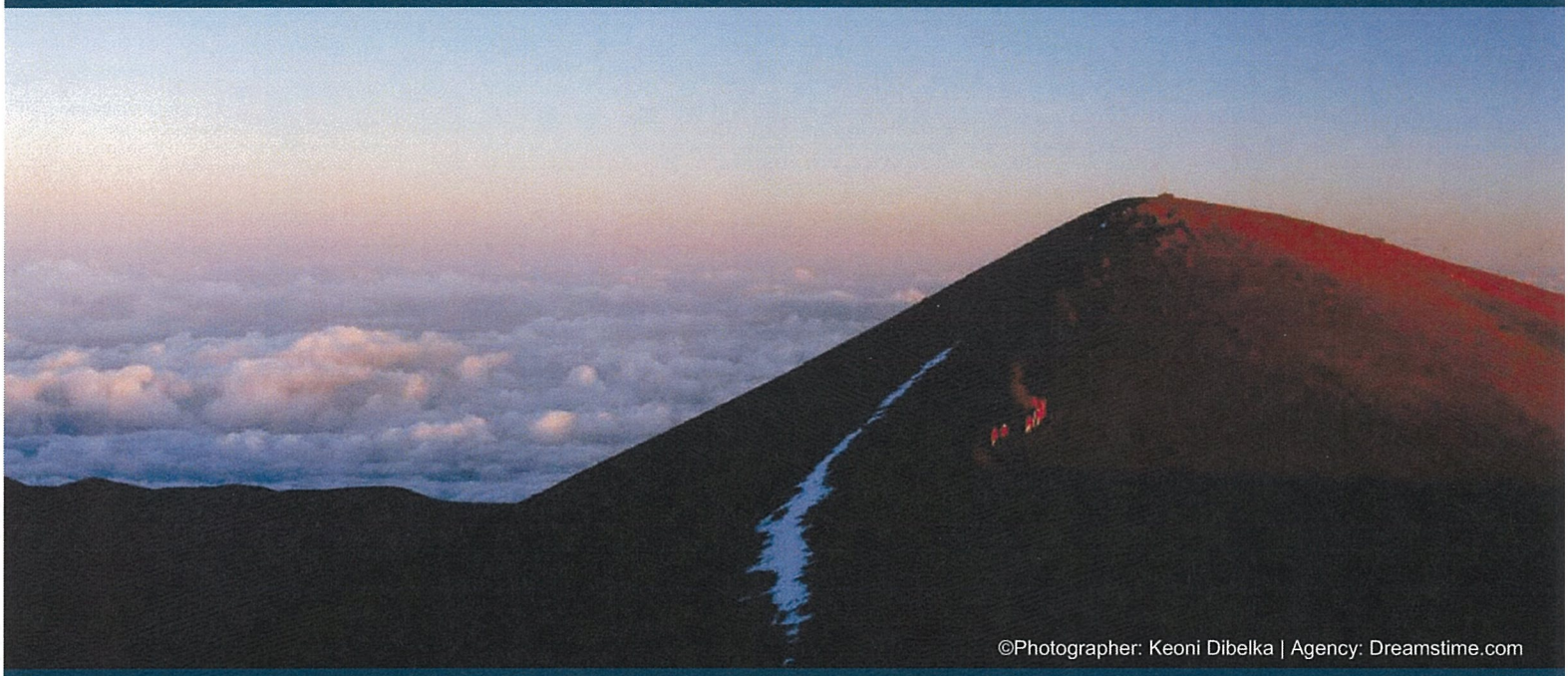
MAUNA KEA COMPREHENSIVE MANAGEMENT PLAN



UH MANAGEMENT AREAS

April 2009

EXHIBIT A-9

MAUNA KEA COMPREHENSIVE MANAGEMENT PLAN

UH MANAGEMENT AREAS

Prepared for
University of Hawai'i

by

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Cultural Anchor

By The Edith Kanaka'ole Foundation

The Birth of Hawai'i, the Place

The *ka'ao*, or sacred records, of the Hawaiian people inform us that the place and space known as Hawai'i are themselves island descendants of Wākea (sometimes translated as "Sky Father) and Papahānaumoku (literally, the firmament or wide place who gives birth to islands, also referred to as Papa, the creator goddess of Hawai'i), who conceived and gave birth to the islands of Hawai'i.

Wākea has many other meanings, two of which speak to the "immensity of our celestial dome." Another refers to "the zone of Kea." Kea refers to "enlightenment" and "progeny." Kea, in simple terms, translates both as "white," a color associated with spiritual enlightenment and the white of "male procreative fluids."

Hawaiian creation chants inform us that Papahānaumoku is an extension of *Haumea* (the-red-sacrifice). *Haumea* is the lava itself, which, after spewing into the atmosphere of Wākea becomes the solid foundation for living. This intercourse between Wākea and Papahānaumoku also produced the mountain child we know today as Mauna Kea. Mauna Kea is both female and male. Mauna Kea's physical manifestations of rock, soil, water and ice, are female attributes; his elevation establishes his maleness, as it brings him closer to the celestial seat of his father Wākea. The equitability of this female-male distribution establishes Mauna Kea as sacred and creates the *piko kapu*, or sacred center, of the island.

The Birth of Hawai'i, the Native Being

The *ka'ao* also informs us of the birth of Hawai'i, the native being. Wākea and Papahānaumoku also gave birth to Komoawa and Ho'ohōkūkalani. Komoawa is both son and high priest of Wākea. Together with Wākea, Komoawa and Ho'ohōkūkalani established the ancient *kapu* system to regulate human impact on the islands that are the sacred children of Wākea and Papahānaumoku.

Ho'ohōkūkalani means the "creator of stars." She, in union with Wākea, becomes the celestial womb from which Hawai'i the original native being takes root, gestates, and is born into a sacred landscape. Yes, the Hawai'i native, is the descendant of the celestial bodies, the stars themselves. And this moekāpi'o, or coming together, of Ho'ohōkūkalani and Wākea, is the primordial union that inserts the Hawai'i native into the sacred parabola of life between the stars and the earth. The *kuahu* or shrine to this "arching reality" is Mauna Kea. At birth, the native being is born into a system that ensured the longevity of the reality of environmental kinship we know as Hāloa.

For this reason, Mauna Kea is sacred. Mauna Kea is where heaven, earth and stars find union. Not just any heaven, but Wākea, not just any earth, but Papahānaumoku, and not just any constellation of twinkling lights, but Ho'ohōkūkalani, whose children descend and return to the stars.

Mauna Kea ka Piko o ka Moku

Mauna Kea is "*ka piko o ka moku*," which means "Mauna Kea is the navel of the island." Understanding the word *piko* may give a deeper understanding of why Mauna Kea is the *piko*, or navel, of the island.

In terms of traditional Hawaiian anatomy, three *piko* can be found. The fontanel is the *piko* through which the spirit enters into the body. During infancy, this *piko* is sometimes "fed" to ensure that the *piko* becomes firm against spiritual vulnerability. For this reason, the head is a very sacred part of the anatomy of the Hawai'i native. To injure the head of someone can mark the beginning of a long feud that may go on for generations, hence the need to refrain from insulting the head of a person.

The second *piko* is the navel. This *piko* is the physical reminder that we descend from a very long line of women. The cutting of this *piko* is done with ceremony. And when the stump of the *piko* falls from the belly, the *piko* "relic" is cared for and put in a location that will be beneficial in protecting the future role and function of the child. Should this *piko* be lost or eaten by a rat, it is believed the child will become a wanderer or a thief. Therefore, the bellybutton *piko* was sealed either in rock or sunk to the bottom of the ocean or placed in the lava to protect it. The care of this *piko* ensured two things: the healthy function of the child and the certification that the child is a product of a particular land base.

The final *piko* is the genitalia. The genitalia are the physical instruments that enable human life to continue. The health of all *piko* ensures that the life of the native person will rest on an axis of spirituality, genealogy and progeny. The absence of one or more *piko* will prevent an entity from becoming whole or complete.

When we understand the three *piko* of the human anatomy, we may begin to understand how they manifest in Mauna Kea. Mauna Kea as the fontanel requires a pristine environment free of any spiritual obstructions. Mauna Kea as the umbilicus ensures a definite genealogy of indigenous relation and function. Mauna Kea as genitalia ensures that those who descend from Wākea (our heaven), Papahānaumoku (our land-base) and Ho'ohōkūkalani (the mother of constellations) continue to receive the physical and spiritual benefits entitled to those who descend from sacred origins.

Thus, Mauna Kea can be considered the *piko ho'okahi*, the single navel, which ensures spiritual connections, genealogical connections, and the rights to the regenerative powers of all that is Hawai'i. It is from this "world navel" that the Hawai'i axis emerges.

EXECUTIVE SUMMARY[1]

Mauna Kea is probably one of the most significant cultural and astronomical sites in the world. For the Hawaiian people Mauna Kea is their cultural connection or *piko* (umbilical cord) to Papa and Wākea, it is the beginning and the end. For the astronomical community Mauna Kea is the scientific umbilical cord to the mysteries of the universe. It is the goal of this Comprehensive Management Plan for the University of Hawai'i Management Areas (CMP) that these two cultures co-exist in such a way that is mutually respectful and yet honors the unique cultural and natural resources of Mauna Kea. The Board of Land and Natural Resources (BLNR) has likewise shared the belief that "these diverse interests can be accommodated," recognizing that Mauna Kea's summit area is unique and one of the most special places on earth. In Native Hawaiian culture, Mauna Kea is a focal point of spiritual and cultural significance, a home of deities, a place of spiritual connection with one's ancestors, history, and the heavens. To astronomers worldwide, Mauna Kea is exceptional in its quality for astronomical observation. Mauna Kea, more than any other place, presents the stewards of the land with an inexorable duty to conserve, protect, and preserve this unique and most special resource.

While many people in the community believed that science and cultural can co-exist they also shared a similar concern that the general community, including the astronomical community, did not really understand or appreciate how significant Mauna Kea was to the Hawaiian people. This lack of cultural sensitivity engendered anger, hurt, and distrust towards the University of Hawai'i for not being a good steward of Mauna Kea. Cultural understanding and information to appreciate Mauna Kea from a cultural perspective will assist in avoiding miscommunications or unintentional disrespect.

Thus, the CMP starts with the premise that if a person is culturally oriented about how valuable and vulnerable the cultural and natural resources are on Mauna Kea, they will become better stewards of Mauna Kea. The CMP begins with a "Cultural Anchor" prepared by The Edith Kanaka'ole Foundation to set the cultural framework of Mauna Kea. Chapter 1 provides a more in depth cultural orientation in the traditional and contemporary cultural significance of Mauna Kea.

Besides the cultural orientation, this CMP is distinguishable from previous management plans and the 2000 Master Plan as it aggressively and extensively engaged the community throughout the development of the CMP. It was very clear from the initial meeting in Hilo that the development of the CMP needed to be initiated from the Big Island community. We needed to first listen in a thoughtful and respectful manner. Chapter 4 is dedicated to describing the extensive community outreach process we engaged in to first ask permission, listen, and then develop a plan that was respectful of what we heard.

Based upon the previous management plans, The 2000 Master Plan, Auditor's reports, and years of contentious litigation, the University, and specifically the Office of Mauna Kea Management (OMKM), determined that a CMP was needed for the Mauna Kea Science Reserve, the lands on Mauna Kea under lease from the BLNR to the University of Hawai'i.[2] The CMP is intended to provide a guide for managing existing and future activities and uses, and to ensure ongoing protection of Mauna Kea's cultural and natural resources, many of which are unique. The CMP has been prepared based upon the most current and available information.

In preparing the CMP, the CMP team utilizes adaptive management strategies to protect Mauna Kea's unique cultural and natural resources. The adaptive strategy suggests that as more information becomes

[1] The Executive Summary is described from the perspective of the consultant team that assisted in the preparation of the CMP.
[2] Hereinafter in the CMP the leased lands shall be referred to as the "UH Management Areas." See Section 3.1.1 for a description of the UH Management Areas.

available the CMP will be amended to adapt to the new information through annual and five year reviews. The CMP encourages that its management strategies be implemented proactively as precautions to protect the environment, without the need for further delay while additional data or information is gathered.

The University recognizes that Mauna Kea is a living resource where Native Hawaiians exercise traditional and customary practices either within the UH Management Areas or access through Mauna Kea's trail system to gather and hunt on surrounding lands. With this recognition comes the obligation to preserve and protect those constitutionally guaranteed rights. The Hawai'i Supreme Court in its decision in *Ka Pa'akai*[3] provides government agencies an analytical framework to ensure the protection and preservation of valued cultural, historical and natural resources. The CMP addresses this requirement through the following process.

(1) The CMP identifies the valued cultural, historical and natural resources, including traditional and customary practices exercised within the UH Management Areas. These include both traditional and customary practices, i.e. gathering of cultural resources, family burials, prayers, ceremonial rituals, using the water of Lake Waiau to the more contemporary practices of accessing Mauna Kea trails system for subsistence hunting and gathering. Chapter 5 provides a comprehensive identification of these valued resources.

(2) The CMP describes the threats or impacts to these valued resources by uses and activities within the UH Management Areas. Many of the human use impacts are unintentional, caused by uneducated visitors and facilitated by loose regulation and minimally managed access. Threats from various user groups vary in type and intensity and are factors that are being considered in the management recommendations. Other threats, such as climate change, act over a longer time frame and are more difficult to quantify and correlate with specific impacts. Chapter 6 provides a description of the threats to the valued resources.

(3) The third step of the *Ka Pa'akai* analysis is the "feasible actions" or in this case the management actions to be taken by the stewards of the land to reasonably protect these valued resources. Management actions being considered have been grouped into a series of specific management actions. The management actions consistently recommend an approach that emphasizes education and orientation as cost effective tools, as well as information gathering, management measures, and regulations and enforcement. Many of the management actions can be implemented as conditions on a Department of Land and Natural Resources (DLNR) Conservation District Use Permit (CDUP) or on an OMKM permit. However other actions will require the adoption of administrative rules to implement and enforce. Section 7 contains the detailed summary of each of the recommended management actions to ensure that the valued cultural and natural resources are protected to the extent feasible. All authorizations to permit uses and activities, including but not limited to CDUP or other permits, shall include as a condition on their permits the specific recommendations noted in Section 7 that address the *Ka Pa'akai* requirements to preserve and protect cultural, historical and natural resources, traditional and customary practices.

There were several recurring issues that we heard during our community outreach process that we did not believe were appropriately management issues but rather policy issues that would require greater dialogue with the community and clear policy direction and decision beyond the scope of the CMP. These issues include ceded lands, state lease, fair and just compensation for use of ceded lands, decommissioning or the timely removal of telescopes from the summit and restoration of the site, community benefits package for the use of Mauna Kea that is more than free viewing time for the University, and greater involvement

[3] Ka Pa'akai O Ka 'Aina v. Land Use Commission, 94 Hawai'i 31, 7 P.3d 1068 (2000) (*Ka Pa'akai*).

of the community in management decisions related to Mauna Kea. These very important policy issues are identified in Section 2.1.4.

The development and preparation of the CMP was a very difficult and challenging task. Not so much because of the complexities of the issues, but more because of the emotions that Mauna Kea triggered, from past hurts to future opportunities. Undoubtedly the community, both Hawaiian and non-Hawaiian, wants the best educational and economical benefits that Mauna Kea can offer balanced against maintaining the cultural integrity of Mauna Kea. Based upon extensive community outreach and the best information available about the cultural and natural resources, this CMP is the most responsible course of action (as opposed to doing nothing) to preserve and protect the valuable cultural and natural resources of Mauna Kea by managing the multiple uses and activities within the UH Management Areas.

TABLE OF CONTENTS

List of Tables

List of Figures

Acronyms

AHCC	Association of Hawaiian Civic Clubs
ATV	All-Terrain Vehicles
BMP	Best Management Practice
BLNR	Board of Land and Natural Resources
CAA	Clean Air Act
CARA	California Association for Research in Astronomy
CatEx	Categorical Exclusion (NEPA)
CDUA	Conservation District Use Application
CDUP	Conservation District Use Permit
CFHT	Canada-France-Hawaii Telescope
CIA	Cultural Impact Assessment
CMP	Mauna Kea Comprehensive Management Plan
CZM	Coastal Zone Management
CZM Program	Coastal Zone Management Program
CRC	Cultural Resource Coordinator
CSO	Caltech Submillimeter Observatory
CWA	Clean Water Act
DAR	Division of Aquatic Resources, DLNR
DHHL	Department of Hawaiian Home Lands, State of Hawai'i
DLNR	Department of Land and Natural Resources, State of Hawai'i
DOCARE	Division of Conservation and Resource Enforcement, DLNR
DOFAW	Division of Fish and Wildlife, DLNR
DOH	Department of Health, State of Hawai'i
EA	Environmental Assessment
EIS	Environmental Impact Statement
FONSI	Finding of No Significant Impact
GPS	Global Positioning System
HAR	Hawai'i Administrative Rules
HIBC	Hawai'i Island Burial Council
HRS	Hawai'i Revised Statutes
IfA	Institute for Astronomy, UH
IRTF	Infrared Telescope Facility, NASA
JCMT	James Clerk Maxwell Telescope
KECK I	W.M. Keck Observatory (1992)
KECK II	W.M. Keck Observatory (1996)
MKMB	Mauna Kea Management Board
MKSS	Mauna Kea Observatories Support Services

NASA	National Aeronautics and Space Administration
NAR	Natural Area Reserve, DLNR
NARS	Natural Area Reserves System, DLNR
NEPA	National Environmental Policy Act
NGO	Non-governmental Organization
NHPA	National Historic Preservation Act
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service, U.S. Department of Agriculture
NRHP	National Register of Historic Places
NSF	National Science Foundation
NWS	National Weather Service
OCCL	Office of Conservation and Coastal Lands, DLNR
OCIA	Onizuka Center for International Astronomy
OMKM	Office of Mauna Kea Management, UH
OMMP	Operations, Monitoring, and Maintenance Plan
PTA	Pōhakuloa Training Area
RDP	Research and Development Plan
RFI	Radio Frequency Interference
SHPD	State Historic Preservation Division, DLNR
SMA	Submillimeter Array
TCP	Traditional Cultural Property
UH	University of Hawai'i
UH-Hilo	University of Hawai'i at Hilo
UKIRT	United Kingdom Infrared Telescope
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VIS	Visitor Information Station
VLBA	Very Long Baseline Array

1. CULTURAL ORIENTATION

1.1 Introduction

"*Mauna Kea kuahiwi ku ha'o i ka mālie*" (Mauna Kea is the astonishing mountain that stands in the calm) (Pukui 1983), is an old saying that expresses the sentiment among the Hawaiian people that Mauna Kea is a source of awe and inspiration. Kepā Maly, a respected researcher and cultural historian, relates, "the mountain is a respected elder, a spiritual connection to one's gods" (Maly 1999). In the 2006 video *Mauna Kea Temple Under Siege*, Pualani Kanaka'ole Kanahele, a renowned Hawaiian cultural practitioner explains, "Mauna Kea is the first-born to us. That's where our roots start; that's where our island begins; that's where the first rain from Wākea hits. It is our mountain. That's where the first sunlight that rises every morning hits. That mountain is first for everything we have ... And so, because Mauna Kea is the first-born, we need to *mālama* (care for) Mauna Kea."

It is clear that to many Hawaiians, Mauna Kea is more than a mountain; it is the embodiment of the Hawaiian people. As we embarked on the development of this CMP and gathered community input, it became apparent there is a general lack of understanding and appreciation of the cultural significance Mauna Kea holds for many Hawaiian people. It could simply be a lack of understanding and appreciation that leads to disrespect for the cultural and spiritual values associated with Mauna Kea, as well as to direct and indirect impacts to Mauna Kea's significant natural and cultural resources. It was therefore not only deemed appropriate, but necessary, to provide the users of this CMP with an orientation on the Hawaiian cultural significance of Mauna Kea.

This significance is presented within both traditional and contemporary contexts. Some within the Hawaiian community may take exception to the use of the terms traditional and contemporary arguing that this establishes a false dichotomy as Hawaiian cultural practices are not static and change through the generations. It is recognized that culture is fluid and that contemporary practices can be as significant as traditional ones. The use of the terms "traditional" and "contemporary" is to be taken at face value and is not intended to carry any connotations of authenticity. The University fully acknowledges and supports the exercise of traditional and customary cultural practices and recognizes that such practices are legally protected under both state and federal laws.

Many traditional practices are associated with physical places, places that are today considered traditional cultural properties. These can be either archaeological sites or natural geographic features of the landscape. Such properties are afforded additional protection under both state and federal laws – protection that in most instances would limit the use of these places to activities that do not result in physical alterations of the property.

As has been documented, some traditional practices associated with Mauna Kea have continued into the present and thus, while undertaken in modern times these practices are nonetheless considered traditional and not contemporary. The contemporary practices undertaken by Hawaiians in modern times may or may not have a basis in traditional practice, but none exhibit an unbroken continuity with past practices. The revival of an ancient practice, without established continuity to the past, can only be considered a modern interpretation of what once was and thus must be considered a contemporary practice.

Whether contemporary or traditional, Hawaiian cultural practices associated with Mauna Kea can be considered aspects of the cultural concept related to the segregation and use of sacred space. Specifically, it is the recognition that the summit region of Mauna Kea, the area of the UH Management Areas, exists both geographically and metaphysically at the apex of a religious structure, perhaps equated with the

uppermost tier (*kahua*)[1] of a *lananu'u mamao* (sacred tower) on top of a *heiau* (temple), space that is considered to be within the domain of the gods.

The remainder of this section is devoted to a presentation of the traditional and contemporary significance of Mauna Kea and to developing guiding principles for culturally appropriate stewardship of the UH Management Areas.

1.2 Cultural Significance of Mauna Kea

1.2.1 Traditional Cultural Properties and Associated Practices

As a result of his exhaustive studies, Kepā Maly identified many traditional cultural properties on Mauna Kea. He documented ongoing traditional cultural practices associated with several of these. It is a sacred landscape that provides a connection, genealogically, physically, and spiritually to ancestral realms. The mythical creation of Mauna Kea is part of a Hawaiian cosmology that establishes a relationship between all things animate and inanimate.

According to Kanahele and Kanahele (1997), Mauna Kea represents the *piko* (the umbilicus) of the island of Hawai'i, which is the first-born (*hiapo*) island child of Wākea and Papahānaumoku, a product of the union of the sky and the earth. This is the ancestral part of a traditional genealogy that later includes the birth of humans, with Wākea as father and his daughter, Ho'ohōkūkalani, as mother. Ho'ohōkūkalani's name means "Creator of the stars," and in union with her father she provides the celestial womb from which the native population ensues. Thus, in a Hawaiian context, Mauna Kea can be viewed as the *kuahu* (shrine) to this union and considered an ancestor to the Hawaiian people. This lineage carries a birthright and responsibilities commensurate with Mauna Kea's status as first-born, whose resources need to be protected for the growth and well being of all.

This relationship did not go unnoticed, as evidenced by Queen Emma (the widow of Kamehameha IV) who in 1881 traveled to "the top of Mauna Kea to bathe in the waters of Waiau ... to cleanse at the *piko* of the island" (Kanahele and Kanahele 1997).

Various cinder cones (*pu'u*) in the summit region and below have also individually been identified as traditional cultural properties, these are Pu'u Kūkahau'ula, Pu'u Poli'ahu, Pu'u Lilinoe, and Pu'u Mākanaka. Pu'u Kūkahau'ula and Pu'u Mākanaka are traditionally associated with the concealment of *piko* (umbilical cords) and with funerary practices. Pu'u Poli'ahu and Pu'u Lilinoe are not only important cultural and geographic features, they represent both goddesses and genealogical ancestors to many Hawaiians living today.

Lake Waiau, located within the DLNR – Natural Area Reserves System (NARS) outside of the UH Management Areas, is also considered a traditional cultural property. The lake, in addition to being a significant natural resource, is a source of sacred water used in healing and worship practices. Waiau also has deity associations and like Pu'u Kūkahau'ula, is used as a ritual repository for children's *piko*.

Several of the trails in and around Mauna Kea are also considered cultural resources. These trails were not only used for travel to the summit region, but also provided access to the resources that sustained communities. Maly (1999) recorded that Hawaiians hunted and gathered within the māmane forests that flank the mountain, which were rich with vegetation and native birds including the 'ua'u (dark-rumped

[1] Hawaiian words have been italicized and Hawaiian place names and proper names have not. This distinction is for consistency purposes only.

petrel), nēnē, and palila. They also traveled to the koa and ʻōhiʻa forest on the mountain's lower slopes to gather wood for canoe-making and to collect bird feathers.

1.2.2 Contemporary Cultural Practices

As it may have been in ancient times, the Mauna Kea landscape is today considered by many in the Hawaiian community to be the most sacred and culturally significant location on the island of Hawaiʻi, if not in the whole of Hawaiʻi. While as Maly (1999:12) relates, "[t]his 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." The practices identified here as contemporary are either not part of a documented longstanding family tradition, are modern adaptations of ancient practices, or are new activities not traditionally practiced. Nonetheless, these contemporary cultural practices are significant to the practitioners and their families and may ultimately be the foundation for future traditional cultural practices.

Chief among the contemporary practices is the use of the whole of Mauna Kea as a spiritual and religious site of prayer and contemplation, which includes the building of family *ahus* or altars and the placement of offerings to honor families or as a form of personal spiritual worship. Other practices include the collection of basalt from Keanakākoʻi; the scattering of ashes of cremated remains of families and friends; and subsistence and recreational hunting.

1.3 Mauna Kea and the *Lananuʻu Mamao*[2] Concept

Mauna Kea as a *kuahu* to the unions of Wākea and Papahānaumoku, as well as, Wākea and Hoʻohōkūkalani, ties the Hawaiian people to the elder Hawaiʻi, and Hawaiʻi to them. The physical prominence of Mauna Kea as well as its stationing nearest to the heavens holds a spiritual significance for the Hawaiian people, a significance that can be expressed in likening the mountain to a sacred altar. This concept is best articulated through the work of Uncle Ed, one of the original members of Kahu Kū Mauna (Guardians of the Mountain) and a cultural practitioner with intimate knowledge of Mauna Kea. Uncle Ed describes the mountain as the physical manifestation of a *lananuʻu mamao*, a sacred tower located within a *heiau* at and upon which worship takes place and offerings to the gods are made. As Malo (1851) relates, *lananuʻu mamao* are constructed with three *kahua* (levels), the lowest and least restricted being the *lana*, which was used for the bestowal of offerings. The second *kahua* is called the *nuʻu*, and is more sacred – being reserved for the priests and their attendants. The third and most sacred *kahua* is the *mamao* where only the high priest and king were allowed to ascend. At times of ritual significance, the *lananuʻu mamao* was draped in *ʻoloa* (fine white *kapa*), and in appearance was perhaps not unlike the upper slopes of Mauna Kea draped in snow.

When considering Mauna Kea as a representation of such an altar, one can begin to understand that the mountain, like the *lananuʻu mamao*, is a revered medium through which contact is made with the gods. In the three-level construct of the *lananuʻu mamao*, physical ascension is tied to escalating sanctity and restriction. With respect to Mauna Kea, the following model is applied: the *lana* would begin at an elevation above the areas of mundane resource procurement, at about 11,000 feet and extend to about 12,000 feet, to the zone where there is a concentration of ancient offering shrines as documented archaeologically. The *nuʻu*, beginning around 12,000 feet extends to about 13,000 feet, to the point where the presence of pre-Contact archaeological features significantly diminishes. Above 13,000 feet is the *mamao*, the partition with the utmost sanctity and highest levels of restriction.

[2] The *lananuʻu mamao* is one cultural concept to describe Mauna Kea. We recognize there may be other perspectives.

The documented distribution of sites facilitates an accounting of the archaeological features of the ancient (pre-Contact) landscape of Mauna Kea within the context of the *lananu'u mamao* construct. As only the fringes of the UH Management Areas extend below 12,000 feet, the archaeological studies are incomplete with respect to the *lana*. There is no observatory activity taking place within the *lana* and limited visitor activity. The archaeological landscape within the *nu'u* contains a preponderance of religious shrines and an immense adze quarry referred to today as Keanakāko'i (formerly Kaluakāko'i). It has been alluded to that the quarrying activities at Keanakāko'i were conducted by craft specialists who underwent both practical and spiritual initiation rituals that were subject to approval by expert craftsmen/priests (McCoy 1999). There is limited observatory activity and moderate visitor activity within the *nu'u*. In the *mamao* relatively few pre-Contact archaeological features exist; perhaps indicative of the highly restrictive nature of this spatial division. The features that do exist may reflect activity associated with the highest ranking members of Hawaiian society. It is within the *mamao* where the Astronomy Precinct (encompassing most of the observatories)[3] is situated and where much of the mountain's visitor activity is focused.

For some Hawaiians, Mauna Kea is so revered that there is no desire to ascend it, no desire to trespass on what is considered sacred space. Simply viewing the tower, the mountain, from afar, both affirms its presence, and reaffirms the sense of connection with both place and personage. For this reason, many Hawaiians feel that activities on Mauna Kea that lead to visible alterations of the landscape not only have a significant effect on the mountain itself, but also have a damaging effect on everything and everyone that is physically, genealogically, spiritually, and culturally tied to Mauna Kea.

Given the above, there must be the recognition that the modern activities that take place on Mauna Kea represent a transgression into sacred space, and that the bulk of this activity takes place within what is considered the most sacred of spaces. It is perhaps through the use of culturally appropriate protocols that one can mediate their encroachment upon the sanctity of Mauna Kea. Such protocols could involve obtaining permission before ascending, observing restrictions appropriate to each level within the *lana-nu'u mamao*, and purifying or cleansing upon descent. While different Hawaiian families and different Hawaiian cultural practitioners may observe different protocols, all are exercised with the knowledge and understanding that Mauna Kea represents the past, the present, and the future of all that is Hawaiian.

[3] The area encompassed by Astronomy Precinct is further defined in Section 3.1.1.

2. INTRODUCTION

The CMP is organized into seven sections. The first four sections discuss the importance of the CMP, the management environment that has resulted in the development of the CMP, and the process of developing it in consultation with interested community members. Sections 5 and 6 include detailed information about cultural and natural resources within Mauna Kea, and on the various activities and uses in the area. Section 7 is the key section of the document, as it lists the management actions for dealing with multiple existing and future activities and uses in the UH Management Areas.

This introductory section explains what the CMP is and how it was developed. It describes how the CMP is derived from previous plans and many years of management efforts, and a reflection of input garnered during consultation with community members and other stakeholders. The section also clearly states that the primary management goal with respect to any activities and uses on Mauna Kea is the protection and preservation of the mountain's many cultural and natural resources.

2.1 Foundation of the Comprehensive Management Plan

2.1.1 Authorization to Adopt and Implement the Comprehensive Management Plan

The University is responsible for managing three areas within state conservation district lands on Mauna Kea collectively referred to as the "UH Management Areas": the Mauna Kea Science Reserve (Science Reserve), the mid-level support facilities at Hale Pōhaku, and the Summit Access Road (see Section 3.1.1). The UH Board of Regents adopted the *Mauna Kea Science Reserve Master Plan* in June 2000 (Group 70 International 2000). In so doing, the University provided for "a single entity to manage a comprehensive integrated plan for the Mauna Kea Science Reserve." The management entity is designated as the OMKM and it is charged with implementing this comprehensive plan for the purpose of addressing:

- General Policies
- Natural and Environmental Resources
- Historic and Cultural Resources
- Education and Research
- Recreational Activities
- Commercial Activities

2.1.2 Need for a Comprehensive Management Plan

This section describes the need for a CMP as an integrated planning tool for resource management that reflects updated guidance, supports the need for rule-making authority, and engages the community. The legal need for a comprehensive management plan per BLNR regulations and judicial guidance is also outlined.

Integrated Planning and Management

OMKM was established in 2000 as the Hawai'i Island management authority for the UH Management Areas (see Section 3.2). This CMP provides the framework for managing multiple existing and future activities, such as astronomy, recreational and commercial activities, scientific research, and cultural and religious activities. More importantly, the CMP provides a guide for protecting Mauna Kea's many

unique cultural and natural resources. Once the CMP is adopted by the BLNR, it will also provide management guidelines and specific management recommendations to be included in BLNR's CDUPs.

Updated Planning Guidance. Since its establishment in 2000 OMKM has operated on the basis of the *Revised Management Plan for the UH Management Areas on Mauna Kea* (1995 Management Plan) (DLNR 1995) and the *Mauna Kea Master Plan* (2000 Master Plan) (Group 70 International 2000). The 1995 Management Plan is the current BLNR approved plan for Mauna Kea. The 1995 plan assigns management and enforcement responsibilities for public and commercial use and institutes commercial use and management controls for the UH Management Areas. The 2000 Master Plan, a development planning document, provides the policy framework for the responsible stewardship and use of the UH Management Areas (see Section 3.2).

This CMP reflects the current state of knowledge on cultural and natural resources and the current institutional structure to manage these resources. The CMP also provides a comprehensive vision for protection of the natural and cultural resources on Mauna Kea from impacts that may result from use of the summit area for astronomical research, recreation, and cultural activities. The need for a comprehensive management plan to ensure resource protection was also identified in the audits of the University and their management of Mauna Kea and the Mauna Kea Science Reserve conducted by the Office of the Legislative Auditor in 1998 and 2005 (Office of the Legislative Auditor 1998, 2005) (see Section 3.2).

Rule-Making Authority. Currently the University lacks administrative control to develop, implement and enforce rules and regulations for public activities within the UH Management Areas. This limits its ability to protect resources and bring enforcement actions (see Section 7.2.2). The 2005 audit conducted by the Office of the Legislative Auditor describes the lack of rule-making authority as a management challenge, lists it as the main reason protection of resources is challenging, and recommends that the University obtain administrative rule-making authority (Office of the Legislative Auditor 2005). Statutory authority for the University to implement administrative rules will protect resources and support some of the management actions identified in this CMP that require rule-making authority.

