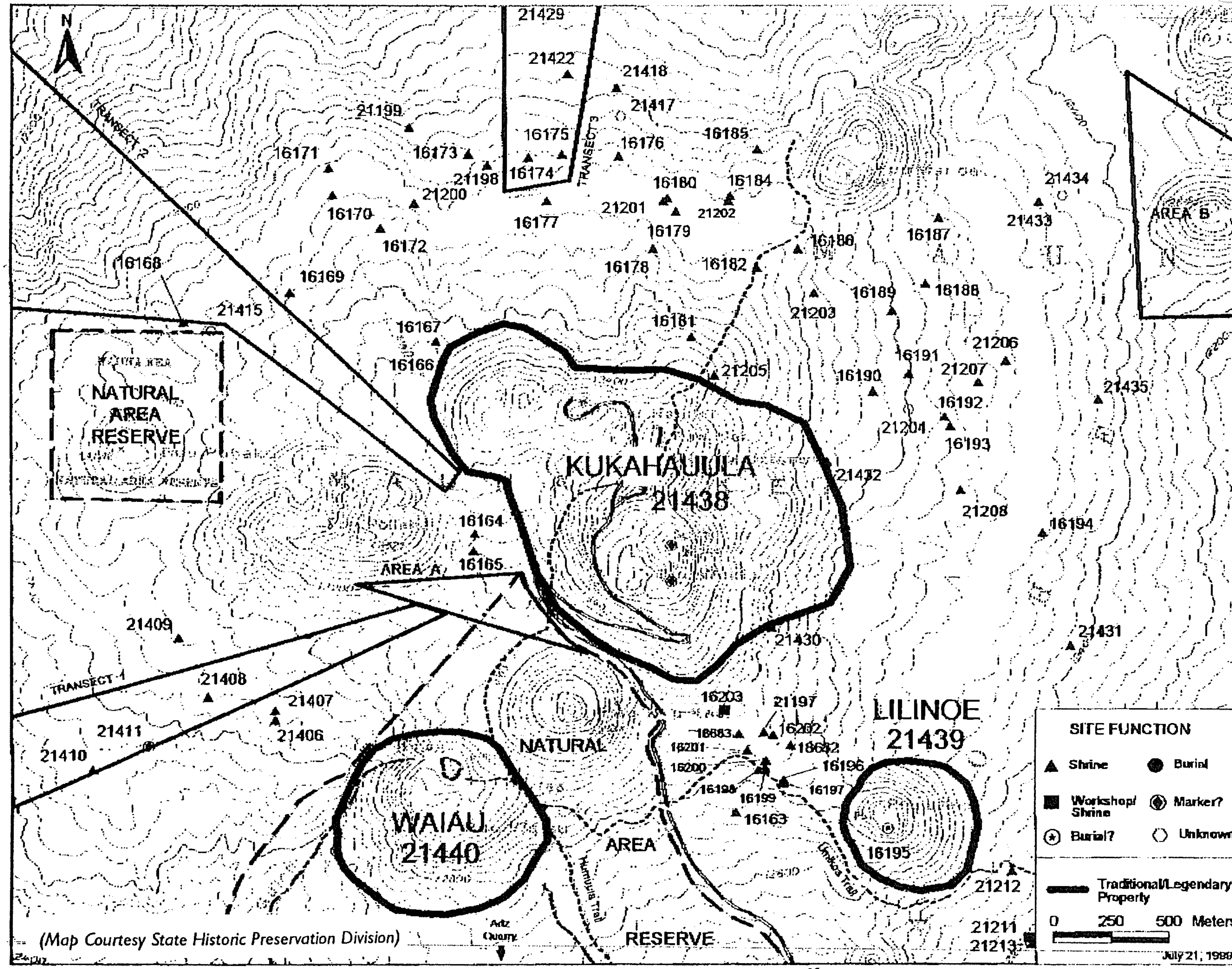


Figure 3. Proposed Mauna Kea Summit Region Historic District (SHPD)



(Map Courtesy State Historic Preservation Division)

Figure 4. Three Potential Traditional Cultural Properties Identified within the Proposed Mauna Kea Summit Region Historic District (SHPD)

NATIVE HAWAIIAN CULTURAL PRACTICES, FEATURES, AND BELIEFS ASSOCIATED WITH THE UNIVERSITY OF HAWAII MAUNA KEA SCIENCE RESERVE MASTER PLAN PROJECT AREA

The principal source of information utilized by the present study for the identification of Native Hawaiian cultural practices, features, and beliefs associated with the Science Reserve Master Plan project area on Mauna Kea was the oral history and consultation study carried out by Kepā Maly (1999). Maly made extensive efforts to identify and contact individuals potentially knowledgeable of Mauna Kea with regard to traditional and customary cultural practices, traditional cultural properties, and contemporary cultural practices. He conducted a total of fifteen recorded interviews with twenty-two different informants, and in the process of carrying out his study consulted with more than 100 individuals, a great number of whom had knowledge about Mauna Kea and were able to provide information which supplemented that obtained during the recorded informant interviews.

In the course of his study, Maly documented on the basis of his recorded informant interviews and informal consultations a wide range of traditional and contemporary cultural practices, features, and beliefs associated with Mauna Kea. Taken together, these manifest a quality which Maly has referred to as the "cultural attachment" between Native Hawaiians and Mauna Kea:

> "Cultural Attachment" embodies the tangible and intangible values of a culture. It is how a people identify with and personify the environment (both natural and manmade) around them. Cultural attachment is demonstrated in the intimate relationship (developed over generations of experiences) that people of a particular cultural share with their landscape – for example, the geographic features, natural phenomena and resources, and traditional sites etc., that make up their surroundings. This attachment to environment bears direct relationship to beliefs, practices, cultural evolution, and identity of a people. In Hawai'i, cultural attachment is manifest in the very core of Hawaiian spirituality and attachment to landscape. The creative forces of nature which gave birth to the islands (e.g., Hawai'i), mountains (e.g., Mauna Kea) and all forms of nature, also gave birth to *na kanaka* (the people), thus in Hawaiian tradition, island and mankind share the same genealogy (Maly 1999:27).

In his study report, Maly summarized the traditional and contemporary cultural practices, features, and beliefs in terms of three different categories: traditional and customary cultural practice claims, traditional cultural property claims, and contemporary cultural practice claims (Maly 1999:27-33). Maly's summary is presented in *Table 2*, which includes the name or designation of practice or property, the sources of information relating to the practice or property, and general comments about the practice or property.

TRADITIONAL AND CUSTOMARY CULTURAL PRACTICES AND BELIEFS

A number of practices and beliefs were identified by Maly in the course of his study as being traditional and customary practices and beliefs associated with the Mauna Kea Science Reserve Master Plan project area *(see Table 2a)*. These include both those generally associated with the overall summit region of Mauna Kea, as well as those more directly associated with specific geographical locations within the Science Reserve project area *(see Table 2b)*. Identified practices and beliefs included the following:

Table 2. Summary of Identified Native Hawaiian Cultural Practics, Features, and Beliefs Associated with the Mauna Kea Science Reserve Master Plan Project Area *

a. Traditional and Customary Practices

Practice	*Source of Identification*	*Comments*
Prayer and ritual observances	Historical literature. Oral history interviews with – A. & A. Lancaster, A.K. Haa Sr. (& Jr.), H.K. Springer, P. Kanahele, I. Lindsey-Fergerstrom et al., Consultation records of: Ed Stevens, Iopa Mauna-kea, L. McCord, K. Pisciotta, L.K. Kimura, E. Kauhi, and AHCC.	See *Appendix D*. Several interviewees discuss past practices as learned from their elders, and others document that such observances remain important to their Hawaiian spirituality.
Collection of water from Waiau for ritual purposes	Historical literature. Oral history interviews with A & A Lancaster, A.K. Haa Sr. (& Jr.), L. Case, and P. Kanahele.	See *Appendix D*. Described as the most sacred of Kāne's waters in all the Hawaiian Islands.
Depositing of *piko* (umbilical cords) at Waiau and the summit peaks of Mauna Kea.	Oral history interviews with – K. Kalili, I. Lindsey-Fergerstrom et al., and P. Kanahele. Consultation records of – L.K. Kimura, and B. Robertson.	Members of the Lindsey-Fergerstrom family describe the practice as on-going. Barbara (Ka'apuni) Robertson, was told be her elders that it was a custom that was unique to people of the Waimea region, who shared a particularly close affinity with Mauna Kea.
Burial Practices: • Interment of remains –	Historical literature. Oral history interviews with – J. Ah San, T. Imoto, S. & D. Kaniho, A. Lan-caster, A.K. Haa Sr. (& Jr.), L. Case, I. Lindsey-Ferger-strom et al. Consultation records of: Ed Stevens, Iopa Mauna-kea, L. McCord, K. Pisciotta, and AHCC.	(see *Appendix D*) Describing specific knowledge of ancient burial sites, and belief that burials occurring in the upper elevations are those of *ali'i* and other sacred personages – the ancestors of some interviewees.
• Releasing of ashes at the summit and other locations on Mauna Kea.	Oral history interviews with – T. Imoto, J. Ah San, T. Bell Sr., S. & D. Kaniho, Tita & JK Spielman, and P. Kanahele.	Described as a continuation of the traditional practice of taking loved ones remains to Mauna Kea.

**from Maly (1999)*

Table 2 b. Traditional Cultural Properties

Property	*Source of Identification*	*Comments*
Ka Mauna a Wākea or Mauna Kea, also referred to as "*Ka piko kaulana o ka 'āina*" (The famous summit or center of the land).	Historical literature. Oral history interviews with all Hawaiian interviewees (particularly – J.K. Lindsey, K.K. Phillips, A. & A. Lancaster, A.K. Haa Sr. & Jr., L. Case, and P. Kanahele). Consultation records of: Association of Hawaiian Civic Clubs (AHCC), Ed Stevens, Iopa Maunakea, L. McCord, K. Pisciotta, L.K. Kimura, E. Kauhi, L. Teves, and B. Robertson. Interviews with Tita & JK Spielman, H.K. Springer, A.K. Haa Sr. (& Jr.), C. Hind, L. Case, and P. Kanahele; and consultation *Appendices B & C.* Oral history interview with Lloyd Case. Consultation records of K. Pisciotta and L. McCord.	See *Appendix D.* Generally described as the mountain region from approximately the 6,000 foot elevation to summit. Described as a sacred landscape that is a physical and spiritual connection between one's ancestors, history, and the heavens. Many of the *pu'u* (hills) and other topographic features on Mauna Kea are named for Hawaiian gods and deities. Also, many of the *pu'u*, particularly those of the upper region, are believed to be burial sites of *ali'i* and other important ancestors. Viewplain: The upper mountain region is described as a sacred landscape; for some interviewees ascending the mountain and viewing its features is important, for other families, the mountain is so scared that there is no desire to ascend it, but seeing it from afar–feeling its presence–is sufficient. Mountain landscape in navigational traditions: Hawaiian Navigational It is noted that while none of the archival-historical literature cited has made specific references to sites or features on Mauna Kea that were recorded as being associated with navigational practices and customs, the gods and deities associated with Mauna Kea have celestial body forms and some were evoked for navigational practices. Ms. Pisciotta was invited to provide the interviewer with a report she has prepared on the navigational-practices—to be included as an appendix under her name with the present study—but at the time of this writing, the report has not been received. (It is likely that Rubellite Kawena Johnson, Clay Bertlemann and Nainoa Thompson could provide the University with additional documentation on native practices and lore of Hawaiian navigation.)

Table 2 b. Traditional Cultural Properties (Continued)

Property	Source of Identification	Comments
Pu'u Kūkahau'ula – the summit peak of Mauna Kea.	Historical literature. Oral history interviews with all interviewees (particularly–I. Lindsey-Fergerstrom et al., A.K. Haa Sr., A. & A. Lancaster, L. Case, Tita Spielman et al., and P. Kanahele). Consultation records of: Ed Stevens, Iopa Mauna-kea, L. McCord, and K. Pisciotta.	See *Appendix D*. Generational repository of: *piko* (umbilical cords of children); ashes of individuals with strong attachment to Mauna Kea; and locations of an *ahu* (possibly more than one over time) associated with navigational practices and historic surveys.
Pu'u Poli'ahu	Historical literature. Oral history interviews with all Hawaiian inter-viewees (particularly – A. & A. Lancaster, L. Case, and P. Kanahele). Consultation records of: Ed Stevens, L. McCord, K. Pisciotta, and AHCC.	See *Appendix D*. As an important cultural-geographic feature, and for its association with the Hawaiian goddess and ancestress of some interviewees.
Pu'u Lilinoe	Historical literature and oral history interviews with all Hawaiian inter-viewees (particularly – A. & A. Lancaster, A.K. Haa Sr., and P. Kanahele). Consultation records of: Ed Stevens, L. McCord, K. Pisciotta, and AHCC.	See *Appendix D*. As an important cultural-geographic feature, and for its association with the Hawaiian goddess and ancestress of some interviewees.
Waiau	Historical literature. Oral history interviews with all Hawaiian inter-viewees (particularly – K. Kalili, J.K. Lindsey, K.K. Phillips, A. & A. Lancaster, A.K. Haa Sr., L. Case, P. Kanahele, and I. Lindsey Fergerstrom et al.). Consultation records of: Ed Stevens, L. McCord, K. Pisciotta, L.K. Kimura, B. Robertson, and AHCC.	See *Appendix D*. As an important cultural-geographic feature – a repository of *piko* of children; and a source of sacred water used for ceremonial and healing practices.

Table 2b. Traditional Cultural Properties (Continued)

Property	Source of Identification	Comments
Pu'u Mākanaka and Kaupō vicinity.	Historical literature. Oral history interviews – particularly J. Ah San, S. & D. Kaniho, and P. L'Orange.	See *Appendix D*. Particularly noted as burial sites.
Trails — • Kūka'iau-'Umikoa to Mauna Kea Trail. There are also other trails which are potential Traditional Cultural Properties; documentation was recorded for the following trails:	Historical literature. Oral history interviews: particularly – J. Ah San, T. Imoto, S. & D. Kaniho, T. Bell Sr., A. Lancaster, A.K. Haa Sr. (& Jr.), M. Pence, L. Case, I. Lindsey Fergerstrom et al., and A.K. Haa Sr. (& Jr.).	See *Appendix D*. Trail generally known to all interviewees, and remains in use by some who travel to Mauna Kea in present times. A portion of the trail which connects with the lower Mānā-Laumai'a Trail (around the base of Mauna Kea) was also known as "Ioane's Trail" (Ioane was the great grandfather of A.K. Haa Sr.)
• Humu'ula to Mauna Kea Trail.	Oral history interviews: particularly – J. Ah San, T. Imoto, S. & D. Kaniho, T. Bell Sr., A. Lancaster, M. Pence, and P. L'Orange.	Trail generally known and traveled on by all individuals who went to Mauna Kea prior to opening of the summit road alignment in the 1960s.
• Laupāhoehoe-Waipunalei-Kanakaleonui to Mauna Kea Trail.	Oral history interviews: particularly – J. Ah San, & L. Case.	Trail generally known to individuals who traveled to Mauna Kea up to ca. 1930.
• Makahālau-Kemole to Waiau Trail. & • Waiki'i-Pu'u Lā'au to Waiau Trail.	Oral history interviews with: J.K. Lindsey, T. Bell Sr, and L. Case. Oral history interviews with: J.K. Lindsey, and Teddy Bell Sr.	These two trails are not generally known to most people who have traveled to the summit region of Mauna Kea. The two elder interviewees last traveled on them in the 1930s, Lloyd Case still travels the trails. In the interviews, it was also noted that most of the trails rising to the summit of Mauna Kea converge in the vicinity of Waiau, with a trail then rising to the summit peak.
•10,000 ft. elevation trail/road around Mauna Kea.	Oral history interviews with: I. Lindsey Fergerstrom et al., and L. Case	Of particular interest to this trail/road feature at approximately the 10,000 ft. elevation are references to: (1) stone platforms and uprights that mark the contour of the trail (Mrs. Fergerstrom et al., associate them with the work on the alignment–there are burials and other features near by which they have personally seen); and (2) the walled enclosures in the region above Pu'u Lā'au.

Table 2c. Contemporary Cultural Practices

Practice	*Source of Identification*	*Comments*
Prayer and ritual observances – including construction of new *kūahu* (altars) as a part of ceremonial observances.	Consultation records of: K. Pisciotta and L. McCord.	See *Appendix C.*
Keanakāko'i – This complex of adze quarries, shrines and numerous associated features is already a property listed on the National Register of Historic Places.	Historical literature. Oral history interviews with all interviewees (particularly – J. Ah San, A. Lancaster, A.K. Haa Sr., H.K. Springer, P. Kanahele and I. Lindsey-Fergerstrom et al.). Consultation records of Wm. Akau.	See *Appendix D.* All interviewees had knowledge of the adze quarries and various caves associated with the practice of collection of stones for adzes, (only I. Fergerstrom et al.,–the result of years of traveling on Mauna Kea with Harry Fergerstrom who worked for the Territorial/State Forestry Div.) had knowledge of the platforms and uprights. None of the other interviewees could recall hearing of, or seeing the shrines in the vicinity of the quarry sites. There is also on-going contemporary practice of collection of stone from adze quarry sites for various purposes. While present-day collection of stone from traditional quarry sites compromises the integrity of the cultural resources, the practice is claimed as a traditional right. This is one of the important management issues which cultural practitioners, the Department of Land and Natural Resources, and the University will need to address. The interviews with J. Ah San, L. Case, H.K. Springer, and P. Kanahele include introductory discussions on protocols for collection of adze stones.
Subsistence and recreational hunting.	Oral history interviews with J. Ah San, and T. Imoto, M. Pence, S. & K. Kaniho, T. Bell Sr., I. Lindsey-Fergerstrom et al., and L. Case.	Described as important to the well-being of practitioner families, and important in maintaining a balance in an already disturbed environment on Mauna Kea.

1. Performance of prayer and ritual observances important for the reinforcement of an individual's Hawaiian spirituality;

2. Collection of water from Waiau for a variety of healing and other ritual uses;

3. Deposition of *piko* (umbilical cords) at Waiau and the summit peaks of Mauna Kea;

4. Use of the summit region as a repository for human burial remains, by means of interment, particularly on various *pu'u*, during earlier times, and more recently by means of releasing ashes from cremations;

5. Belief in the upper mountain region of Mauna Kea, from the Saddle area up to the summit, as a sacred landscape – as the personification of the spiritual and physical connection between one's ancestors, history, and the heavens; and

6. Association of unspecified traditional navigation practices and customs with the summit area.

TRADITIONAL CULTURAL PROPERTIES

In the course of his study, Maly identified a number of potential traditional cultural properties within the Mauna Kea Science Reserve Master Plan project area. These are historic properties that are of importance to Native Hawaiians because they possess traditional cultural significance derived from associated cultural practices and beliefs *(see Table 2b)*. (See also Figure 2 in Maly 1999 for a map indicating the locations of identified properties.) Potential traditional cultural properties identified to Maly by knowledgeable informants and cultural practitioners as being present within the Science Reserve Master Plan project area included the following:

1. The entire mountain region of Mauna Kea, from approximately the 6,000 foot elevation (the Saddle area) to the summit;

2. Pu'u Kukahau'ula – a cinder cone that is the summit peak of Mauna Kea (sometimes also referred to by the modern name of Pu'u Wekiu);

3. Pu'u Poli'ahu – a prominent summit region cinder cone situated to the west of Pu'u Kukahau'ula;

4. Pu'u Lilinoe – a prominent summit region cinder cone situated to the southeast of Pu'u Kukahau'ula;

5. Waiau – a shallow lake and its adjacent cinder cone situated in the summit region to the southwest of Pu'u Kukahau'ula;

6. Pu'u Makanaka and Kaupo vicinity – a cluster of two prominent cinder cones situated near the edge of the summit region to the northeast of Pu'u Kukahau'ula;

7. Mauna Kea-'Umikoa Trail – a foot and horse trail extending between Kuka'iau in Hāmākua to immediately south of the summit area;

8. Mauna Kea-Humu'ula Trail – a foot and horse trail extending from the Humu'ula Sheep Station up to the summit area; and

9. A number of lesser foot and horse trails – including the Mauna Kea-Laupahoehoe-Waipunalei-Kanakaleonui Trail, the Mauna Kea-Makahalau-Kemole Trail, and the Waiau-Waiki'i-Pu'u La'au Trail.