Community Engagement. An important component in resource management is the human community. Mauna Kea is a sacred site to the Native Hawaiian community (Maly 1999; Maly and Maly 2005). Mauna Kea also serves as an important astronomical site, educational facility, and recreational area. These human uses of the environment can directly conflict with the protection of cultural and natural resources. This CMP recognizes Mauna Kea's importance from both the cultural and natural standpoints while also attempting to provide for evolving astronomical use. Stakeholder cooperation in the long-term management of Mauna Kea's resources is therefore essential. As a result, this plan offers processes for on-going education and community consultation in the management of the UH Management Areas. These processes to engage the community is important for successful implementation of the CMP as well as rebuilding trust between stakeholders and the University and ultimately sustaining the resources for future generations (see Section 2.3.1 and Section 4).

Consistency with BLNR Regulations

The UH Management Areas are in the resource subzone of the State Conservation District. For this reason, any land use in these areas is regulated by the BLNR, and all activities and uses within the UH Management Areas must be in compliance with BLNR's Conservation District regulations.

As defined by DLNR Administrative Rules (HAR § 13-5-2), a management plan is "a comprehensive plan for carrying out multiple land uses." This CMP specifically address multiple land uses and resource values within the UH Management Areas. Pursuant to Judge Hara's decision of January 19, 2007, BLNR

shall approve a comprehensive management plan that considers multiple uses as a precondition for any future development on Mauna Kea (see Section 3.2).[1] This CMP is being prepared in accordance with Judge Hara's decision.

2.1.3 Approval of the Comprehensive Management Plan

This CMP will be submitted to the BLNR for approval. Once approved, the CMP will be the controlling management plan for the UH Management Areas; it will supersede and replace the 1995 Management Plan (see Section 2.1.2 and Section 3.2). The CMP will be the "approved management plan" for any future land use. Accordingly, all activities and uses within the UH Management Areas will be consistent with the management actions described in the CMP. This will provide consistency and long-term viability of the management objectives.

The CMP will not replace the 2000 Master Plan, which continues to serve as the University's development planning framework for the responsible stewardship and use of the UH Management Areas. As the CMP maintains consistency with the 2000 Master Plan, future updates to that plan should be consistent with the CMP. In addition, the proposed CMP provides a process through which it can be regularly updated as part of an adaptive management strategy. That process will allow the BLNR and the University to evaluate and modify management approaches over time based on new information (see 7.4.2) that may become available.

2.1.4 Issues and Concerns Beyond the Scope of the CMP

Through the extensive community outreach that took place during the preparation of this CMP (see Section 4), it became clear that the community had a number of issues and concerns related to past and future activities on Mauna Kea and specifically within the UH Management Areas that were beyond the scope of this CMP. These issues and concerns are listed below and policy makers are urged to consider them in their broader decision making related to Mauna Kea.

- Termination of the State Lease between the University and the BLNR
- Use of ceded lands for $1 a year or nominal consideration
- Subleases between the University and the observatories
- Extension of the State lease beyond 2033
- Proposed new development on Mauna Kea, including the Thirty Meter Telescope (TMT) and Pan Starrs
- Community benefit package with increased educational benefits
- Guaranteed employment opportunities for Native Hawaiians and the people on the Island of Hawai'i

2.2 Management Approach

The establishment and evolution of the UH Management Areas, support facilities, and related management entities recognizes the unique values, global significance, cultural sensitivity and ecological vulnerability of the summit region of Mauna Kea. OMKM is the local management authority for UH Management Areas (see Section 3.1.1). OMKM's mission, as an organization, is:

[1] *Mauna Kea Anaina Hou, et al v. Board of Land and Natural Resources*, Civ. No. 04-1-397, Decision and Order dated January 19, 2007 (Hara 2007).

To achieve harmony, balance, and trust in the sustainable management and stewardship of the Mauna Kea Science Reserve through community involvement and programs that protect, preserve, and enhance the natural, cultural and recreational resources of Mauna Kea while providing a world class center dedicated to education, research, and astronomy.

2.2.1 Goals, Objectives, and Desired Outcomes

The goals, objectives, and desired outcomes of the CMP are consistent with the purposes and values described for State of Hawai'i Conservation District lands and OMKM's mission statement. The overarching goal of the CMP is to provide management strategies that protect, preserve, and enhance Mauna Kea's resources. The CMP was developed with the following concepts in mind:

1. Mauna Kea is a culturally significant site.
2. The high elevation areas of Mauna Kea represent a unique global resource that should be preserved for future generations.
3. Management activities will be focused on limiting the impacts of human activities on cultural and natural resources.
4. The planning and execution of resource management programs will involve input from the larger community (e.g., managers, scientists, educators, cultural practitioners, and the public).

The management actions are presented in Section 7, which is structured as four primary objectives and thirteen component plans. Each component plan has its own desired outcome, which is presented below in Table 2-1.

Table 2-1. CMP Management Objectives, Component Plans, and Desired Outcomes

7.1 Understanding and Protecting Mauna Kea's Cultural and Natural Resources
7.1.1 Native Hawaiian Culture and History Increase understanding and appreciation of Native Hawaiian history and cultural practices related to Mauna Kea to ensure that these practices are protected and respected. Identify, document the condition of, and protect historic properties in the UH Management Areas.
7.1.2 Natural Resources Increase understanding of the status of natural resources (biotic and abiotic), and identify threats to these resources in order to better protect and preserve unique geological features, ecosystem functions, subalpine and alpine habitats, and biological communities through adaptive management of stressors and threats.
7.1.3 Education and Outreach Build and maintain a constituency to engage in active and meaningful stewardship of Mauna Kea, through education and involvement of the public, to support and enhance conservation of the natural, cultural, and astronomical resources of Mauna Kea.
7.1.4 Astronomy Resources Astronomical resources must also be protected. The University's lease of the Summit Area provides that the scientific reserve shall be operated as a buffer zone to prevent intrusion of activities incompatible with the use of the land as a scientific complex or observatory. The lease recognizes light and dust interference as well as certain types of electronic installation as incompatible.

7.2 Managing Access, Activities and Uses
7.2.1 Activities and Uses To retain and enhance recreational and cultural activities, ensure regulation of commercial activities, and support scientific studies while maintaining adequate protection of resources, educating users regarding resource sensitivity, and ensuring the health and safety of those visiting or working at Mauna Kea.
7.2.2 Permitting and Enforcement Achieve compliance with existing and any new policies and regulations designed to manage and minimize human impacts, to preserve and protect Mauna Kea's resources.
7.3 Managing the Built Environment
7.3.1 Infrastructure and Maintenance Manage the built environment by implementing an Operations, Monitoring and Maintenance Plan (OMMP) containing specific maintenance strategies and protocols that will result in minimal disruptions to activities and uses, minimize impacts to the resources, and ensure that permittees remain compliant with their CDUP requirements.
7.3.2 Construction Guidelines Minimize adverse impacts to resources during all phases of construction, through use of innovative best management practices.
7.3.3 Site Recycling, Decommissioning, Demolition, and Restoration To the extent possible, reduce the area disturbed by physical structures within UH Management Areas by upgrading and reusing buildings and equipment at existing locations, decommissioning, and removing obsolete facilities, and restoring impacted sites.
7.3.4 Considering Future Land Use To protect cultural and natural resources in the assessment of future projects.
7.4 Managing Operations
7.4.1 Operations and Implementation Conduct effective operations to support management that is focused on resource protection, education, and public safety.
7.4.2 Monitoring, Evaluation, and Updates Determine whether management actions are achieving the goals of the CMP and provide a process for improving and updating management strategies through evaluation and revisions of the CMP.

2.2.2 Guiding Principles for Resource Management

The CMP was developed using an integrated approach drawing upon the Hawaiian approach to managing natural and cultural resources, as well as contemporary science-based management tools. This integrated approach also recognizes the need to balance cultural sensitivities with natural resources protection and other activities, including recreation and astronomy. As described in Section 3.3.1, Kahu Kū Mauna was established to provide guidance and advice on Hawaiian cultural matters affecting the UH Management Areas.

Hawaiian principles used in the consultation process will guide management decision-making (see Section 4.2). Recent work documenting the cultural and historical landscapes of Mauna Kea compiles a significant amount of historical material and provides valuable descriptions of: Native Hawaiian traditions; traditional and customary practices and beliefs; the early landscape, land use and access; changes in the environment; and efforts at conserving the mountain landscape (Maly 1999; Maly and Maly 2005). Additional cultural and historic information was documented through the community consultation process, including specific approaches to understanding Native Hawaiian practices, values and beliefs (see Section 4). This information provides an essential baseline for ongoing management of the cultural and natural resources of Mauna Kea.

In addition to looking to Hawaiian culture for guidance on management strategies, the CMP employed a science-based approach. A science-based management plan provides the foundation for making the best management decisions possible, provides the flexibility for modifying them, and fosters confidence and consensus from a public that must co-exist with the management decisions. A scientific framework also provides consistency to the planning and management process, through time and staff changes. The key components of science-based planning are a collaborative approach to setting goals and priorities, developing strategies or hypotheses to address those goals, measuring and evaluating results, and then revisiting the process to address any new or on-going issues. This CMP utilizes key concepts from adaptive management and ecosystem management in the development of management actions.

Adaptive management is defined as a systematic process for continually improving management policies and practices for resource protection by learning from the outcomes of past and current management activities. Adaptive management recognizes that there is a level of uncertainty about the "best" policy or practice for a particular management issue, and therefore requires that each management decision be revisited in the future to determine if it is providing the desired outcome. Management actions in a plan guided by adaptive management can be viewed as hypotheses and their implementation as tests of those hypotheses. Once an action has been completed, the next, equally important, step in an adaptive management protocol is the assessment of the actions effectiveness (results). A review and evaluation of the results allows managers to decide whether to continue the action or to change course. This experimental approach to resource management means that regular feedback guides managers' decisions and ensure that future strategies better define and approach the objectives of the management plan.

Ecosystem management is an important concept in natural resource management.[2] Management at the ecosystem level approaches the protection, enhancement, and restoration of natural resources from the perspective that ecosystems are structural wholes, and it recognizes that people, policies, and politics are as much a part of an ecosystem as are plants and animals. The five general goals of ecosystem management plans are: 1) maintaining viable populations; 2) having a representation of all ecosystem types on the landscape; 3) maintaining ecological processes, notably natural disturbance regimes; 4) protecting the evolutionary potential of species and ecosystems; and 5) accommodating human uses of the landscape (Grumbine 1994). These five goals have been incorporated into the natural resources management actions found in the CMP.

2.3 Development of the Comprehensive Management Plan

This section addresses the question of "how" the CMP was prepared, including community consultation, building on previous management plans, and utilizing the *Ka Pa'akai* analytical framework.

2.3.1 Consulting with the Community

Historically the University has been criticized for not involving the larger public community in the management of Mauna Kea. Knowing that community involvement in the CMP process is critical to the success of the project, the University engaged in an extensive community consultation process. The community consultation process was grounded in fundamental principles such as listening to the community; being respectful and asking permission before acting; being truthful in our representations, even if it meant that not everyone's viewpoint or recommendation would be incorporated into the CMP and following through on commitments to keep the community informed and involved throughout the entire process.

[2] An ecosystem is defined as a dynamic system of living organisms (plants, animals, and microorganisms) within an area, the environment that sustains them, and their interactions.

An integral part of the consultation process was listening to the community and hearing their concerns. In many instances this meant listening to the anger, the mistrust, the hurt feelings, and the disappointment in unfulfilled promises. Community input was gathered in public meetings, small talk story sessions, a survey, and through website input. The community's concerns and cultural, archaeological, and scientific information was used to develop the CMP management actions. Draft CMP management actions were taken back out to the community for their review and comment. The intent was to constantly and consistently keep the community informed and involved throughout the entire CMP drafting process. The community consultation process is fully described in Section 4.

2.3.2 Building on Pre-existing Management Plans

A summary of previous management plans for the UH Management Areas is provided in Section 3.2. These plans detail both the past progression of infrastructure development, management of activities and uses, and planning for resource management and protection. The CMP builds on these plans to provide a management framework. The CMP is also designed to address the areas that the community and regulatory agencies felt have not been adequately dealt with in the past.

2.3.3 Utilizing the *Ka Pa'akai* Analytical Framework

One of the fundamental approaches to the development of the CMP was based upon addressing the Hawai'i Supreme Court's analytical framework to ensure that traditional and customary Native Hawaiian rights are preserved and protected. This framework has its foundation in *Ka Pa'akai.* This includes at a minimum addressing: "(1) the identity and scope of 'valued cultural, historical, or natural resources' in the petition area, including the extent to which traditional and customary native Hawaiian rights are exercised in the petition area; (2) the extent to which those resources – including traditional and customary native Hawaiian rights – will be affected or impaired by the proposed action; and (3) the feasible action, if any, to be taken by the [agency] to reasonably protect native Hawaiian rights if they are found to exist." *Ka Pa'akai*, 94 Hawai'i at 52, 7 P.3d at 1089.

The CMP methodically applies the three components to ensure that traditional and customary Native Hawaiian rights and cultural, historical, and natural resources are preserved and protected.

1) *The identity and scope of valued cultural, historical, or natural resources that are found within the UH Management Areas, including the extent to which traditional and customary Native Hawaiian rights are exercised in the areas*

The identification and scope of the valued cultural resources to a large extent was gathered from personal interviews and meetings, as well as historical documentation about cultural resources and traditional and customary practices that may have been historically and are contemporarily exercised within the UH Management Areas. There were several families who claim a lineal connection to Mauna Kea as demonstrated by burying *iwi* or bones of their families or the *piko* of their children on Mauna Kea. There were other Native Hawaiian practitioners who shared that historically and contemporarily their *ohana* gathered mamake, ko'oko'olau, and māmane for medicinal purposes. Others talked about accessing through Mauna Kea for subsistence hunting and gathering purposes. Some Native Hawaiians did not provide details as to their activities on the mountain, as it is deemed to be "*maha'oi*" (rude) to ask a Hawaiian what and where they gather. Rights of confidentiality were respected. Additional information came from the archaeological surveys and existing documentation about historical uses of Mauna Kea and some contemporary uses, including the building of shrines and altars (see Section 5).

Valuable natural resources were identified though literature review, reports on past surveys conducted on the UH Management Areas, and interviews with local experts and concerned community members. All natural resource management activities have the overarching goal of protecting, preserving, and enhancing natural resources in the UH Management Areas.

2) *The extent to which those resources – including traditional and customary Native Hawaiian rights – will be affected or impaired by the proposed action*

In this case, the proposed action is the adoption of the CMP to manage the multiple activities and uses on Mauna Kea in a way that will preserve and protect the valuable cultural, historical and natural resources. The proposed action is designed to protect, not impair, Native Hawaiian rights as well as valued cultural, historical and natural resources. There are existing activities, including unrestricted access, astronomy, scientific research, recreation and tourism, commercial activities, and cultural and spiritual practices that may affect the protection and preservation of these valued resources. There are also existing uses and activities related to infrastructure, including facility maintenance, utilities, water and waste removal, roads, safety, and future land uses that may pose similar impacts. These existing activities and uses are described in Section 6.

3) *The feasible action, if any, to be taken by the agency to reasonably protect Native Hawaiian rights if they are found to exist*

There is no doubt that there are Native Hawaiians who are exercising traditional and customary rights on Mauna Kea. The CMP is designed to ensure that those rights are preserved and protected, balanced against the preservation and protection of natural and cultural resources and the protection of public safety. Access to engage in traditional and customary rights will not be adversely affected by the CMP. Section 7 is designed specifically to provide a set of management actions with guidelines to manage existing and potential future activities and uses to ensure that the cultural, historical, and natural resources are properly managed and protected not only for this generation but for future generations. In those instances where specific cultural protocols need to be addressed and developed, the CMP recommends that Kahu Kū Mauna or the Mauna Kea Management Board (MKMB) Hawaiian Cultural Committee work in coordination with families with lineal and historic connections to Mauna Kea, *kūpuna*, cultural practitioners, the Office of Hawaiian Affairs and other Native Hawaiian groups to develop culturally appropriate protocols.

3. MANAGEMENT ENVIRONMENT

The OMKM has primary responsibility for managing the UH Management Areas, ensuring the coordinated planning and execution of activities so they are consistent with applicable legal mandates, authorities, and policies. The management environment includes the following key elements:

- a clear statement of the areas under UH management, including a discussion of regional land use and land owners;
- a timeline of historical and current management planning documents;
- a description of the entities responsible for managing the area; and
- the legal and policy statutes that guide management decision-making.

3.1 Overview of Management Areas

This section provides an overview of the UH Management Areas, as well as a description of the surrounding land uses in order to support efforts to promote and enhance collaboration in management. Activities and uses that take place within the UH Management Areas are described in Section 6.

3.1.1 Location and Description of UH Management Areas

The management area covered by this plan begins at approximately 9,200 ft (2,804 m) on Mauna Kea and extends to the summit, at 13,796 ft (4,205 m), encompassing three distinct areas: the Mauna Kea Science Reserve (Science Reserve), the mid-level facilities at Hale Pōhaku, and the Summit Access Road (see Figure 3-1). These areas are collectively referred to as the "UH Management Areas." The UH Management Areas on Mauna Kea are classified in the resource subzone of the state conservation district lands (see Section 3.4.2).

The largest area is the Mauna Kea Science Reserve (TMK: (3) 4-4-15:09), which was established in 1968 through a 65-year lease (General Lease No. S-4191) between the BLNR and the University.[1] Originally, the UH Management Areas encompassed approximately 13,321 acres (5,391 ha), but in 1998, 2,033 acres (823 ha) were withdrawn as part of the Mauna Kea Ice Age Natural Area Reserve (NAR) (see Section 3.1.2).[2] The area now encompasses 11,288 acres of state land (4,568 ha) above approximately 11,500 ft (3,505 m) elevation, which, according to the lease is to be used "as a scientific complex." The University's 2000 Master Plan for the UH Management Area designated 525 acres (212 ha) of the leased land as an "Astronomy Precinct," where development is to be consolidated to maintain a close grouping of astronomy facilities, roads and support infrastructure (Group 70 International 2000). The remaining 10,763 acres (4,356 ha) are designated a Natural/Cultural Preservation Area in order to protect natural and cultural resources within the UH Management Areas.

[1] The lease requires the University to "maintain the land in a clean and orderly condition, use the land as a scientific complex, and obtain prior written approval from the department [DLNR] before subleasing or making improvements. It may be terminated at any time by the lessee or for cause by the lessor. The department's reserved rights include hunting and recreation, and trails and access" (General Lease No. S-4191).

[2] A portion of the NAR overlapped the Science Reserve when it was established in 1981. The official removal of that piece of land took place in 1998.

Figure 3-1. UH Management Areas

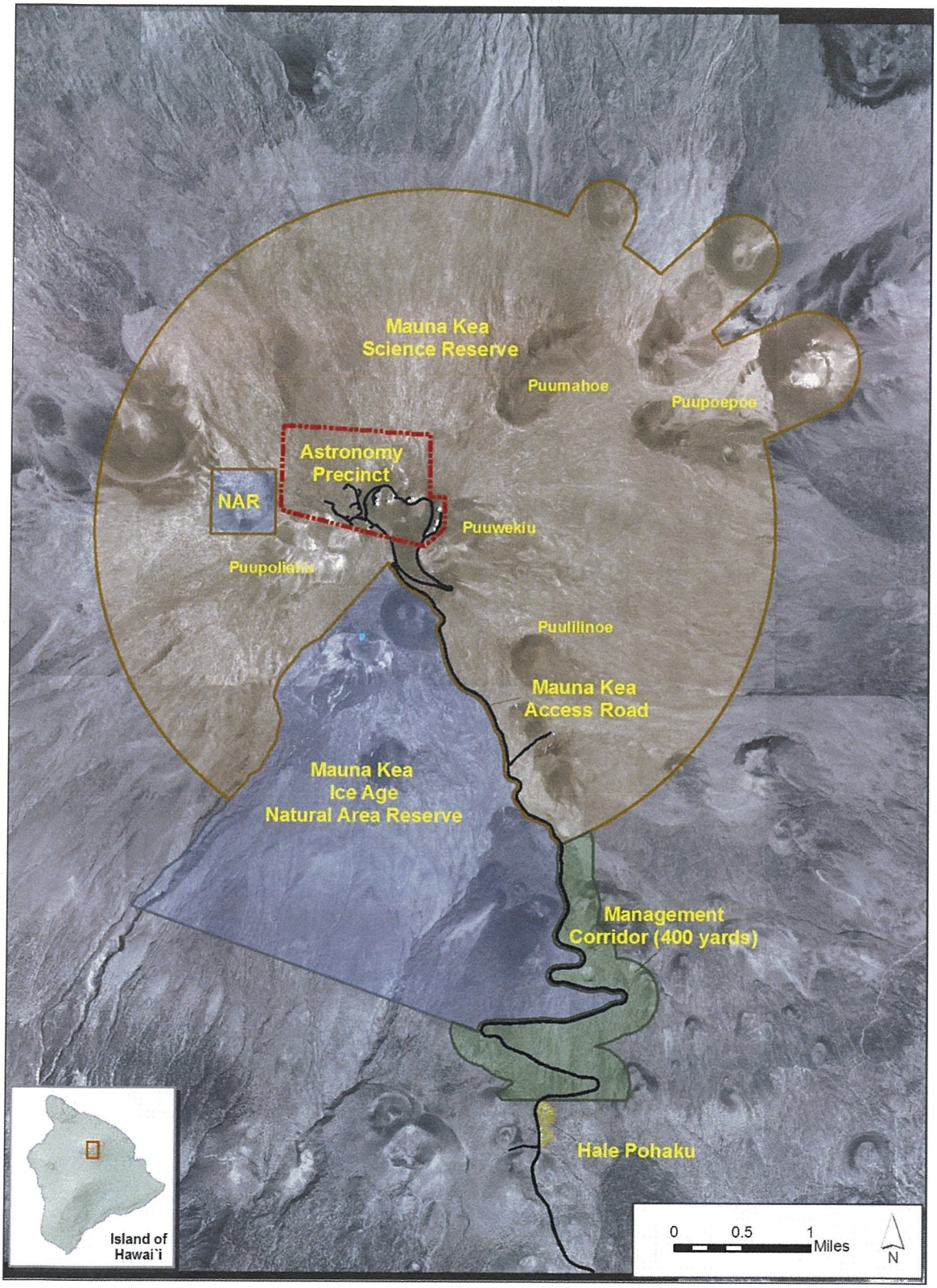
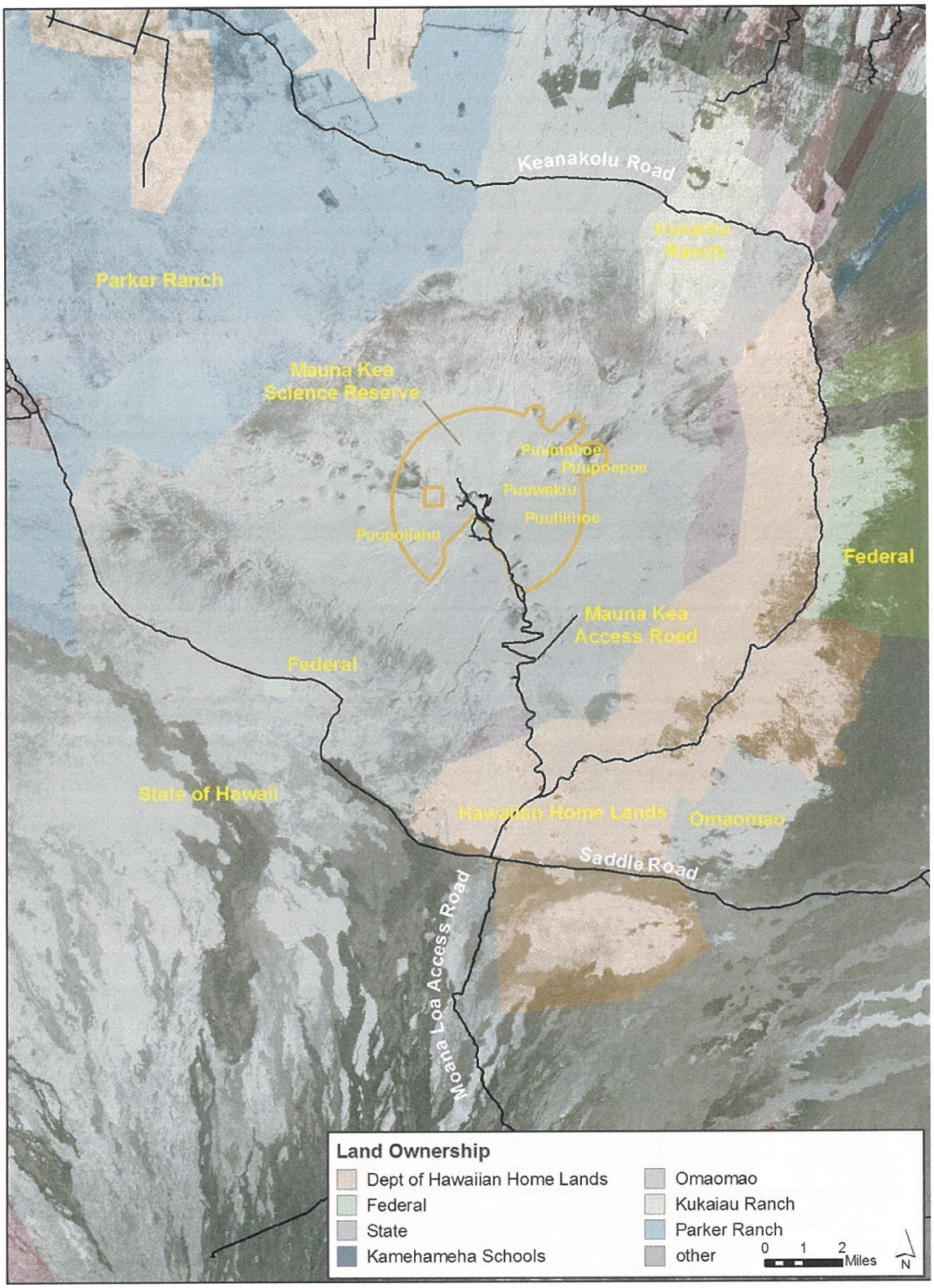


Figure 3-2. Regional Land Use on Mauna Kea



Situated at an elevation of about 9,200 ft (2,804 m), the mid-level facilities at Hale Pōhaku (TMK (3) 4-4-15:12) also fall under the area of management responsibility of this CMP by General Lease No. S-5529, which extends through 2044. This parcel comprises 19.3 ac (7.8 ha) on the south slope of Mauna Kea and encompasses the Onizuka Center for International Astronomy, the Visitor Information Station (VIS), and construction laborer camp, comprising two old buildings and four modern cabins.

The third management area, the Summit Access Road, extends from Hale Pōhaku to the boundary of the UH Management Areas, at approximately 11,500 ft (3,505 m). Although the Grant of Easement (No. S-4697) includes only the Summit Access Road, the 1995 Management Plan added a strip approximately 400 yards (366 m) wide on either side of the road but excluding areas within the NAR, to the UH Management Area.

3.1.2 Regional Land Use

While the CMP has been developed specifically for the UH Management Areas, it necessarily considers the cultural and natural landscape of nearby areas as well. The diversity of land divisions and land uses on Mauna Kea requires coordinated management. Often the scope of the discussion necessarily incorporates features within the general boundaries of approximately 9,000 ft (2,700 m) elevation to the summit, including adjacent lands such as the Mauna Kea Ice Age NAR and the Mauna Kea Forest Reserve; both properties managed by DLNR (see Figure 3-2). Other state and federal managed areas on the mountain include Hakalau Forest National Wildlife Refuge, Hawaiian Home Lands, and Pōhakuloa Training Area. Although these lower elevation areas do not border the UH Management Areas, their proximity, sometimes similar management issues (e.g., invasive species), and potential for collaborative working relationships, underscore the need to include them in the discussion of regional land use. Management actions for working with other agencies and owners of surrounding land owners are described in Section 7.

Mauna Kea Ice Age Natural Area Reserve. The Mauna Kea Ice Age NAR, established in 1981, is comprised of two parcels that are surrounded by the UH Management Areas. The NAR is under the jurisdiction of DOFAW and overseen by the Natural Area Reserves System Commission. A 143.5 acre (58 ha) square parcel around Pu'u Pohaku, is located to the west of the summit area. Fossil ice left behind by glaciations has been found within its boundaries. The larger 3,750 acre (1,518 ha) triangular-shaped parcel extends from approximately 10,070 ft (3,069 m) up to 13,230 ft (4,033 m) at the upper tip of the parcel. Within this piece are several special features: the Mauna Kea Adze Quarry; Lake Waiau – the only high elevation lake in the state; and geomorphic features created by glaciers such as moraines and glacial till. In addition to the lake, the NAR includes another rare ecological community, the invertebrate-dominated aeolian desert. Special status species found in the NAR include the federally-listed endangered Mauna Kea silversword, and the wēkiu bug, a candidate for federal-listing as endangered. Management currently is focused on inventorying archaeological sites, conducting wēkiu bug surveys and research, educating and managing recreational and cultural users, and controlling non-native ungulates (Mitchell et al. 2005). In 2008, BLNR, Division of Forestry and Wildlife (DOFAW)-NARS and OMKM have reached a tentative agreement to formalize coordinated management of cross-boundary issues between OMKM and the NAR. Under the proposed agreement, OMKM would provide visitor assistance using OMKM rangers, engage in joint research and educational efforts with NAR staff, and report violations occurring in the NAR (See Section 7.2.2).

Mauna Kea Forest Reserve. Mauna Kea Forest Reserve lands encompass approximately 52,500 acres (21,246 ha) above 7,000 ft (2,134 m) surrounding the UH Management Areas, Hale Pōhaku, and the Mauna Kea Ice Age NAR. The forest reserve is under the jurisdiction of the DLNR DOFAW. The forest reserve contains māmane (*Sophora chrysophylla*) forest, critical habitat for the federally-listed endangered palila bird. The māmane forests on Mauna Kea contain the entire known world population of

palila. Management issues include browsing by introduced ungulates (e.g., sheep, mouflon, and goats), increasing populations of invasive plant and exotic animal species, and human-caused wildfires. In an effort to curb habitat degradation, ungulate control is conducted by DOFAW and recreational hunting is permitted year-round.

Hakalau Forest National Wildlife Refuge. The Hakalau Forest National Wildlife Refuge consists of the 33,000 acre (13,355 ha) Hakalau Forest Unit and the 5,300 acre (2,145 ha) Kona Forest Unit on the slopes of Mauna Kea and Mauna Loa, respectively. It was established to conserve endangered forest birds and their habitat. The Hakalau unit of the refuge occupies an area between 2,500 ft and 6,600 ft (762 m and 2,012 m) on Mauna Kea and contains native-dominated montane rainforest, mixed native/exotic forest areas, and grasslands dominated by exotic plants. This area contains at least nine federally-listed endangered plant species, eight federally-listed endangered bird species, and one federally-listed endangered bat species.

Hawaiian Home Lands. The Department of Hawaiian Home Lands (DHHL) has jurisdiction over approximately 53,000 acres (21,448 ha) of the lower elevation lands of Mauna Kea around Humu'ula Saddle that were designated by the Hawaiian Homes Commission Act of 1920 to be made available for homesteading purposes. This land was held under leases by Parker Ranch from 1914 to 2002. Today, limited cattle ranching continues on Humu'ula, under a permit issued by DHHL. DHHL, along with beneficiaries and applicants for pastoral lease lands, is currently working on a plan for land stewardship and lessee opportunities on Humu'ula lands near the junction of Saddle Road and the Summit Access Road.

Pōhakuloa Training Area. At 108,863 acres (44,055 ha), Pōhakuloa Training Area (PTA) is the largest military training area in Hawai'i, extending up the lower slopes of Mauna Kea to approximately the 6,800 ft (2,073 m) elevation. PTA lands are within the general, limited, and resource subzones of the state conservation district. PTA lands are under the jurisdiction of DLNR, with a portion having been leased to the US Army since 1956. Over 343 archaeological and culturally significant sites are known to be located within PTA. PTA is known to contain 15 federally-listed threatened and endangered plants, three federally-listed endangered bird species, and one federally-listed endangered bat species.

3.2 History of Planning and Management

This section summarizes the history of planning and management for the UH Management Areas, including site and master planning documents for the astronomy complex and more recent documents focusing on the area's important cultural and natural resources.

The Early Years

As early as 1909, the summit of Mauna Kea was recognized as a prime site for astronomical observation (Office of the Legislative Auditor 1998). In 1964, researchers from the University conducted tests that substantiated earlier opinions that conditions for viewing were exceptional, and the Lunar and Planetary Station constructed atop Pu'u Poliahu started operation. Also in 1964, Mauna Kea lands were placed within the state's Conservation District, giving management authority to the BLNR. In 1965 and 1966, the University further explored the potential for astronomy at the summit and contracted with the National Aeronautics and Space Administration (NASA) to design and build an 88-in (2.24 m) telescope. The University established the Institute for Astronomy (IfA) in 1967, and that same year began planning of the first of the 13 telescopes now located at the summit. In June 1968, the University secured a 65-year lease from BLNR for 13,321 acres (5,391 ha) at the summit of Mauna Kea for the land known as the Mauna Kea Science Reserve. The Science Reserve was a new construct not previously defined by DLNR's mandate, and did not have its own set of rules or an administrative support structure within

DLNR. While the BLNR retained general regulatory authority over the Science Reserve and some broad responsibilities were given to the University, permitted and prohibited activities were not defined. During this early period, the summit and the Science Reserve have been managed by the University and DLNR.

By 1974, with three telescopes in place on the summit, local groups, including hunters and environmentalists, voiced concerns about further development on the mountain. As a result, the state sought to better plan and manage development of future facilities, and a memorandum issued by then Acting Governor George Ariyoshi, directed DLNR to develop and promulgate a master plan for all of Mauna Kea above Saddle Road.

1977 DLNR Mauna Kea Plan; 1980 Hale Pōhaku Complex Development Plan

In 1977, after two years of planning, study and public hearings, BLNR approved *The Mauna Kea Plan* (DLNR 1977). This plan created five management areas and indicated the management objectives and permitted uses for each. Responsibility for the management and upkeep of the Science Reserve and the astronomy facilities at Hale Pōhaku were deemed to be the responsibility of the University. Management and upkeep of the Hale Pōhaku park facilities was assigned to DLNR. Management and upkeep of the Summit Access Road from the Saddle Road to the Summit were assigned to the Department of Transportation. The 1977 plan indicated that development of any mid-level facilities at Hale Pōhaku should ensure that the impacts to the surrounding māmane-naio forest ecosystem should be minimal. The *Hale Pōhaku Mid-Elevation Facilities Master Plan: Complex Development Plan* was prepared in 1980 (Group 70 1980).