CONTEMPORARY CULTURAL PRACTICES

Contemporary cultural practices and beliefs would be those of cultural practitioners for which no clear specific basis in traditional culture can be clearly established or demonstrated for example, the conducting of ritual ceremonies at sites or features for which no such prior traditional use and associated beliefs can be demonstrated. In some cases, however, it may be possible to demonstrate the reasonable evolutionary development of a contemporary practice from an earlier traditional practice.

In the course of his study, Maly identified several contemporary cultural practices and beliefs associated with the Mauna Kea Science Reserve Master Plan project area *(see Table 2c)*. The following were related to Maly by knowledgeable informants and cultural practitioners:

1. Prayer and ritual observances – including construction of new *kuahu* (altars) in connection with ceremonial activities;

2. Collection of raw material stone from quarry sites within the Mauna Kea Adze Quarry Complex; and

3. Subsistence and recreation hunting.

CURRENT NATIVE HAWAIIAN PERSPECTIVES ON MASTER PLAN PROJECT

As a consequence of conducting his recorded interviews and informal consultations with knowledgeable informants and cultural practitioners, Maly was able to formulate a series of general recommendations and comments that reflected current Native Hawaiian perspectives on the Science Reserve Master Plan project (Maly 1999:34-5). The most substantial of these may be summarized as follows:

1. The great majority of individuals expressed the desire that no further development of astronomy facilities on Mauna Kea. Visual impacts and physical impacts upon the *pu'u* were often mentioned as important concerns;

2. Protection of the general landscape and view planes, especially among the *pu'u* and other cultural resources, was regarded as very important;

3. The present lessee should appreciate the past opportunity for the use of Mauna Kea, honor prior commitments, complete studies and work that were called for by the original complex development plan, and establish and comply with its own guidelines and requirements for the use of Mauna Kea;

4. In terms of management planning, the Native Hawaiian model of *ahupua'a* management, which incorporates and integrates all aspects of the physical, cultural, and spiritual environments, should be utilized;

5. All users of Mauna Kea should enter into a sustainable partnership, with the Native Hawaiian and other components of the local community, that would provide for the future stewardship of Mauna Kea; and

6. Plans need to be formulated, in consultation with cultural practitioners and families having genealogical ties to Mauna Kea, for access to and use of traditional sites and resources.

CONCLUSION

The basic purpose of this concluding section is to assess the findings of the present cultural impact assessment study to determine if any of the Native Hawaiian cultural practices, beliefs, or features identified as being associated with the University of Hawai'i Science Reserve Master Plan project area represent traditional and customary practices or places which might potentially be affected by future development of any astronomy facilities or related uses. The specific objectives of this conclusion include the following:

1. Summarize the nature and variety of identified Native Hawaiian cultural practices, beliefs, and features;

2. Evaluate the significance of identified Native Hawaiian cultural practices, beliefs, and features;

3. Assess the potential effects that any further development or use of the Science Reserve might have upon identified Native Hawaiian cultural practices, beliefs, and features; and

4. Make recommendations for measures that might (a) mitigate any potentially adverse effects of future development or use upon identified Native Hawaiian cultural practices, beliefs, and features, or (b) be otherwise appropriate.

NATIVE HAWAIIAN CULTURAL PRACTICES AND PROPERTIES ASSOCIATED WITH THE UNIVERSITY OF HAWAI'I MAUNA KEA SCIENCE RESERVE MASTER PLAN PROJECT AREA

The number and variety of individuals and groups contacted and consulted by Maly during the present study, as evidenced by the twenty-two knowledgeable informants and cultural practitioners *(see Table 1)* who provided information in the form of fifteen tape recorded and transcribed interviews, and the more than 100 individuals and groups that provided additional information through more informal consultations (Maly 1999:Appendix B), demonstrates an adequate, appropriate, and reasonable good-faith effort to identify the full range of Native Hawaiian cultural practices, features, and beliefs currently associated with the Science Reserve Master Plan project area on Mauna Kea. This documented effort indicates it likely that the full range of current cultural practices, features, and beliefs associated with the Science Reserve Master Plan project area has been identified, even though in many instances only the general nature of these practices, features, and beliefs has been determined but not documented in any great detail.

An overview of the cultural practices – including the component behaviors, features, beliefs, and values – summarized in the preceding section of the present report, and presented more fully and in richer detail in Maly's oral history and consultation study (1999) illustrates a pervasive general theme which flows throughout native Hawaiian culture and binds it together. To Native Hawaiians, the natural elements of the physical environment – the land, sea, water, winds, rains, plants, and animals, and their various embodied spiritual aspects – comprise the very foundation of all cultural life and activity – subsistence, social, and ceremonial; to Native Hawaiians, the relationship with these natural elements is one of family and kinship.

The Native Hawaiian cultural practices identified as currently associated with the University of Hawaii Mauna Kea Science Reserve Master Plan project area can be categorized as two general types: (a) practices with active behaviors involving both observable activities with material results and their inherent values or beliefs; and (b) practices with more passive behaviors which seek to produce nonmaterial results. The former type of behaviors involves such activities as the gathering and collecting of natural resources for various purposes, the deposition of *piko*, and the funerary release of cremated human remains. Uses such as these generally have associated beliefs and values, as indicated in the preceding section *(see Table 2)*. The latter type of behaviors involves more experiential activities focused on "becoming one" with natural setting; that is, behaviors relating to spiritual communication and interaction that reaffirm and reinforce familial and kinship relationships with the natural environment.

Several potential traditional cultural properties were identified within the Science Reserve Master Plan project area. These included the entire mountain region of Mauna Kea, several of the distinctive *pu'u* that dominate the summit region, the shallow lake, and several foot and horse trails which access the summit region from the lower slopes of the mountain. Several of these properties comprise physical manifestations which reinforce cultural mythologies and relationships.

EVALUATION OF IDENTIFIED NATIVE HAWAIIAN CULTURAL PRACTICES AND PROPERTIES

Traditional and Customary Practices

For purposes of evaluating the significance of the Native Hawaiian cultural practices, features, and beliefs identified in association with the Science Reserve Master Plan project area, it would be useful to consider them in terms of the three types of informant claims that were defined earlier in the Introduction section of the present report. Information obtained by Maly in his oral history and consultation study (1999) suggests that several of the identified practices and beliefs would appear to fall within the category of traditional and customary practice claims. These would be claims which would lie within the purview of Article XII, Section 7, of the Hawaii State Constitution ("Traditional and Customary Rights"), particularly as reaffirmed in 1995 by the Hawaii State Supreme Court in the decision commonly referred to as the "PASH decision," and further clarified in the 1998 decision in "State v. Hanapi," and which would include various cultural practices and beliefs associated with the general geographical area of the summit region, rather than a clearly definable property or site. While certain other practices, such as prayer and ritual observances involving the construction of new *kuahu* (altars), or the releasing of cremated human remains rather than interment on *pu'u*, might seem to be contemporary cultural practices, they may as well be considered to be reasonable cultural developments evolving from earlier traditional practices.

A general familiarity with the content of traditional Hawaiian culture – both in its tangible material aspects and, perhaps to a somewhat lesser degree, its immaterial and behavioral aspects, indicated nothing unusual among the identified practices. While the geographical setting of the Mauna Kea, and especially the distinctive landscape of the summit region, may not be matched elsewhere within the Hawaiian Islands, none of the identified cultural practices would appear to be particularly unique to the Science Reserve Master Plan project area; similar practices traditionally took place in other settings throughout the islands.

Traditional Cultural Properties

Several potential traditional cultural properties were identified within the Science Reserve Master Plan project area, including the entire mountain region of Mauna Kea, several of the distinctive *pu'u* which dominate the summit region, the shallow lake, and several foot and horse trails which access the summit region from the lower slopes of the mountain. As defined earlier, traditional cultural property claims are the only ones strictly falling within the purview of the historic preservation process. Such claims would involve traditional practices and beliefs of Native Hawaiian informants and cultural practitioners that (a) are associated with a definable physical property (an entity such as a site), (b) are founded in the history of the local community, (c) contribute to the maintenance of the cultural identity of the community, and (d) demonstrate a historical continuity of practice or belief up to the present. Additionally, a potential traditional cultural property must be able to demonstrate its historical significance in terms of established evaluation criteria, such as those of the National Register of Historic Places (CFR 1981) and/or the Hawaii Register of Historic Places, to qualify as a legitimate traditional cultural property within the historic preservation context.

The claims for several of the summit region *pu'u* – specifically for Kekahau'ula, Lilinoe, and Makanaka, and for the shallow lake and adjacent *pu'u* collectively known as Waiau, certainly would seem likely to qualify them as a traditional cultural properties which meet the National Register test for historical significance because the entities (a) are tangible physical properties, (b) appear to have sufficient integrity – that is, the ability to convey their significance, and (c) meet one or more of the four basic National Register criteria. As sites, all four have clearly recognizable and definable physical boundaries. While knowledgeable informants and cultural practitioners acknowledge that several of the *pu'u* have been damaged by past construction activities, they also appear to believe that the *pu'u* have not been so substantially damaged as to destroy their integrity. And finally, by reason of their association with a significant figures in Hawaiian cultural mythology (Kukahau'ula, Lilinoe), and as acknowledged traditional areas for burials (Makanaka) and ritual practices (Waiau), these four properties would seem to satisfy at least one or two of the four basic National Register Criteria: Criterion (A) by association with events that have made a significant contribution to the broad patterns of Hawaiian history, and Criterion (B) by association with the lives of persons significant in the Hawaiian past.

To satisfy Criterion (A), the direct association of a specific site with a significant event, or pattern of events, in Hawaiian history (either written documentary or oral traditional history) would have to be established. All four properties – Kukahau'ula, Lilinoe, Waiau, and Makanaka – would appear to satisfy this criterion because of associated traditional cultural practices and/or the cultural values they represent, as indicated by information provided by many of the knowledgeable informants and cultural practitioners.

To satisfy Criterion (B), the direct association of a specific site with a person significant in Hawaiian history (either written documentary or oral traditional history) would have to be established. National Register Bulletin No. 38 notes that the terms "persons" can mean both "persons whose tangible, human existence in the past can be inferred on the basis of historical, ethnographic, or other research," as well as legendary and mythological "persons" who exist only in the cultural traditions of a group (Parker and King 1991:11). As the personification of important characters in local traditional Hawaiian mythological history, both Kukahau'ula and Lilinoe certainly would seem to meet the requirement of specific persons of significance in traditional Hawaiian legend and myth.

It should be noted that this evaluation of Kukahau'ula, Lilinoe, and Waiau as traditional cultural properties concurs with a preliminary determination of the SHPD staff *(see Figures 3 and 4, and related discussion)* that the three features, with the definition of Kukahau'ula expanded to incorporate the cluster of three *pu'u* which form the summit of Mauna Kea, are believed to qualify as traditional cultural properties on the basis of traditional Native Hawaiian cultural practices and beliefs associated with them. SHPD staff concurrence should also be noted with regard to another *pu'u*, Poli'ahu, that had been identified in the Maly study as a potential traditional cultural property. While the current name of the latter feature might seem to indicate association with a significant mythological personage, it has been pointed out that while Poli'ahu as manifest by snow has long been traditionally associated with the upper slopes of Mauna Kea, the named assignment to a specific *pu'u* was a relatively recent historic period designation made in 1892 by W.D. Alexander during the mapping of Mauna Kea (McEldowney 1982:A-21), and not an earlier Native Hawaiian designation. Thus the feature would not seem to meet the criteria for definition as a traditional cultural property.

Finally, with regard to the various named foot and horse trails that ascended to the summit region and which were identified in the Maly study (1999) as potential traditional cultural properties, it seems likely that they are primarily historic period routes and not specific features of Native Hawaiian tradition; rather than following specific established routes up the slopes of Mauna Kea, travelers in earlier times were apparently guided by distinctive features of the landscape such as *pu'u* and ridgelines (McEldowney 1982:A-15,16).

Contemporary Cultural Practices

With regard to the current practices identified by Maly (1999) as contemporary cultural practices, it would seem that they all bear close enough relationships to earlier traditional cultural practices associated with the upper slopes and summit region of Mauna Kea so that no purpose would be served by distinguishing them as something different. Furthermore, as has been pointed out previously, it is likely that they represent reasonable cultural evolution from earlier traditional practices.

Concluding General Evaluation

Based on an evaluation of the findings of the present cultural impact assessment study made in reference to (a) the known content of traditional Hawaiian culture and (b) the National Register Criteria as clarified by National Register Bulletin No. 38, it is believed that with the exceptions noted above, most of the Native Hawaiian cultural practices, features, and beliefs identified as being currently associated with the Mauna Kea Science Reserve Master Plan project area can be considered to be culturally and historically significant. Most, if not all, of the identified practices and beliefs would seem to qualify as traditional and customary cultural practices within the meaning of the Hawaii State Constitution, while the principal *pu'u* and the shallow lake with adjacent *pu'u* would seem to satisfy the criteria for being regarded as a legitimate traditional cultural property. Finally, none of the identified practices and beliefs would seem to represent strictly contemporary cultural practices or beliefs lacking some measure of traditional connection.

Mauna Kea Summit Region as a Cultural Landscape

As was discussed earlier, SHPD staff have recently indicated that they will be proposing a historic district designation for the summit region of Mauna Kea which they believe will meet the eligibility criteria for inclusion in both the Hawaii State and the National Register of Historic Places. A historic district is defined as a historic property that "...possesses a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development" (NPS 1990:5).

The approximate boundary of the proposed historic district, provisionally referred to as the "Mauna Kea Summit Region," incorporates the virtually the entire Science Research summit area, extending beyond limits of the reserve, and also includes portions of the Natural Area Reserve. The proposed district includes the total of 93 archaeological sites identified within the Science Reserve, three landscape features within the reserve believed to qualify as traditional cultural properties, and the Mauna Kea Adze Quarry Complex situated within the Natural Area Reserve.

Consideration of the properties included within this proposed historic district, and their associated practices and beliefs, suggests it to represent a type of historic property best referred to as a cultural landscape. A cultural landscape is a geographical definable area that clearly reflects patterns of occupation and land use over a long time period, as well as the cultural values and attitudes which guide and regulate human interaction with the physical environment. Based on the Native Hawaiian traditional cultural practices and beliefs associate with Mauna Kea, as documented in the Maly (1999) oral history and consultation study, the proposed historic district could perhaps even more appropriately be considered to be a special type of cultural landscape referred to by the National Park Service as ethnographic landscapes: "those landscapes imbued with such intangible meanings that they continue to be deemed significant or even sacred by contemporary people who have continuous ties to the site or area". Such an ethnographic landscape would seem to be embodied in the concept of "cultural attachment" used by Maly (1999:27) to describe the connection of many Native Hawaiians to Mauna Kea.

ASSESSMENT OF POTENTIAL PROJECT EFFECTS

The assessment of potential project effects upon the Native Hawaiian cultural practices, features, and beliefs, and potential traditional cultural properties identified as associated with the Mauna Kea Science Reserve Master Plan project area has been done in general accordance with the guidance documents cited in the earlier "Study Methodology" section of the present study. Of particular relevance were Part 800.9 ("Criteria of effect and adverse effect") of the federal regulations of the Advisory Council on Historic Preservation for the "Protection of Historic Properties" (CFR 1986), and Section 13-275-7 ("Determining effects to significant historic properties") of the DLNR draft administrative "Rules Governing Procedures for Historic Preservation Review" (DLNR 1998).

Discussion

The University of Hawaii Science Reserve Master Plan project focuses on the formulation of planning and management strategies to guide and regulate any proposed future development and use of the project area. The plan does not involve specific development projects with definable impacts, therefore discussion of potential effects and measures for the mitigation of potentially adverse effects must involve consideration of a range of possible effects and mitigation measures.

Direct effects are those caused by an action and which occur at the same time and place, while indirect effects are those caused by an action and are further removed in time and/or distance, but can still be reasonably foreseen. Cumulative effects are those which result from the incremental effect of actions which, taken together with similarly minor past, present, and future effects, over time become significant.

There are two principal types of actions the direct effects of which have potential to adversely effect the Native Hawaiian cultural practices, features, and beliefs associated with the Science Reserve Master Plan project area: (a) maintenance programs and routine operations, and (b) planned development and construction projects. Both types of actions could result in long-term effects that could damage, reduce, or destroy the integrity of the traditional cultural resources.

Planned development and construction projects are also the principal type of actions the indirect effects of which have potential to adversely effect the Native Hawaiian cultural practices, features, and beliefs associated with the Science Reserve Master Plan project area. This could potentially occur as the result of increased access to and use of the Mauna Kea summit region by the public for various recreation activities, and would also constitute long-term effects.

The integrity of the spiritual and sacred quality of the landscape of Mauna Kea's summit, and astronomy's relationship to the cultural landscape, appears to be a crucial issue with the future activities in the Science Reserve. Given the viewpoints expressed in the informant interviews, and research on the mountain's cultural importance, a common concern is the perceived lack of respect on astronomy's part for the Native Hawaiian cultural practices, features and beliefs. At Mauna Kea, however, a potential bridge may exist between the current study of astronomy and the Hawaiian cultural beliefs. Although the specific functions of the shrines clustered around the summit have not been identified through the interviews of knowledgeable informants, it is believed that they represent symbols of spiritual or heavenly worship offered by individuals or families closely linked to the mountain. It is known that the Polynesian voyagers studied and used the constellations as a navigational guide. A validation of Mauna Kea's astronomical and spritual importance was a recent visit to the summit shrine complex by some crew of the Hokuleia voyaging canoe, prior to their leaving for the South Pacific. Astronomers also share a deep respect for the natural elements and the heavens, but need to better understand the Native Hawaiian people's deep beliefs tied to the physical landscape, its signs and meanings. The Master Plan and Management Plan propose to bring together the knowledge and values of the traditional culture to appropriately direct the future management of the Science Reserve, with ongoing involvement and wisdom of a kahu/kupuna council to be jointly involved in advising the management of the mountain.

The existence of both the shrine complexes and Keanakakoi Adze Quarry on the summit plateau region reiterates a fundamental aspect of Native Hawaiian culture; the integration of the spiritual and religious aspects of life with secular activities of daily living. The adze quarry is essentially a tool making activity, an equivalent of manufacturing or industry involving changing the landscape for functional purposes. That this activity co-existed side by side with what seem to be worship shrines indicates that all activities are imbued with spirituality and that issues of compatibility was resolved through the attitude and protocol with which activities were pursued. A protocol that includes requesting permission from the *aina, kupuna and akua*, expresses appreciation for the generosity and bounty of nature and follows practices of stewardship is the key to appropriateness. The basic conceptual difference between this indigenous use of the mountain's sacred summit area for a lithic industry, and the modern day use of the summit for the study of the stars by astronomers is the issue of appropriate protocol and respect. The Master Plan demonstrates respect for the resources of land, ecology, and culture, while the Management Plan can provide a new start for cooperative stewardship of the mountain's resources with the Native Hawaiian people.

Concluding Assessment

Based on an evaluation of the Native Hawaiian cultural practices, features, and beliefs identified as currently associated with the Mauna Kea Science Reserve Master Plan project area, and a general consideration of the potentially adverse direct and indirect effects that might result from future development and use of the summit region, it is obvious that a comprehensive plan for both the short-term and long-term management of the Science Reserve Master Plan project area is vital for the protection and preservation of significant traditional cultural resources. The Master Plan minimizes potential direct and indirect impacts to cultural practices, features and beliefs through the careful limits set upon future development within the proposed Astronomy Precinct and restrictive design guidelines. The Management Plan proposes specific necessary actions to protect the cultural resources and traditional cultural access rights and uses.