1982 Research and Development Plan for the Mauna Kea Science Reserve; 1983 Mauna Kea Science Reserve Complex Development Plan

In 1982 the *Research and Development Plan (RDP) for the Mauna Kea Science Reserve and Related Facilities* was approved by the University of Hawai'i Board of Regents (UH Institute for Astronomy 1981). This plan was created as a programmatic master plan for the continued development of the Science Reserve (Office of the Legislative Auditor 1998). The following year, the Board of Regents approved a second plan that was designed to facilitate the implementation of the specific research facilities identified in the RDP. The *Mauna Kea Science Reserve Complex Development Plan* was a plan to provide the physical planning framework to implement the RDP (Group 70 1983a). The objective was to guide and control development, in order to preserve the scientific, physical, and environmental integrity of the mountain. Incorporated into this document was a proposal for managing resources and for monitoring and controlling visitor use. The plan stated the University would be responsible for managing and monitoring its leased areas. Accompanying the plan was an environmental impact statement that evaluated the potential general impacts of implementing the actions proposed in the complex development plan and that proposed actions to mitigate potential negative impacts (Group 70 1983b). The *Mauna Kea Science Reserve Complex Development Plan* was not submitted to BLNR for approval as an overall management plan. This plan was amended in 1987 to address the development of the Very Long Baseline Array (VLBA).

1985 Mauna Kea Management Plan

In 1985, BLNR approved the University's *Mauna Kea Management Plan* (also referred to as CDUA HA-1573) (University of Hawai'i 1985). The plan was a revised version of the conceptual Management Plan contained in the 1983 *Mauna Kea Science Reserve Complex Development Plan.*

1995 Revised Management Plan for the UH Management Areas on Mauna Kea

In 1995 BLNR approved the *Revised Management Plan for the UH Management Areas on Mauna Kea* (1995 Management Plan) (DLNR 1995). One of the subjects this plan discusses in detail is which public use activities are permitted within the UH Management Areas (see details in Section 7.2.1). These include recreational, educational, cultural, and commercial activities. In general, recreational activities such as

hiking, sightseeing, amateur astronomy, snow sports, and hunting are permitted but may be controlled or restricted. Cultural activities that do not involve physical impacts are permitted. Commercial activities that are permitted include skiing and sledding tours, hiking tours, and sight-seeing tours. Other commercial activities that are allowed but require special permission include tours of the telescope facilities, film-making and night use of the Visitor Information Station at Hale Pōhaku. Recreational use of off-road vehicles and commercial hunting tours are prohibited.

One of the major tasks of the 1995 Management Plan was to address the lack of management over commercial use. To that end, all management responsibilities, except those related directly to astronomical facilities or the Summit Access Road, were transferred back to DLNR. In addition, the plan incorporated management controls for permitted commercial uses. The plan states that DLNR is responsible for issuing permits, setting and collecting fees, and enforcement for the activities of commercial operators. The University has the right to review and comment on these, as well as a responsibility to help monitor the activities of these operators. The University maintains the right to control visitor activities around the astronomy facilities, to manage access to the Science Reserve, and to restrict access under certain conditions. The University also has the right to ask other agencies to assist in visitor management when DLNR enforcement officers are not available and to require a waiver of liability before allowing access to the upper elevations. The plan outlines some commercial rights of the University itself, such as the right to operate concessions within the UH Management Areas and the right to contract a shuttle service to take visitors to the summit for various activities.

The 1995 Management Plan was approved by BLNR subject to certain conditions. Other conditions included education of Mauna Kea Observatories Support Services (MKSS) staff on the details of the plan and instruction on reporting violations; prohibition of tampering with all historic, archaeological and cultural sites; upon completion of biological and archaeological reports, staff shall report back to the BLNR to review whether any modifications to the plan are warranted; posting of additional signage and subject to funding; and the VIS should be open seven days a week.

1998 Audit of Management of Mauna Kea and the Mauna Kea Science Reserve

In 1998, at the request of the legislature, the state auditor conducted an audit of the management of Mauna Kea and the Science Reserve (Office of the Legislative Auditor 1998). The audit found a number of deficiencies in the management of Mauna Kea by the University and by DLNR. The audit charged that the University focused on developing astronomical facilities at the expense of protecting the mountain's resources. With DLNR, the audit found inadequate monitoring and enforcement of permitting requirements that put state resources at risk. Overall the audit found that although protection controls had been established by management plans, these controls were poorly implemented, leading to inadequate protection of cultural, historic, and natural resources. The audit concluded with a list of recommendations.

2000 Mauna Kea Science Reserve Master Plan

In 1998, in an effort to improve management of the Science Reserve and the facilities at Hale Pōhaku, and to assist with the planning of future development, the University created the Mauna Kea Advisory Committee. The committee met from June 1998 through August 1999 and, with representatives from Group 70 International, consultant to the University, held a series of public meetings at various sites around the Island of Hawai'i. Issues concerning better management of the mountain's resources and limiting development of observatories were raised at the meetings. Representatives of Group 70 also discussed recommendations for a master plan with community members.

In 2000, with consideration of issues raised in the public meetings and the state audit, the University released the *Mauna Kea Science Reserve Master Plan* (2000 Master Plan) (Group 70 International 2000). The 2000 Master Plan called for 525 acres (212 ha) of the summit area leased land to be designated an "Astronomy Precinct." To help protect natural and cultural resources within the Science Reserve, and to

protect the astronomy facilities from outside impacts, all astronomy facilities would be confined to this area. A significant portion of the 2000 Master Plan is dedicated to what are referred to as "issues and opportunities for management." This section, complete with recommendations, addresses management authority, access, natural resources, cultural resources and practices, education and research, and recreation.

The UH Board of Regents approved the *Mauna Kea Science Reserve Master Plan* in June 2000. The 2000 Master Plan was not adopted nor approved by BLNR. In the 2000 Master Plan, the University concluded that there was a need for a single entity to manage the comprehensive plan for the Science Reserve. The 2000 Master Plan calls for the management organization to be housed within the University system and funded as an ongoing program unit of the University of Hawai'i at Hilo (UH-Hilo). In accordance with the 2000 Master Plan, UH-Hilo Chancellor established the OMKM on August 1, 2000. OMKM is the office charged with ensuring compliance with and implementation of the 2000 Master Plan.

The 2000 Master Plan sought to include community involvement in the management of the Science Reserve and recommended a management board "composed of members representing the major stakeholders of Mauna Kea." In fulfillment of this recommendation, the MKMB was established. The MKMB is comprised of seven members appointed by the University of Hawai'i Board of Regents. Kahu Kū Mauna (Guardians of the Mountain), is appointed by the MKMB to serve as advisors to the OMKM and MKMB on all matters impacting the cultural integrity of Mauna Kea.

2005 Audit of the Management of Mauna Kea and the Mauna Kea Science Reserve

A follow-up audit, conducted by the state in 2005, recognized that the University and DLNR had implemented many of the recommendations of the 1998 audit, but found that more needed to be done (Office of the Legislative Auditor 2005). The audit praised implementation of the 2000 Master Plan—specifically the establishment of the Astronomy Precinct, the implementation of the ranger program, and increased community involvement through OMKM—but stated that management plans for the Science Reserve need to be updated to reflect its current use and management and to provide transparency and accountability to the University (Office of the Legislative Auditor 2005).

One of the management challenges described in the audit is that while the University is responsible for the protection of cultural and natural resources within its jurisdiction, it lacks authority to establish and enforce administrative rules. The audit recommended that the University obtain rule-making authority and develop, implement, and monitor a comprehensive management plan for natural, cultural, and historic resources of the summit and Hale Pōhaku area. It also recommended that the University implement and enforce a permit and sublease monitoring system for observatories.

Outrigger Telescope Project Case

In 2001, the UH IfA filed a CDUA with BLNR to construct and operate up to six 1.8-meter Outrigger Telescopes within the Astronomy Precinct at the summit area of the Science Reserve. Public hearings on the CDUA were held in 2001 and 2002. Before the public hearings concluded, several citizen groups and private individuals requested a contested case hearing on the CDUA. BLNR appointed a hearing officer to conduct the contested case hearing. In June 2003, the hearing officer recommended that the permit for the Outrigger Telescope project be granted. In October 2004, BLNR granted the permit for the proposed project, and approved the management plan for it.[3] The citizen groups and private individuals appealed this decision in the Circuit Court of the Third Circuit in Hilo.

[3] BLNR's Decision Granting Conservation District Use Permit for the Construction and Operation of Six 1.8-Meter Outrigger Telescopes Within the Summit area of the Mauna Kea Science Reserve dated October 29, 2004.

On appeal, BLNR's decision was overturned (Hara 2007).[4] Judge Hara specifically concluded that the BLNR shall approve a comprehensive management plan that "covers multiple land uses within the larger overall area that UH IfA controls at the top of Mauna Kea in the Conservation District." Further, that the Management Plan is a "precondition to granting CDUP."

3.3 Management Responsibilities

Given that several entities share management responsibilities for Mauna Kea lands, coordinated management of the mountain has been a challenge. Differing rules and regulations govern the different jurisdictional areas (e.g., Conservation District, Natural Area Reserve, Forest Reserve, Science Reserve), and management units do not correspond to ecosystem boundaries. Presently, both DLNR and the University are responsible for managing the UH Management Areas. Both have a number of agencies or organizations within them, which are assigned certain responsibilities based on state regulations, stipulations of the lease, or by the 1995 Management Plan and the 2000 Master Plan. DLNR shares certain responsibilities for management of the mountain. The IfA has responsibility for managing the observatories and their operations, but is not a land manager. Since its establishment, OMKM has taken on that responsibility for the UH Management Areas. Table 3-1 lists the entity responsible for each aspect of the UH Management Areas and adjacent lands based on the latest plans and statutory requirements.

The 2000 Master Plan acknowledged that joint management by DLNR and the University, and layers of management requirements and recommendations outlined in historical leases, plans, permits and written or verbal commitments, have created a complex and often confusing pattern of management responsibility (Group 70 International 2000). A similar short-coming was detailed in the 2005 audit – that the ability to ensure the ongoing protection of natural and cultural resources through comprehensive management is compromised by unclear management and lack of enforcement (Office of the Legislative Auditor 2005). Currently there is no mechanism for integrated or coordinated management of Mauna Kea's resources (including lands outside of the UH Management Areas). Management actions to improve coordinated management and develop collaborative partnerships are detailed in Section 7.

3.3.1 University of Hawai'i

As the lessee, the University has responsibility for managing the UH Management Areas. The UH Board of Regents has final approval authority over major projects (see Section 7.3.4). The acceptance of the 2000 Master Plan by the UH Board of Regents prompted the creation of OMKM, the MKMB, and Kahu Kū Mauna. The MKMB serves in an advisory capacity to the UH Hilo Chancellor and Kahu Kū Mauna serves in the advisory capacity, primarily to the MKMB, but also to the UH Hilo Chancellor. The MKMB has also established several advisory committees, including the MKMB Environmental Committee and the MKMB Hawaiian Cultural Committee.

Office of Mauna Kea Management. OMKM was established in 2000 and is responsible for the day-to-day management of the cultural and natural resources of the UH Management Areas. OMKM is housed within and funded by the UH-Hilo, and OMKM staff report directly to the Chancellor of UH Hilo. Included within OMKM's charge is the responsibility to "protect, preserve and enhance the natural, cultural, and recreational resources of Mauna Kea"; a significant piece of this mandate is coordination with other stakeholders, both public and private. OMKM also works with other agencies on issues that are related to the mountain but outside OMKM's jurisdiction. In addition, OMKM establishes management policies and oversees the ranger program.

[4] *Mauna Kea Anaina Hou, et al v. Board of Land and Natural Resources*, Civ. No. 04-1-397, Decision and Order dated January 19, 2007.

Table 3-1. Mauna Kea Responsibility Matrix

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
Wēkiu 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	UH	UH	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 Hale Pōhaku)	---	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 Hale Pōhaku)	---	---	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/not applicable; UH = University of Hawai'i (inc. IfA, OMKM); BC = Burial Council; CTY = County of Hawai'i; *= Done but not required.

Mauna Kea Management Board. The MKMB is comprised of seven members of the community who are nominated by the UH Hilo Chancellor and approved by the UH Board of Regents. The MKMB advises the Chancellor and OMKM. The volunteer members represent a cross section of the community and serve as the community's main voice, advising on activities, operations and land uses planned for Mauna Kea. MKMB works closely with Kahu Kū Mauna.

Kahu Kū Mauna. Kahu Kū Mauna (Guardians of the Mountain) is a nine-member volunteer council whose members are approved by the MKMB. Kahu Kū Mauna advises the MKMB, OMKM, and the UH Hilo Chancellor on Hawaiian cultural matters affecting the UH Management Areas. The council comprises individuals from the Native Hawaiian community. Members are selected on the basis of their awareness of Hawaiian cultural practices, traditions and significant landforms as applied to traditional and customary use of Mauna Kea, and their sensitivity to the sacredness of Mauna Kea.

Advisory Committees. Other committees have been formed to advise OMKM and the MKMB on specific topics. They include the MKMB Environment Committee, which provides expertise on environmental issues; the Hawaiian Cultural Committee, which assists in integrating Hawaiian perspectives into OMKM's programs; the Wēkiu Bug Scientific Committee; and the Public Safety Committee. These committees are coordinated by OMKM.

Rangers. Shortly after its founding in the fall of 2000, OMKM established the ranger program to help educate visitors, monitor for violations of the permitted uses within the UH Management Areas, and generally help provide for the health and safety of visitors (see Section 7.2.2). A key responsibility is conducting patrols by 4 wheel drive vehicles to the summit four times daily. The primary purpose of these patrols is to observe and document the activities of the general public, observatory personnel, and commercial tour operators. Patrol reports are submitted to OMKM daily. Rangers perform a variety of other duties including providing emergency assistance for lost or injured people in the summit area, assisting stranded motorists, coordinating litter removal, conducting trail maintenance, inspecting the observatories for compliance with their CDUPs, and providing visitors some cultural information about Mauna Kea. The rangers typically have diverse backgrounds, from those with cultural ties to the land, to those drawn to the mountain because of astronomy, to those looking to share their knowledge about the important natural resources of the area.

Institute for Astronomy. The IfA, based at UH Mānoa, conducts state-of-the-art astronomical research. Its faculty and staff are also involved in astronomy education, and in the development and management of the observatories on Haleakala and Mauna Kea. IfA oversees the conduct and coordination of astronomical research in the Science Reserve, including long-term planning and visioning.

Mauna Kea Observatories Oversight Committee. The Mauna Kea Observatories Oversight Committee is composed of representatives from all of the observatories including those operated by IfA. Each observatory pays into accounts held by The Research Corporation of the University of Hawaii that are used to fund MKSS activities including road maintenance, snow removal, facilities maintenance and management at Hale Pōhaku, common utilities and the VIS.

Mauna Kea Observatories Support Services. Mauna Kea Observatories Support Services (MKSS) operates under the direction of the observatories through the Mauna Kea Observatories Oversight Committee funds and oversees the general maintenance and logistical services to all Mauna Kea observatories and the facilities at Hale Pōhaku. MKSS also supports, under the direction of OMKM, ranger services. Under the 2000 Master Plan, at least some of MKSS' services are to be transferred to OMKM, but no deadline was specified and the transfer has not occurred. The MKMB recently approved the transfer of the management and oversight of MKSS to OMKM.

3.3.2 Hawai'i State Agencies

The Department of Land and Natural Resources. DLNR is headed by the BLNR and manages the state's public lands. Several divisions within DLNR share management responsibility for Mauna Kea lands, including the Division of Aquatic Resources (DAR), Division of Conservation and Resource Enforcement (DOCARE), the Division of Forestry and Wildlife (DOFAW), the Natural Area Reserves Commission, the Land Division, the Office of Conservation and Coastal Lands (OCCL), and the State Historic Preservation Division (SHPD).[5]

Division of Aquatic Resources. DAR has as its mission to manage, conserve and restore the state's unique aquatic resources and ecosystems for present and future generations. This agency sets overall water conservation, quality and use policies; defines beneficial and reasonable uses; protects ground and surface water resources, watersheds and natural stream environments; establishes criteria for water use priorities while assuring appurtenant rights and existing correlative and riparian uses and establishes procedures for regulating all uses of Hawai'i's water resources.

Division of Conservation and Resource Enforcement. DOCARE is responsible for enforcing all laws and rules that apply to all lands managed under DLNR. This includes protecting and conserving the state's lands and natural resources, investigating complaints and violations, and monitoring all leases, permits, and licenses issued by DLNR. Pursuant to Act 226 Session Laws of Hawai'i 1981, DOCARE's enforcement officers have full police powers to execute all state laws and rules within all state lands. The division's Island of Hawai'i branch includes Mauna Kea in the East Hawai'i district.

Division of Forestry and Wildlife. DOFAW is charged with protecting and managing watersheds, natural resources, outdoor recreation resources, and forest product resources. It is also charged with public education and develops and manages statewide programs on forest and wildlife resources as well as natural area reserves and trail and access systems. DOFAW manages the Mauna Kea Forest Reserve (see Section 3.1.2). DOFAW also manages outdoor recreation programs and activities, including hunting, which occurs on state-owned lands on Mauna Kea.

Natural Area Reserves Commission. The Natural Area Reserves Commission is administratively attached to DLNR; its staff is in DOFAW. It establishes criteria that are used in determining whether an area is suitable for inclusion within the state reserves system. The commission also establishes policies and criteria for the management, protection, and permitted uses of the reserves system. The statewide reserves system was established with the mandate of protecting the best remaining examples of native ecosystems and geological sites on state managed lands. There are currently 19 reserves, including the Mauna Kea Ice Age NAR (see Section 3.1.2).

Land Division. The Land Division is responsible for managing state-owned lands in ways that will promote the social, environmental, and economic well-being of Hawai'i's people and for ensuring that these lands are used in accordance with the goals, policies, and plans of the state. Lands that are not set aside for use by other government agencies come within the direct purview of the Land Division, as do the management and enforcement of leases, permits, executive orders, and other encumbrances for public lands. The division also investigates local land problems, maintains data for the State Land Information Management System, serves as custodian for all official transactions relating to public lands, and maintains a central repository of all government documents dating back to the "Great Māhele" of 1848.

[5] This information taken primarily from the DLNR website (http://hawaii.gov/dlnr/) and the 2005 audit report (Office of the Legislative Auditor 2005).

Office of Conservation and Coastal Lands. DLNR reorganized the Land Division in 2002, creating the OCCL. The office regulates and enforces land use for approximately two million acres of private and public lands that lie within the state's conservation district, including Mauna Kea. OCCL is also responsible for processing conservation district land use requests, developing administrative rules for the conservation district, investigating complaints and violations, and monitoring all CDUP conditions.

State Historic Preservation Division. SHPD helps to carry out the responsibilities outlined in the National Historic Preservation Act (NHPA) (see Section 3.4.1). The goal of the NHPA is to preserve and protect historical and culturally significant properties. The division is guided by the Statewide Historic Preservation Plan (2001)[6] and the rules and regulations set forth in Chapter 6E of the Hawai'i Revised Statues (see Section 3.4.2). SHPD manages several programs to promote the use and conservation of historic properties, including those on Mauna Kea. These programs include: Statewide Inventory of Historic Properties, Burial Sites Program, Certified Local Government Program, National Main Street Program, Historic Preserves Program, Information and Education Program, Interagency Archaeological Services, and maintenance of the Hawai'i and National Register of Historic Places. SHPD also reviews proposed development projects to ensure minimal effects of change on historic and cultural assets.

Hawai'i Island Burial Council. The management of all human remains over 50 years old falls under the jurisdiction of SHPD. Island burial councils are administratively attached to SHPD to address concerns relating to Native Hawaiian burial sites. The burial council determines whether to relocate or preserve in place any previously identified Native Hawaiian burial sites. The burial council also works to educate landowners as to the cultural beliefs and views regarding burials encountered on their lands. Any burial protection plan or burial treatment plan for Mauna Kea must be done in consultation with Hawai'i Island Burial Council (HIBC).

3.4 Management Mandates and Regulatory Context

Resource management must include adherence to applicable federal and state laws, regulations, and other directives. A representative summary of applicable to the UH Management Areas is provided below.

3.4.1 Federal Level

Clean Air Act (42 U.S.C. 7401 *et seq.*)
The Clean Air Act (CAA) governs the nation's air quality. The CAA prohibits new and existing sources of air pollution from emitting pollution that exceeds ambient air quality levels designed to protect public health and welfare. New sources are subject to more stringent control technology and permitting requirements. Hazardous air pollution and visibility impairment are also addressed by the CAA.

Clean Water Act (33 U.S.C. 1251 *et seq.*)
The Clean Water Act (CWA) is the major federal legislation concerning improvement of the nation's water resources. The Act was amended in 1987 to strengthen enforcement mechanisms and to regulate stormwater runoff. The Act provides for the development of municipal and industrial wastewater treatment standards and a permitting system to control wastewater discharges to surface waters.

Coastal Zone Management Act (16 USC §145 et seq.). The Coastal Zone Management Act of 1972, as amended, requires that, to the maximum extent practicable, federal actions affecting any land or water use or coastal zone natural resource be implemented consistent with the enforceable policies of an approved

[6] http://hawaii.gov/dlnr/hpd/presplan.htm

state management program.[7] The Act authorizes states to administer approved coastal nonpoint pollution programs. Advance concurrence from the state coastal commission is required prior to taking an action affecting the use of land, water, or natural resources of the coastal zone.

Endangered Species Act (16 USC §1531 et seq.). The Endangered Species Act is implemented by 50 CFR 402 and 50 CFR 17. This Act requires all federal agencies to carry out programs to conserve federally listed endangered and threatened plants and wildlife and the habitat on which they depend. Development and implementation of these programs must be carried out with the consultation and assistance of the Departments of the Interior and Commerce. A biological assessment may be required to determine whether formal consultation with the US Fish and Wildlife Service (USFWS) is necessary, and it may also serve as a basis for a USFWS biological opinion. USFWS also maintains a listing of candidate species and species of concern.[8] Section 4.2.2 details federally-listed species found or potentially found on the UH Management Areas.

National Environmental Policy Act (42 USC §4321 et seq.). The National Environmental Policy Act (NEPA) requires consideration of environmental concerns during project planning and execution of federally funded projects. The Act requires federal agencies to prepare an environmental assessment or environmental impact statement for actions that have the potential to significantly affect the quality of the human environment, including both natural and cultural resources. NEPA is implemented by regulations issued by the Council on Environmental Quality (40 CFR 1500). A NEPA analysis can have one or more of several outcomes: a determination of categorical exclusion (CatEx) where an action can be categorically excluded from further environmental analysis; the preparation of an Environmental Assessment (EA) if the action cannot be categorically excluded or is not a "major federal action"; the EA can result in a "finding of no significant impact" (FONSI), or in the decision to conduct an Environmental Impact Statement (EIS) study because the action has been found to be a major federal action through the NEPA analysis.

National Registry of Natural Landmarks (Program 15.9100 § 62.2). The National Registry of Natural Landmarks is administered by the National Park Service, under the Department of the Interior. The landmarks registered under this program are not intended for acquisition by the federal government, but rather, voluntary maintenance and preservation is encouraged. This designation is given to sites thought to best exemplify the geological and ecological history of the United States. The program goal is that acknowledgment of these areas may increase public appreciation for the natural heritage of the United States. Mauna Kea was designated a natural landmark in November 1972 (NPS 1994).

National Historic Preservation Act, Section 106 (16 USC §470f). The National Historic Preservation Act (NHPA) was created to support efforts to identify and protect sites, buildings, and objects that have historic, architectural, archeological, or cultural significance. The purpose is to ensure that the historical and cultural foundations of the nation are preserved. This act specifies that there should exist a National Register of Historic Places (NRHP), an Advisory Council on Historic Preservation, individual State Historic Preservation Offices and a review process for assessing potential impacts to sites as described in Section 106 of the NHPA. The NRHP designation is used to identify areas and properties that have been granted certain protections with regard to planning and development and been deemed worthy of

[7] Due to the small land area and extensive amount of coastline, the State of Hawai'i Coastal Zone Management Program (CZMA) encompasses the entire State (see Section 3.4.2).

[8] Candidate species and species of concern are those that are being monitored but, due to insufficient information, have not been placed on the endangered and threatened species lists.

preservation, whether by private, state, or federal agencies.[9] Projects within the UH Management Areas that are carried out with federal funding (e.g., from the National Science Foundation or National Aeronautics and Space Administration) that may impact a site that is listed or eligible for listing on the NRHP are covered by Section 106. In addition, any activities that require a federal permit, license, or approval (e.g., a permit or approval from the USFWS under the Endangered Species Act) also fall under Section 106. If it is determined that there would be an adverse effect, the agency conducting the project is required to seek ways to avoid, minimize, or mitigate that effect, as well as to consider alternative plans. Section 106 dictates that the views of the public should be solicited and considered throughout the process. The Advisory Council on Historic Preservation has made it possible to combine the NEPA and Section 106 processes, and the implementing regulations for Section 106 encourage this approach to project planning. While the statute broadly defines the requirements of Section 106, the implementing regulations, at 36 CFR Part 800, describe the process by which historic properties are identified and handled during an undertaking.

3.4.2 State and Local Level[10]

Land Use

HRS 183C, Conservation District. Chapter 183C conserves, protects, and preserves important natural resources of the state through appropriate management and use to promote their long-term sustainability and the public health, safety and welfare.

HRS Chapter 205, State Land Use Law. The State Land Use Law establishes an overall framework for land use management whereby all lands in the State of Hawai'i are classified into one of four major land use districts: urban, rural, agricultural and conservation. Conservation lands are comprised primarily of lands in existing forest and water reserve zones and include areas necessary for protecting watersheds and water sources, scenic and historic areas, park, wilderness, open space, recreational areas, and habitats of endemic plants, fish and wildlife. Conservation districts are administered by the BLNR and uses are governed by rules promulgated by the DLNR.

HRS Chapter 205-A, Hawai'i's Coastal Zone Management Program. The objective of the state coastal zone management (CZM) program is to use an integrated approach to determine the policies and procedures that regulate state and county actions dealing with land and water uses and activities. Because in Hawai'i there is no point of land more than 30 miles from the ocean, the coastal zone management program is designed as an overall resource management policy and encompasses the entire state. The areas managed under this program have economic, historical, cultural, and biological considerations. HRS Chapter 205-A requires all agencies to assure that their statutes, ordinances, rules and actions comply with the CZM objectives and policies.

HRS Chapter 226, Hawai'i State Planning Act. The purpose of the Hawai'i State Planning Act is to define the topics and priorities for consideration in development planning. It is intended to improve coordination among different agencies, to provide for the wise use of resources and to guide development. The Act sets forth the state goals and objectives with regard to the development of policies and plans regarding economic development, population growth, education, crime, housing, and resource management.

[9] The Adze Quarry, located in the Mauna Kea Ice Age NAR, the Mauna Kea Science Reserve, and the Mauna Kea Forest Reserve has been listed on the NRHP since 1962, and is a National Historic Landmark. This site contains religious shrines, rock shelters and petroglyphs and is thought to be the largest ancient quarry of its type, anywhere. Archeological evidence indicates that this area was used by prehistoric Hawaiians for obtaining basalt to make stone implements.

[10] Hawai'i Administrative Rules (HAR) are developed to implement the provisions of Hawai'i Revised Statutes (HRS).

HAR Title 13, Administrative Rules of the Department of Land and Natural Resources. HAR Title 13 defines the rules of practice and procedure for the lands that fall under the jurisdiction of DLNR. Each division within DLNR has its own mission statement and set of rules. Several of these divisions have rules that are applicable to the management of Mauna Kea.

HAR Title 13, Chapter 5, Conservation District. HAR Title 13, Chapter 5 regulates land use in the state's Conservation District for the purpose of conserving, protecting, and preserving the important natural resources of the state through appropriate management and use, to promote their long-term sustainability and the public health, safety and welfare.[11] The chapter establishes five subzones within the Conservation District: protective, limited, resource, general, or special. For each subzone, the chapter describes the objective of the level of protection and identifies permitted uses along with the procedures necessary to obtain permission to engage in that use. Each use is assigned to one of four categories. The first category does not require a permit from the DLNR or BLNR. The second category requires a site plan, to be approved by the DLNR. The third category requires a departmental permit from DLNR permit. The fourth category requires a BLNR permit, and, where specified, an accompanying management plan.

The UH Management Areas on Mauna Kea are in the resource subzone. The objective of this subzone is to develop areas using management that ensures that the natural resources of those areas are sustained. To that end, many of the identified uses in this subzone fall under the third or fourth categories of land use and require a permit from the DLNR or BLNR. Some examples of activities that require a permit are data collection that involves incidental ground disturbance (e.g., rain gauges), erosion control, noxious weed removal that results in ground disturbance, the demolition of existing structures and removal of more than five trees larger than 6" in diameter. Astronomy facilities require both a permit and an approved management plan.

Environmental Review

HRS Chapter 343 and HAR Section 11-200, Environmental Review. HRS Chapter 343 and HAR Section 11-200 establish a system of environmental review at the state and county level. The statute and rules provide that environmental concerns are considered for all proposed actions on state and county lands or for projects using state or county funds. HRS 343 requires an environmental assessment (EA) for actions that propose the use of any state or county land, including lands classified as within the Conservation District, shoreline areas and historic sites. An environmental impact statement (EIS) is required if it is determined that the proposed action may have a significant impact. HRS 343 also requires a cultural impact assessment (CIA) to determine what effects the proposed project would have on Native Hawaiian cultural practices, features, and beliefs. In addition, Section 11-200 HAR provides for public participation through a public review process, as well as listing what classes of action are exempt from submission of an EA.

Cultural Resources

HRS Chapter 6E, Historic Preservation. HRS Chapter 6E preserves, restores, and maintains historically and culturally significant property. This chapter provides that all proposed projects that may affect any historic property, aviation artifact, burial site, or sites listed on the Hawai'i register of historic places, must be reviewed by the SHPD, which operates under DLNR. A project requires departmental agreement in order to progress. The summit region of Mauna Kea is designated as a historic district by the State of Hawai'i.

[11] Land use is defined as (1) the placement or erection of any solid material on land if that material remains on the land more than fourteen days, or which causes a permanent change in the land area on which it occurs; (2) the grading, removing, harvesting, dredging, mining or extraction of any material or natural resource on land; (3) the subdivision of land; or (4) the construction, reconstruction, demolition, or alteration of any structure, building, or facility on land.

Several sections of HRS Chapter 6E are integral to cultural resource management issues in the UH Management Areas. Provisions of §6E-7, 6E-8, 6E-10.5, 6E-11, 6E-43, and 6E-43.6 may be applicable to one or more aspects of various future actions. In addition, various chapters of the Hawai'i Administrative Rules implementing HRS Chapter 6E will govern activities within the management areas. In all of the statutes cited, the phrase "historic property" refers to "...any building, structure, object, district, area, or site, including heiau and underwater site, which is over fifty years old." Similarly, a burial site "means any specific unmarked location where prehistoric or historic human skeletal remains and their associated burial goods are interred, and its immediate surrounding archaeological context, deemed a unique class of historic property and not otherwise included in section 6E-41" (§6E-2). All three UH Management Areas are state land, and therefore HRS Chapters 6E-7 and 6E-8 apply.

According to HRS Chapter 6E-7, historic sites upon state lands belong to the state, and are to be managed by DLNR. Departmental oversight includes disposition of historic properties subject to certain conditions and the issuing of any permits for research on historic sites and setting conditions for such research. HRS Chapter 6E-8 requires review of the effects of proposed state projects on historic properties.

HRS Chapter 6E-10.5, HRS (Enforcement) and HRS Chapter 6E-11 (Penalties) apply to any instances of damage or vandalism to historic and cultural sites within the UH Management Areas. In addition, the provisions of both chapters also cover any failure to follow approved historic preservation compliance measures such as mitigation plans.

HRS Chapters 6E-43 (Prehistoric and Historic Burial Sites), 6E-43.5 (Island Burial Councils; Creation; Appointment; Composition; Duties) and 6E-43.6 (Inadvertent Discovery of Burials) cover the treatment and disposition of all burials over 50 years old. In the case of the UH Management Areas, burials covered by these statutes will most likely be those of Native Hawaiians; no non-Native Hawaiian burials are currently known to be present in the UH Management Areas.

HAR Title 13, Subtitle 13, Chapter 300, Inadvertent Discovery of Human Remains. SHPD has jurisdiction over any inadvertently discovered human skeletal remains and any burial goods over fifty years old, regardless of ethnicity. Any discovery shall be immediately reported to the appropriate authorities including SHPD. Upon discovery all activity in the immediate area of the remains must cease and appropriate action must be taken to protect the integrity of the burial site.

Natural Resources

HRS Chapter 195D, Conservation of Aquatic Life, Wildlife and Land Plants. HRS Chapter 195D governs the conservation of indigenous aquatic life, wildlife, land plants, and their habitats and is similar to the federal Endangered Species Act.

HAR Title 4, Administrative Rules of the Department of Agriculture. Regulations set forth by HAR Title 4 govern pesticides, noxious weeds, importation and exportation of plants, prohibited animals, quarantines of plants and animals, restrictions on the importation of microorganisms, intrastate movement of bees, pests for control or eradication, management of agricultural resources, and aquaculture development.

HRS Chapter 152, Noxious Weed Control. According to HRS Chapter 152, "noxious weed" means any plant species that is, or that may be likely to become, injurious, harmful, or deleterious to the agricultural, horticultural, aquacultural, or livestock industries of the state and to its forest and recreational areas and conservation districts, as designated by the Department of Agriculture. This chapter establishes criteria for the designation of noxious weeds and outlines the duties of the Department of Agriculture to control

and eradicate noxious weeds. Among other provisions, this chapter prohibits transportation of noxious weeds and assigns responsibility to the Department of Agriculture to restrict the introduction and establishment of noxious weed species in areas that have been declared free of those noxious weeds.