POTENTIAL MITIGATION MEASURES

SHPD Historic Preservation Plan

As mentioned earlier in the Introduction section of the present report, the staff of the SHPD are currently preparing for the University of Hawaii a Historic Preservation Plan for the Mauna Kea Science Reserve Master Plan project area. As presently conceived, this plan will consist of two major essential components: (a) an information component which described the significant historic properties of Mauna Kea and the Mauna Kea Science Reserve, and (b) a management component which identified potential impacts of proposed development and appropriate measures through which potentially adverse effects could be avoided or mitigated.

The management component of the preservation plan will deal two principal topics: (a) plans for specific development projects and related activities, and (b) plans for the long-term management of historic properties within the Science Reserve Master Plan project area. The former topic will address in detail the direct and indirect adverse effects that might potentially result from specific development projects and related activities, and propose a range of mitigation measures to avoid or minimize adverse effects. The latter topic will address in detail long-term management plans for interpretive development, monitoring, routine consultation with Native Hawaiian organizations and individuals, cultural uses, and continued inventory of historic properties.

Potential Mitigation Measures

One general mitigation measure of value would be the preparation of an appropriate programmatic agreement which would provide a mechanism by which interested parties could reach a mutual understanding on what historic preservation review and compliance measures would be applicable to defined classes of development and use actions within the Science Reserve Master Plan project area. A vital component of any such agreement would close and meaningful consultation with the Native Hawaiian community, especially cultural practitioners who utilize the summit region for various purposes.

With regard to planned development and construction projects, procedures essentially the same as those presently contained in the draft SHPD administrative rules should be followed to assure that sufficient effort is given to the identification and evaluation of traditional cultural resources that might be effected by any specific proposed project. The procedures contained in the draft SHPD administrative rules generally parallel the federal historic preservation review process usually referred to as the "Section 106 Review." Basic elements of this review process would include the following: (a) inventory survey to identify all cultural resources within a specified project area; (b) evaluation of the significance of all identified cultural resources; (c) assessment of the potential effects of a project upon significant cultural resources; (d) determination of appropriate mitigation measures to avoid or minimize potentially adverse effects upon significant cultural resources; (e) identification and treatment of potential burial sites; (f) consultation with Native Hawaiian individuals and organizations; and (g) preparation of written agreements to project-specific preservation and management issues.

Perhaps the single most significant mitigation measure that could be implemented would be the restriction of virtually all future planned development and construction projects to the proposed 525-acre Astronomy Precinct. This area represents less than five percent of the entire Science Reserve. The Astronomy Precinct area has been carefully situated to exclude undeveloped *pu'u* and the concentrations of shrine features near the summit, so as to greatly minimize potential adverse direct effects upon the cultural resources of the summit region. All of the undeveloped *pu'u* in the Science Reserve are protected from future astronomy development, reflecting the stated wishes of many Native Hawaiians interviewed in the oral history process, that these culturally significant landforms be preserved. Further, only three shrines are located within the Astronomy Precinct, and these will not be directly affected by construction activities with a proposed minimum buffers of 200 feet from any proposed observatory locations. Importantly, the proposed siting for new observatories avoids interference with visual connections between the shrines and the significant *pu'u* cultural landforms.

With regard to the long-term management of cultural resources within the Mauna Kea Science Reserve Master Plan project area, a series of specific management plans could be formulated to address a wide range of issues. As with any other planning activities, close and meaningful consultation with Native Hawaiian individuals and organizations should be undertaken. Specific management plans could include the following:

1. Monitoring plan involving systematic strategies to monitor the condition of cultural resources to determine what activities and uses within the project area are effecting cultural resources, the nature and intensity of such effects, and appropriate mitigation measures to avoid or minimize any adverse effects;

2. Plan to complete the identification and documentation of cultural resources within the project area;

3. Burial treatment plan for the protection of known and suspected burials sites, and for the treatment of any burials inadvertently discovered during planned development

and construction projects. Preparation of a burial treatment plan should involve consultation with the Hawai'i Island Burial Council;

4. Cultural use plan to provide for access to and use of traditional cultural properties and other culturally significant areas by Native Hawaiian practitioners;

5. Interpretation plan that would designate sites and areas appropriate for public access for purposes of education and recreation, and could include such elements as self-guided and guided tours, informational signage, brochures, and displays; and

6. Enforcement plan to provide for protection of natural and cultural resources and systematic enforcement of all rules and regulations governing access to and use of the Science Reserve Master Plan project area.

REFERENCES CITED

Alexander, W.D.

1892 The Ascent of Mauna Kea, Hawaii. *The Hawaiian Gazette* 27(38):7.

Auditor, State of Hawai'i

1998 Audit of the Management of Mauna Kea and the Mauna Kea Science Reserve. A Report to the Governor and the Legislature of the State of Hawaii. Report No. 98-6. Office of the Auditor (February)

Ayau, E.H.

1991 Native Hawaiian Burial Rights. *In* MacKenzie, ed. 1991:245-273.

CFR (Code of Federal Regulations)

1981 36 CFR Part 60: Natural Register of Historic Places. (Including Part 60.4: Criteria for evaluation.)

1986 36 CFR Part 800: Protection of Historic Properties. (Including Part 800.9: Criteria of effect and adverse effect.)

Cordy, R.H.

1994 A Regional Synthesis of Hamakua District, Island of Hawai'i. Historic Preservation Division, Department of Land and Natural Resources, State of Hawaii.

DLNR (Department of Land and Natural Resources, State of Hawai'i)

1993 Revised Scope of Work: Historic Preservation Management Plan for Mauna Kea Areas Under University of Hawaii Institute for Astronomy Administration. State Historic Preservation Division (May 27, 1993)

1998 Chapter 275: Rules Governing Procedures for Historic Preservation Review for Governmental Projects Covered Under Sections 6E-7 and 6E-8, HRS. Hawaii Administrative Rules; Title 13, Department of Land and Natural Resources; Subtitle 13, State Historic Preservation Division Rules. (October) (Draft rules)

n.d. Chapter 284: Rules Governing Procedures for Ethnographic Inventory Surveys, Treatment of Traditional Cultural Properties, and Historical Data Recovery. Hawaii Administrative Rules; Title 13, Department of Land and Natural Resources; Subtitle 13, State Historic Preservation Division. (Draft rules; 1997)

In prep. Historic Preservation Plan for University of Hawaii Management Areas on Mauna Kea, Island of Hawai'i. State Historic Preservation Division

DLNR and UH-IfA (Hawaii State Department of Land and Natural Resources and University of Hawaii-Institute for Astronomy)

1995 Revised Management Plan for the UH Management Areas on Mauna Kea. Prepared for and approved by Board of Land and Natural Resources. (March)

Ellis, W.

1979 *Journal of William Ellis.* Rutland, VT: Charles E. Tuttle Company, Inc.

Group 70 International, Inc.

1999 Mauna Kea Science Reserve Master Plan--Draft #3. Prepared for the University of Hawai'i. (July 12)

In prep. Draft Environmental Impact Statement: Mauna Kea Science Reserve Master Plan. Prepared for the University of Hawai'i.

Juvik, J.O., and S.P. Juvik

1984 Mauna Kea and the Myth of Multiple Use Endangered Species and Mountain Management in Hawai'i. Mountain Reserch and Development 4(3).

Kanahele, P.K., and E.L.H. Kanahele

n.d. A Social Impact Assessment: Indigenous Hawaiian Cultural Values of the Proposed Saddle Road Alignments. Project A-AD-6(1). Prepared by Native Hawaiian Cultural Consultants for U.S.Dept. Transportation-Federal Highways Administration. (1997)

Kau, C., and M.K. MacKenzie

1991 Religious Freedom. *In* MacKenzie, ed. 1991:229-244.

Langlas, C.

1998 Supplement to Archaeological, Historical and Traditional Cultural Property Assessment for the Hawai'i Defense Access Road A-AD-6(1) and Saddle Road (SR200) Project. (July) *In* Langlas et al. 1999.

Langlas, C., T.R. Wolforth, and J. Head

1999 The Saddle Road Corridor: An Archaeological Inventory Survey and Traditional Cultural Property Study for the Hawai'i Defense Access Road A-AD-6(1) and Saddle Road (SR200) Project; Districts of South Kohala, Hamakua, North Hilo, and South Hilo; Island of Hawai'i. PHRI Report 1939-043099. Prepared for Okahara & Associates, Inc. (April)

Lucas, P.N.

1991a Traditional and Customary Rights: Access Rights. IN MacKenzie, ed. 1991:211-222.

1991b Traditional and Customary Rights: Gathering Rights. IN MacKenzie, ed. 1991:223-223.

MacKenzie, M.K. (editor)

1991 *Native Hawaiian Rights Handbook.* Honolulu: Native Hawaiian Legal Corporation and Office of Hawaiian Affairs

Macrae, J.

1922 With Lord Byron at the Sandwich Islands. Honolulu: W.F. Wilson.

Maly, K.

1997 Mauna Kea - *Kuahiwi Ku Ha'o I Ka Malie*: A Report on Archival and Historical Documentary Research; *Ahupua'a* of Humu'ula, Ka'ohe, Districts of Hilo and Hamakua, Island of Hawai'i. Report HiMK-02d(082796). Prepared by Kumu Pono Associates (Hilo) for Native Lands Institute (Hilo). (March)

1999 Mauna Kea Science Reserve and Hale Pohaku Complex Development Plan Update: Oral History and Consultant Study, and Archival Literature Research; *Ahupua'a* of - Ka'ohe (Hamakua District) and Humu'ula (Hilo District), Island of Hawai'i. Report HiMK-21 (120199). (Including Appendices A thru E.) Prepared by Kumu Pono Associates (Hilo) for Group 70 International (Honolulu). (February)

McCoy, P.C.

1976 The Mauna Kea Adze Quarry Complex, Hawaii: A First Analysis. *In* C.W. Smith, ed., Proceedings of the First Conference in Natural Sciences in Hawaii:135-142.

1977 The Mauna Kea Adze Quarry Project: A Summary of the 1975 Field Investigations. *Journal of the Polynesian Society* 86(2):223-244.

1978 The B.P. Bishop Museum Mauna Kea Adz Quarry Project. Report No.012778. Prepared by Dept.Anthro., B.P. Bishop Museum for the Historic Preservation Office, Department of Land and Natural Resources, State of Hawaii. (January)

1981 Stones for the Gods: Ritualism in the Mauna Kea Adze Quarry Industry. Paper presented at the 46th Annual Meeting of the Society for American Archaeology; San Diego, California.

1982 Report 2. Archaeological Reconnaissance Survey. *In* McEldowney and McCoy 1982:A-28 thru A-64.

1984a Archaeological Reconnaissance of Hopukani, Waihu, and Lilinoe Springs, Mauna Kea, Hawai'i. Report No. 102584. Prepared by Dept.Anthro., B.P. Bishop Museum for the U.S. Army Corps of Engineers-Pacific Ocean Division. (October)

1984b Mauna Kea Summit Region Survey: A Summary of the 1984 Fieldwork. Ms. report. Dept. Anthro., B.P. Bishop Museum. (Revised version of earlier McCoy Ms.a draft report.)

1986 Archaeological Investigations in the Hopukani and Lilinoe Springs Area of the Mauna Kea Adze Quarry, Hawai'i: A Data Summary Report. Report No. 092386. Prepared by Mountain Archaeology Research Coproration and Dept.Anthro., B.P. Bishop Museum for the U.S. Army Corps of Engineers-Pacific Ocean Division. (September)

1990 Subsistence in a 'Non-Subsistence' Environment: Factors of Production in a Hawaiian Alpine Desert Adze Quarry. IN D.E. Yen and J.M.J. Mummery, eds., Pacific Production Systems: Approaches to Economic Prehistory. Occ. Papers in Prehistory, No. 18:85-119. Dept. Prehistory, Research School of Pacific Studies, The Australian National University, Canberra.

1997 Neither Here Nor There: A Rites of Passage Site on the Eastern Fringes of the Mauna Kea Adze Quarry, Hawai'i. Ms. report. Hawaii DLNR-SHPD.

1999a Mauna Kea Science Reserve Archaeological Site Inventory: Formal, Functional, and Spatial Attributes. Manuscript report. State Historic Preservation Division. (February)

1999b Descriptions of Four Archaeological Sites Located in the Proposed 600 Acre Astronomy Precinct, Mauna Kea Science Reserve, Hawai'i. Manuscript report. State Historic Preservation Division. (February)

Ms.a Mauna Kea Summit Region Survey: A Summary of the 1984 Field Work. (Includes draft National Register of Historic Places Inventory - Nomination Form for the Mauna Kea Summit Plateau Shrine Complex). Manuscript report. Dept.Anthro., B.P. Bishop Museum. (1984)

McEldowney, H.

1979 Archaeological and Historical Literature Search and Research Design: Lava Flow Control Study, Hilo, Hawai'i. Dept.Anthro., B.P. Bishop Museum. Prepared for U.S. Army Engineers Division, Pacific Ocean. (May)

1982 Report 1. Ethnographic Background of the Mauna Kea Summit Region. *In* McEldowney and McCoy 1982:A-1 thru A-27.

McEldowney, H., and P.C. McCoy

1982 Cultural Resources Reconnaissance of the Mauna Kea Summit Region. Dept. Anthro., B.P. Bishop Museum. Prepared for Group 70. (November)

NPS (National Park Service)

1990 How to Apply the National Register Criteria for Evaluation. *National Register Bulletin No.* 15. Washington, D.C.: U.S. Dept. Interior, National Park Service. (Revised 1991, 1995)

OEQC (Office of Environmental Quality Control, State of Hawai'i)

1997a A Guidebook for the Hawaii State Environmental Review Process. (October)

1997b Guidelines for Assessing Cultural Impacts. Adopted by the Environmental Council; November 19, 1997.

n.d. Environmental Report Card, 1997: An Assessment of Hawaii's Environmental Health. The 1997 Annual Report of the Environmental Council, State of Hawaii.

Parker, P.L., and T.F. King

1990 Guidelines for Evaluating and Documenting Traditional Cultural Properties. *National Register Bulletin No.* 38. Washington, D.C.: U.S. Dept. Interior, National Park Service.

PASH/Kohanaiki Study Group

1998 Report on Native Hawaiian Traditional and Customary Practices Following the Opinion of the Supreme Court of the State of Hawai'i in Public Access Shoreline Hawaii v. Hawai'i County Planning Commission. Prepared in Response to H. R. No. 197, H.D. 1, Regular Session of 1997, Nineteenth State Legislature, State of Hawai'i. Submitted by the Office of Planning, State of Hawai'i. (January)

Pukui, M.K.

1983 *Olelo Noeau*. B.P. Bishop Museum Special Publication 71. Honolulu: Bishop Museum Press.

Sebastian, L.

1993 Protecting Traditional Cultural Properties Through the Section 106 Process. *CRM Vol.* 16 (Special Issue):22-26.

VOICES AND VISIONS OF MAUNA KEA

MAUNA KEA SCIENCE RESERVE MASTER PLAN AND IMPLEMENTATION PROCESS SUMMARY

"Mauna Kea kuahiwi kū ha'o i ka malie"
(Mauna Kea is the astonishing mountain that stands in the calm.)
—Pukui 1983: No. 2147

"It will afford me unfeigned satisfaction if my kingdom can add its quota toward the successful accomplishment of the most important astrono-mical observation of the present century and assist, however humbly, the enlight-ened nations of the earth in these costly enterprises . . ."
—King David Kalakaua

"After all, the ancient Hawaiians were among the first great astronomers, using the stars to guide them among the islands in the vast Pacific, centuries before anyone else had developed such skill. Long before Europeans and mainlanders, Hawaiian astronomers were studying the heavens with awe and wonder, the same feelings that draw modern astronomers to study the heavens. At this very deep level, I feel we are brothers and sisters."
—Frederic Chaffee,
Director, W.M. Keck
Observatory

PREPARED BY THE UNIVERSITY OF HAWAI'I
MARCH 2000

DOCUMENT PURPOSES

1. To provide an educational tool for broad public dissemination to further an understanding of the master plan and its process, including steps and challenges for implementation of the plan.

2. To focus on the physical, management and implementation aspects of the Mauna Kea Science Reserve Master Plan.

3. To make a distinction between the master plan as a policy framework, and the implementation process that will occur after the master plan is adopted.

4. To incorporate and respect the voices and visions of various parties who have been involved in the planning process.

MASTER PLAN GOALS

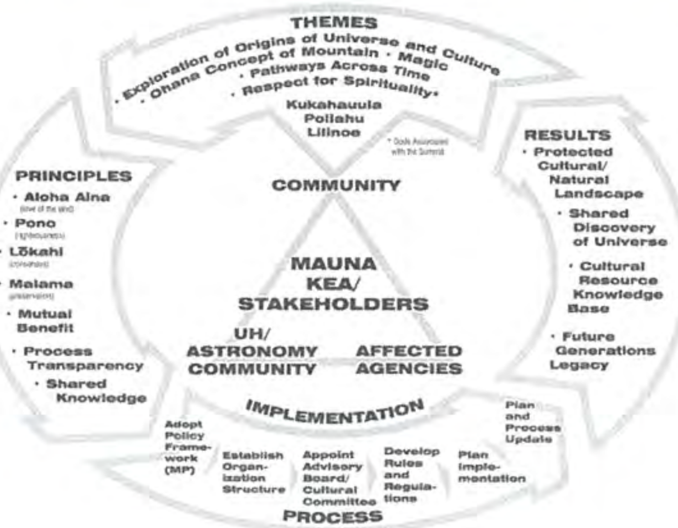
To update the 1983 Mauna Kea Science Reserve Complex Development Plan by:

1. Developing a vision for the sustainable use and enhancement of the Mauna Kea Science Reserve as a Hawaiian place with significant and unique cultural, natural, educational/research and recreational values, meanings and potentials, both locally and globally.

2. Integrating and balancing cultural, natural, educational/research and recreational values and uses in a physical and management plan which will remedy existing problems and provide a framework and structure for the responsible and sustainable stewardship of the Mauna Kea Science Reserve.

MASTER PLAN CONCEPT

The graphic below provides an integrated conceptual framework of the plan in terms of overriding themes, principles, implementation steps and expected results. This surrounds the central image of the mountain, its stakeholders and the relationship of Mauna Kea to cultural perspectives and the related themes of exploring the origins of the universe and origins of Native Hawaiian culture.



DEFINITIONS

Master Plan - A policy framework with a 20 year horizon that includes the plan methodology, existing conditions, cultural background and the physical and management plans. The Master Plan is an update and extension of the 1983 Mauna Kea Science Reserve Complex Development Plan.

Science Reserve – An 11,228 acre area on the Mauna Kea summit that is leased by the University of Hawai'i from the State of Hawai'i for use as a scientific complex. The Astronomy facilities are near the summit, while 95 percent of the Science Reserve serves as a protected buffer area.

Astronomy Precinct – A 525 acre area where astronomy development will be consolidated to maintain a close grouping of astronomy facilities while minimizing the potential impact to the natural and cultural resources of the summit region.

Implementation – A short term process of establishing the organization structure, consultation protocols, rules and regulations and actual phases of development and resource protection after adoption of the Master Plan.

"Astronomers don't seek to exploit the land. We respect the fragility of the mountain. The Mauna Kea Master Plan doesn't call for covering the slopes with telescopes. Concern for the consequences...The Mauna Kea Master Plan is a plan to share the mountain."
—Peter Kapack, student, Institute for Astronomy

"Stargazing from Mauna Kea and the success of Hokule'a are all tied together."
—Herring Kalua, Native Hawaiian

THE PLANNING PROCESS

THEMES

The planning process for the Mauna Kea Science Reserve is driven by a related set of factors and principles including:

- Extensive consultations – A series of consultations with interested stakeholders and the community through a variety of means including the Advisory Committee, written testimony, presentations to the Board of Regents and the formation by Senator Inouye of a special group to address stakeholder concerns, with an emphasis on Native Hawaiian issues.

- Special scientific and cultural studies – An extensive series of studies, technical research, related management plans and related research to establish comprehensive baselines for the formation of policies regarding the management of Mauna Kea and related resources.