HRS Chapter 342B, Air Pollution Control. The Department of Health, Clean Air Branch is responsible for air pollution control in the state pursuant to the federal Clean Air Act; HRS Chapter 342B; HAR Title 11, Chapter 59, Ambient Air Quality Standards; and HAR Title 11, Chapter 60.1, Air Pollution Control. The engineering, monitoring, and enforcement sections conduct engineering analysis, issue permits, perform monitoring and investigations, and enforce the federal and state air pollution control laws and regulations.

HRS Chapter 342D, Water Pollution Law. The Water Pollution law provides a comprehensive regulatory program for discharges of pollutants to the waters of Hawai'i. Administrative rules pertaining to wastewater systems are included in HAR Title 11, Chapter 62.

HRS Chapter 342J, Hawai'i Hazardous Waste Law. Hawai'i's Hazardous Waste law governs the management of hazardous waste and prohibits hazardous waste pollution.

HAR Title 11, Administrative Rules of the Department of Health. HAR Title 11 covers the administrative rules of items or concerns that fall under the jurisdiction of the Department of Health. Rules governing water quality, water pollution, wastewater management, solid and hazardous waste management, litter control, emergency medical services system, and sanitation all must be considered relevant to activities and management actions on Mauna Kea.

4. COMMUNITY ENGAGEMENT PROCESS

This section describes the extensive community engagement process that was undertaken to involve the community throughout the development of the CMP. It also explains the consultation principles, based upon fundamental Hawaiian cultural values, which were used to engage the public in the development of the CMP.

4.1 Basis for Consultation

Clearly, many in the community believe the basis for the preparation of the CMP for the UH Management Areas stems, in large part, on the ruling by Judge Hara in January 2007. In the face of this decision, the University recognized the necessity to "step back" and re-evaluate its perspectives on management of Mauna Kea, as well as the circumstances and history that led them to the present state. This self-assessment revealed shortcomings in past planning and management efforts and underscored the need to address them during the CMP process.

During the recent Outrigger Telescope permitting process, many in the Hawaiian community experienced frustration as they attempted to express their perspectives and suffered psychological and spiritual hurt as their values and traditions were not given the attention and respect they deserved. As a result, they lost trust in the University as a responsible steward of the UH Management Areas and criticized the University for circumventing its own management policies. Subsequently, many individuals dissociated themselves from the process or resorted to other venues to express their views and advocate their position.

The University acknowledges these feelings and frustrations, and recognizes that a process of meaningful engagement and dialogue is necessary. The challenge in the CMP process has been to re-engage the individuals who lost confidence and trust in the University, to participate in a consultation process that will have far reaching effects to the entire community.

4.2 Consultation Principles

The consultation process is intended to be not only responsive to community involvement, but also attempts to establish a meaningful relationship between the University and the community. As with any relationship, shared commitments and values are central to its health and longevity. The University implemented its community consultation process grounded in several principles that are intended to be the foundation for sustaining a long term relationship with the community. These principles, common in most cultures, are especially important in a Hawaiian context.

Purposeful or *Mākia* – The time and attention of the community is very important. The University recognizes that community consultation must be mindful in order to be meaningful. The basis for consultation and dialogue with the community is to listen, discuss, understand and identify appropriate management strategies for the UH Management Areas.

Respectful or *Mahalo* – The University acknowledges the importance of a genuine dialogue with the community, and recognizes that past efforts and interaction with the community may not have attained this level of respect. The importance of "asking for permission" before acting and being grateful for the opportunity to discuss issues cannot be overstated.

Humility or *Ha'aha'a* – The University further acknowledges that in the development of previous plans for Mauna Kea many in the Hawaiian community were hurt by the lack of sensitivity, awareness, and

understanding. The University further recognizes that future management cannot be successful without first seeking to heal these pains. "Listening" with attention, respect, and compassion is very important.

Trust or *Hilina'i* – As with any relationship, trust is fundamental. The University recognizes and commits to being truthful, open, and honest in the development of the CMP even if it meant that not everyone's viewpoint or recommendation would be incorporated into the CMP although we thoughtfully listened to what everyone had to say.

Thoughtful or *No'ono'o* – As with any management plan, words must be translated into action. It is therefore essential and critical that the CMP be prepared in a way that best reflects the spirit and interests of the community, notwithstanding that members of the community may have differing perspectives.

Consistency or *Pono* – The University understands that when the CMP is implemented, it is especially important that its actions are consistent with the contents of the plan. Doing so not only validates the content of the plan, but also reinforces the input provided by those who contributed to its preparation and strengthens the relationships that were formed during the process.

Continuity or *Ho'omau* – The University recognizes that community consultation is not a limited process for a specific issue. Successful management and stewardship are contingent upon long term relationships based on mutual trust and understanding. These relationships must be continually fostered and maintained to sustain the resources.

Responsibility or *Kuleana* – Responsibility is reciprocal for both the University and the community. The University commits to being a responsible steward of Mauna Kea's cultural and natural resources. Similarly, the community must commit to working in partnership with the University to manage the resources so that they may be sustained for future generations.

4.3 Consulted Parties and Stakeholders

The mere presence and visibility of Mauna Kea suggests that anyone who can see the summit or who has heard of it may have a view or opinion as to its management. There are also a number of families, organizations and agencies who have an active (and in some cases, genealogical) relationship to Mauna Kea. The views of the general public are important and have been given due consideration in the development of the CMP. However, there are certain stakeholders whose views and perspectives were given careful consideration because of their cultural, legal, or political affiliation with Mauna Kea. They include the following:

Kahu Kū Mauna (Guardians of the Mountain) was established as an advisory body to the OMKM, MKMB and UH-Hilo specifically on cultural issues.

Families with lineal or historic relationship to Mauna Kea either through their genealogy, burials, or children's *piko*.

Hawaiian Cultural Practitioners include those who access the UH Management Areas for religious and spiritual purposes and/or cultural ceremonies for the observance of events.

Natural Resource Scientists who are studying the physical and biological elements for the purposes of science and protection of the unique natural environment found within the UH Management Areas.

Astronomical Community are the scientists, engineers, technicians, and workers who access the UH Management Areas to either maintain the telescopes and their associated facilities or who gather and use the data.

Hunters and Resource Gatherers are individuals, families, and organizations that access the UH Management Areas to hunt and gather materials for cultural and subsistence purposes.

Archaeologists and Historic Preservationists who study and seek to preserve the oral history, physical structures, and cultural stories associated with past uses of Mauna Kea.

Government Agencies (federal, state, and local) who either have regulatory oversight of activities of the resources or who are in a contractual relationship (i.e., lease agreement) for the use of the UH Management Areas.

Elected Officials who serve the island of Hawai'i at the county, state and federal levels.

Office of Hawaiian Affairs which works towards the betterment of Native Hawaiians.

4.4 Consultation Process and Methods

The University's sought to re-establish a meaningful community relationship with the general public and particularly with the range of stakeholders involved with the UH Management Areas. To achieve this goal, a multi-faceted consultation process was undertaken. A deliberate attempt was made by the University to initiate the request with various stakeholders to "listen" to them in a setting or forum of their choosing. The following is a brief description of the approaches that were engaged in to reach out to the community and some of the results of that engagement:

Individual and Small Talk Story Sessions. For many Hawaiians who previously dissociated themselves from community dialogues, requests were made to meet them in informal, one-on-one meetings. Similarly, elected officials and government agencies were given individualized briefings. For various Hawaiian families, cultural practitioners and resource gatherers, requests were made for smaller talk-story sessions where the discussion could be confidential and respectful. In each of these meetings, not only did the University seek to listen and hear the issues raised, but it also provided information regarding Mauna Kea, the CMP, and its intentions for better management of the UH Management Areas. Since the start of the CMP process in the fall of 2007, the University or its representatives[1] requested and held over 150 individualized or small group meetings. Appendix A1 is a list of all the individuals and groups that we met with throughout the CMP process.

Traditional Public Meetings. In an effort to reach out to the broader Hawai'i Island community, two rounds of public meetings were held in Hilo, Kona, and Waimea. The first round of meetings was held from May 6-13, 2008 primarily to inform the community about the CMP process and to listen to its concerns and issues regarding Mauna Kea. The second round of meetings was held from November 14-18, 2008 to follow-up with the community and provide information on the management concepts that were being developed based in part on their concerns and issues. Appendix A2 contains the announcements and attendance sheets. Two presentations were made to BLNR at its duly noticed public meeting (April 11, 2008 and October 10, 2008). A presentation was also made before the Office of Hawaiian Affairs Beneficiary Advocacy and Empowerment Committee (July 23, 2008) and OHA's Native Hawaiian Historic Preservation Council (June 30, 2008 and December 15, 2008).

[1] The University retained the services of a consultant team to develop the CMP. The consultant team initiated and represented the University in the community consultation process.

Statewide Survey. To independently gauge the community's understanding of Mauna Kea, the cultural, environmental and scientific issues related to Mauna Kea, a statewide telephone survey was conducted in March 2008. In total, 635 telephone interviews were conducted on Kaua'i (100), O'ahu (150), Maui (111), and Hawai'i (135 in Kona and 139 in Hilo). Of the total, 164 respondents self identified as Native Hawaiian. The results of this survey are contained in Appendix A3.

Establishment of a Website. The University sponsored the creation of a website in late 2007 to reach any interested person who had internet access. Not only does the website, www.maunakeacmp.com, provide information about Mauna Kea, the CMP process, and links to various documents, it also allows users to submit their questions, comments, and concerns electronically. The website also provides the email address, mailing address, and fax number for persons interested in submitting written comments. Appendix A4 is a copy of the information posted on the website.

Media Coverage. During the CMP development process questions were raised by the Hawai'i Island and major daily print media about the CMP, its role in management, and the preparation process. Consistent information was provided to the media through the assemblage of media kits that contained a fact sheet and other relevant background material. Additionally, the University sought to meet with the editorial boards for the major daily and the Hawai'i Island newspapers to provide them with similar information and respond to their questions. Appendix A5 is a sampling of the media coverage.

Mauna Kea CMP Newsletter. In a further attempt to keep the community informed on the status of the CMP process as well as the results of what was heard in the community through outreach efforts, a newsletter was posted on the website and mailed to those who participated in the public community outreach process. Appendix A6 is a copy of the newsletter.

***Kūpuna* Workshops on Astronomy**. Pursuant to a desire by the community, and in particular Aunty Mabel Tolentino, a Waimea Kupuna who wanted to have a better understanding about astronomy, several of the observatories and Kahu Kū Mauna collaborated in convening a series of workshops entitled, *Sharing Astronomy with Kupuna.* Appendix A7 is a copy of the workshop flyer and schedule.

Outreach to Engage the Plaintiffs in the Outrigger Telescopes Lawsuit. The University recognized that the Plaintiffs involved in the Outrigger Telescopes' lawsuit, which formed the basis for Judge Hara's 2007 ruling, represented an important stakeholder interest group. As such the Plaintiffs were proactively contacted through their legal counsel on at least two separate occasions to seek their participation in the CMP process. Appendix A8 contains the two letters that were sent to the Plaintiffs' attorneys. The Plaintiffs felt it inappropriate to participate in the CMP process because at that time the University was appealing Judge Hara's decision. At a later date, the University withdrew its appeal of Judge Hara's decision.

Institute for Astronomy's Plans to Remove and Decommission Obsolete Telescopes. During the community engagement process a recurrent theme heard from both Hawaiian and non-Hawaiians was that since the summit of Mauna Kea is so culturally significant, the community would like to see a specific plan that shows the removal of obsolete telescopes from the summit and decommissioning plans for each of the observatories, including restoration plans. Appendix A9 contains a series of related communications including: a letter to IfA requesting this information; IfA's letter dated July 15, 2008 proposing a Revised Plan for the Mauna Kea Observatories; the letters IfA sent to each of the observatories regarding their decommissioning plans; and responses from each of the observatories acknowledging their responsibilities for removal and restoration as provided under their sublease with the University.

Association of Hawaiian Civic Clubs Resolutions. Pursuant to a request from the Big Island Hawaiian Civic Club, the Association of Hawaiian Civic Clubs (AHCC) took formal action at their annual convention to adopt a resolution, "that it strongly urges the State of Hawai'i Board of Land and Natural Resources, approve a Comprehensive Management Plan covering the lands leased to the University of Hawai'i on Maunakea Mountain." The AHCC passed another resolution urging the legislature to authorize OMKM to develop administrative rules for Mauna Kea. Appendix A10 is a copy of the Resolutions.

4.5 Comment Review and Issue Formulation

During the course of listening to stakeholders and the Hawai'i community throughout the CMP development process, a broad range of concerns and issues were put forth. Included among them were statements regarding religious and spiritual beliefs, cultural practices, cultural and natural resources, legal matters, education, economic development, social justice, land use, management, and communication. Given the diversity of comments received, an effort was made to identify recurrent issues or concerns that would foster the formulation of the CMP management recommendations. Issues were evaluated in the context of the CMP scope, the current lease between the University and DLNR, existing statutes and rules, and other similar parameters regarding the University's use and stewardship of the UH Management Areas. Comments were received from some individuals who believe that all astronomy on Mauna Kea should be halted, all telescopes removed, and that Mauna Kea should be restored and preserved solely for cultural and religious purposes. While such perspectives are understandable, they were not consistently held across the community; in fact, they were put forth by relatively few individuals.

One of the most consistent viewpoints was that science (astronomy) can co-exist within the cultural and natural resource setting of the UH Management Areas. This perspective was held across nearly all groupings and individuals ranging from families that have a lineal or a historic connection to Mauna Kea to individuals who reside on neighbor islands. Beyond this generally held belief however, perspectives varied with regard to how such uses should occur and be managed and it is from these viewpoints that the management actions, detailed in Section 7 were established.

4.6 Framing the Management Concepts

Based on a review of the community input, several trends emerged that allowed for the framing of distinct management concepts. These concepts were used as precursors or guides in the development of the specific management actions detailed in Section 7.

The cultural integrity and significance of Mauna Kea must be preserved

Many individuals, Hawaiian and non-Hawaiian, believe that the CMP and the University's management of their lands on Mauna Kea must be grounded in Native Hawaiian understanding and values. From this point, a range of concepts were suggested as to how culture can be preserved and integrated as part of the CMP management framework. For example, suggestions arose not only for an orientation for persons accessing the UH Management Areas, but also for a substantial educational outreach component that would bring the culture and science from Mauna Kea to classrooms or other forums.

Multiple uses and activities must be managed

The UH Management Areas are currently accessed for cultural and religious purposes, astronomy, subsistence hunting and gathering, archaeology, scientific research, and sightseeing and recreation. It is clear to the community that improved management is necessary. Some suggestions for improvement were

aimed at the people accessing the area and included: access control procedures, signage, improved education, and orientation.

Development within the Astronomy Precinct must be controlled

One of the more consistent comments from the community was that additional controls were necessary for astronomy-related development in the summit region. The community approached this issue from several viewpoints. Many believe that the 13 existing facilities are too many and disapprove of adding more. Others believe that some of the existing telescopes must be decommissioned before any new telescope is constructed. The basis for this was not only to preserve a "zero net gain" of telescopes, but also because of the recognition that decommissioning is perhaps the most tangible form of actually listening to the community's concerns that before new telescopes can be considered some obsolete facilities must come down.[2] Some individuals focused on the telescopes themselves and held that should a new telescope be constructed on Mauna Kea, it should be the best in the world not only for scientific purposes, but also reflect the Hawaiian commitment to excellence – *kūlia i ka nu'u*.

Other commenters applied a land use planning approach and identified specific areas within the summit region that should be preserved and not used for telescope development because of the presence of *'iwi kupuna*, cultural sites, and use for ceremonial purposes. While others focused on site restoration, remediation of environmental contaminants, and management of hazardous substances.

The University must restore its trust and confidence with the community.

One of the broader issues that emerged from the community consultation was that many Native Hawaiians continue to feel emotional pain and distrust of the University and its management of UH Management Areas. Reconciliation and re-establishment of confidence in the University is difficult to convey solely through a document such as the CMP, but must occur through action and implementation. The community was clear in its desire to be consulted on a regular basis and to be actively involved in the management decision-making process.

The community also holds the University, including UH-Hilo, IfA, OMKM, the MKMB and others accountable, to be consistent and coordinated in implementing the CMP. More specifically, that plans and policies not be circumvented and that the lines of communication and coordination are well maintained between all the University entities. The community further expects transparency from these entities as management decisions are contemplated and agreed upon.

The community also expressed the view that the amount of resources (funding, staffing, facilities, and equipment) and legal authority to manage the UH Management Areas is insufficient. This view was expressed particularly with regard to OMKM Rangers and their lack of ability to enforce rules governing use and access within the UH Management Areas.

4.7 Commitment to Consultation

Using the management concepts identified above, the specific management actions detailed in Section 7 were assembled. In the spirit and intent to maintain a continued consultation, the draft CMP management actions were presented and discussed with the community in October and November 2008.

These meetings, referenced in Section 4.3, were similar to the first round of meetings insofar as individual stakeholders were contacted for one-on-one or small group meetings, and publicly-noticed community meetings were held in Hilo, Kona and Waimea. During this process, the draft CMP management actions

[2] Although issues related to future astronomical developments and decommissioning were a recurring theme in the community outreach project, these issues are beyond the scope of the CMP but have been identified in Section 2.1.4 as policy issues.

were validated by many stakeholders and community members as having addressed a number of their initial concerns, particularly with regard to ensuring that cultural values, practices, and access are preserved.

However, despite the cautious optimism expressed, stakeholders continued to express frustrations that the CMP management actions do not go far enough to ensure compliance and commitment by the University to the policies it previously established. As noted above, however, the true test of the effectiveness of the CMP will lie with its implementation and the extent to which the University and its subsidiary agencies can continue to embrace the values outlined in Section 4.2.

5. CULTURAL AND NATURAL RESOURCES

"Resource" is defined as the natural environment or human practices, values, and traditions and their physical manifestations. The unique and sensitive cultural and natural resources of Mauna Kea are described herein to give the reader a sense of the range of resources being preserved and protected by the management strategies presented in this plan. The section on cultural resources describes fundamental Hawaiian cultural and natural resources management principles, Mauna Kea's valued cultural resources and Native Hawaiian cultural practices, the cultural background and history of Mauna Kea, and historic properties and archaeological resources. The section on natural resources describes both the physical environment and the biotic elements, including flora and fauna. Section 5 is also designed to satisfy the first step in the *Ka Pa'akai* analytical framework to identify the valued cultural, historical, and natural resources.

While the CMP has been developed specifically for the UH Management Areas, it is impossible to constrain attributes of the cultural and natural environment within these boundaries. Therefore, while information within this section attempts to describe attributes specific to the UH Management Areas often the scope of the discussion will, out of necessity, incorporate features within the general landscape boundaries of approximately 9,000 ft (2,700 m) elevation to the summit, including adjacent lands such as the Mauna Kea Ice Age NAR and the Mauna Kea Forest Reserve, both properties managed by the DLNR.

5.1 Hawaiian Cultural and Natural Resource Management Principles

'E malama poni I ka 'aina; nana mai ke alo
Take good care of the land; it grants you life.[1]

5.1.1 Overview of Hawaiian Cultural Practices and Resources

Davianna Pomaika'i McGregor attributes the quality and abundance of natural resources within a community to the persistence of *'ohana* (family) values and practices in the conduct of subsistence activities. "An inherent aspect of these *'ohana* values is the practice of conservation to ensure availability of natural resources for present and future generations. These rules of behavior are tied to cultural beliefs and values regarding respect of the *'aina*, the virtue of sharing and not taking too much, and holistic perspective of organisms and ecosystems that emphasizes balance and coexistence. The Hawaiian outlook that shapes these customs and practices is *lokahi* or maintaining spiritual, cultural and natural balance with the elemental life forces of nature" (McGregor 1996). It is the ancestral knowledge about the land and its resources that is reinforced through continued subsistence practices. "The practitioners stay alert to the condition of the landscape and the resources and their changes due to seasonal and life cycle transformations. This orientation is critical to the preservation of the natural and cultural landscape. The land is not a commodity to them. It is the foundation of their cultural and spiritual identity as Hawaiians. They proudly trace their lineage to the lands in their region as being originally settled by their ancestors. The land is a part of their *'ohana* and they care for it as they do the other living members of their families" (McGregor 1996). In addition, many Hawaiians view religion as the root of the Hawaiian culture. (Fergestrom, Temple of Lono, 2009).

[1] Aunty Edith Kanaka'ole, scholar and *kumu hula*, quoted by Davianna Pomaika'i McGregor, PhD, in "*Hawaiian Cultural and Natural Resource Management*".

5.1.2 Principles of Hawaiian Cultural Resource Management

First, the *ahupua'a* is the basic unit of Hawaiian cultural resource management. Second, the natural elements – land, air, water, ocean – are interconnected and interdependent. Third, of all the natural elements, fresh water is the most important for life and needs to be considered in every aspect of land use and planning. Fourth, Hawaiian ancestors studied the land and the natural elements and became very familiar with its features and assets. Ancestral knowledge of the land was recorded and passed down through place names, chants which name the winds, rains, and features of a particular district, and legend; therefore, it is important to consult these sources to learn of the culture and natural resources of a particular district (McGregor 1996).

5.1.3 Cultural Land Use Practices

Within a Hawaiian context the land and ocean are an integrated whole. McGregor notes that the methods and techniques of accessing, acquiring or utilizing traditional and natural resources may have changed over time but this does not detract from the fact that the resources are used and prepared for Hawaiian custom and practice related to subsistence, culture and religion. Hawaiian custom and practice is embedded in the honor and respect for traditional *'ohana* values and customs to guide subsistence harvesting of natural resources. For example, only take what is needed, don't waste natural resources, take care of the *kupuna* who passed on the knowledge and experience, and respect the resources (McGregor 1996).

5.1.4 Sources of Information About Cultural Practices

Traditionally, cultural knowledge was remembered and passed down through oral tradition in chants, legends, myths, genealogies, and place names. There is still a wealth of knowledge that is kept alive and practiced by living generations of Hawaiian families, and those who received traditional training such as *kumu hula* and *kahuna la'au lapa'au*. Moreover, the living culture is constantly undergoing growth and change. Therefore, any effort to understand and document the natural and cultural resources of an area must include consultation with the Hawaiian *'ohana*, *kumu*, and cultural groups who live in the area and take responsibility for the cultural and natural resources of the area (McGregor 1996).

5.1.5 Cultural Landscape

A cultural landscape is composed of physical elements which manifest the technological and cultural basis of human use of the land through time. While McGregor identifies several components of a Hawaiian cultural landscape, of relevancy to Mauna Kea is the following. *Wahi pana,* which are sacred sites such as *heiau*, shrines, burial caves and graves and geographic features associated with deities and significant natural, cultural, spiritual or historical phenomenon or events. Ed Kanahele offers a description of *wahi pana* in the introduction in Ancient Sites of O'ahu, by Van James (1991) as "The gods 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, shrines, as well as selected observation points, cliffs, mounds, mountains, weather phenomena, forests, and volcanoes." Domains of *'aumakua* or ancestral deities is another component of the cultural landscape. These are places where particular natural and cultural areas are important as traditional domains of *'aumakua* or ancestral spirits and deities, where Hawaiians renew their ties to ancestors through experiences with natural phenomena and witnessing *ho'ailona* or natural signs. Finally, trails and roads are part of the cultural landscape as they provide access to the cultural resource and use areas (McGregor 1996).

5.2 Mauna Kea's Valued Cultural Resources and Practices

5.2.1 Mauna Kea in Creation Stories and as a Home of the Gods

Native Hawaiian traditions state that ancestral *akua* (gods, goddesses, deities) reside within the mountain summit area. These personages are embodied within the Mauna Kea landscape – they are believed to be physically manifested in earthly form as various *pu'u* and as the waters of Waiau. Because these *akua* are connected to the Mauna Kea landscape in Hawaiian genealogies, and because elders and *akua* are revered and looked to for spiritual guidance in Hawaiian culture, Mauna Kea is considered a sacred place.

Native Hawaiian genealogical *mele* (poems, chants) explain the centrality of Mauna Kea within Hawaiian genealogy and cultural geography. *Mele* recount that as a result of the union of Papa and Wākea, who are considered the ancestors of Native Hawaiians, the island of Hawai'i was birthed. In the *Mele a Paku'i*, a chant describing the formation of the earth, Mauna Kea is likened as the first-born of the island children of Papa and Wākea, who also gave rise to Hāloa, the first man from whom all Hawaiians are descended (Kamakau 1991:126 in Maly and Maly 2005:7-8). A *mele hānau* (birth chant) for Kamehameha III, who was born in 1814, describes the origins of Mauna Kea:

> *Born of Kea was the mountain,*
> *The mountain of Kea budded forth.*
> *Wākea was the husband, Papa*
> *Walinu'u was the wife,*
> *Born was Ho'ohoku, a daughter,*
> *Born was Hāloa, a chief,*
> *Born was the mountain, a mountain-son of Kea.*
> (Pukui and Korn 1973:13-28 in Maly and Maly 2005:9).

Some contemporary Native Hawaiian cultural practitioners continue to view Mauna Kea as a first-born child of Papa and Wākea, and thus, the mountain is revered as "the *hiapo*, the respected older sibling of all Native Hawaiians" (Kanahele and Kanahele 1997 in Langlas 1999:7). Cultural practitioner Kealoha Pisciotta explains that this link to Papa and Wākea "is the connection to our ancestral ties of creation" (Orr 2004:61). Pualani Kanaka'ole Kanahele states that "the very fact that it is the 'Mauna a Wākea' tells you that it is the mauna that is meeting Wākea" (Maly 1999:A-368).

Traditional genealogical *mele* (poems, chants) and *mo'olelo* (stories, traditions) recount associations between Mauna Kea and the following *akua* – Poli'ahu, Lilinoe, Waiau, and Kahoupakane. In a *mo'olelo* recounting the travels of Pūpū-kani-'oe, it was said that Mauna Kea was a mountain "on which dwell the women who wear the *kapa hau* (snow garments)" (Maly and Maly 2005:31). Yet another *mo'olelo*, which dates to the 1300s, explains that Ka-Miki was sent atop Mauna Kea's summit to the royal compound of Poli'ahu, Lilinoe, and their ward, Ka-piko-o-Waiau, to fetch water for use in an *'ai-lolo* ceremony (Maly and Maly 2005:42-43).

In the post-Contact period, Native Hawaiian historian S.N. Haleole transcribed *Ka Mo'olelo o Laiekawai* in 1844, which tells that after Poli'ahu broke her engagement to Aiwohikupua, she took up residence on Mauna Kea along with her three maidens Lilinoe, Waiaie (Waiau), and Kahoupakane (Maly and Maly 2005:20-26). As well, other 19th century ethnographers published on the associations between Mauna Kea and Poli'ahu, Lilinoe, and Waiau. W.D. Westervelt claimed that Poli'ahu, Lilinoe, and Waiau were snow goddesses "who embodied the mythical ideas of spirits carrying on eternal warfare between heat and cold, fire and frost, burning lava and stony ice" (Westervelt 1963:55-56). Westervelt also credits Poli'ahu as the rival of the fire-goddess, Pele, said that she battled Pele on numerous occasions, and credits her with

having "kept the upper part of the mountain desolate under her mantle of snow and ice" (Westervelt 1963:62).

In 1931, Emma Ahu'ena Taylor, a historian of Hawaiian descent and with genealogical ties to the lands of Waimea and Mauna Kea, reported on Poli'ahu's residence at Mauna Kea, but also described the creation of Lake Waiau. She wrote:

> "Poli'ahu , the snow-goddess of Mauna-kea, was reared and lived like the daughter of an ancient chief of Hawaii. She was restricted to the mountain Mauna-kea by her godfather, Kane. She had a nurse Lihau who never left her for a moment. Kane created a silvery swimming pool for his daughter at the top of Mauna-kea. The pool was named Wai-au. The father placed a supernatural guard [Mo'o-i-nanea] at that swimming pool so that Poli'ahu could play at leisure without danger of being seen by a man..." (Maly and Maly 2005:53).

According to Taylor, on Mauna Kea, Poli'ahu's attendants – Lilinoe, Lihau, and Kipu'upu'u drove away her suitor, Kūkahau'ula (the pink-tinted snow god). But Mo'o-i-nanea allowed the snow god to embrace Poli'ahu, and to this day, Taylor reports, "Ku-kahau-ula, the pink snow god, and Poli'ahu of the snow white bosom, may be seen embracing on Mauna-kea" (Maly and Maly 2005:53).

In modern-day accounts, Poli'ahu continues to be commonly referred to as "the beautiful snow goddess of Mauna Kea" while Lilinoe is called "a goddess of the mists and younger sister of the more famous Poli'ahu." (Pukui and Elbert 1971:392, 396). Langlas reports that Pualani Kanaka'ole Kanahele told him that three *pu'u*—Poli'ahu, Lilinoe, and Waiau, were sister goddesses who are female forms of water and that all three of the cinder cones or *pu'u* that bear their names are important religious sites (Langlas 1999). Kealoha Pisciotta also retains knowledge that Mo'o Ina'ne'a was the guardian for Poli'ahu and Lilinoe (Orr 2004:51).

Today, in regards to Lake Waiau, cultural practitioner Pualani Kanaka'ole Kanahele believes that because the waters of Waiau have not "had a chance to come down to the rest of us, then it is sacred water...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" and in her estimation, "water is the source of life" (Maly 1999:A-368, A-370). Kealoha Pisciotta believes the cultural significance of Lake Waiau rests in several facts - the Kūmulipo creation chant describes a lake that resides in the heavens, the ancient trails meet at the lake, the lake is a navigational gourd, and it is a jumping off point for ancient Hawaiian souls (Orr 2004:44-45).

5.2.2 *Wahi Pana* / Place Names

The place name evidence indicates that the "summit" was at the very least a *wahi pana*, or a legendary place in Hawaiian traditions (Pukui and Elbert 1971). As already noted in the previous section, the reference to Mauna Kea as the abode of the gods is emphasized - the word "Kea" is taken to be an abbreviated form of Wākea, the male god who procreated with Papa to form the mountain.

Into the post-Contact period, the mountain summit and some of its physiographic features continue to figure prominently into place name descriptions contained in *mele,* and in historical maps and court testimony. In an account of Queen Emma's trip to the Mauna Kea summit in 1881 or 1882, de Silva and de Silva (2006) compare eight *mele* composed about that trip and identify three place names of the mountain's summit region – Poli'ahu, Lilinoe, and Waiau. In her ethnographic study, McEldowney (1982:1.13 – 1.18) assembles and analyzes historical maps and Native Hawaiian court testimony from the 1860s – 1890s that document place names of significance. McEldowney explains that various place

names are included and omitted, depending upon the map source, and thus contribute to debate over name origins and meanings. For example, in an effort to formalize the Ka'ohe and Humu'ula Ahupua'a boundaries in 1862, surveyor C.S. Wiltse ascended the mountain, guided by Native Hawaiians and mapped the summit region. Wiltse's map depicts the lake and named it Pond Poli'ahu. Yet, Wiltse's Native Hawaiian guides also provided court testimonies in 1873 before the Boundary Commission, which identify the following place names Pu'u o kukahauula (the highest peak), Waiau (the lake, a gulch), and Poli'ahu. Subsequent survey expeditions further complicate place name designations. The 1884-1891 Lyons map designates Kūkahau'ula, Waiau, and Lilinoe as place names of the summit area. The 1892 Alexander map names Poli'ahu, Waiau, and Lilinoe. Alexander apparently reports that he designated the name Poli'ahu for a "nameless peak." Further, in Alexander's notes he reports that the highest peak was named Kūkahau'ula, yet this name is not upon his map. Into the early to mid 1900s, both traditional and modern place names were designated upon maps of the mountain, mixing traditional names like Poli'ahu, Waiau, and Lilinoe with modern Euro-American explorer and missionary surnames, as well as with physically descriptive Hawaiian words and with other purportedly traditional names (Pu'u Wekei, Pu'u Hau Kea, Pu'u Hau Oki, Pu'u Pohaku, etc).

Today, ethnographers Maly and Maly (2005) argue that:

> "The name Pu'u of Kūkahau'ula is the traditional name of the summit cluster of cones on Mauna Kea, appearing in native accounts and cartographic resources until c. 1932. The recent names, Pu'u Wekiu, Pu'u Hau'oki and Pu'u Haukea, have, unfortunately, been used since the 1960s (since the development of astronomy on Mauna Kea), and have displaced the significant spiritual and cultural values and sense of place associated with the traditional name, Pu'u o Kūkahau'ula." (Maly and Maly 2005:vi)

5.2.3 Religious Practices and Beliefs

At the time of Contact, Hawaiian cultural and religious practices were inseparably intertwined. Ranging from Euro-American explorers and missionaries journal accounts to early Native Hawaiian historians like David Malo, Kepelino, and S.M. Kamakau, and to later 19th and 20th century ethnologists, there is rich documentation of religious ceremonial and ritual life throughout the islands (Valeri 1985:37-44). Indeed, prior to and following significant undertakings, such as battles, dance, voyaging, the cultivation and harvesting of crops and fish, apprenticeship training, and the manufacture of tools or structures, etc., rites marked by offerings or sacrifices occurred. Propitiatory offerings were made to *'aumakua*, or family gods, and *akua* to avert disasters, like famines, volcanic eruptions and disease, or to ensure the coming of rain, success in crop fertility and fish harvest bounties, or victory in battle.

Following European contact, increasing numbers of Hawaiians converted to Christianity, while restrictions were placed upon traditional religious observances. As a result, traditional oral histories and written documentation of historic religious practices and any associated beliefs on Mauna Kea remain virtually non-existent. Because Ka'ahumanu abolished the *kapu* system in 1819 and imposed restrictions on certain traditional Hawaiian religious practices in the post-Contact period (Kamakau 1961:307, 322), in all likelihood, the voices of those practitioners were silenced, or perhaps simply muted, with traditional knowledge being passed on covertly. It is possible that close proximity to missionary settlements and Christian-converted chiefs may have, to a greater degree, influenced decline in traditional religious practice. In areas further removed from Christian centers, where new religious teachings had less appeal, traditional religious practices may have continued (Barrere et al. 1980:34).

Aside from Ka'ahumanu's restrictions, it has also been suggested that it may be culturally inappropriate for practitioners to speak aloud of their ceremonial or ritual practices and beliefs. As Jess Hannah points out when asked about the presence of *heiau* or burials upon Mauna Kea, "those days...if they know about them...they don't talk about 'em. Even Alex [Bell], he knew 'em all, they had something here and there, but they would never pin 'em down. You couldn't pin point it. Something about how they were brought up or raised, it was bad luck or hard luck to talk" (Maly and Maly 2006:A-437,438). Likewise, when Johnny Ah San was asked about burial locations on Mauna Kea, he revealed that "you take those Hawaiians, they were superstitious, and they hardly want to talk about that" (Maly 1999:A-75).

Nevertheless, modern-day oral history interviewees explain their knowledge, as well as an unfortunate lack thereof, concerning the presence of and meaning of *ahu* and burials in the summit region. And cultural practitioners also describe their knowledge of and beliefs surrounding the following contemporary religious practices - *kūahu* (family shrine) erection, the scattering of cremation remains, *piko* deposition in Waiau, pilgrimage, offerings, and prayer.

Ahu and Kūahu

In the early post-Contact period, the existence of *ahu* on Mauna Kea are reported – however, information is unavailable concerning their traditional function, be it ritual, ceremonial, or otherwise. In the 1880s – 1890s, two surveyors, J.S. Emerson and E.D. Baldwin, independently denoted various *ahu* located upon *pu'u* in the lowlands surrounding Mauna Kea and the presence of "a pile of stones on the highest point of Mauna Kea" (Maly and Maly 2005:494-502, 505).

At this point, clarification of the usage of the term *ahu* may be helpful – in a morphological sense, *ahu* are characterized as upright stones or a pile or mound of stones, yet in the functional sense, *ahu* may have served historically as altars or shrines, or as markers signifying burial locales, *ahupua'a* boundaries, or trail routes. As it was noted in the previous section, when Thomas Thrum visited Haleakala on Maui in the 1920s, he reports that *ahu* functioned as trail and way marks, memorials of traveling parties, land boundaries, burial markers, or tributes to deities (Thrum 1921:259). While Emerson and Baldwin certainly confirm the presence of *ahu* as they are defined morphologically, the surveyors do not specifically speak to the functional meanings of the *ahu* on Mauna Kea.

Likewise, oral history interviewees reveal that they have heard of or have seen the presence of *ahu* on the summit plateau and on the Mauna Kea summit (Maly 1999:A-134, -372; Orr 2004:47; Maly and Maly 2006:A-183, -335, -349, -565). Yet, little information is available about the particularities of traditional religious observances practiced in association with the *ahu*. Libert Landgraf states that he had "no idea whether they were trail markers or a grave site or something else" (Orr 2004:47). Pualani Kanaka'ole Kanahele discloses that she does not know if *ahu* "represent these *ahupua'a* markers...or whether they are actually *kūahu* [altar] or *ahu* for different families that lived in that mountainous area...or if it had to do with *konohiki* [land overseers] that were in charge of a particular *ahupua'a* and so this family went there to mark the upper regions...they could also be new ones" (Maly 1999:A-372). On the other hand, Kealoha Pisciotta offers up the following explanation of the significance of *ahu* – "some of the shrines mark the birth stars of certain *ali'i*...and also birth and death" (Orr 2004:47).

Pisciotta is the only cultural practitioner to describe a contemporary attempt to maintain a *kūahu* (family shrine) on Mauna Kea, which was undermined by repeated destruction and removal of the shrine. It is significant to note that in 1870 Kamakau wrote that "it was not right to trespass on someone else's altar" (Kamakau 1964:96). This statement is the only indication of a traditional cultural practice that regulated people's access to *kūahu* and *ahu*. Pisciotta explains that she erected the *ahu*, which consists of a stone

from her family, on Mauna Kea because as an employee of one of the observatories, "I thought I would put it where I'm going all the time. And also it was very beautiful and I was always attracted to that place. I prayed at that place all the time" (Orr 2004:52). Pisciotta's contemporary cultural practice of erecting *kūahu* represents a revival of a traditional practice. Accordingly, the *ahu* and *kūahu* are recognized cultural resources with various functions, and these functions are both historic and contemporary but, nonetheless, rooted in traditional beliefs.

Burials and the Scattering of Cremation Ashes

Concerning burial locations and practices, there are numerous historical references to human burials on Mauna Kea. The practice of burying the dead in remote, high elevation areas may have been traditional and common, based on the information collected by Thomas Thrum for Haleakala on Maui:

> "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." (McEldowney 1982:1.9).

Other accounts suggest the placement of upper-elevation burials ensured the safekeeping of high-ranking members of the *ali'i* class. Ed Stevens maintains that "oral history and traditions tell us that...the bones of very special personages were placed in the *pu'us* at or near the summit for safekeeping... they were the special ones" (Maly 1999:C-10, 13). Daniel Kaniho Sr. suggests that "they were all *ali'i*...they were kind of high-ranking people" (Maly 1999:A-169).

There are a couple of early accounts of burials having been found in the general vicinity of Pu'u Lilinoe. E.D. Preston's account of his work at Lake Waiau, in 1892, noted that "At an elevation of nearly 13,000 feet, near Lilinoe, a burying ground was found, where the ancient chiefs were laid to rest in the red volcanic sand" (Preston 1895:601). W.D. Alexander's surveying party saw what they interpreted as graves on the top of Pu'u Lilinoe, also in 1892:

> 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 13,000 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).

Kamakau indicated that Queen Ka'ahumanu, who considered Lilinoe a person, made an unsuccessful attempt to recover her bones on Mauna Kea in 1828 (McEldowney 1982:1.4). Kamakau added that the body of Lilinoe "was said to have lain for more than a thousand years in a well-preserved condition, not even the hair having fallen out" (Kamakau 1961:285). Kamakau's description of Lilinoe's body is probably the source of modern stories about a mummified body having been found on Mauna Kea and removed to some unknown location.

Of the many locations with confirmed and possible burial sites, Pu'u Makanaka is perhaps the best known. The 1925-26 USGS survey team found human remains on the summit of Pu'u Makanaka:

> To set up Camp Four at 12,400 feet near Pu'u 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 Pu'u Makanaka means "Hill crowded with many people" and the grave must have been ancient (Kilmartin 1974:15).

Today, numerous oral history interviewees reveal that they have knowledge of burials located at a number of *pu'u* dotting Mauna Kea's western and eastern slopes, including Ahumoa, Kemole, Papalekoki, Makanaka, Kihe, Kanakaleonui, Kaupo, and Pu'u O'o (Maly 1999:A-22, -48, -75, -165, -250, -279, -351, -395, -397).

Some cultural practitioners explain practices that relate to ancient family burials atop the mountain. Alexander Kanani'alika Lancaster reveals that he and his family members went up to Mauna Kea "for ceremonial. They go up there bless the whole mountain for all our ancestors who's buried up there...the old folks always said, 'Our family is up there'" (Maly 1999:240). As no documentation exists on traditional cultural practices relating to ancient Mauna Kea burials, it is unknown whether blessing ceremonies would be considered a traditional cultural practice or a contemporary cultural practice.

Other cultural practitioners reveal that they have participated in the practice of scattering the cremated remains of loved ones from atop Mauna Kea. It is noteworthy that cremation was not a common practice in traditional Hawaiian culture, and when it was done it was a punishment and meant to defile the dead person. Writing in the 1830s, Native Hawaiian historian David Malo stated that "the punishment inflicted on those who violated the tabu of the chiefs was to be burned with fire until their bodies were reduced to ashes" and that cremation was practiced on "the body of anyone who had made himself an outlaw beyond the protection of the tabu" (Malo 1951:57, 20). In recent years, noted Native Hawaiian historian and ethnologist Mary Kawena Pukui explains why cremation was a defilement – "if the bones were destroyed, the spirit would never be able to join its *aumakua*" (Pukui et al. 1972:109).

The cultural practitioners who express participation in cremation-related cultural practices on Mauna Kea include Toshi Imoto, Tita Elizabeth Kauikeōlani Ruddle-Spielman, and Kealoha Pisciotta. Imoto explained that in 1954, he and six others ascended to Mauna Kea's summit, where paniolo Eben Low's ashes were scattered from an *ahu*, which is described as an old survey marker. It is also noteworthy that at the time Low's ashes were scattered, a commemorative cement plaque was placed at Lake Waiau in Low's honor (Maly 1999:25-26). Ruddle-Spielman, who happens to be the granddaughter of Eben Low, explained that in 1969, she and her family members scattered her parents' cremation ashes from the Mauna Kea summit (Maly 1999:273-274). Kealoha Pisciotta also revealed that she brought her aunties' ashes to Mauna Kea (Orr 2004:52). Finally, Theodore "Teddy" Bell says that he wants his ashes to be scattered from the mountain (Maly and Maly 2006:A-293).

Undoubtedly, the scattering of cremation ashes today is a contemporary cultural practice that has taken the place of traditional interment practices. But debate ensues over whether this practice has evolved from traditional practices and beliefs or whether it is a new practice based on modern customs and beliefs. Pualani Kanaka'ole Kanahele explains that while the scattering of cremation remains on Mauna Kea may be viewed by some as non-traditional, she counters that notion saying: "it may not be the *iwi* [bones]

itself, but the ashes are the essence of what is left of the *iwi*. It doesn't matter, it's going back" (Maly 1999:A-377). On the contrary, in 1970, a woman identified solely as Kolokea C. testified before the Hawaiian Culture Committee of the Queen Liliuokalani Children's Center that when her brother died, she intended to have his body cremated. However, she was told by her 73-year old great-great-grandaunt that "cremation was *puhi i ka iwi* [bone burning]" and that cremation was an expressly prohibited by Kolokea's great-great-grandfather. This auntie recommended burial in the ground or at sea instead, as with a cremation "the body will be without peace." In the end, Kolokea C. decided to bury her brother (Pukui et al. 1972:106-107). Ms. Kanahele explains that cremation is an evolutionary development of a contemporary practice from an earlier traditional practice, whereas Kolokea C. concluded that cremation was non-traditional in learning of the traditional prohibitions of this practice. Nevertheless, while some Hawaiian scholars may suggest that cremation may historically have been a sign of disrespect, those Hawaiians who choose cremation in modern times do it as a respectful commitment to the loved ones, which is a traditional cultural practice and fundamental value based upon *'ohana*.

Piko Deposition

The cultural weight that Mauna Kea carries within the Hawaiian community is also evident in the phrase, "*piko kaulana o ka 'āina*," which translates as "the famous summit of the land" and is used as a term of endearment (Maly 1999:A-3). However, the phrase also expresses the belief that the mountain is a *piko* (the navel, the umbilical cord) of the island and for this reason it is sacred (Maly 1999:D-20). In this context, the significance of the cultural practice of transporting and depositing a baby's *piko* on Mauna Kea may be better understood. Pualani Kanaka'ole Kanahele explains the symbolic importance of this practice, saying that:

> "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 back to her mama and so on. So it takes it back, not only to the *wā kahiko* [ancient times], but all the way back 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 that *piko* and that child, but life again to the whole family." (Maly 1999:A-376)

Other Native Hawaiian cultural practitioners illustrate that for some families the practice of *piko* deposition on Mauna Kea is a long-standing traditional cultural practice. In 1956, Kaleohano Kalihi revealed that his grandfather had taken a gourd container "the *piko* of Mauna Kea. The place of the *punawai* [spring]..." which had been filled with 40 *piko* from "all of the people that had been born into this family" (Maly 1999:A-1). Kahili also mentioned that until he took the *piko* to Lake Waiau, his grandfather had "taken care of" those *piko*. Another practitioner, Elizabeth 'Tita' Lindsey Kimura, describes being a *piko* caretaker for her family – "I still have some of her *piko* that she [her mother] collected. Not collected, but when she goes to my sisters that have babies and the *piko hā'ule* [a *piko* that has fallen off], she'd pick it up and bring it home. ...yes, I have it in the *'ōmole* [bottle]...And I'm waiting for somebody to go up to Mauna Kea with it" (Maly and Maly 2006:A-217). One of Kimura's relatives, Irene Loeyland Lindsey-Fergerstrom, also confirms that she took her children's *piko* and the *piko* of her one of her relatives up to Mauna Kea (Maly 1999:390).

These cultural practitioners also provide insight into the proper means of practicing *piko* deposition. Irene Loeyland Lindsey-Fergerstrom recalls that "we put the *piko* in a little cotton and put 'em in a bottle. And sometimes it's hard to come out, so *kūkū* [grandmother] Laika said all you do is take the cover off and put it on the ground and it will just deteriorate" (Maly 1999:A-392). Also, when Lindsey-Fergerstrom took *piko* to Mauna Kea, her husband "dug a little hole and put the *piko* in...the summit" (Maly 1999:A-391).

Elizabeth 'Tita' Lindsey Kimura relates that her mother "was very particular...you don't just *hana kapulu* [to act carelessly or slovenly]...you got to treat it with respect" (Maly and Maly 2006:A-217). Kimura also says that the reason for taking the *piko* up to Mauna Kea is that the mountains is "neat" and "clean," practitioners "don't want any *kapulu*...in the discarding of the *piko*" (Maly and Maly 2006:A-217). It is clear that maintaining cleanliness and purity is an important component in this cultural practice. Kealoha Pisciotta explains that in light of some practitioners belief that Lake Waiau has become polluted, she fears that "people won't put the *piko* of the baby in there if it's polluted" (Orr 2004:45).

Pilgrimage, Prayer, Offerings, and the Spiritual Resonance of Mauna Kea

In public testimony before the Mauna Kea Advisory Committee, Ed Stevens ascribed Mauna Kea's spiritual significance to the fact that it is the highest point in Polynesia. Stevens states the mountain is significant "because it was considered to be the gateway to heaven. When the ancient *kāula* [priests, prophets] made their treks to the summit, it was to be nearest to *akua* where prayers could be offered in the highest reverence" (Maly 1999:C-10).

Instances of the cultural importance of Mauna Kea are related in several pilgrimages made to the mountain by royalty to partake in ceremonial practices in the late pre-Contact and early post-Contact periods. During the reign of Kamehameha I, fearing dissension amongst some of his chiefs, in the company of Kekuhaupi'o, the king is reported to have traveled to Mauna Kea to make a ceremonial offering close to Lake Waiau (Desha 2000:94 in Maly and Maly 2005:50). In 1881 or 1882, Queen Emma ascended Mauna Kea and at Lake Waiau, she swam across the lake, riding on the back of Waiaulima (Maly 1999:A-4, -5, -387; Maly and Maly 2005:158; de Silva and de Silva 2006). Queen Emma's swim across Waiau was a cleansing ceremony initiated in an effort to prove her genealogical connection to Wākea and Papa (Kanahele and Kanahele 1997:9 in Maly 1999:D-21).

In addition, some oral history interviewees reveal seeing offerings left on Mauna Kea in recent times. Libert Landgraf recalls seeing *pu'olo* (offerings) left at Lake Waiau and on the summit of Mauna Kea, which he describes as "a gift or something wrapped in *ti* leaves. My feeling of that is it has cultural, I don't want to go out on a limb and say religious, but it has a significant cultural significance...someone is taking a gift or presentation to a particular area." (Orr 2004:51) Other interviewees, including Rally Greenwell, Hisao Kimura, Coco Vredenburg-Hind, and Daniel Kaniho Sr., testify that they either saw or had heard that *'opihi* shells were present in the Mauna Kea adze quarry (Maly 1999:A-118, -260; Maly and Maly 2006:A-37, -215). Archaeologists theorize that because these *'opihi* shells are too few to be interpreted as the remains of food consumption activities, it is more likely that they were offerings to the *akua* (McCoy 1990:108).

Other oral history interviewees demonstrate the spiritual resonances of Mauna Kea in the following statements:

> Libert Landgraf – "I looked at sites, the area, as the church. ...In this instance maybe the summit of Mauna Kea represents to us what the church is, and the individual sites or the individual platforms is the altar." (Orr 2004:49)

> Kealoha Pisciotta – "This is a really hard issue for Hawaiian people, because Hawaiian people have really no temples. [They're] in the state or national parks....So Mauna Kea represents one of the last kind of places where the practice can continue. ...But for Mauna Kea, it's not a temple built by man. It's built by Akua..." (Orr 2004:49)

> Pualani Kanaka'ole Kanahele – "If you want to reach *mana*, that [the summit] is where you go." (Maly 1999:A-372)
>
> Pualani Kanaka'ole Kanahele – " Mauna Kea was always *kupuna* [an elder, ancestor] to use. ...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 it is there, and you don't need to go there. You don't need to bother it. ...And it was always reassuring because it was the foundation for our island." (Maly 1999:A-366)
>
> Florence La'i-ke-aloha-o-Kamāmalu 'Coco' Vredenburg-Hind oral history – "I don't think I could live anywhere else. I feel like it's right, I belong to the dirt, the soil....It just like they protect all of us. These mountains protect us." (Maly 1999: A-117, 120)
>
> Alexander Kanani'alika Lancaster – "My grandmother...she said, 'When you go up there, you going feel the spirit.' And you do feel the spirit." (Maly 1999:A-234)
>
> Tita Elizabeth Kauikeōlani Ruddle-Speilman – "Yes the *mana* is there. There is no question." (Maly 1999:A-286)

Clearly, these statements demonstrate that Mauna Kea continues to be viewed as a realm of great spiritual and sacred importance, a belief rooted in Hawaiian tradition.

5.2.4 Resource Extraction

Adze Quarrying and Stone Tool Manufacture

The presence of ancient adze quarries and stone tool workshops on Mauna Kea is well documented in archaeological investigations conducted since the 1970s, and is discussed in the historic properties section (section 5.4.2). Radiocarbon dates indicate that the quarry was utilized over a period of possibly as much as 700 years between ca. A.D. 1100 and 1800 (McCoy 1986:Figure 28; 1990:Figure 4). The time period the quarry was abandoned is unknown and may never be known with any certainty, but there is some evidence that it may have occurred as late as European contact in 1778 or shortly thereafter. No ethnographic information is available concerning traditional quarrying and manufacturing practices or beliefs.

Currently, however, it appears that the modern-day practice of adze collection is on-going, although cultural practitioners appear to have differing perspectives on appropriate collection protocols and whether collection should be taking place at all. For instance, Lloyd Case does not believe adze collection should take place whatsoever. Case states:

> "I think that what ever is there, should stay there. Because not only would it be a resource that people can go and see, what the old Hawaiians did and how things were. But if you take everything off of that mountain, and people keep taking things, you have nothing to show for our past." (Maly 1999:A-352)

On the other hand, Hannah Springer believes that if it can be demonstrated that the quarries lack potential for archaeological analysis, adze quarrying could be permitted. She expresses that she does not know how access could or should be regulated, but expects that if it were stipulated that practice be done in a traditional manner, not many individuals would engage in quarrying. Springer says:

> "Should there be fresh mining? I don't know if there's information that can still be extracted from the fragments that remain from past work done there. If already there has been tremendous removal of material, how valid is the data that remains? What sort of picture would we get from analysis of it? I cannot answer that. If it has relatively low value maybe we would want people to continue to mine an already tapped source. Hundred and eighty degrees away from that, I can't imagine how many people would make the effort if they had to go *kālai* [carve or cut] the *pōhaku* [stone]. So that might be self regulation, right there. To identify and designate an area where people could go. And again I don't know how you determine who's authentic to go up there." (Maly 1999:A-310)

Pualani Kanaka'ole Kanahele believes that adze quarrying should be permitted, but only if those quarrying can demonstrate a genealogical tradition of adze quarrying. She says:

> "I have two *mana'o* [opinion, thought] for that. One is, an old site should be approached...it depends on what you are taking it for. I can only say, 'Yes, take it if I see that you bring down the *ko'i* [adze] and you use it for something.' It has to be functional for you, and not just a show piece or something that you want to use commercially. ...So I am thinking that if you would go to an old place to mine the *ko'i*, then you need to show some kind of genealogy where your *kūpuna* also had that kind of function. So if your *kūpuna* were some kind of *kālai ki'i* [carvers of images] or *kālai wa'a* [canoe makers] or had some kind of function with the *ko'i*, if you have that...Because then it would make us stronger to know that you still have that and that you still continue this in some form. ...So it's not like saying, 'Oh you cannot, first you have to show us your genealogy.' No. 'Show us what your genealogy is because that makes you stronger, that makes us stronger, that brings *mana* to the place.' That it is still being continued by the *mo'opuna kuakāhi, kualua, kuakolu* [the great; great great great; and great great great grandchildren] of this *kūpuna*" (Maly 1999:A-373-374).

Modern-day adze collection and quarrying is a revival of a traditional cultural practice that has been modified to include the use of contemporary methods (such as the use of steel tools).

Bird Gathering and Canoe Making

Because the majority of Mauna Kea lies within an alpine desert exhibiting sparse vegetation historically, bird gathering and canoe making were restricted to the subalpine forested regimes on the lower slopes of the mountain. These lands, except for Hale Pōhaku and the road from Hale Pōhaku to the summit, do not lie within the UH Management Areas. According to Native Hawaiian testimony provided in Land Commission hearings and in ethnographic publications of the late 19th and early 20th centuries, within the māmane and ōhi'a forests, *kia manu* (bird catching) was practiced, with the aim of trapping various species for feather collection and for nourishment - *mamo*, *'ō'ō*, *apapane*, *i'iwi*, *ua'u*, *nēnē*, *kōloa*, *amakihi*, and *'ō'ū* (Maly and Maly 2005:32-40, 278-279). Likewise, it was only in the lower forest areas that *koa* grew and could be harvested for canoe-making. For instance, Johnny Ah San tells that 'Umi cut his *koa* for canoes at Pu'u Loa and that 'Umikoa Village was named on account of this (Maly 1999:A-91).

Waiau Water and Snow Collection

Little documentation exists that Hawaiians sought to collect water or snow in ancient times, yet Lloyd Case says that "they went there because that mountain has the power to heal and it still does...I've heard of the old ones getting water from Waiau to use for healing..." (Maly 1999:A-353). Presently, cultural

practitioners engage water and snow collection for ceremonial/medicinal purposes. Regarding the waters on the mountain, Anita Leilani Kamaka'ala Lancaster and Alexander Kanani'alika Lancaster explain that their family uses the "sacred water" of Waiau for baptisms (Maly 1999:A-246). And Kealoha Pisciotta states that "it's for medicine...all of these waters" (Orr 2004:45). However, concern surrounding the purity of Lake Waiau is also a factor influencing the contemporary practices of Lake Waiau water collection and snow collection on Mauna Kea. Some cultural practitioners believe that effluent from the observatories enters the aquifer and has caused the green coloration of Lake Waiau's water. Although scientific studies disprove the theory that effluent has in fact leached into the aquifer, Kealoha Pisciotta states that "we are not really trusting to take the water for the medicine anymore" (Orr 2004:45). Pisciotta states that because she is unsure about the purity of the Waiau waters, she gathers snow instead. In her words, "the snow along this ridge in here and by the lake, is what I was told is the snow to collect. It's powerful snow..." (Orr 2004:51).

Plant Gathering

Review of historic documentation does not reveal discussion of plant gathering on Mauna Kea as a traditional cultural practice. But, just as bird gathering and canoe making were restricted to the subalpine forested regimes of the mountain, any traditional plant gathering would likely have been restricted to those lower areas as well. Only one oral history interviewee reports utilizing plants in the forests on the lower Mauna Kea slopes for traditional medicinal purposes. Toshi Imoto explains that if he had a toothache, he would use leaves of the *'awa* plant to numb the ache. Also, Imoto says that the small blue flowers of the *'owi* were smashed up and applied to an area with a fractured bone (Maly 1999:A-36, 37).

Hunting

There is no evidence that hunting in the summit region was a traditional cultural practice. Available information indicates that it was not until the late 19th century and throughout the 20th century, following the introduction of numerous non-native ungulate species such as bullock (cattle), goats, and sheep that hunting for subsistence and for sport began on Mauna Kea. Following the *Māhele,* livestock was deemed the property of the King and the government, although private parties could apply for license to own and brand livestock (Maly and Maly 2005:270). Interestingly, government correspondence dating from 1850-1856 shows that illegal hunting activity by individuals was becoming problematic (Maly and Maly 2005:270-273).

In 1861, a legal dispute over hunting rights led to the decision that no hunting activities could take place on Mauna Kea, except for individuals who acquired leasehold interests in the mountain lands or who gained special permission to hunt (Maly and Maly 2005:274-277). In the years that the forested slopes of Mauna Kea were controlled by cattle ranching operations, Jess Hannah contends that one benefit of being employed as a ranch hand lay in one's ability to practice subsistence hunting. He says, "If you go hunting that was the main benefit because guys could go hunt pig, sheep, and all that. You could always eat" (Maly and Maly 2006:A-428). Dave Woodside, a former government naturalist, concurs and explains that it was only after the World War II era that public hunting on Mauna Kea lands was permitted. This managed hunting policy was developed in part because non-native goats and sheep were adversely impacting the forests and in part because individuals interested in sport and subsistence hunting organized to gain the right to hunt (Maly and Maly 2006:A-323-326). Indeed, Lloyd Case explains the importance of subsistence hunting to many ranch families, "a lot of my brothers and the old timers like David Hogan Kauwē, when they went out hunting, it was basically a hunt where each family took home so much of the meat so that everybody had meat" (Maly 1999:A-345).

5.2.5 Trail Systems

Although traditional accounts of trails upon Mauna Kea do not provide precise route information, they do suggest the presence of ancient trails through the summit region. A *mo'olelo* associated with chief Pili-a-Ka'aiaea, and thus dating from the 1300s, recounts the journey of two brothers, Ka-Miki and Maka-iole, who traveled around the island using ancient *ala hele* (trails). Sent up to the Mauna Kea summit, Ka-Miki was guided by the following traveling *mele:*

> *The path goes to the uplands*
> *The path goes to the lowlands*
> *It is a lonely path to the mountain*
> *A damp dreary path*
> *A fire will be the wrap*
> *Warming you along the sacred trail...*
> (Maly and Maly 2005:42)

Kamakau reports on a battle that ensued between 'Umi-a-Liloa and the chief of Hilo in the 1500s, wherein 'Umi-a-Liloa and his warriors traveled from Waipi'o to Hilo via Mauna Kea. Kamakau states that "it was shorter to go by way of the mountain to the trail of Poli'ahu and Poli'ahu's spring at the top of Mauna Kea, and then down toward Hilo. It was an ancient trail used by those of Hamakua, Kohala, and Waimea to go to Hilo." (Kamakau 1961:16 in Maly and Maly 2005:453). Maly and Maly (2005:454) contend that ancient trail systems across all the mountain lands afforded travel to burial sites and facilitated travel for the collection of resources like adze stone, canoe *koa*, and bird feathers.

The ancient trails were essentially footpaths, which, by the 1840s, proved inadequate for travel with the newly-imported horses, wagons, and wagon team animals associated with cattle ranching and bullock-hunting activities; hence, formal wagon road developments, funded by the Hawaiian Kingdom, ensued in the lowland mountain slope regions (Maly and Maly 2005:454). However, the mountain's summit region remained accessible only by trails, on foot or horseback. The difficulty of travel on the terrain by horse and on foot is well documented in historical accounts by European visitors and surveying expedition field notes. Formalized road developments continued in the lowlands into the early 20th century, with the CCC (Civilian Conservation Corps) and the U.S. Army Corps of Engineers improving existing roads, such as the Saddle Road, to accommodate vehicular traffic (Maly and Maly 2005:482). The first road from Hale Pohaku to the Mauna Kea summit was completed in 1964 and basically consisted of a jeep road.

Today there are two major named trails in the summit region of Mauna Kea, the Mauna Kea-Humu'ula Trail and the Mauna Kea-Umikoa Trail. The better known of the two, is the Humu'ula Trail which apparently began in the Kalaieha area where the Humu'ula Sheep Station is located. The earliest map showing the upper part of the trail was made by W.D. Alexander's survey party in 1892 (Alexander 1892; Preston 1895). The Alexander map and the 1930 edition of the USGS Mauna Kea Quadrangle map show the trail going around the eastern flank of Pu'u Keonehehee and onward up the mountain to Lake Wai'au. This alignment closely follows the modern road.

A new section of the Humu'ula trail was built by the CCC in the 1930s that took a straighter course to the west of Pu'u Keonehehee. The new trail was described by L. Bryan in a 1939 article in *Paradise of the Pacific*:

> During the past few years this lake has been visited by increasingly large numbers of visitors. Three years ago the Civilian Conservation Corp reconstructed an old trail from near the Humu'ula Sheep Station (Kalaieha), past Hookomo and Halepohaku to Lake Waiau and thence to the

> summit. This trail is well made and carefully marked on the ground with Ahus or piles of stones and the trip to the lake and on to the summit can easily be made by strangers without the assistance of a guide (Maly and Maly 2005:257).

The Umikoa Trail, which is labeled the Mauna Kea-Umikoa Trail on some maps, first appears as a named trail on the advance sheet of the Lake Waiau Quadrangle that was based on the mapping by J.O. Kilmartin in 1925-26. This trail, and the Mauna Kea-Humu'ula Trail are shown as terminating at Lake Waiau on the Kilmartin map. The absence of the Umikoa Trail on the 1892 map may be significant.

While many of the oral history interviewees expressed knowledge of the presence of trails upon Mauna Kea, it was only those cattle ranch employees (i.e. Toshi Imoto, Theodore Bell Sr., Sonny Kaniho, Daniel Kaniho Sr., L. "Rally" Greenwell, Kamaki Lindsey Jr., Hisao Kimura, and Jiro Yamaguchi) who demonstrated an intimate knowledge of the trail systems, which were heavily utilized for cattle drives (Maly 1999; Maly and Maly 2005). This circumstance is understandable – historically, those not in the employ of the cattle ranches were restricted from mountain slope access. As well, forest reserve employees (i.e. Johnny Ah San, David Woodside, and AhFat Lee) discussed their knowledge of the presence of the mountain trails (Maly 1999; Maly and Maly 2005).

5.2.6 Navigation/Orienteering

Kepā Maly notes in his collection of archival documentation on traditional practices that no specific references to *kilo hōkū* (observing and discerning the nature of the stars) upon Mauna Kea are present (Maly and Maly 2005:95). Maly speculates it is likely that *kilo hōkū* was practiced upon the mountain, as the gods and deities associated with the mountain are also embodied in the heavens, but such accounts are absent from the historical literature (Maly and Maly 2005:95). Libert Landgraf also says that he has "no personal knowledge of it," but he suspects "that it probably was a very good observation [point]" (Orr 2004:55). Lloyd Case says that he believes a platform, which he believes to have been a "navigational *heiau*" was present on the Mauna Kea summit. He states that "before the observatories were there, they had one when all the stones were piled up, kind of similar to some of the *heiau* at Mahukona" (Maly 1999:A-349).

In contrast to Maly's statement that there is an absence of evidence of traditional Hawaiian astronomical observations, cultural practitioner Kealoha Pisciotta believes that "the lake [Waiau] is like the navigation gourd," a concept which she learned from her auntie (Orr 2004:45). According to Pisciotta, her auntie also took her to the lake and when she did, Kealoha says "I could see clearly why she wanted to look into the lake. Because when you look into the lake, the whole heavens are reflected in it and it's just like the gourd that they carry on the canoe with the water and the *ane ane*" (Orr 2004:45).

Pisciotta states that *mo'olelo* passed down from her auntie describe solstice alignments with Mauna Kea, thus she believes that the solstices were marked from the Mauna Kea summit. Pisciotta emphasizes that she does not doubt the validity of *mo'olelo*, but she is interested in understanding how the solstice alignments work. Thus, she has concerns that the view plane from Mauna Kea has been diminished and obstructed by the leveling of *pu'u* and the erection of observatory domes (Orr 2004:54-55). Pisciotta reveals the importance of the solstice alignments by stating that "if you do not measure the solstice and the equinox, you cannot keep track of the sacred time. And if you don't know what year you're at, you don't know part of the *wā* or the epic period you're in, so you don't know where you are in the prophesy either" (Orr 2004:58-59). It is noteworthy that not only is Pisciotta interested in validating traditional Hawaiian astronomy techniques, she also holds a degree in physics and has worked as a telescope systems specialist at a Mauna Kea observatory.

On a similar note, Tita Elizabeth Kauikeōlani Ruddle-Spielman conveys the significance of the Mauna Kea view plane, but as a landscape viewed from the sea. She says:

> "It was so important when we used to go fishing with uncle Francis, I used to go with him. From Keawaiki. When we started out, he'd say 'Now watch the *pu'u* on the mountain.' And we'd go out, and that was my job to watch the *pu'u* as we went along. And as soon as a cloud came down to that certain *pu'u* we'd turn around and go right home again, because he knew that the ocean would change. It was anywhere that we went, whether we were going towards Kona or coming this side towards Kohala. He said 'You watch that *pu'u* and as soon as you see the clouds hug it, or heading towards it, let me know, because we are turning around and going home.' And he never failed. ....No, it was on the side, the slopes [not the *pu'u* near the summit, but on the slopes]. But he knew, and sure enough, by the time we got home, that wind would change, but we had gotten home safely. ...that is very important, this whole idea of line of sight, cultural landscape. So not only is it important close up on top, but as viewed from afar." (Maly 1999:A-282)

5.2.7 *Kapu* and Land Access Regulations

Following the settlement of the islands by Hawaiians, a system of land and resource management developed and evolved over time. Traditionally, Hawaiians divided their island landscapes into vertical management and resource zones (Maly and Maly 2005:12; NASA 2005:ii). These vertical divisions ran from mountain ridge summits to the ocean. The island of Hawai'i was vertically divided into six *moku* (districts), which were further sub-divided into *ahupua'a*, with each unit traditionally under the control of a Hawaiian *konohiki* (chief-landlords). Each *ahupua'a* was generally narrow "wedge-shaped pieces of land that radiate out from the center of the island, extending to the ocean fisheries fronting the land unit" (Maly and Maly 2005:12). Mauna Kea rested within Ka'ohe Ahupua'a (Hāmākua District) and Humu'ula Ahupua'a (Hilo District), but as Boundary Commission testimonies and surveys indicate, their boundary was contested in the post-Contact period (Maly and Maly 2005:278-392). These land divisions served to permit and regulate access to resources, following the traditional cultural code of *kapu*. The *ahupua'a* resources thus supported the *maka'āinana* (commoners) and the *ali'i* (chiefly class). Maly and Maly state that:

> "as long as sufficient tribute was offered and *kapu* (restrictions) were observed, the common people who lived in a given *ahupua'a* had access to most of the resources from mountain slopes to the ocean, needed to sustain life and culture. These access rights (*pono*) were almost uniformly tied to residence on a particular land, and earned as a result of taking responsibility (*kuleana*) for stewardship of the natural environment, and supplying the needs of one's *ali'i*." (Maly and Maly 2005:12)

It is of significance that when Native Hawaiians testified before the Boundary Commission regarding the disputed Ka'ohe and Humu'ula Ahupua'a boundaries, they describe landmarks representing boundaries because the consequence of trespass onto another's *ahupua'a* lands resulted in punishment. For instance, Nainoa, Waiki, Hanioa, and Kamohaiulu testified that if bird gatherers trespassed onto *ahupua'a* other than their own and were caught taking birds, said birds would be confiscated (Maly and Maly 2005:285, 291, 293, 295).