- Technical drafts – A series of five drafts of the Management Plan, widely circulated and posted on the Internet for public review and completion of a Final Environmental Impact Statement.

- Response to auditor report – The February 1998 State Auditor's report on management of the mountain identified key issues for the planning process. The Master Plan includes specific responses to the Auditor's report recommendations.

- Plan the beginning – The completion and adoption of a Master Plan signals only the beginning, and not the end of the process. Goals, objectives and policies outlined in the plan are a framework of action and not actions in and of themselves. Specific action steps are further outlined under the section entitled Pathways to Implementation.

PLANNING AND MANAGEMENT PROCESS

A ten step generalized process as outlined below, beginning with the Legislature's required audit report and ending in the evaluation amendment and update of the plan after its initial implementation steps. Implementation is discussed in greater detail on page 6.

RELATED STUDIES AND PLANS

The master plan process has triggered the most extensive assessment and consultation process in the history of Mauna Kea. These include, but are not limited to, the following:

- Cultural study and surveys, respecting Hawaiian natural and cultural resources
- Historic Preservation Plan, guiding management of historic and cultural properties
- Botanic and Geologic Resources Management Plans – Plans reflecting the concept that geologic, hydrologic and botanic resources are all part of the life cycle of the mountain
- Cultural Impact Assessment – Native Hawaiian cultural practices, features and beliefs
- Economic Impact Study - Economic impacts of observatories on the County and State
- Astronomy Research Development Plan and plan updates
- Mauna Kea Astronomy Education Center

ROLES AND RESPONSIBILITIES

A variety of key players share responsibility for the planning and management of the Mauna Kea Science Reserve. The principal legal responsibility is vested with the University of Hawai'i through the Office of the President, with policy decisions approved by the Board of Regents. Other key parties include the following:

- University of Hawai'i Hilo Office of Mauna Kea Management
- Institute for Astronomy
- Mauna Kea Advisory Board
- Kahu/Kūpuna Advisory Committee
- Observatory Organizations
- State Department of Land and Natural Resources
- State Office of Historic Preservation

"Mauna Kea offers an unequaled opportunity for research. The University of Hawai'i must work actively to preserve this leadership."
—R.D. Joseph, IFA and Director, NASA Infrared Telescope Facility

"Had we had the opportunity to be part of the planning from the very beginning, you would not have the problems you have today. But we are happy to see outreach from the scientists to the community."
—Eleanor Ahuna

Plan Setting - Values and Voices

Overview and Themes

All planning is based on values and Mauna Kea is a unique setting that requires a balancing of needs and values of all who are involved, especially when it comes to the management of the summit. Values are best expressed through the voices of the various players who are stakeholders in Mauna Kea, and this section is representative of the various values and voices, as well as the changes that have been made in Master Plan through the process of consulting and listening to those whose beliefs and aspirations are focused on Mauna Kea. In understanding the values setting of Mauna Kea the following themes have resonated throughout the Mauna Kea Science Reserve Master Plan process:

- *Sharing "Place" – The Master Plan provides opportunities for sharing the unique setting of Mauna Kea including sharing science while minimizing intrusiveness on sacred and traditional values.*

- *Two Way Education – The plan and management of the mountain involves the values of research and education on technology, combined with the education of native Hawaiians and the broader community on cultural and traditional origins and beliefs.*

Values Dimensions

The Master Plan attempts to balance varied and sometimes competing values of process stakeholders. These are best represented by the following:

"The mountain is very sacred. The iwi (ancestral remains) found there must be returned. There are few Hawaiians here tonight. They know they will not have the chance to share their mana'o. We are astronomers ourselves. We understand. But you don't need more . . . there are enough there already. Some of us feel that you need to remove these structures, but I must accept them. I know that our children need the education. They are gone because there are no jobs here. Just maintain what you have now."

—Aunty Maile, Kupuna

"There is little recognition of the faces behind the science. This is the only industry that has withstood the tides of economic decay. Hilo is dying, and Mauna Kea is giving it back."

—Pat Cravello, Keck Observatory Employee

"The outriggers will allow us to look for other planets around other solar systems. The Master Plan provides a spirit that will result in responsible use of the Mauna Kea summit. We should not give in to polarization."

—Al Conrad, Keck Observatory

"All of my children have benefited from my employment. But this represents a crossroads of two important Hawaiian values: preserving the aina or protecting my ohana. Nothing can be found in the past that can compensate for failure in the present."

—Samuel Alameda Jr., Keck Observatory Employee

"The Mauna Kea Science Reserve directly pumps over $50 million into the Big Island economy annually and over 400 positions associated with that activity."

—University of Hawai'i Fact Sheet

Changes

The Mauna Kea Science Reserve Master Plan has undergone five different drafts during the past year. In response to issues, concerns and input, especially from the native Hawaiian community, a number of changes were made in the Master Plan and its proposed policies. These changes include the following:

1. Limiting astronomy activities to an area of no more than 150 acres over the next 20 years and creating a natural/cultural preservation area of 10,760 acres as a natural and cultural buffer around the 525 acre astronomy precinct which is ten acres less than the 1983 Master Plan.

2. Redefinition of astronomy precinct boundary preventing reuse of the Very Long Baseline Array site for a new facility.

3. Prohibiting any new facilities on currently undeveloped pu'u (cinder cones)

4. Local management structure incorporating strong participation of community, including establishment of the Advisory Board and Cultural Council (Kahu/Kūpuna) to maximize local consultation and preservation of environmental and cultural resources

5. Development limited to replacement of existing facilities, expansion of two facilities and four telescopes at new sites, over a 20 year period, all subject to new design guidelines.

"Changes in the Draft Management Plan over the past few months reflect concerns over natural and cultural issues. Thus, there has been a greatly increased understanding between the respective groups as a result of the process."
—Antony Schinckel, Director of Operations, Submillimeter Array

Education

(Adopted from the UH Hilo Proposal for the Mauna Kea Astronomy Center) The Plan setting goes beyond the legal boundaries of the Science Reserve to embrace educational initiatives that extend the values of discovering the origins of the universe and Hawaiian culture to the Hawaiian community and the world beyond. Thus, one of the critical elements of the Plan is to engender an educational outreach to native Hawaiians and to the world at large. Components include:

- Collaborative use of Mauna Kea telescopes to enhance instruction in K-12 schools, community colleges and universities locally and nationally.

- Summer astronomy workshops and courses for secondary school students, community colleges and universities using the Center's facilities and the Mauna Kea observatories.

- Professional development programs for teachers through year-round workshops, on-site and distance learning courses, curriculum development and research opportunities in collaboration with University of Hawai'i astronomy facility.

- Year-round Hawaiian and indigenous culture workshops.

- Academic programs in Hawaiian and other indigenous languages.

- Enhancement throughout the State of astronomy instruction by in-class programs presented by Center staff affiliated UH astronomy faculty and students.

"All islands have their sacred places. The highest places are the most sacred. Mauna Kea is our legendary place. The summit was too sacred for the workings of man. It was a burial site for only the most special personages of the past."
—Ed Stevens

Physical Plan

Overview And Objectives

This section summarizes the main features of the Mauna Kea Master Plan physical plan contained in Chapter IX of the Plan document. The principal objective of the physical plan is to promote the sustainable use, enhancement and development of the resources of The Mauna Kea Science Reserve including:

- Protect natural resources (e.g., Wekiu bug habitat, alpine ecosystems)
- Protect historic and Hawaiian cultural resources and practices (e.g., archaeological sites, cultural landforms)
- Protect and enhance education and research (e.g., astronomy, ecology, geology)
- Protect and enhance recreational opportunities (e.g., skiing, hiking)

MAJOR FEATURES

Figure 1, Aerial View of Summit – The concentration of the observatories and astronomy precinct, surrounded by the land forms of the natural/cultural preservation area

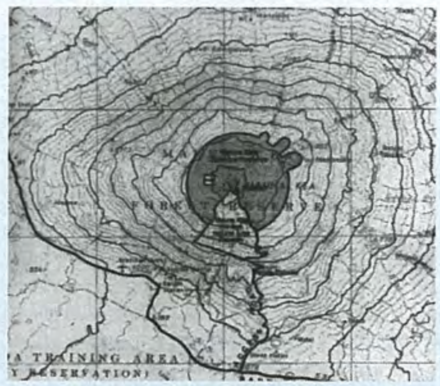


Figure 2, the setting of the Science Reserve, including access roads, the Mauna Kea Ice Age Natural Area Reserve and Hale Pōhaku, the mid elevation facility

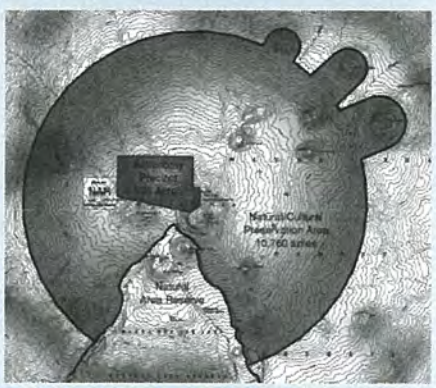


Figure 3, a detailed map of the Mauna Kea Science Reserve noting the acreages of the astronomy precinct and natural/cultural preservation area, as well as zones for the Natural Area Reserve

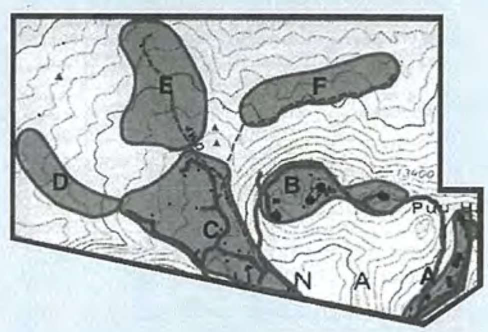


Figure 4, telescope siting areas (2000-2020). This figure notes the 6 siting areas. The Plan reduces areas A and B, reconfigures areas C and D and adds areas E and F. However, the Master Plan reduces the total area allocated for telescope siting from the 1983 Plan to 150 acres, 10 less than the previous plan.