Further, the inland reaches of the island were horizontally divided into environmental and cultural zones, according to the access rights and restrictions of the *maka'āinana*. The *wao kanaka* was a low-lying coastal area where the *maka'āinana* were free to move and inhabit. The *wao kele* was the upland forested

area that the *maka'āinana* could only access for gathering purposes. The *wao akua*, which was believed to be inhabited by *akua*, was the subalpine desert region above the tree line. The *maka'āinana* were hesitant to venture into the *wao akua* and could do so only by offering prayer and displaying great respect (NASA 2005:3-18, 3-19).

Essentially, the Mauna Kea summit region lies within the *wao akua. Wao akua* can also be understood to mean "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" (PHRI 1999:24). Indeed, when Rev. William Ellis toured the island in 1823, he noted the reluctance of Native Hawaiians to venture into the summit areas of Mauna Kea.

> " ...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)

Today, the *ahupua'a* system of land and resource management, with *kapu* restrictions, is no longer in existence legally, due to the collapse of the *ali'i – maka'āinana* social and cultural system. Still, knowledge of the some traditional *kapu* restrictions endures, although both traditional and contemporary cultural practices and belief are apparent. One cultural practitioner, Pualani Kanaka'ole Kanahele reveals traditional knowledge of *kapu* restrictions and her traditional cultural practice regarding entering *kapu* areas. She learned from her *kūpuna* that the forested regions are not the realm of humans; instead, the forest's *kupa* (citizens) are the trees. Kanahele says that "when I go *maha'oi* [intrude] in their realm, I have to ask permission to be up there" (Maly 1999:A-371). In a similar sense, Irene Loeyland Lindsey-Fergerstrom reveals, in the context of taking *piko* up to the Mauna Kea summit, that her *tūtū* (grandmother) had knowledge of the *kapu* restriction that only *ali'i* were permitted on the summit. Yet, Lindsey-Fergerstrom's *tūtū* instructed her to take her family's *piko* to the summit anyways, saying "it's not like we going be *ali'i*, but at least you can try..." (Maly 1999:A-390).

5.3 Historical Background

There are several studies that provide information on the cultural and historical significance of Mauna Kea. Holly McEldowney (1982) compiled a comprehensive summary of previous cultural and historical research, based on a review of early journal accounts and maps, ethnographic collections, and the Boundary Commission Book for Hawai'i. More recent research by Kepā Maly (1999) and Charles Langlas (Langlas et al. 1997; Langlas 1999) used oral interviews as well as archival research to study the cultural and spiritual significance Mauna Kea for modern Hawaiians. A study by Maly and Maly (2005) that was commissioned by OMKM and entitled *Mauna Kea—Ka Piko Kaulana o Ka 'Aina* (Mauna Kea—the Famous Summit of the Land) is a compilation of native traditions, historical accounts, and oral history interviews concerning Mauna Kea and surrounding lands.

The cultural background and history of the Mauna Kea summit area can be examined in terms of three periods: 1) the Pre-Contact Period, before 1778; 2) the Post-Contact Period, from 1778 to the beginning of the 20th century; and 3) the Modern Period, from the beginning of the 20th century onward.

5.3.1 Pre-Contact Period

There is little information on Hawaiian use of the upper elevations of Mauna Kea in the Pre-Contact Period, prior to 1778; however, it is known that the area was exploited for uses such as bird catching, collecting material for adze and canoe making, and for burial of the dead. It is thought that because of the extreme sacredness of the summit area, few ancient Hawaiians ventured there, and because of the high altitude it would have been too cold for agriculture and permanent habitation. According to McCoy and McEldowney (1982) shrines at the edge of the summit plateau may signify the boundary of a "spiritual zone."

5.3.2 Post-Contact Period

The Post-Contact Period spans 1778 to the beginning of the 20th century. As would be expected, there is more information concerning the early impacts of Western culture on Hawaiian culture for the areas of denser population than for more remote areas, such as the upper regions of Mauna Kea. It is known, however, that soon after the arrival of Captain James Cook, in 1778, Hawaiians began to take up more Western ways. In areas of the most intense contact with Westerners, such as trading centers, Hawaiians rapidly took up the use of Western tools, clothing, and other items, with the *ali'i* being the first to do so.

The first European known to have ascended Mauna Kea was Reverend Joseph Goodrich, in 1823 (Goodrich 1833). During that same year, Dr. Abraham Blatchley and Mr. Samuel Ruggles, also went to the top (Skinner 1934). Other early visitors included botanists James Macrae in 1925 and David Douglas in 1934 (Wentworth 1935). Maly and Maly (2005) detail other early visits to Mauna Kea, including expeditions to the summit. "By the early 1820s, foreign visitors, in the company of native guides, began making trips across the *'āina mauna* and to the summit of Mauna Kea" (Maly and Maly 2005). On a scientific expedition in 1892, the Preston and Alexander party recount being shown a pillar of stones that was raised to commemorate Queen Emma's journey over the mountain in 1883 (Maly and Maly 2005). There are numerous printed accounts of scientific expeditions to the summit in the late 1800's and early 1900's. Two geologists who studied Mauna Kea in the early 20th century wrote that

> There have doubtless been many unrecorded visits to the summit of Mauna Kea since Goodrich's time. Indeed, it is probable that fifty or more years ago, when ranch operations were of relatively greater importance and the old Makahalau–Keanakolu trail was in general use as a route from Kawaihae and Waimea to Hilo, the upper slopes of the mountain were more generally known to the residents of Hawai'i than they are today (Gregory and Wentworth 1937).

5.3.3 Modern Period

During the Modern Period, land use on Mauna Kea changed markedly. As the 20th century began, large flocks of feral sheep were devastating the forests on the mountain, and in the 1930s, prompted by the extreme damage, the Civilian Conservation Corps (CCC) undertook a large fencing project. At about the same time, the CCC worked to improve roads and was building facilities for visitors to the mountain. The CCC also worked on improvements to what was probably the Mauna Kea–Humu'ula Trail, from the vicinity of the Humu'ula Sheep Station, at Kalaieha, to the summit (Bryan 1939). At about the same time, the CCC also built a stone cabin at Hale Pōhaku, which gained its name (house of stone) from that structure (Bryan 1939). The cabin at Hale Pōhaku provided a shelter for overnight hikers and snow players (McCoy 1985).

In 1943, construction of a road from Hilo to what would become the Pōhakuloa Training Area began. After the end of World War II, the Saddle Road, as it was called, was extended to Waimea, greatly improving access to the south side of Mauna Kea. In 1964, the first road to the summit, a "jeep road" was

completed, and in July of that year, the Lunar and Planetary Station, located on the summit of Pu'u Poli'ahu was opened (Group 70 International 2000). The jeep road was improved in 1970, allowing much easier access to the summit. The easier access brought private and commercial users. Current activities and uses of the Mauna Kea summit region, including on-going cultural practices, are described in Section 5.1.3 and Section 6.

5.4 Historic Properties and Archaeological Resources

5.4.1 Brief History of Archaeological Investigations in the UH Management Areas

Numerous archaeological surveys and field work have been conducted in the UH Management Areas (see Table 5-1 and Table 5-2).

Table 5-1. Summary of Archaeological Surveys and Fieldwork in the UH Management Areas

Year	Project	Survey Type	New Sites	Reference
1975-76	NSF Research Project on the Mauna Kea Adze Quarry	Reconnaissance and inventory	3	(McCoy 1977)
1981	Kitt Peak National Observatory	Reconnaissance	0	(McCoy 1981)
1982	Hawaii Institute for Astronomy	Reconnaissance	21	(McCoy 1982a)
1982	Caltech Telescope	Reconnaissance	0	(McCoy 1982b)
1983	Mauna Kea Observatory Power Line	Reconnaissance	0	(Kam and Ota 1983)
1984	NSF Grant-in-Aid Survey	Reconnaissance	21	(McCoy 1984)
1987	Summit Road Improvement	Reconnaissance	0	(Williams 1987; McCoy 1999b)
1988	VLBA Telescope	Reconnaissance	3	(Hammatt and Borthwick 1988)
1990	Subaru Telescope	Reconnaissance	0	(Robins and Hammatt 1990)
1990	Gemini Telescope	Reconnaissance	0	(Borthwick and Hammatt 1990)
1991	Pu'u Makanaka	Reconnaissance	1	McCoy field notes
1992	Smithsonian Astrophysical Observatory	Relocation of two known sites	0	(McCoy 1993)
1995	SHPD site relocation and GPS recording	Reconnaissance	18	(McCoy 1999a)
1997	SHPD transect survey	Reconnaissance	29	(McCoy 1999a)
1999	SHPD survey of Pu'u Wekiu	Reconnaissance	1	(McCoy 1999a)
2005	PCSI survey of the Science Reserve	Inventory	12	(McCoy et al. 2005)
2006	PCSI survey of the Science Reserve	Inventory	73	(McCoy and Nees 2006)

Table 5-2. Summary of Archaeological Investigations at Hale Pōhaku

Year	Project	Investigation	Reference
1979	Hale Pōhaku Mid-Level Facilities Complex Development Plan	Reconnaissance survey	(McCoy 1979)
1984-85	Supplemental EIS for Construction Laborer Camp	Reconnaissance survey	(McCoy 1985)
1986	HELCO transmission line and substation	Reconnaissance survey	(Bonk 1986)
1987	HELCO transmission line and substation	Reconnaissance survey	(Sinoto 1987)
1987	HELCO substation and surrounding area	Data recovery	(McCoy 1991)
1990	Japan National Large Telescope Dormitories	Reconnaissance Survey	(Robins and Hammatt 1990)
1993	Japan National Large Telescope Dormitories	Data Recovery	(Hammatt and Shideler 2002)
2005	Septic Tank Excavations	Monitoring	(McCoy 2005)

5.4.2 Summary of Historic Property Types

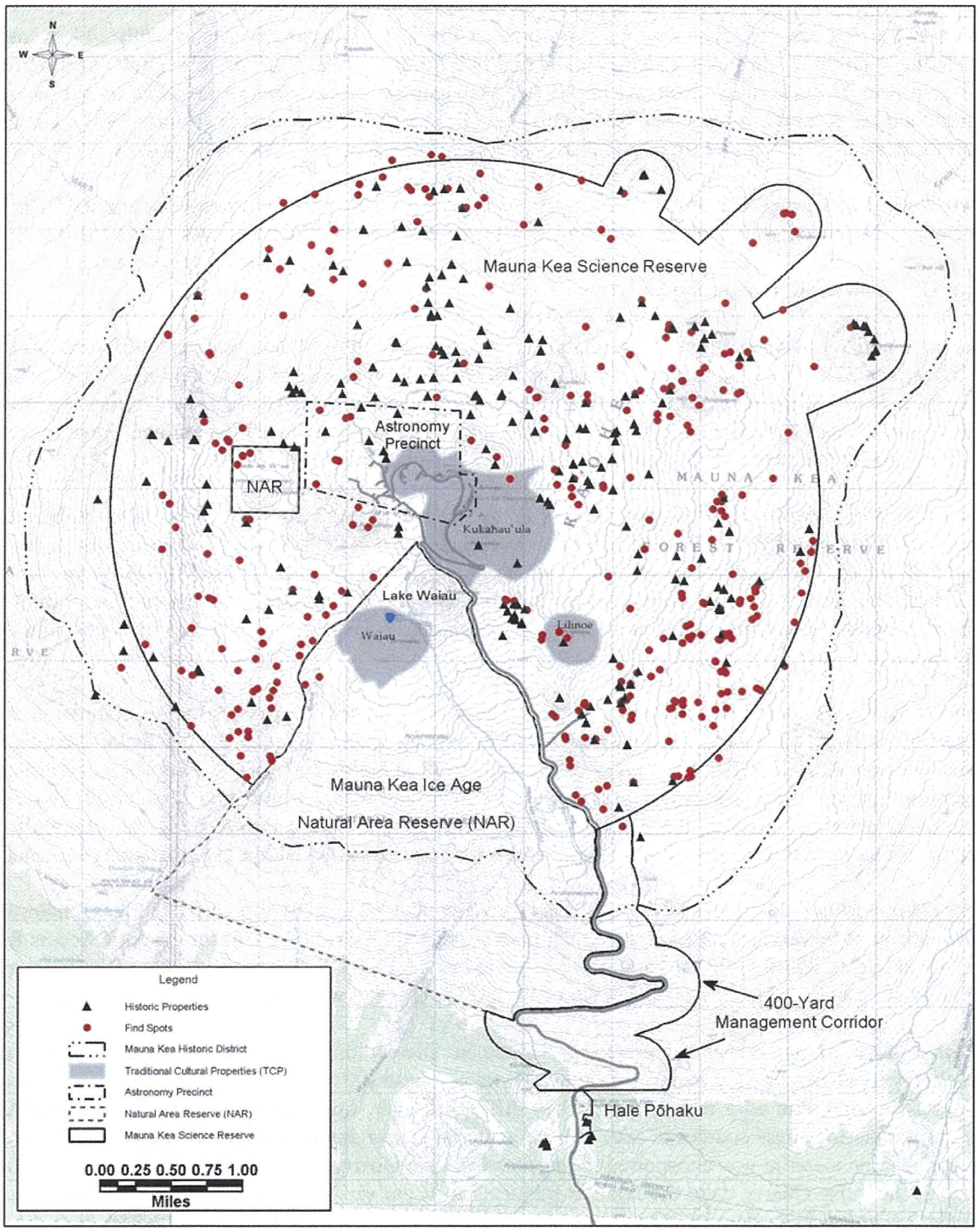
Archaeological surveys and field work within the UH Management Areas have identified and recorded 223 historic properties (see Table 5-3 and Figure 5-1) (McCoy and Nees, in prep). All of these properties are located within the Science Reserve with the exception of one located within Hale Pōhaku. Most of the 223 identified sites are single-feature sites. Early surveys in the Science Reserve identified only four site types, but recent work identified seven additional types, bringing the total to eleven. The site types are discussed below.

Table 5-3. Site Types in the UH Management Areas[2]

Site Type	Number	Percent Total
Traditional Cultural Properties	2	0.90
Shrines	149	66.81
Burials and Possible Burials	26	11.66
Stone Tool Quarry/Workshop Complexes	2	0.90
Adze Quarry Ritual Center	1	0.44
Isolated Adze Manufacturing Workshops	17	7.62
Isolated Artifacts	3	1.35
Stone Markers/Memorials	10	4.50
Temporary Shelters	3	1.35
Historic Campsites	1	0.44
Unknown Function	9	4.03
TOTAL	**223**	**100%**

[2] Source: McCoy and Nees, in prep.

Figure 5-1. Historic Sites, Find Spots and Traditional Cultural Properties in the UH Management Areas



Source: McCoy and Nees in prep

In 2000, SHPD designated three areas on Mauna Kea as Traditional Cultural Properties (TCPs) (Group 70 International 2000). Within the Science Reserve were Kūkahau'ula and Pu'u Lilinoe. Lake Waiau, in the adjacent Mauna Kea Ice Age Natural Area Reserve, was also designated a TCP. SHPD cited association with legendary figures and ongoing cultural practices in the designation of the three TCPs.

Shrines: Shrines are the most common site type in the UH Management Areas, with 149 examples (including "possible shrines") making up about two-thirds of the total of 223 sites. The defining characteristic of the shrines identified in the UH Management Areas was the presence of one or more upright stones. Kenneth Emory was the first to describe shrines on Mauna Kea (Emory 1938). He noted their Polynesian affinities and suggested that each upright represented an individual god.

Two classes of shrines are posited, "occupational specialist" shrines and "non-occupational" shrines. Occupational specialist shrines are distinguished by associated lithic scatters and context. Both shrine types are variable in ground plan and in the number of uprights, and "...are in this regard no different from Hawaiian shrines in general".

The large number of shrines located around the base of the summit of Mauna Kea is part of what has been characterized as a "ritual landscape." The number of shrines suggests that summit region became, at some point in time, a "pilgrimage center" (McCoy 1990, 1999a). The pilgrimages are interpreted to have been part of pre-contact Hawaiian worship rituals involving the snow goddess, Poilahu, and other mountain gods and goddesses such as Kūkahau'ula, Lilinoe and Waiau (McCoy 1982, 1990).

Burials and Possible Burials: Twenty-six sites in the Science Reserve have been interpreted as burials or possible burials, and they are the second most common site type in the UH Management Areas. Several of the sites are on Pu'u Makanaka as confirmed by the 2005-2007 study. Possible burials are strongly evidenced by factors such as their topographic location and morphology, but cannot be definitively termed burials because no human remains were observed. No burials have been identified within the Astronomy Precinct.

Stone Tool Quarry/Workshop Complexes: Two kinds of stone tool quarry/workshop complexes were identified in the UH Management Areas, one each in the Science Reserve and Hale Pōhaku (McCoy and Nees, in prep). At Hale Pōhaku, the Pu'u Kalepeamoa site is a multi-function site complex that consists of several temporary camp sites where manufacture of adzes and octopus-lure sinkers occurred, as well as ceremonial activity (based on the presence of two shrines). This site complex is, so far, thought to be unique. No stone tool quarry/workshop complexes have been identified within the Astronomy Precinct.

Adze Quarry Ritual Center (Keanakāko'i): This site (Site 50-10-23-16204) comprises shrines, enclosures, and a scatter of by-products of adze manufacture. It is located on a ridge east of the Summit Access Road slightly above 12,250 ft (3,733 m) and was interpreted by McCoy (1999b) as the "locus of initiation rites for apprentice adze makers". The Adze Quarry Ritual Center is not within the Astronomy Precinct.

Isolated Adze Manufacturing Workshops: Seventeen sites within the Science Reserve have been tentatively identified as adze manufacturing workshops. These sites are characterized by the presence of debris associated with adze manufacture. They differ, however, from the workshops found in the Adze Quarry in that no natural sources of adze-making material is near any of the sites, and with a few possible exceptions, the material was transported to the sites from the Quarry. Also distinguishing these sites from those in the Adze Quarry were the relative frequencies of the various artifact classes. For example, the number of unfinished adzes in some sites was disproportionate to the number of flakes, in a manner suggesting that most of the manufacture had been done elsewhere. It has been suggested by some that

manufacture at these sites was ceremonial in nature. Several of these sites also contain shrines with lithic debris on or near them, similar to shrines in the Adze Quarry that have been interpreted as "offerings to the tutelary gods of adze making" (Malo 1951; McCoy 1990; McCoy 1999b). The sites are considered highly significant for information value. None of these isolated adze manufacturing workshops are within the Astronomy Precinct.

Isolated Artifacts: A number of different types of isolated artifacts have been identified within the UH Management Areas (McCoy and Nees, in prep).[3] All of the isolated artifacts identified within the Science Reserve are contained within the boundaries of the proposed Mauna Kea Summit Region Historic District, which has been determined to be eligible for inclusion in the National Register of Historic Places.

Stone Markers/Memorials: These artifacts include cairns, mounds, and less formal piles of rocks placed on boulders (McCoy and Nees, in prep). Elaborate examples are cylindrical and faced. Some of them are modern in origin. Nine sites within the UH Management Areas fall within this type, but this figure could change upon further analysis on the interpretation of whether they are historic or modern. Functional site types in this group include trail marker and ceremonial. Sites of this type are morphologically distinct from burial markers.

Temporary Enclosures: Enclosures consisting of crude stone walls were identified in various locations within the Science Reserve. Most of these were found in association with lithic scatters (McCoy and Nees, in prep). They were interpreted as temporary shelters based on morphology and environmental setting. No datable materials were found in association with these sites, but they are estimated to be late Prehistoric or Historic in age.

Historic/Modern Campsite: In 2007, near Pu'u Mahoe, a campsite occupied by a USGS survey team in 1926 was identified. A possible USGS campsite was also identified near Pu'u Makanaka, just outside the Science Reserve (McCoy and Nees, in prep).

Unknown Function: Nine sites of uncertain or unknown function were identified, including the only site known on the summit. Three of the sites were possible markers consisting of cairns or piles of rocks. One site was a terrace with a possible upright that may be an unfinished shrine.

5.4.3 Site of Unknown Modern Origin

Within the UH Management Areas, there are a large number of sites that do not meet the criteria for classification as sites, as normally defined under state and federal guidelines. Nonetheless, according to King (1998), these should be considered when formulating management strategies for the mountain, because all cultural resources should be considered. Termed "find spots" (formerly "locations"), these remains generally refer to isolated sites that are obviously modern or features that cannot be confidently classified as historic because they are of uncertain age or function. A total of 21 find spots were recorded in 1997; however, only 11 of these were relocated during the fieldwork conducted between 2005 and 2008. The total number of find spots found during both surveys is 336 (McCoy and Nees, in prep). The determination whether these "find spots" constitute "cultural resources" is a matter more appropriately delegated to Kahu Kū Mauna in consultation with families with lineal and historic connections to Mauna Kea, *kūpuna*, cultural practitioners, and the Office of Hawaiian Affairs other Native Hawaiian groups.

[3] It must be noted, however, that the distinction between a site and an isolated artifact is arbitrary.

5.4.4 Proposed Mauna Kea Summit Region Historic District

In 1999, during preparation of the master plan for the Science Reserve, SHPD proposed that the cultural landscape at the Mauna Kea summit be designated as the Mauna Kea Summit Region Historic District. The individual sites described in the preceding sections are all considered contributing properties within this district. The proposal for the historic district was summarized in the cultural impact assessment for the 2000 Master Plan (PHRI 1999) and was discussed in depth during planning for the Keck Outrigger project (Hibbard 1999; NASA 2005). Interested parties on the summit, including NASA and IFA agreed that the proposed district would include all of the Science Reserve, the Natural Area Reserve, and other lower-elevation locations and that, as proposed, the district meets the eligibility requirements for inclusion on the National Register of Historic Places.

5.5 Natural Resources

Rising 30,000 feet above the sea floor, Mauna Kea is the highest insular volcano in the world (NPS 1994). It is home to numerous unique geologic features and a truly awe inspiring natural environment. Revered by Hawaiians for centuries, Mauna Kea still evokes feelings of spirituality from its visitors through majestic views and a landscape that reflect the volcanic history of our planet. Seemingly barren, desolate, and unchanging, the natural environment of the upper slopes and summit area are actually very much alive, revealing through its topography, geology, and climate an impressive history of geomorphic process and ecosystem development.

5.5.1 Physical Resources of Mauna Kea

The discussion in this section covers the area under management as three geographic zones: Hale Pōhaku; the upper slope zone, the area extending from roughly 9,000 to 12,800 ft (2,700 to 3,900 m); and the summit area, lands located above 12,800 ft (3,900 m).

Geology

The Hawaiian Archipelago exists due to the west-northwest movement of the Pacific Plate, over a "hotspot" (mantle plume) that is the source of magma creating the Hawaiian Islands. As the Pacific Plate moves slowly over the mantle plume, volcanoes spring up, formed by the repeated discharge of magma. The advance of the plate eventually moves the volcano off the plume, cutting off the source of magma, but at a rate so slow that the deposited cooled magma creates a mountain we identify as a volcano. About 129 different Hawaiian volcanoes have been formed this way, stretching 3,800 miles (6,000 km) across the Pacific Plate (Walker 1990; Juvik and Juvik 1998).

Hawai'i's volcanoes do not usually erupt explosively, and instead produce relatively slow-moving lavas that build up locally, forming rounded peaks. These are called shield volcanoes. Mauna Kea is the third oldest, and highest, of the five volcanoes composing the Island of Hawai'i.

Mauna Kea has completed the submarine, emergent, and shield building stages of the Hawaiian volcanoes life cycle and is now in the post-shield stage (Wolfe et al. 1997). Close to 95 percent of Mauna Kea's mass was generated during the shield stage, and comprises primarily tholeiitic basalts, none of which are visible at Mauna Kea's summit, today (Sherrod et al. 2007). Lavas and other ejecta discharged during the current post-shield stage are primarily alkalic in composition and have been divided into two sub-stages, the Hāmākua and the Laupāhoehoe Volcanics, the Hāmākua being the earlier of the two (Macdonald et al. 1983; Wolfe et al. 1997; Sherrod et al. 2007). The Laupāhoehoe, and to a lesser extent the Hāmākua lava and tephra deposits, are the most visible on the surface of the summit area and cover

the older shield-stage basalts (Porter 1979b; Sherrod et al. 2007). The post shield stage also included an explosive period producing highly vesicular materials such as ash, lapilli and cinder (often termed scoria). Once ejected, finer particles such as ash were transported downwind, falling on the landscape in layers of significant depth (Porter 1997). Heavier and denser products such as lapilli and cinder, falling close to the source, formed the massive cinder cones seen today across Mauna Kea's surface.

Mauna Kea is currently estimated to be between 600,000 and 1.5 million years old (Moore and Clague 1992; DePaolo and Stolper 1996; Wolfe et al. 1997; Sharp and Renne 2005) and is considered by the U.S. Geological Survey (USGS) to be an active post-shield volcano (U.S. Geological Survey 2002). While there has been no recent volcanic activity at Mauna Kea, volcanologists believe that it "is likely to erupt again" (Walker 1990; U.S. Geological Survey 2002). It is expected, however, that any future volcanic activity at Mauna Kea will be prefaced by seismic activity and that erupted materials will resemble the thick and sticky lava flows of its more recent past (Lockwood 2000).

The formation of cinder cones, the movement of ice sheets, and the interaction of lava and ice has shaped much of the summit area. Probably the most significant naturally-occurring geomorphic contributor to alteration of the summit landscape since the decline of post-shield volcanic activity has been the series of glacial events that occurred between approximately 180,000 and 13,000 thousand years ago (Porter 1979a, 2005; Sherrod et al. 2007). Within the last several hundred thousand years, the summit of Mauna Kea is believed to have been covered by three glaciers (Lockwood 2000). Evidence of these glacial events includes till and moraines, glacially polished rock surfaces, lava-ice contact zones, and hydrologic features such as Pōhakuloa Gulch. These can be seen throughout the Science Reserve and within the neighboring Mauna Kea Ice Age NAR. Today, erosion processes are occurring across the landscape. In addition, Mauna Kea's significant mass induces subsidence at a rate of approximately 0.12 in/yr (3 mm/yr), or 1,312 ft (400 m) in 130,000 years (Wolfe et al. 1997; Sharp and Renne 2005).

Topography

Mauna Kea formed through the accumulation of large volumes of lava from a series of volcanic eruptions. The morphology of the upper flanks and summit area of Mauna Kea was subsequently altered by the post-shield eruptions of the Hāmākua and Laupāhoehoe Volcanics. Explosive eruptions that deposited tephra more or less symmetrically around the vents were typical of this volcanic period and formed the *pu'u* that dot the landscape. This period of volcanism also coincided with the presence of glaciers on the upper mountain. When ejected lavas met the glacial ice, they were cooled immediately, creating an explosive eruption called a pyroclastic event. Products of these events included extremely fine particles (tuff) and ash. Lava and ice interaction is also responsible for the lava outcrops associated with the adze quarries (Bayman and Nakamura 2001; Bayman 2004), as well as the massive volumes of melt water believed to have carved features such as Pōhakuloa Gulch (Macdonald et al. 1983; Lockwood 2000; Porter 2005). The combination of these factors resulted in the unique and varied geomorphic features of Mauna Kea, none of which would have been formed had the glaciers not been present.

Mauna Kea Science Reserve: The Science Reserve encompasses 11,288 acres (4,568 hectares), from its boundary, which encircles the mountain at approximately 11,500 ft (3,505 m) to the summit of Pu'u Wēkiu, at 13,796 ft (4,205 m).

Classified as semi-arid, barren alpine-desert tundra (Mueller-Dombois and Krajina 1968; McCoy 1977; McCoy and Gould 1977; Ziegler 2002), and dotted with isolated lava outcrops and boulders, the upper slopes and summit area are sparse, rough landscapes dominated by exposed rock with little soil cover or vegetation. A combination of coarse gravel to cobble-sized pieces of cinder and lava covers the ground

surface of most of the summit area. Lava flow outcrops are scattered throughout the Science Reserve, poking out from layers of cinder, till, and a slowly increasing coating of finer particles as one descends the mountain. Many of these outcrop formations are the result of lava erupting under the icecaps of the glacial periods.

The summit area, which includes elevations from approximately 12,800 ft (3,900 m) to the tops of the highest cinder cone, encompasses a large, nearly flat plateau of remnant lava flows that were subsequently sculpted by glaciers. Cinder cones of various sizes jut up above the upper reaches of the mountain and dominate the summit landscape (Wolfe et al. 1997). Cinder cones typically have steep slopes, averaging approximately 25–27 degrees along both their outer and inner faces (Porter 1972). The largest cone, Pu'u Makanaka has a basal diameter greater than 4,000 ft (1,219 m) and is more than 600 ft (183 m) high (Macdonald et al. 1983); however, most of the cones are between 656–1,969 ft (200–600 m) wide and 98–328 ft high (30–100 m) (Porter 1972).

Cinder cones are the dominant geologic feature across the summit, including the outer slopes (Porter 1972; Wood 1980; Wolfe et al. 1997). Areas that were capped by lava flows at the summit plateau are relatively flat and dark grey to black in color, with a low albedo.[4] Exposed outcrops of moraine and till from glacial icecaps are composed of poorly sorted cobbles, rocks, and boulders (Wolfe et al. 1997). Rills and small gullies incising the flanks of Pu'u Poli'ahu, Pu'u Waiau, and other cones indicate a naturally altered subsurface layer that is less porous and more prone to runoff resulting in erosion, as compared to cones containing porous cinder materials from the ground surface to significant depths (Wolfe et al. 1997).

The cool, dry climate, a general lack of vegetation, and the high elevation topography limit soil formation in the summit region of Mauna Kea. The Department of Agriculture Natural Resources Conservation Service (NRCS), which houses the national soil survey, does not list any soils at the summit of Mauna Kea (Sato et al. 1973).[5] However, isolated pockets of weathered geologic formations, including volcanic lavas, ash, glacial till, and other materials that have soil-like properties such as horizons, have been found within the summit region. These isolated pockets provide a growth medium for sparse grasses and shrubs in the Science Reserve.

Hale Pōhaku: The approximately 19-acre (7.7 ha) Hale Pōhaku parcel, located at 9,200 ft (2,804 m) is situated at the base of Mauna Kea's upper slopes. There are three *pu'u* in the vicinity of Hale Pōhaku: Pu'u Kilohana, Pu'u Hawaihine and Pu'u Kalepeomoa. The slopes of cinder cones near Hale Pōhaku contain larger fragments than those on the summit and are dusted with fine-grained aeolian particulates. The ground surface of the lower-elevation Hale Pōhaku facilities area is covered with small cinder and lava rock particles that have accumulated to several centimeters deep in some locations.

Unique Geologic Features

Five physiographic variables, volcanic, glacial, fluvial, aeolian, and meteorological, are responsible for the unique geological features we see today on Mauna Kea. The most significant processes are volcanism and glaciation—and the interaction of the two some 10,000 years ago. These processes resulted in a landscape whose surface textures range from relatively smooth and free of large particles, to areas of broken lavas composed of *a'ā* chunks and other large rock material, to cinder cones with uniform surface

[4] Albedo refers to the ratio of sunlight that is reflected off a surface. It is dimensionless and ranges from zero on a dark-colored object to one for a light-colored object.

[5] See also: http://www.hi.nrcs.usda.gov/soils.html

particle size and relief. Figure 5-2 illustrates the location of unique geological features in the Mauna Kea summit region.

Cinder Cones: Mauna Kea contains more than 300 large cinder cones (Porter 1972). Wolfe and others (1997) mapped 23 cinder cones within the area of the Science Reserve, including four within the Mauna Kea Ice Age NAR; Porter (1979b) shows 25. Cinder features most commonly formed during both the basaltic Hāmākua and the younger alkali Laupāhoehoe post-shield eruptions (Macdonald et al. 1983; Juvik and Juvik 1998). In many instances, extremely thick, sodium-rich flows of ʻaʻā (Macdonald et al. 1983; Wolfe and Morris 1996) erupted from cinder cones, often emerging through lower portions of the cone (Porter 1972). Lava dikes that did not reach the surface would form part of the cone's inner structure (Macdonald et al. 1983). Subsurface investigations during construction in Puʻu Hauʻoki revealed deposits of cinder at least 130 feet (40m) below the surface (University of Hawaiʻi Institute for Astronomy 2002). This gives the impression that for at least some cones, a large portion of the volume may be composed of only light-weight pyroclastic material and not lava flows.

Hawaiite Outcrops: Hundreds of outcroppings of hawaiite, the highly prized tool-making material of the Mauna Kea adze quarries were formed approximately 70,000 to 150,000 years ago as a result of the interaction of glacial ice and hot lava (Porter 1979a; Sherrod et al. 2007). The outcrops lie between elevations of 8,600 and 11,130 ft (2,622 and 3,393 m) (McCoy 1977; Bayman and Nakamura 2001). They are not continuous, and not all outcroppings are of similar adze-making quality (Bayman and Nakamura 2001).

Till and Moraines[6]: Glaciers slowly eroded large amounts of lava and tephra material from their upper reaches on Mauna Kea and transported this material down slope. Most of this eroded debris (till) is deposited at the bases of the glaciers as an uneven ridge called a terminal moraine. Moraines stretch over acres of land around the summit and mark the extent of glacier advance (Wentworth 1935; Wolfe et al. 1997; Porter 2005). Till blankets much of Mauna Kea's summit above 11,000 ft (3,353 m), while some terminal moraines are found as low as 9,842 ft (3,000 m) (Porter 1979a) and are as thick as 130 ft (40 m) (Wolfe et al. 1997).

Glacially polished rock surfaces: Glacially polished lava outcrops are found throughout the Science Reserve and Mauna Kea Ice Age NAR. Marks on rock outcrops, such as ground-in striations and "chatter marks" (fine-scaled curved cracks), as well as smooth-polished rock, tell of the immense weight and force of the ice sheets as they moved across the summit plateau.

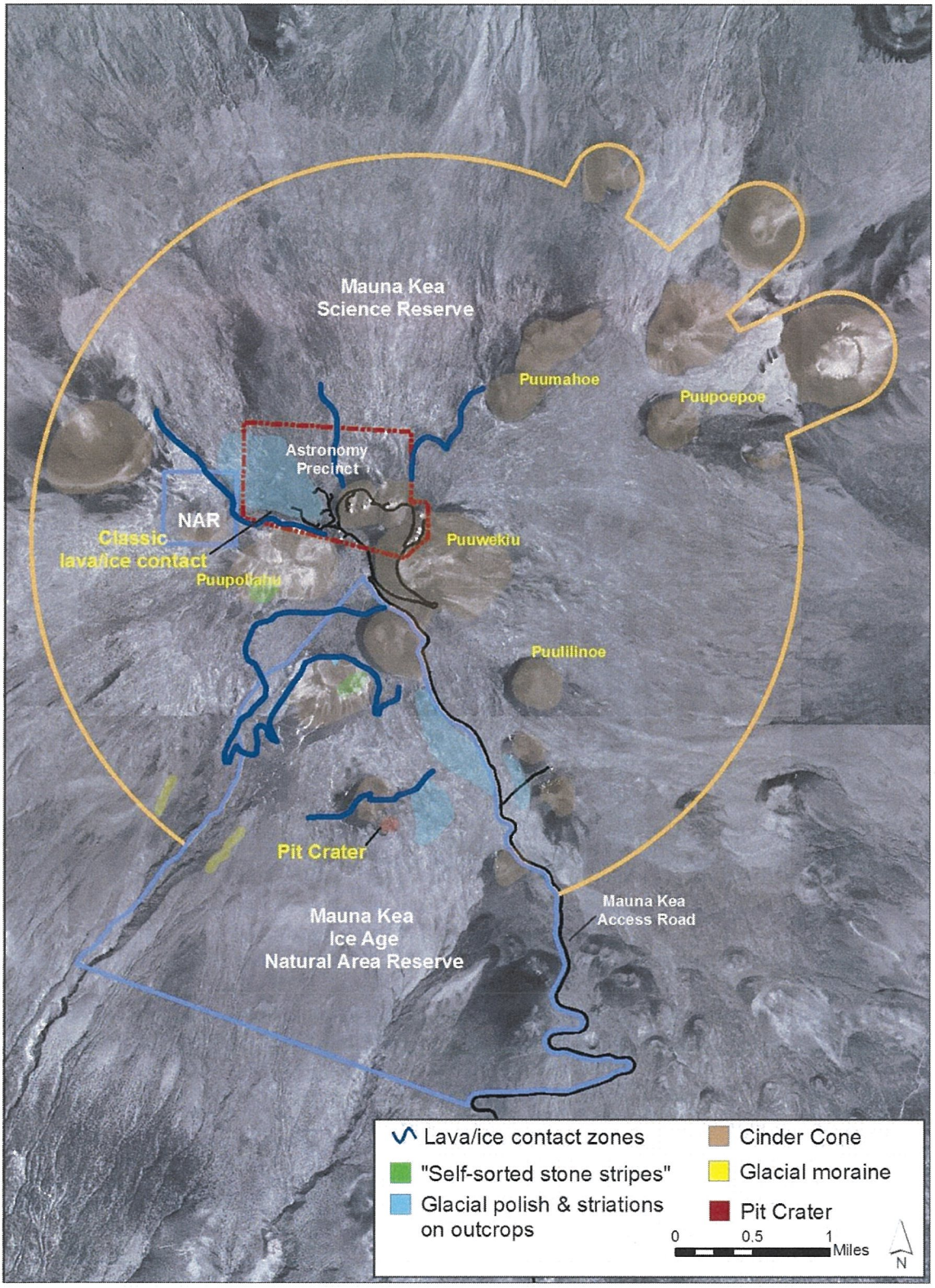
Lava and ice contact zones: Interactions of lava and glacial ice have been documented at several summit locations within the Science Reserve and in the Mauna Kea Ice Age NAR (Porter et al. 1977; Wolfe et al. 1997). Some of these events produced fine-grained flow margins at the lava-ice interface and the fine-grained adze material found within the Mauna Kea Adze Quarry (Bayman and Nakamura 2001; Bayman 2004). The large pillow lavas, gas spiracles, and hyaloclastic deposits (quenched glass) also created by these sub-glacial eruptive events are normally found in submarine environments (Lockwood 2000).

Sorted Stones: Found on the inner rim of Puʻu Waiau and on the southwestern slopes of Puʻu Poliʻahu, particulates of ash and pebble-sized materials are neatly sorted into parallel lines by freeze and thaw events that capture and then release the particles. The lines follow the in-situ slope (Lockwood 2000).

[6] *Moraine* is any deposit, consolidated or unconsolidated displaced by a glacier, that is deposited within a fairly discrete area usually parallel (lateral) to the direction of or at the end (terminal) of the glaciers movement. *Till* is any deposit, transported in the glacier and deposited along broad areas either adjacent to, but predominantly at the toe of the glacier.

Permafrost: Permafrost has been documented in two locations at the summit of Mauna Kea. The largest patch is approximately 98 ft (30 m) wide and 33 ft (10 m) thick and has inundated a matrix of boulders, cinder, and ash found at the base of the south slope of the Pu'u Wēkiu crater (Woodcock et al. 1970). The second patch is found on the southeast rim of Pu'u Hau Kea (Woodcock et al. 1970). Despite the fact that the ambient air temperature is often far above freezing, it is believed that the permafrost forms due to a combination of very high evaporation rates, low angle of sunlight, and the presence of cool air trapped at the bottom of the cinder cone, directly above the ground cover at these locations (Woodcock 1974).

Figure 5-2. Unique Geological Features in the Mauna Kea Summit Region



Nieve Penitentes: Not a common occurrence, nieve penitentes (also called sunspikes or suncups) often several feet high have been spotted for brief periods at Mauna Kea (Wentworth 1940; Cooper 2008). These jagged pinnacles of snow form through a combination of meteorological conditions favoring differential melting and evaporation.

Hydrology

The science of hydrology revolves around the properties, distribution, and circulation of water. The following discussion presents the most current understanding of the mountain's upper watershed surface and ground water features. Figure 5-3 illustrates the hydrological features in the Mauna Kea summit region (see Figure 5-3).

Surface Water: The summit area and upper flanks of the mountain are dissected by very small ephemeral rills and gullies, which are only moderately incised and do not have hydraulic geometries that would convey much water. Pōhakuloa and Waikahalulu Gulches are the most developed drainage channels along the upper slopes of the mountain. Unlike the rills and gullies, the gulches originate in higher elevation areas covered in lava and cinder. These channels likely formed following large-scale scouring of and movement of materials down the present day gulch alignment from a process initiated by melting glaciers (Macdonald et al. 1983; Lockwood 2000; Porter 2005). These melt waters are also thought to be responsible for first filling Lake Waiau (Sherrod et al. 2007).

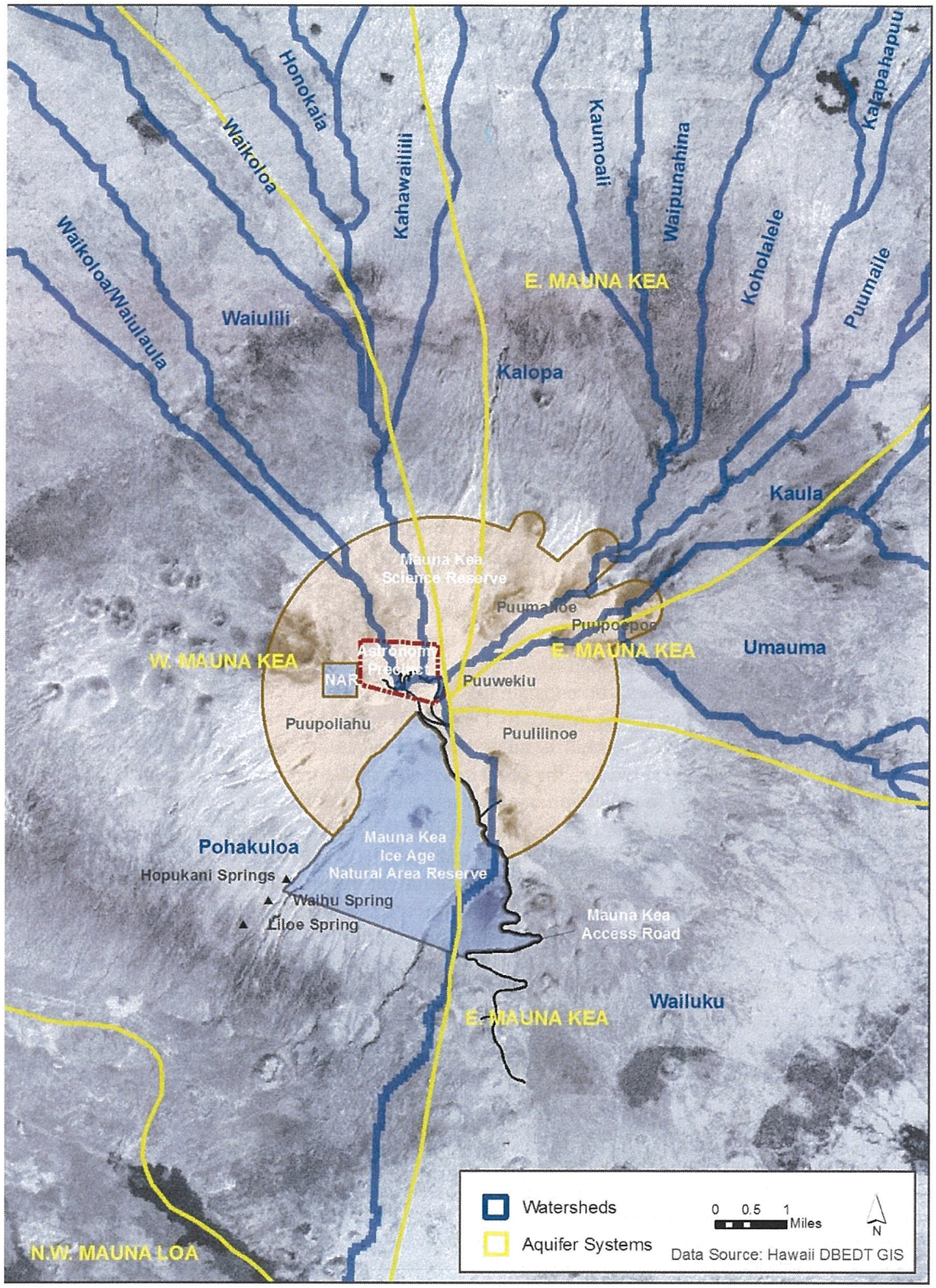
According to the DLNR Commission on Water Resource Management, the state agency that defines stream flow status, none of the streams in Mauna Kea's watersheds are perennial in the summit region (having continuous flow all year).[7] The Wailuku River is the only river whose numerous gulches extend along the upper flanks of Mauna Kea, and where these coalesce, downslope near the 10,000 ft elevation (3,048 m), stream flow is considered to be perennial.

Lake Waiau is located within the Mauna Kea Ice Age NAR. Located at the bottom of Pu'u Waiau, the lake freezes almost entirely during colder times of the year and has never been known to dry up. Lake Waiau is one of Hawai'i's few confined surface water bodies (Massey 1979) and one of the highest alpine lakes in the United States (Laws and Woodcock 1981). Lake Waiau is revered by many Hawaiians as a pool created for the snow goddess Poli'ahu by her father, Kane (Melvin 1988). The lake is heart-shaped, 300 ft in diameter (91 m) and reaches approximately 7.5 ft deep (2.3 m) at capacity (Woodcock et al. 1966; Laws and Woodcock 1981). Lake Waiau is believed to have formed approximately 15,000 years ago, following the last glacial retreat (Woodcock 1974). The primary source of the lake's water is now thought to be precipitation, rain and, snow melt, collected within Pu'u Waiau's approximately 35 ac (14.2 ha) watershed and not from relic layers of ice or permafrost within the ground as previously thought (Woodcock 1980; Ehlmann et al. 2005; Lippiatt 2005).

Groundwater flowing downslope is the water source for seeps and streams found between 8,500 and 11,000 ft (2,591 and 3,353 m), near Pōhakuloa and Waikahalulu Gulches (Woodcock 1980; Arvidson 2002). There is evidence that the water discharging at the seeps and springs is derived from recent rainfall and snow melt across the upper slopes of Mauna Kea (Arvidson 2002; Ehlmann et al. 2005) and not from melting permafrost or buried ice as previously suggested (Woodcock 1980).

[7] Perennial/Significant Streams as defined by the Hawaii Stream Assessment Project, 1993

Figure 5-3. Hydrology of the Mauna Kea Summit Region



Groundwater: Groundwater transportation rates in the summit region of Mauna Kea are unknown, and no flow paths have been identified. It is generally believed that groundwater flows along the direction of the ground surface slope, although the presence of variable subsurface features, such as dikes and sills, with low hydraulic conductivity, likely alter groundwater flow rates and flow paths. Groundwater flow-paths are important to understanding the potential movement of leachate from underground waste water systems. A limited investigation on groundwater transmission between Lake Waiau and existing and proposed septic systems located in the Astronomy Precinct was conducted by Nance (NASA 2005). His conclusion was that leachate from septic systems would not flow into or toward Lake Waiau.

The Science Reserve is located above five State of Hawai'i delineated aquifer systems, while Hale Pōhaku is over one, the Waimea Aquifer. The Waimea Aquifer system also lies under the land encompassed by the west half of the Science Reserve, including both NAR parcels. The southeast portion of the Science Reserve, approximately one-quarter of its surface area, lies on top of the Onomea Aquifer. The three other aquifers, Hakalau, Pa'auilo and Honoka'a, lie beneath the lands comprising the east and northeast areas of the Science Reserve. The Astronomy Precinct is located entirely above the Waimea Aquifer.[8]

Water Budget Analysis: A hydrologic cycle describes the movement of water on, above and below the earth's surface. To understand Mauna Kea's hydrologic cycle and effectively manage its components, it is necessary to know the spatial distribution of precipitation inputs. Spatial distribution is also needed to calculate a water budget analysis, which is a hydrologic assessment that accounts for the inputs and losses and identifies flow paths and the fate of water in a given area. For Mauna Kea, inputs come in the form of rainfall and snow, and to a lesser extent fog condensation,[9] and losses occur through infiltration, evapo-transpiration, and sublimation.

On Mauna Kea, above 9,000 ft (2,743 m), mean annual precipitation is low and evaporation rates are high. Anecdotal evidence and published literature agree that water input from rain and snow varies from year to year and that the range can be considerable. Snow's contribution to the total precipitation of the upper slopes and summit area was found to be significant (Ehlmann et al. 2005). The scarcity of vegetation means that very little rainfall is intercepted by vegetation and subsequently evaporated from leaves or other plant surfaces. However, the broken rocky surfaces that cover much of the region increase overall surface area, resulting in collection of water in small pockets on and between rocks, exposing it to evaporation. Although the amount of precipitation that infiltrates into the ground is unknown, it is generally accepted, and is reported by the NRCS (Sato et al. 1973), that surface infiltration rates in the summit region are high, and that during heavy precipitation events, water reaching the ground surface infiltrates quickly. The depth and rate of transmission of water that infiltrates is unknown and most likely varies depending on the rock type and the subsurface structure.

Water Quality: Water quality parameters of Lake Waiau investigated by Massey (1978) and others in 2003 indicated a slightly alkaline water and very low levels of dissolved constituents (NASA 2005). A turbid look and greenish tint to the lake water has been noted by observers for many years, dating back to the mid-1840s[10] (Bryan 1939; Neal 1939; Wentworth and Powers 1941; Maciolek 1969; Group 70 1982;

[8] The Astronomy Precinct is the 525 acre (212 ha) area within the Science Reserve reserved for astronomical development, as further described in Section 3.1.1.

[9] On Mauna Kea, fog drip is associated with vegetated areas below 9,000 ft (2,743 m) and is not a contributing source of water for upper elevation watersheds (Arvidson 2002).

10 "About five hundred-feet down, in a southerly direction, lay the pond of water [*Waiau*], the existence of which has been often doubted. It lies in the basin of a small crater, and at a distance appeared green and slimy" [Jarves, in The Polynesian, July 25, 1840], as cited in (Maly and Maly 2005).

Arvidson 2002; Maly and Maly 2005) and is attributed to algae mats growing on the bottom of the lake (Woodcock et al. 1966; Massey 1978; Dillon 1979). There are, however, accounts from visitors to the lake in which a green tint was not mentioned (Raine 1939). In 1977, a severe reduction in lake water levels with concomitant increases in phytoplankton biomass was identified and classified as hypereutrophication (a significant increase in nutrients, including nitrogen and phosphorus) (Laws and Woodcock 1981). Fecal coliform and bacteria parameters obtained from samples from Hopukani Spring were found to be negligible (NASA 2005). Similar investigations into well water found at much lower elevations were also found to be negligible (NASA 2005).

Climate

At the upper elevations of Mauna Kea, the prevailing conditions are dry and cool, with high visibility and low surface albedo during non-snow covered conditions, resulting in its classification as a semi-arid, barren alpine desert tundra (Ugolini 1974). The low surface albedo values during non-snow pack cover allows the ground surface to heat up, which has the effect of increasing evaporation of water and making plant establishment difficult. Albedo values increase during periods of snow cover, which most likely regulates surface warming.

There are two seasons in Hawai'i, winter (October–April), and summer (May–September), with the trade winds blowing approximately 80 percent of the time in the summer and 50 percent of the time in the winter (Giambelluca and Sanderson 1993). On the windward sides of the islands, trade wind showers are common, with the highest trade wind rainfall rates occurring in an elevation band between 2,500 and 7,000 feet (762 and 2,133 m). At 7,000 ft, (2,133 m), however, when the trade winds are blowing, the inversion caps upward migration of the clouds, and above this level, rainfall decreases with elevation, keeping Mauna Kea dry and cool from roughly 7,000 ft (2,133 m) upwards (da Silva 2006).

As evidenced from reported data, the mean precipitation in the summit region varies significantly from year to year. Further, quantitative snow measurements on rugged terrain with swirling winds severly complicate accurate measurement efforts. Data collected in the summit region by the National Weather Service (NWS) from 1969-2000 reports an average annual precipitation of 7.41 in (188 mm), though it is unknown if the value includes the contribution of water from snow fall. Mean annual precipitation based on data collected by the Subaru Telescope from 1999-2005 was estimated at 15.5 in (393 mm) (Miyashita et al. 2004), including the contribution from snowfall, although the efficiency of snow capture by the recording instrument is unknown. Ehlmann et al. (2005) reports annual precipitation as a range of 4.7 to 17.7 inches (12 to 45 cm) recorded at the VLBA, located below the summit area.

Although no data on average snowfall, snow water equivalence,[11] or patterns of ice formation for the Science Reserve was found in the literature, it is known that varying amounts of snow and ice regularly occupy the summit during the months of November–March (Laws and Woodcock 1981), and snow packs fluctuate from year to year (da Silva 2006) as does, most likely, the formation of ice.

The frequency of storms reaching the upper slopes and summit of Mauna Kea is highest during the winter. Storms can include cold-fronts, upper-level and surface low-pressure systems (including kona lows), tropical depressions, and hurricanes. These storm systems bring most of the annual precipitation to the areas above the trade wind inversion, including Mauna Kea (Giambelluca and Sanderson 1993). No records were located documenting the number of storms that affect Mauna Kea annually, but it is presumed to be highly variable, with a range of two to ten storms a year.

[11] Snow water equivalence refers to the amount of liquid water contained within the snow pack.

Approximately 80 percent of the time, wind direction at the upper elevations of Mauna Kea is from the west. This typically changes during warmer months, and for the remaining 20 percent of the time, wind comes from the east (Juvik and Juvik 1998; da Silva 2006). On occasion, unstable upper atmospheric conditions bring southerly winds, often accompanied by storm fronts that generate high amounts of rain (Birchard 2008). Wind speeds at Mauna Kea's summit normally vary between a maximum of 23 miles per hour (10 meters per second) in January and a minimum of 11 miles per hour (5 meters per second) in September (da Silva 2006); however, higher speeds have been noted during storm events (NASA 2005). Available data is limited concerning the frequency of extreme winds. Wind speeds in excess of 45 miles per hour (20 meters per second) have been recorded during every month of the year in the summit area, and maximum winds exceeding 90 miles per hour (40 meters per second) have been recorded on several occasions (de Silva 2006). The dry and breezy conditions facilitate high rates of evaporation at the summit and maintain the cool, dry atmosphere (da Silva 2006; Birchard 2008). Wind direction and speed across the summit area play a large role in the aeolian environment on Mauna Kea, transporting small debris, including bugs, from lower elevations up to the summit area. Average wind speeds at 8,530 ft (2,600 m) at Pu'u La'au, near Hale Pōhaku, range between 2.7 to 3.6 miles per hour (1.2 to 1.6 meters per second) (Nullet et al. 1995).

Mean monthly temperatures above the inversion layer generally range between 24.8°F and 32.9°F (-4°C and 0.5° C) in January, one of the coldest months, and between 38.3°F and 42.8°F (3.5°C and 6.0°C) in September, considered a warm summer month (da Silva 2006). Even though variability between annual mean lows and highs is minimal, temperature ranges recorded at the summit area are quite large, ranging from 2°F to 61°F (-16.6°C to 16.1°C). Average temperatures at Hale Pōhaku, at 9,000 ft (2,743 m), range between 30°F and 70°F (-1°C and 21°C) throughout the year (Group 70 International 1999).

Air Quality

Although there is no active monitoring for air quality at the Mauna Kea summit, its geographic and meteorological isolation results in excellent air quality, well known throughout the astronomy community.[12] The summit is above the altitude of temperature inversions, and pollutants such as smoke, dust, and smog that are generated below the inversion layer generally do not affect the air quality at the summit of Mauna Kea. However, upslope winds can carry pollutants to the summit area from lower elevations. Locally generated contributors to air pollution at the summit include vehicle exhaust and fugitive dust. Dispersion of the pollutants is aided by strong winds.

Noise

Noise measurements are not routinely taken, but it is generally assumed that the ambient noise levels at the summit and Hale Pōhaku areas are low, with vehicle traffic, wind, and short-term construction being the most pervasive contributors. Regular observatory operations contribute only minimally (NASA 2005). However, because noise measurements are not routinely taken, it is difficult to document what "low" actually describes. Noise-sensitive receptors include primary users of the mountain such as scientists, cultural practitioners, and recreational users.

[12] Data for the summit of Mauna Loa, collected by the National Oceanic and Atmospheric Administration (NOAA) Mauna Loa Observatory, indicate that the air quality at Mauna Loa is excellent. Given the similarities between the two locations, it has been suggested that the overall air quality at Mauna Kea is excellent, as well (NASA 2005; Barnes 2008).

Visual Environment

Views of Mauna Kea from the lowlands, along with views from the summit region are one of the mountain's resources that have been valued for generations (see Section 4.1.3). When skies are clear, the summit region and observatories can be seen from Hilo, Honoka'a, Waimea, Kilauea summit, sections of the Mauna Kea Summit Access Road and much of Puna. On cloud-free days, views from the summit region include Mauna Loa to the south, Hualālai to the west, the flanks of summit cinder cones to the east, and other islands in the Hawaiian chain to the north-northwest. Hilo is visible unless it is blocked by the inversion cloud layer. Existing observatories have impacted the viewscape in some locations, both from the summit and of it, and they do obscure portions of the 360-degree view from the summit area. Trails that become etched into the cinder from repeated use and roads also impact the viewscape.

It is well known that the "seeing" ability from the summit region, as it relates to astronomy, is very high, and it has been well documented that the Science Reserve is a premier location for astronomical activities (Walker 1983; Businger et al. 2002; Wainscoat 2007). Dark skies, generally favorable weather, and clean, clear air permit almost year-round un-obscured conditions for optimal night seeing. These attributes of seeing ability result directly and indirectly from four primary factors: the site's remote location, its elevation, topography, and climate (Businger et al. 2002). Managing these attributes for optimal influence on night sky viewing will be essential to the continued success of astronomy at the Science Reserve.

5.5.2 Flora and Fauna of Mauna Kea

High elevation areas on Mauna Kea, such as those found at Hale Pōhaku and the Mauna Kea Science Reserve, can be divided into two basic types: the subalpine ecosystem (5,600 ft to 9,800 ft elevation), and the alpine ecosystem (above 9,800 ft) (Gagné and Cuddihy 1990). Hale Pōhaku occurs in the upper reaches of the subalpine ecosystem, while the Mauna Kea Science Reserve occurs in the alpine ecosystem.

Many unique species occur in the subalpine and alpine ecosystems of Mauna Kea, and there are several federal and/or state protected species that potentially occur on UH Management Areas, including 12 Endangered, one Threatened, two Candidate, and 16 Species of Concern (two of which are also listed as State Endangered on islands other than Hawai'i). A list of these species is presented in Table 5-4 below. Presence, abundance and distribution of most of these species are currently unknown. Species currently known to be found on UH Management Areas are the wēkiu bug (Candidate for listing), the Mauna Kea silversword (Federal and State Endangered), and the *palila* (Federal and State Endangered).

Subalpine Flora and Fauna (Hale Pōhaku and Access Road)

The subalpine plant community found at Hale Pōhaku is made up primarily of clumps of māmane (*Sophora chrysophylla*) trees interspersed with open areas of bare soil or rocky outcroppings (Char 1999a). Understory plants tend to be concentrated under the māmane trees, where they receive fog drip, an important source of moisture in this dry environment (Gagné and Cuddihy 1990). Common grasses include two native grasses, alpine hairgrass (*Deschampsia nubigena)* and pili uka (*Trisetum glomeratum)*, and an introduced needlegrass, *Nassella cernua* (Char 1999a). Shrub species found at Hale Pōhaku include 'āheahea (*Chenopodium oahuense*), pūkiawe (*Leptecophylla tameiameiae*) and nohoanu (*Geranium cuneatum*). The latter two are associated with rocky areas. Three native fern species, kalamoho (*Pellaea ternifolia),* 'iwa'iwa *(Asplenium adiantum-nigrum),* and olali'i *(Asplenium trichomanes),* are also found among the rocks, along with Hawai'i catchfly (*Silene hawaiiensis)*, a Federally Threatened Species (Char 1985). Two native vines, littleleaf stenogyne (*Stenogyne*

microphylla) and mā'ohi'ohi (*Stenogyne rogosa*) are found climbing into the canopy of some māmane trees (Char 1999a).

Table 5-4. List of Federal and State Threatened, Endangered, Candidate and Species of Concern found, or potentially occurring, in the UH Management Areas

Group	Scientific Name	Common Name	Legal Status[13]
Endangered Species			
Plant	*Argyroxiphium sandwicense sandwicense*	'Ahinahina, Mauna kea silversword	FE, SE
Plant	*Asplenium fragile var. insulare*	Diamond spleenwort	FE, SE
Plant	*Phyllostegia racemosa var racemosa*	Kiponapona	FE, SE
Plant	*Vicia menziesii*	Hawaiian vetch	FE, SE
Bird	*Branta sandvicensis*	Nene (Hawaiian goose)	FE, SE
Bird	*Buteo solitaries*	'Io	FE, SE
Bird	*Hemignathus munroi*	'Akiapola'au	FE, SE
Bird	*Loxioides bailleui*	Palila	FE, SE
Bird	*Pterodroma sandwichensis*	'Ua'u (Hawaiian petrel)	FE, SE
Mammal	*Lasiurus cinereus semotus*	'Ope'ape'a (Hawaiian hoary bat)	FE, SE
Threatened Species			
Plant	*Silene hawaiiensis*	Hawai'i catchfly	FT, ST
Candidate Species			
Plant	*Ranunculus hawaiiensis*	Makou	FC, SC
Arthropod	*Nysius wekiucola*	Wēkiu bug	FC
Species of Concern			
Plant	*Chamaesyce olowaluana*	'Akoko	HSOC
Plant	*Cystopteris douglasii*	Douglas' bladderfern	HSOC
Plant	*Dubautia arborea*	Mauna Kea dubautia, na'ena'e	HSOC
Plant	*Sanicula sandwicensis*	Hawaii black snakeroot	HSOC
Arthropod	*Agrotis melanoneura*	Black-Veined Agrotis Noctuid Moth	FSOC, HSOC
Arthropod	*Coleotichus blackburniae*	Koa bug	FSOC
Arthropod	*Hylaeus difficilis*	Yellow-faced bee	HSOC
Arthropod	*Hylaeus flavipes*	Yellow-faced bee	FSOC, HSOC
Snail[14]	*Succinea konaensis*	Succineid snail	FSOC
Snail	*Vitrina tenella*	Zonitid snail	FSOC
Bird	*Asio flammeus sandwichensis*	Pueo	FSOC, SE[15]
Bird	*Chasiempis sandwichensis*	Hawai'i 'Elepaio	FSOC
Bird	*Hemignathus virens virens*	'Amakihi	FSOC
Bird	*Himatione sanquinea*	'Apapane	FSOC
Bird	*Pluvialis fulva*	Kolea (Pacific Golden Plover)	FSOC
Bird	*Vestiaria coccinea*	'I'iwi	FSOC, SE[16]

[13] Legal Status: FE = Federally Endangered, FT= Federally Threatened, FC = Federal Candidate for listing, FSOC = Federal Species of Concern, SE = State Endangered, SC = State Candidate for Listing, HSOC = Hawaii State Species of Concern, ST = State Threatened.

[14] It is unknown whether snails are present at Hale Pōhaku – no surveys for snails have been completed at this elevation.

[15] State Endangered on Oahu only.

[16] State endangered on Oahu, Lanai, and Molokai only.

Māmane woodlands once stretched from sea level on the leeward side of Mauna Kea to the tree line, but have been greatly reduced due to habitat alteration at lower elevations and uncontrolled grazing at the higher elevations by feral sheep (*Ovis aries*), mouflon sheep (*O. musimon*), goats (*Capra hircus*) (Giffin 1982; Scowcroft and Giffin 1983; Hess et al. 1999). Although attempts have been made to control feral grazers, the forest has not fully recovered, due to continued browsing and the presence of invasive plant species that inhibit māmane regeneration (Williams 1994; Hess et al. 1996). Invasive plants include common mullein (*Verbascum thapsus*), ripgut brome (*Bromus diandrus*), orchardgrass (*Dactylis glomerata*), hairy cats-ear (*Hypochoeris radicata*), alfilaria (*Erodium cicutarium*), sheep sorrel (*Rumex acetosella*), common groundsel (*Senecio vulgaris*), and telegraph plant (*Heterotheca grandiflora*). Māmane regeneration is highest in the higher elevation areas (such as Hale Pōhaku) where grass densities are low (Hess et al. 1996).

Māmane woodlands are home to a wide variety of native arthropods (insects, spiders), the native Hawaiian hoary bat (*Lasiurus cinereus semotus*), and several native bird species, including the Palila (*Loxioides bailleui*), ʻAmakihi (*Hemignathus virens*), ʻApapane (*Himatione sanguinea*), ʻElepaio (*Chasiempis sandwichensis sandwichensis*), ʻAkiapolaʻau (*Hemignathus munroi*), and ʻIʻiwi (*Vestiaria coccinea*) (Scott et al. 1986). Of these species only the Palila, ʻAmakihi, ʻApapane and ʻIʻiwi have been observed at Hale Pōhaku in recent times. Māmane trees are the primary food source for birds in the region, providing nectar and seeds on a seasonal basis (Hess et al. 2001). Several bird species also prey in the insects that inhabit the māmane trees. Perhaps the most notable bird species is the Federally Endangered Palila (*Loxioides bailleui*). Palila feed on the green seedpods of māmane trees, eating the seeds inside and preying on caterpillars of moth species that also feed on the seeds. Palila also eat naio fruits as well as māmane flowers, buds, and young leaves (Hawai'i Audubon Society 1997; Banko 2006). These unique endemic birds were once common in lowland dry forests on several of the Hawaiian Islands, but due to habitat alteration first by humans, and subsequently by grazing mammals, the Palila's range has decreased to a small band around Mauna Kea, in the last remaining stands of māmane woodlands.

The māmane woodlands are also inhabited by many species of non-native birds and mammals. Invasive predators such as cats, rats, barn owls, and mongoose have a direct impact on native bird populations. Cats and mongoose eat both adult birds and chicks, while rats primarily consume eggs (and sometimes chicks). Although rats, cats, and mongoose are not abundant in māmane woodlands, they still impact Palila populations (Banko et al. 2002). Non-native birds can compete directly with native birds for resources such as food. Japanese white-eye are likely to compete directly with insectivorous and nectarivorous honeycreepers for limited resources in māmane woodlands. Non-native birds also can act as a food base for predators, which will take native birds as prey in addition to the non-natives.

Alpine Flora and Fauna (Mauna Kea Science Reserve)

Traveling up the mountain towards the summit, the vegetation decreases in diversity, density and size. Alpine plant communities on Mauna Kea begin just above the treeline, at approximately 9,800 ft (2,987 m), and rise to the summit of the mountain at 13,796 ft (4,205 m). The alpine plant communities can be divided into shrublands, grasslands, and stone desert. There are no sharp lines of delineation between the plant community types: the three communities grade into one another, beginning with the alpine shrubland at the treeline, grading into the alpine grasslands, and culminating with the alpine stone desert at the summit (Mueller-Dombois and Fosberg 1998; Char 1999b; Conant *et al.* 2004). The three community types are all characterized as being predominantly barren rock and cinder with scattered sparse vegetation (Aldrich 2005).