Integrated Approach

The physical plan is an integration and balancing of four components. The natural resource component documents the extent of significant habitat areas and unique geology areas, and delineates preservation areas. The historic and Hawaiian cultural component identifies archeological sites and culturally significant land forms to be preserved. The education and research component identifies appropriate sites for the future expansion of astronomy facilities, with respect for natural and cultural resource preserve areas. Lastly, the recreational uses of the mountain are defined.

"Research in astronomy is necessarily passive. It is observational alone, possessing as such a humble quality. It demands access to the best sites and the best facilities. We should make, not every possible, but every reasonable effort to improve those facilities, for without continuing to strive, we are saying we've learned enough."
—Harald Ebeling, Assistant Astronomer, IFA

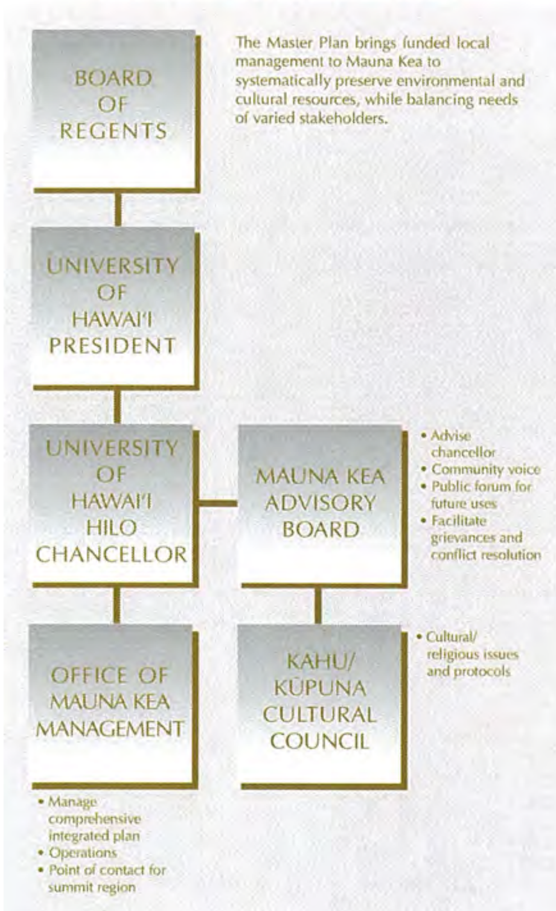
"I am sentimentally opposed to development. But reality is more complex. Technology resides within the mountains. I want the children to have a choice. Supporting astronomy and other scientific research cultivates choice. I expect the university to follow through on their obligations."
—Peggy Kamisato, Waimea Resident

OVERVIEW AND OBJECTIVES

This section summarizes Chapter X, Management Plan, of the Mauna Kea Science Reserve Master Plan. The Management Plan provides policies and strategies to integrate and balance the natural, cultural, educational/research and recreational values of Mauna Kea within a framework that provides responsible stewardship of the resources. This includes creating a structure to meet the following objectives:

- Promote community input
- Establish local management
- Establish a focal point for management responsibility
- Establish clear lines of decision making and accountability
- Establish economic and structural feasibility
- Provide a base for future expansion beyond astronomy that includes cultural, educational and community programs

MANAGEMENT ORGANIZATION



COMMITMENTS

Management and implementation of a master plan requires firm commitments on the part of the lead authority, The University of Hawai'i. These commitments include the following:

1. University President committing funding, in the amount of at least $400,000 annually, to support the Mauna Kea Management Office
2. Board of Regents adoption of the concept of a Mauna Kea Management Authority
3. Significant commitment by the University to community and native Hawaiian involvement through the Master Plan Advisory Board, the Inouye Group and the Kahu/ Kūpuna Cultural Council
4. Commitment to unrestricted religious and cultural practices in the Mauna Kea Science Reserve
5. Commitment to a program of education and research and extends beyond the summit and brings the magic of discovery of the origins of the universe and discovery of the origins of Hawaiian culture to the youth

THEMES

The following themes underlie the Management Plan for the Mauna Kea Science Reserve:

- Managed access – Policies and protocols to manage access while still providing unrestricted religious and cultural practices
- Balance of management and cultural perspectives – management goes beyond astronomy to include the cultural perspective and the integration of biological, geological and hydrological elements in a Native Hawaiian view of life cycles

"Protecting culture is important. Astronomy is important. The Draft Plan calls for a balance of uses, with greater attention to natural and cultural resources and limited, carefully controlled and restricted development. The Management Plan is a good starting point."
—Barbara Schaefer, Observing Support Coordinator, W.M. Keck Observatory

"Hawaiian and astronomical questions are similar. Where do we come from, where are we going? Good solutions bring convergence."
—Jim Kennedy, Operations Manager, Gemini Observatory Northern Operations Center

Pathways To Implementation

Overview And Objectives

The adoption of the Mauna Kea Science Reserve Master Plan by the Board of Regents is just the beginning of the voyage of discovery. This section touches on highlights of Chapter XI, Implementation Plan, of the Master Plan and identifies the major pathways to the future that translate the framework of policies of the Master Plan into realities of integrated management of the Science Reserve and related resources. It also respects the voices and viewpoints of the community and those native Hawaiians who did not necessarily agree with the total direction of the Master Plan by framing a set of challenges that should be addressed during the implementation of Master Plan policies.

Implementation Pathways

Implementation of the updated Mauna Kea Master Plan begins with the adoption of the plan by The University of Hawai'i Board of Regents. As noted in the section on the planning process, this is step 9 of the general process, but it actually triggers a whole new series of processes and pathways that flesh out and add substance to the broad policies of the Master Plan. These pathways and their action horizons are summarized as follows:

PATHWAY	FEATURES	HORIZON
Establish Office of Mauna Kea Management (UHMKM)	This includes finalizing the organizational structure, setting up funding, selecting and training staff.	Within six months
Mauna Kea Advisory Board	This includes appointing the Advisory Board, establishing administrative rules and organizing the Kahu Kupuna Cultural Council.	Within six months
Rules and Regulations	These are the rules that guide daily operations and management of the Science Reserve. These will involve public hearings and incorporate traditional protocols as required. Rules should also be adopted for both the MKM and the Advisory Board.	Draft rules within six months of hiring Director and final rules adopted within 18 months of formation of the UHMKM
Reorganize Hale Pōhaku Operations	This includes renovation of the Visitor Information Station, establishing registration protocol and education materials/programs and a control point kiosk.	Renovations and kiosk within one year and Visitor Information Station expansion within three years
Design and Project Review Guidelines	This is to assure that any development is done in a manner which integrates it into the summit environment and contributes to the mountain's overall character and environmental quality.	Appoint Design Review Committee within six months of adoption of Master Plan and implement policies
Programs Development	These are community, research and education programs that extend beyond the astronomy at the summit and bring the excitement of astronomy and discovery to the community, schools and youth.	Program prioritization within one year and program launch based on funding and resource capture
Facility Development	Summit, mid-elevation and off-mountain base facilities	Ongoing, subject to design and project review guidelines
UHMKM Management Operations	The day to day operations of UHMKM including building of management and technical capacity and implementation of rules and regulations as adopted.	Appointment of staff and coordination with adopted rules and regulations
Master Plan Evaluation, Amendment and Update	This includes a periodic assessment of operations and review with the President and Board of Regents, as well as implementation of amendment procedures and formal update of the Master Plan, as required.	Assessment after 18 months and plan amendments per adopted policies

Challenges

The intense planning process can be characterized as a voyage through varying rough and calm waters of debate, disagreement and enlightenment. It is critical to recognize and respect the realities of differing viewpoints and hold these as challenges for implementation, including:

1. Beyond the Summit – The challenges of the Master Plan and its implementation go beyond the summit, especially with respect to education programs and community outreach.
2. Intrusion – Spiritual and sacred places are considered threatened by elements of the plan; policies and protocols need to assure maximum respect and protection.
3. Trust and Healing – The planning process raised understanding but equally raised fears and suspicions among many native Hawaiians. This requires continued communication, education and relationship building.
4. Management Protocols – Special attention is needed to maintain a balance of interests in the rules, regulations and management protocols, especially the roles of players and decision making authorities.
5. Education Benefits – Capturing the imagination of the community and especially native Hawaiian youth through an aggressive astronomy and cultural education program.

"Planning does not include na'au...soul. There will be Hawaiians who feel that nothing has been done. All they can see is that the plan is to build up there, and the building has to do with science. The public has to see that the Master Plan is not the end . . . it's the beginning."
—Pualani Kanahele

"We face the problem of improving education for our youngsters. They suffer from a lack of excitement and learning. Mauna Kea astronomers generate new excitement and their study of the heavens ties in with ancient navigators. What is beyond that horizon?"
—Alan Okinaka, GTE Hawaiian Tel

Voices and Visions of Mauna Kea

MAUNA KEA SCIENCE RESERVE MASTER PLAN AND IMPLEMENTATION PROCESS SUMMARY

Message From The President, University of Hawai'i

This document represents the commitment by the University of Hawai'i to fulfill its legal responsibilities for the planning and management of the Mauna Kea Science Reserve. But the vision for this special and sacred place is not just ours. It truly comes from the voices and visions of many people. Likewise, the responsibility for implementation is a shared venture. As noted, adoption of the Master Plan by the Board of Regents is just the beginning, not the end. This voyage of discovery, learning and sharing is at the heart of an educational institution and we look to our many partners and the community to guide us in the next steps and challenges ahead.

Dr. Kenneth Mortimer, President

"This mountain is big enough to embrace us all."

—Christopher Mullis, Research Associate, IFA

DOCUMENT SCOPE

This document is organized into a series of highly graphic, easy to read panels that highlight various aspects of the planning process and its implementation. Sections include the following:

Master Plan Availability

The complete two-volume Master Plan is available at all Hawai'i Island libraries and is posted at www.hawaii.edu/maunakea. Comments are welcome and should be sent to the Office of the Senior Vice President for Research at UH Manoa, 2444 Dole Street, Bachman Hall, Suite 105, Honolulu, HI 96822

Canoe Logo

Traditional canoe symbol, patterned after Hokule'a, represents planning process as a voyage surrounded by stars, with the canoe carrying cultural beliefs and practices.

Credits

Document concept and text: The Johnson Strategy Group, Inc.
Master Plan materials and layout: Group 70 International, Inc.