Alpine shrublands are inhabited mainly by low-lying shrubby species such as pūkiawe (*Leptecophylla tameiameiae*), ōhelo (*Vaccinium reticulatum*), and Mauna Kea dubautia (*Dubautia arborea*); scattered grasses such as Hawaiian bentgrass (*Agrostis sandwicensis*), and pili uka (*Trisetum glomeratum*); and native ferns such as Douglas' bladderfern (*Cystopteris douglasii*), kalamoho (*Pellaea ternifolia*), 'olali'i (*Asplenium trichomanes*), and 'iwa'iwa (bird's nest ferns, *Asplenium adiantum-nigrum*). Historically common, but now rare, species found in this community include 'āhinahina (the Mauna Kea silversword, *Argyroxiphium sandwicense* ssp. *sandwicense*), lava dubautia (*Dubautia ciliolata* ssp. *ciliolata*), 'ōhelo papa (Hawaiian strawberry, *Fragraria chiloensis*), 'ena 'ena (*Pseudognaphalium sanwicensium*), nohoanu (*Geranium cuneatum* ssp. *hololeucum*) and alpine tetramolopium (*Tetramolopium humile* ssp. *humile* var. *humile*). Several non-native plant species that have taken hold in the alpine shrublands on Mauna Kea, including hairy cat's ear (*Hypochoeris radicata*), sheep sorrel (*Rumex acetosella*), common mullein (*Verbascum thapsus*), fireweed (*Senecio madagascariensis*), and the common dandelion (*Taraxacum officinale*). Heavy grazing by feral ungulates has greatly impacted the plant communities in the alpine shrublands and grasslands (Hartt and Neal 1940; Mueller-Dombois and Fosberg 1998), and invasive plant species now compete with native plants for limited resources such as water and sheltered growing locations.

Alpine grasslands replace alpine shrublands around 11,000 ft in elevation, although pūkiawe shrubs can be found in all habitats, clear to the summit (Mueller-Dombois and Fosberg 1998). The alpine grasslands on Mauna Kea, which occur up to 12,800 ft in elevation, are dominated by two native grasses: Hawaiian bentgrass (*Agrostis sandwicensis*), and pili uka (*Trisetum glomeratum*) (Mueller-Dombois and Fosberg 1998). These grasslands are now very rare, as they have been decimated by feral ungulates (goats, sheep).

At one time, the Mauna Kea silversword, or 'āhinahina (*Argyroxiphium sandwicense* ssp. *sandwicense*) dominated the alpine landscape on Mauna Kea. 'Āhinahina is a spectacular plant with thick sword-shaped shiny silvery-green leaves growing in a giant rosette. It only flowers once, usually sometime between 3 to 50 years of age. After flowering, it dies. When it flowers, the Mauna Kea silversword grows a large stalk, up to 9 feet tall, that is covered with up to 600 pink to wine-red flowers (Wagner et al. 1990). The Mauna Kea silversword is found only on Mauna Kea, and historically occurred from 6,000 ft to 12,300 ft (Hartt and Neal 1940; Wagner *et al.* 1990; Robichaux *et al.* 2000). The population size of the Mauna Kea silversword was drastically reduced through grazing by feral sheep, goats, mouflon sheep and cattle (Hartt and Neal 1940; USFWS 1994; Robichaux et al. 2000). Although the impact of grazing ungulates on the silversword and other vegetation on Mauna Kea was recognized early on (Hartt and Neal 1940), the efforts to control feral ungulates on the mountain have waxed and waned over time, and grazing animals have never been eliminated from Mauna Kea (Juvik and Juvik 1984). Recovery efforts for the Mauna Kea silversword are underway through the efforts of federal and state agencies. Recently a new population of Mauna Kea silverswords was discovered in the Science Reserve (Nagata 2007; Tomlinson 2007), which is exciting news for the people trying to protect this rare species.

The alpine shrublands and grasslands have a fairly low diversity of vertebrate animal species that utilize it on a regular basis. Invertebrates have not been well studied at these locations but no doubt there are some interesting species to be discovered. One Federally Endangered bird, the Hawaiian petrel or 'Ua'u (*Pterodroma sandwichensis*), has been observed in subalpine lava flows on Mauna Loa at 8,000 – 9,200 ft elevation, and occasionally in subalpine and alpine habitats on Mauna Kea (Conant 1980; Kjargaard 1988; Hu et al. 2001). However, it has not been spotted near Hale Pōhaku or the Mauna Kea Science Reserve in recent times. Feral sheep and goats stray into the lower regions of the alpine zone and cause considerable damage to the native plant communities there.

The summit of Mauna Kea (12,800 to 13,796 ft) is considered an Alpine Stone Desert (Mueller-Dombois and Fosberg 1998). This plant community consists of several species of mosses and lichens, an unknown number of species of algae, and a limited number of vascular plants, predominantly the same species found in the alpine shrublands and grasslands (Hartt and Neal 1940; Char 1999b; Aldrich 2005). Most of the species of plants found in the region are endemic (occurring only in Hawai'i) or indigenous (native to Hawai'i but occurring elsewhere). A few non-native plant species have also become established here, even at the summit (Hartt and Neal 1940; Char 1999b). Vascular plants are found mainly at the base of rock outcrops where there is an accumulation of soil and moisture, and some protection from wind (Char 1999b). The most abundant native plants found at this elevation are two grass species, Hawaiian bentgrass (*Agrostis sandwicensis*) and pili uka (*Trisetum glomeratum*), and two fern species, 'iwa'iwa (*Asplenium adiantum-nigrum*) and Douglas' bladderfern (*Cystopteris douglasii*). Non-native species found in the alpine stone desert include Hairy cat's ear (*Hypochoeris radicata)* and common dandelion (*Taraxacum officinale*), both of which are temperate weed species with a world-wide distribution (Smith *et al.* 1982; Char 1999b).

Lichens and mosses dominate the alpine stone desert in terms of diversity and abundance. Lichens, which are not really plants, but instead are a symbiotic relationship between a fungus and either a green alga or a blue green bacterium, or both (Hemmes and Desjardin 2002), are found throughout the summit of Mauna Kea. The highest densities and diversity of lichens tend to be found on andesite (lava) rocks, in north and west facing protected locations away from direct sun exposure (Smith et al. 1982). Areas to the west of the major cinder cones have a low density and diversity of lichens, most likely due to a rain shadow effect created by the cinder cones (Smith et al. 1982). A survey of lichens on the summit of Mauna Kea identified 21 species (plus five possible other species). Around half of the lichen species found on Mauna Kea are endemic (found only in Hawai'i), two of which (*Pseudephebe pubescens* and *Umbilicaria pacifica*) are limited to Mauna Kea alone (Smith et al. 1982; Char 1999b). *Pseudephebe pubescens* has not been recorded anywhere else in Hawai'i, or any other tropical island, as this species is primarily found in high altitude and alpine regions of the world (Smith et al. 1982). The remaining species are indigenous to the Hawaiian Islands. *Lecanora muralis* is the most abundant lichen on Mauna Kea, and is found throughout the summit on all substrate types including cinders and colluvial material on the cinder cones up to the summit of Pu'u Wēkiu (Smith et al. 1982). Other common species on the summit are *Lecidea skottsbergii* and *Candelariella vitellina,* both of which are found on rocks "larger than a small fist" (Smith et al. 1982).

Mosses at the summit occur in protected places where water availability is more consistent, such as under overhanging rocks and in shaded crevices or caves where snow melts slowly (Smith et al. 1982). Mosses are predominantly found on the north-northeast and south-southeast facing sides of rocky mounds, generally in association with runoff channels from snow melt (Smith et al. 1982). Moss cover is much lower in the rain shadow region west of the summit cone, due to the more arid conditions (Smith et al. 1982). Mosses have not been observed in loose cinders or on the aeolian or colluvial fields (Char 1999b). A survey of the mosses on the Mauna Kea summit area (above 13,000 ft) identified approximately 12 species (some could not be identified with certainty to the species level), most of which are indigenous to the Hawaiian Islands. Two moss species, *Bryum hawaiicum* and *Pohlia mauiensis*, are endemic (Smith et al. 1982). All the moss species found at the summit are related to temperate species. The most common species of moss were a previously undescribed species of *Grimmia* and *Pohlia cruda* (Smith et al. 1982). *Grimmia* are silvery-gray mosses that form clumps in run-off channels and semi-exposed rock faces (Smith et al. 1982). *Pohlia cruda* is a bright green moss found in well-protected, deeply shady locations, and are so well hidden they are unlikely to be seen by the casual observer (Smith et al. 1982). The remaining moss species were not as abundant and tended to occur in habitats intermediate between the somewhat exposed *Grimmia* habitats and the protected *Pohlia* habitats (Smith et al. 1982).

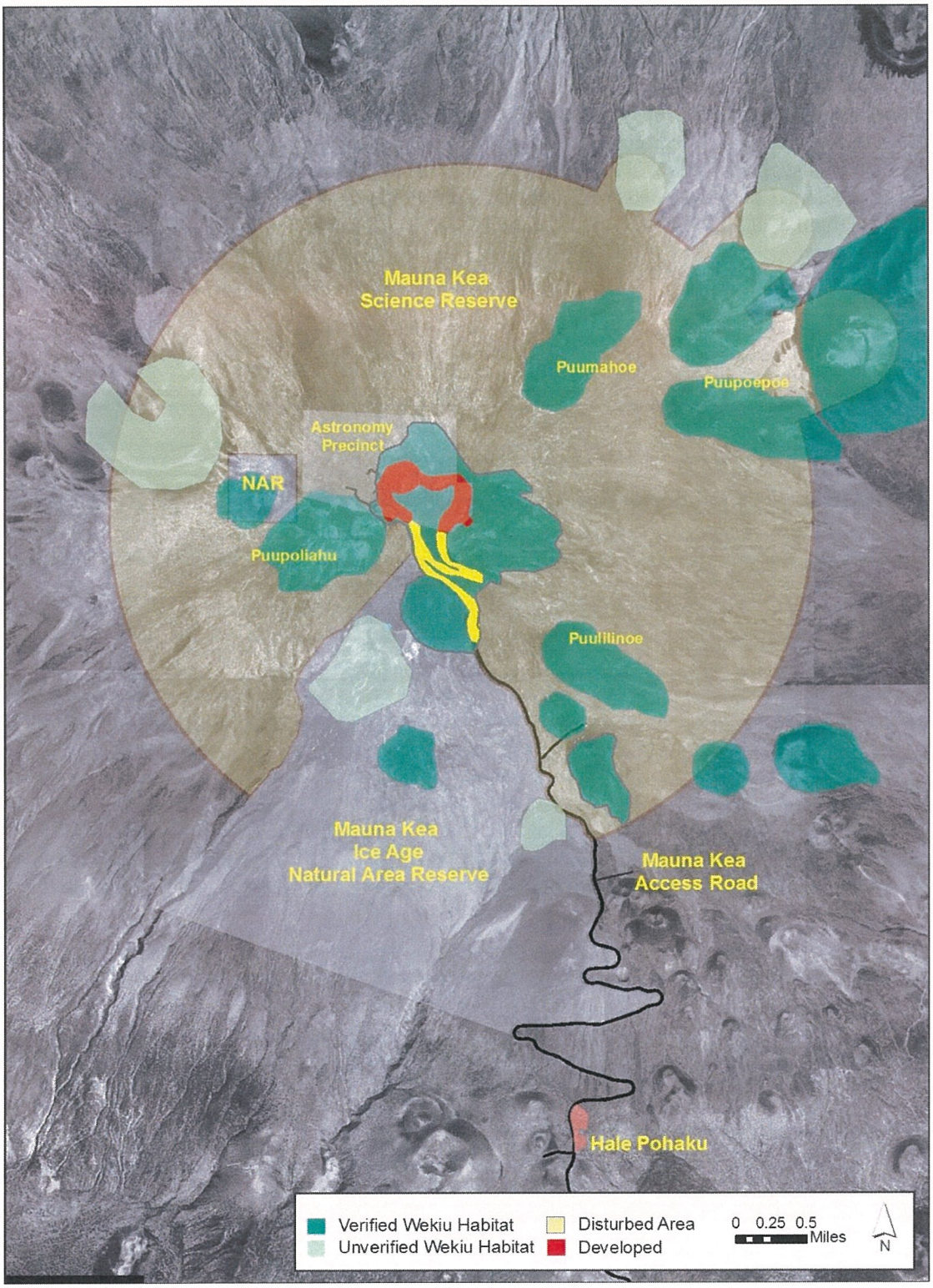
Although it may appear barren to the casual observer, the summit of Mauna Kea supports an interesting variety of species, many of which are found nowhere else in the world. The animal community at the summit is dominated by arthropods (invertebrates such as insects and spiders): there are only a few vertebrate species (other than man) that venture this high, and these are primarily non-native mammals such as mice that reside in and around the observatories (Conant et al. 2004). The arthropod community on the summit of Mauna Kea can be divided into two parts: those species that are blown up the mountain from lower elevations by the wind and die there in the cold (referred to as aeolian drift), and those cold-adapted species that are permanent residents, that feed on the dead and dying arthropods found in the aeolian drift or on one-another (Howarth and Montgomery 1980; Howarth and Stone 1982). The arthropod community on the summit is highly unusual in that it is mostly made up of predators and scavengers, and there are very few species that rely on plants as their sole food source.

Through the various studies conducted at the summit of Mauna Kea, 21 resident species, and 14 species of undetermined origin (unknown if they are resident or aeolian) have been recorded as occurring in the alpine stone desert. Native resident species include the wēkiu bugs (*Nysius wekiuicola*), a noctuid moth (*Agrotis* sp.), a hide beetle (*Dermestes maculatus*), a large wolf spider (*Lycosa* sp.), two sheet web spiders (*Erigone* species), an unidentified Linyphiid sheet web spider (Family Linyphiidae), two unknown Entomobryid springtails (Family Entomobryidae), a Collembolla springtail (Class Collembola, family and species unknown), two species of mites (Families Anystidae and Eupodidae), a bark louse (*Palistreptus inconstans*) and a centipede (*Lithobius* sp.). Non-native resident species include a book louse (*Liposcelis divinatorius*), big-eyed bug (*Geocoris pallens*), a hunting spider (*Meriola arcifera*), a sheet web spider (*Lepthyphantes tenuis*), and an unidentified jumping spider (family Salticidae).

The wēkiu bug (*Nysius wekiuicola*) is the best-studied invertebrate at the summit – there is little information available regarding the habits of most of the other summit species. The wēkiu bug is a Federal Candidate species, meaning that it is being considered for listing as Threatened or Endangered, but has not yet been listed. The wēkiu bug was first recognized as a new species in 1979. It is a true bug in the family Lygaeidae (order Heteroptera), and is approximately the size of a grain of rice (Ashlock and Gagne 1983; Richardson 2002). The wēkiu bug, and its sister species, the Mauna Loa bug (*Nysius aa*), which resides at the high elevation areas on Mauna Loa, differ from other species in the genus Nysius in being scavengers and predators of dead and dying arthropods, while all other known species in the genus are seed and/or plant feeders (Ashlock and Gagne 1983; Polhemus 1998). Wēkiu bugs reside in the cinders on the summit of Mauna Kea, where they use their straw like beaks to suck the hemolymph (blood) from dead and dying insects blown up the mountain from lower elevations (Howarth and Montgomery 1980; Ashlock and Gagne 1983; Howarth 1987; Richardson 2002). They do not appear to feed on healthy/living individuals of the other resident arthropod species (Ashlock and Gagne 1983). Wēkiu bugs are most abundant on or near the crater rims of cinder cones that formed nunataks (ice free areas rising above the surrounding glacier) or that lay at the glacier limit during the last glaciation, especially on the north- and east-facing slopes (and on slopes shaded by local topography), where seasonal snow remains the longest (Porter and Englund 2006). They can also be found on the flanks and at the bases of the cones where cinders have accumulated to sufficient depths (Eiben 2008). Snowfields may be important to the scavenger species on the summit, as they chill and store insects in the aeolian drift for later consumption. Wēkiu bugs can often be seen foraging on the edge of snow banks (Englund et al. 2006). Crests of glacially overridden cones and inter-cone expanses of glacial till appear to lack suitable wēkiu bug habitat (Porter and Englund 2006). Figure 5-4 shows the potential and known wēkiu bug habitat in the Mauna Kea Science Reserve, as determined by Jesse Eiben (2008).

There has been some discussion about whether wēkiu bug populations have decreased, increased, or remained the same over time since the first survey in 1982 (Howarth et al. 1999; Polhemus 2001; Englund et al. 2002). Many insect populations naturally undergo cycles of low and high abundance over long periods of time (Howarth et al. 1999). Most of the studies were not designed to calculate population densities of wēkiu bugs, and instead measured activity levels. Wēkiu bug capture rates appear to be heavily influenced by climactic conditions such as presence of snow (Englund et al. 2006; Porter and Englund 2006; Englund et al. 2007), which makes it difficult to compare capture rates across studies that were conducted during different conditions or time of year. However, ten years of study following the 1997-98 surveys suggest that wēkiu bugs are still abundant on Mauna Kea, and that they are able to reside in both undeveloped and developed areas at the summit (Polhemus 2001; Englund et al. 2002; Englund et al. 2005; Englund et al. 2006; Porter and Englund 2006; Englund et al. 2007).

Figure 5-4. Potential and Known Wēkiu Bug Habitat in the Mauna Kea Science Reserve



6. HUMAN ENVIRONMENT

In ancient times, the very highest reaches of the mountain were probably rarely approached because of their extreme sacredness. In addition, the summit area has been characterized as a "non-subsistence" environment due to cold temperatures and the lack of essentials such as food and fuel (McCoy 1990). The cultural and economic activities of the ancient Hawaiians occurring at the upper elevations of the Mauna Kea were primarily for resource procurement and for religious purposes. The Mauna Kea Adze Quarry, located in the Mauna Kea Ice Natural Area Reserve may have been the largest source of high-quality stone for adze making in all of Polynesia. Other activities likely included catching birds for food and feathers, canoe making and burial of the dead (McEldowney 1982). Significant changes to the natural resources of the high elevation areas of Mauna Kea began in the late 1700s, primarily as a result of the introduction of domestic cattle, sheep, and goats to support human existence. The mid 20th century brought astronomical development to Mauna Kea, with infrastructure having lasting effects on the physical, biological, and cultural resources. More recently Mauna Kea has become a popular site for tourism and recreational use, drawing visitors from around the world to its summit to experience scenic terrestrial and astronomical vistas. The range of human activities results in on-going impacts to the natural and cultural resources of Mauna Kea and must be considered in the development of any management plan.

6.1 Activities and Uses

6.1.1 Astronomy

The summit of Mauna Kea hosts the world's largest ground-based astronomical observing site in terms of light gathering power, considered to be the finest in the world. Physical characteristics that set Mauna Kea apart from other sites include: high altitude, atmospheric stability, minimal cloud cover (about 325 days per year are cloud free at the summit), low humidity, dark skies (because of its distance from urban development), and the transparency of the atmosphere to infrared radiation. A tropical inversion layer about 2,000 ft (600 m) thick that exists between 5,000 and 9,000 ft (1,520 and 2,743 m) provides the upper atmosphere with a buffer from the lower, moist, maritime air, keeping it clear, dry, and free of atmospheric pollutants. Due to the location of the Hawaiian Islands within the northern hemispheric tropics, astronomers can observe the entire northern sky and nearly 80 percent of the southern sky.

In the 1960s, the University initiated an astronomical research program to attract global interest in constructing and operating telescopes in Hawai'i. The BLNR created the Mauna Kea Science Reserve in 1968, granting the University a 65-year lease (Lease No. S-4191) for a scientific complex including observatories. The UH Management Areas includes all land within a 2.5 mile radius of the summit, above about 11,500 ft (3,505 m), except for the area within the Mauna Kea Ice Age NAR. The University has entered into scientific partnership agreements with various organizations to develop and use observatory facilities on Mauna Kea. As a part of these agreements, the University has subleased parcels of the UH Management Areas to those organizations. Twelve telescope facilities are in operation in the summit area. These include: eight major optical/infrared telescopes, one 0.6 meter telescope, two single-dish millimeter/submillimeter-wavelength telescopes, and a submillimeter array. The VLBA Antenna Facility is situated at the 12,200 foot elevation of the UH Management Area (see Table 6-1). Astronomers access the telescopes both on-site and remotely. As technology allowing remote access and control of the scopes continues to improve, more astronomers are likely to access data remotely, decreasing the amount of astronomy-related traffic traveling to the summit.

Table 6-1. Mauna Kea Telescopes (2008)

Source: http://www.ifa.hawaii.edu/mko/telescope_table.htm

	Name	Mirror	Owner/Operator[1]	Year Built
Optical/Infrared				
UH 0.6m[2]	UH 0.6-m telescope	0.6m	University of Hawai'i	1968
UH 2.2m	UH 2.2-m telescope	2.2m	University of Hawai'i	1970
IRTF	NASA Infrared Telescope Facility	3.0m	NASA	1979
CFHT	Canada-France-Hawai'i Telescope	3.6m	Canada/France/UH	1979
UKIRT	United Kingdom Infrared Telescope	3.8m	United Kingdom	1979
Keck I	W. M. Keck Observatory	10m	Caltech/University of California	1992
Keck II	W. M. Keck Observatory	10m	Caltech/University of California	1996
Subaru	Subaru Telescope	8.3m	Japan	1999
Gemini	Gemini North Telescope	8.1m	USA/UK/Canada/Argentina/ Australia/Brazil/Chile	1999
Submillimeter				
CSO	Caltech Submillimeter Observatory	10.4m	Caltech/NSF	1987
JCMT	James Clerk Maxwell Telescope	15m	UK/Canada/Netherlands	1987
SMA	Submillimeter Array	8x6m	Smithsonian Astrophysical Observatory/Taiwan	2002
Radio				
VLBA	Very Long Baseline Array	25m	NRAO/AUI/NSF	1992

6.1.2 Scientific Research

Mauna Kea is a tropical high altitude environment with unique geological, biological and cultural features. Although there are hundreds of cultural features on Mauna Kea, until recently much of the research focused on the adze quarry complex located in the Mauna Kea Ice Age NAR. Recently, archaeological field work was conducted for almost the entire UH Management Areas to document and map the locations of historical and cultural resources. This comprehensive work details many previously undocumented resources and provides a baseline with which to gauge future creation and alteration of sites (see Section 5.4).

Although there have been some in-depth scientific studies conducted on geological history, geomorphic processes and meteorological attributes, the main focus of scientific work on the mountain has been astronomy. The focus of most biological research at the summit has been on the wēkiu bug, and less is known about the other species that reside there. Recent research to understand microhabitat and microclimate selection by the wēkiu bug was initiated in 2001, and analysis of meteorological data is being conducted.

OMKM both funds and provides logistical support for scientific studies. The existing facilities at Hale Pōhaku are occasionally used to support visiting scientists, other than astronomers, who are conducting research on the mountain. As use of the mountain for ground-based scientific research grows, managers must consider the potential impacts of further studies, weighed against potential benefits. Recent scientific studies commissioned by OMKM give significant consideration to minimizing the potential

[1] AUI: Associated Universities, Inc.; NASA: National Aeronautics and Space Association (NASA); NRAO: National Radio Astronomy Observatory; NSF: National Science Foundation (NSF)

[2] UH Hilo is in the process of replacing the 0.6-meter telescope with a 0.9-meter telescope for instructional use.

impacts on natural and cultural resources in the Science Reserve and involve consultation with Kahu Kū Mauna, the MKMB Environment Committee, and the MKMB.

6.1.3 Recreation and Tourism

The natural beauty, scenic vistas and accessible high peaks of Mauna Kea provides visitors with a unique experience unlike anywhere else. Tourism and private recreational activities, including hiking, biking, hunting, snow-play and sightseeing, has increased over the past several decades due to better access and a greater number of organized commercial and educational tours. Except for commercial activities and time of day limits, public access to all three of the UH Management Areas is currently unrestricted. The Visitor Information Station of the Onizuka Center for International Astronomy (VIS), established in 1986 at Hale Pōhaku, serves to increase visitor knowledge. The VIS provides information on safety and hazards, astronomy, the observatories, and the natural and cultural resources of Mauna Kea as well as restrooms, a gift shop, and an evening stargazing program.

DLNR DOCARE is tasked with providing enforcement on Mauna Kea. To help ensure the safety of visitors, a ranger program was established in 2001 by OMKM. While the rangers do not have any enforcement authority, they do wear uniforms, drive state-owned vehicles and interact extensively with visitors. The perception this creates likely has the benefit of reducing the impact of visitors (e.g., making them less likely to litter, to respond favorably to requests to stay on trails and deter actions that disturb historic properties). The rangers also fulfill a variety of duties including visitor education, recording visitor activity, search and rescue, trail maintenance and litter pick-up. There are at least two OMKM rangers on duty daily.

While there is no official registration system to track users, in recent years OMKM has been keeping detailed records on the number of people visiting the VIS and the summit (Nagata 2007). It is estimated that in 2002, 105,000 visitors stopped at the VIS (Good 2003). Byrne (2008) indicates similar estimates of greater than 100,000 visitors per year at the VIS over the past few years. The recorded total for all types of summit visitations by vehicles was 32,066 in 2006 and 32,017 in 2007 (OMKM, unpublished data).[3] Observatory vehicles and visiting 4-wheel drive vehicles represent, by far, the largest percentage of total vehicles on the mountain, with just over 13,000 of the former and over 10,500 of the later, in 2007 (OMKM, unpublished data). Ranger estimates indicate an average of about 30 non-commercial visitors a day to the summit, most of them staying less than 30 minutes (OMKM Rangers 2007). The majority of non-observatory traffic occurs in the afternoon. It is anticipated that as tourism on the Big Island continues to grow, and with the ongoing improvements to Saddle Road, more tourists and recreational visitors will visit Mauna Kea in coming years. Currently OMKM rangers estimate that most recreational visitors are from the mainland or overseas, but there is no official tracking of visitor demographics (OMKM Rangers 2007).

Hiking is currently a popular day-use activity for visitors to Mauna Kea. There are several established (but unmarked) trails in the summit region and other trails at lower elevations. Rangers monitor the trails that lead to the most popular places of interest and work to curtail unwanted new trails by directing visitors to the established ones and covering over evidence of unwanted trails. New trails are mainly created when visitors or researchers opt to explore new terrain. Due to lack of signage and a maintained trail network, a faint trail used infrequently may be discovered by others and become more established and impacted. Trail maps are available at the VIS and hikers are requested to register there and inform

[3] The reference (OMKM, unpublished data) refers to data from OMKM database on Ranger patrol reports, ongoing collection 2001–present. Data is housed in a Microsoft Access database at the OMKM main office.

rangers of their travel plans. Ranger reports between 2001 and 2007 suggest that approximately five to six thousand hikers visit the summit region every year (OMKM, unpublished data).

Hunting occurs in many areas on Mauna Kea. Although hunters are known to start looking for animals as far up as 12,000 ft (3,660 m), mammal hunting typically takes place at lower elevations on Mauna Kea in the DLNR Mauna Kea Forest Reserve where the animals are more numerous. As a result of a lawsuit filed to protect designated critical habitat for the endangered Palila, the māmane-naio forest, a federal court ordered the eradication of sheep and goats from Mauna Kea, in 1979. Although this goal was nearly achieved in 1981, the animals are still present on the slopes of Mauna Kea, and hunting continues to be a popular recreational and subsistence activity with local residents. DLNR maintains an active control program for sheep, goats and mouflon from the lower boundaries of the Mauna Kea Forest Reserve up into the Mauna Kea Science Reserve.

Skiing and snow-play are a common winter pastime on the Big Island when the conditions are right. Other than for plowing the roads (conducted by MKSS) and directing parking, there is no logistical support for snow operations on the summit and it is difficult to control use and access. During periods of heavy snow, rangers keep the road closed at Hale Pōhaku until they receive confirmation that conditions are safe for visitors to proceed up the mountain. Sometimes people wait overnight in their cars for the opportunity. The primary area used for snow play, known as the Poi Bowl, is located directly east of the Caltech Submillimeter Observatory—in part because it is accessible by road at both the top and bottom of the run. Because there are no designated trails or ski lifts, visitors often hike off-trail to reach the ski runs, sometimes travelling across open cinder between the snow-covered areas. Vehicle and visitor traffic to the summit may be particularly high on snow days, especially when they fall on weekends. Many people (especially locals) visit the mountain only when there is snow. As many as 600 vehicles were recorded traveling to the summit on one heavy snow day, and each of these is likely carrying several passengers (OMKM, unpublished data). On New Year's Day 2004, after a period of particularly heavy snowfall, rangers estimated there were 1,400 vehicles on the summit (MKMB, 2004) and during the nineteen days documented by OMKM Rangers as snow days in 2007, a total of 2,547 vehicles were recorded on the mountain (OMKM, unpublished data).

6.1.4 Commercial Activities

Commercial tours are a popular way for out-of-town visitors, including cruise ship passengers, to journey to Mauna Kea. Since most rental car companies do not permit the use of their vehicles on the Saddle Road or to the summit of Mauna Kea, and a 4-wheel-drive vehicle is recommended for driving to the summit, many individuals choose to join an organized tour. OMKM regulates commercial tour use and is responsible for issuing permits. Proceeds collected under OMKM from the permitting process are deposited into a revolving fund used to support management of the mountain. At this time each of the nine permitted operators is allowed two evening tours per day, with no restrictions on the number of daytime or sunrise tours until further notice. The maximum number of passengers per vehicle is 14 with a total capacity including the driver, not to exceed 15. The number of commercial vehicles within the UH Mnagement Areas is not to exceed 18 at any time and no more than two standard commercial tour vehicles or one modified commercial tour vehicle per tour operator are allowed in the VIS parking lot at any one time.

OMKM reviews requests for the commercial use of the Science Reserve, including filming, concessions resource extraction, and special events. Filming is the most common request, and all permits are initiated through the State of Hawai'i Film office.

6.1.5 Cultural, Religious, and Spiritual Practices

Mauna Kea has been a center of cultural activities and practices by Hawaiians for centuries. The range of traditional and customary practices and contemporary cultural practices engaged in on Mauna Kea is described in Section 5.2. Although cultural activities may be documented by the rangers in their daily observation reports, there is no estimate of the level of use of the mountain by cultural practitioners. Lake Waiau and the Adze Quarry are destinations of interest, as is the summit Pu'u Wēkiu.

6.2 Infrastructure

Infrastructure, in the form of buildings, roads, and utility lines, supports the existing observatories on Mauna Kea, both at the summit and at the mid-level Hale Pōhaku facility. Major construction activities at the summit, undertaken to build, redevelop, or deconstruct facilities, require at least MKMB and UH Board of Regents approval, BLNR/DLNR permits (such as a CDUP), and appropriate environmental analysis. Minor construction may be conducted as part of on-going facility maintenance and are subject to review by OMKM and MKMB but generally do not require a CDUP.

6.2.1 Facilities

The 525 acre Astronomy Precinct encompasses twelve of the thirteen telescopes on Mauna Kea. The total disturbed area for the installation of the existing observatories at the summit is approximately 17 acres (7 ha), of which 4 acres (2 ha) is impervious surface, and the area remaining being adjacent and mostly unpaved leveled areas and access roads or driveways (NASA 2005). As depicted on construction drawings, the foundation depths and sizes of the buildings vary, but can extend over a hundred feet below the ground surface and cover hundreds of square feet of surface area. Some of the building's useable areas are also located below grade. The VLBA antenna is situated approximately 1,591 ft (485 m) below the summit. The dish antenna and control building are accessed by a dirt-road spur from the Summit Access Road.

Buildings at Hale Pōhaku include a support facility for the observatories, construction camp facilities, and VIS facilities. The observatory support facilities contain dormitories, dining facilities, and recreational areas and offer a place for astronomers and technicians working at the summit to acclimate before going up, and to live while working. They are occasionally used to support visiting scientists, other than astronomers, who are conducting research on the mountain. The VIS, a 950 sq ft facility, houses an interpretive center and a rest stop for visitors on their way to the summit.

6.2.2 Utilities

Underground power and communication lines supply Hale Pōhaku and summit facilities. Installation of the underground system to transmit electricity to the summit facilities began in 1985 and was completed in 1995. Rather than on-site generators, the facilities are now powered from a sub-station below Hale Pōhaku that is connected by overhead lines to the Humu'ula Radio Site. In the mid-1990s, underground fiber optic lines were installed to provide high speed communications capability to the observatories. One benefit of these lines was a reduction in personnel needed on-site at some of the observatories, as they can now be controlled remotely.

6.2.3 Roads and Parking

Hale Pōhaku and the summit of Mauna Kea are accessible from the Saddle Road (Route 200). The Summit Access Road extends 16.3 mi (26.2 km) from its intersection with the Saddle Road to the

summit, with an average width, including cuts and fills beyond the main route, of 45 ft (14 m) (NASA 2005). The road is paved along its entire length except for a 4.6 mile unpaved, gravel section that extends from Hale Pōhaku to below the summit area. Future plans may include paving the unpaved portion of the summit access road and the remainder of the summit spur road, from the SMA building, past the Subaru Telescope to the Keck Observatory; however, concerns related to cost, environmental impacts, and facilitating access to the summit need to be evaluated (see Section 7.3).

There are three visitor parking areas along the Summit Access Road: Parking Area 1, located just after the paved road begins; Parking Area 2, near the trailhead to Lake Waiau; and Parking Area 3, just past the junction of the access road and the summit loop. These areas are depicted on the map included in the safety brochure made available to workers and visitors, but are not identified by signage on-site. At the summit many visitors park near the UH 2.2m telescope if they plan to hike the summit trail. During the winter, before roads are fully cleared of snow and when there are large numbers of private vehicles in the summit area, parking becomes congested and visitors park their vehicles along the road wherever there is space. Commercial tour vehicles usually park in the area around the UH 2.2m telescope and Gemini Telescope during the sunset viewing times. For evening stargazing, there are designated parking areas for tour vehicles on lower portions of the mountain. Observatory vehicles park in designated areas near their buildings. Most parking areas are graded but unpaved.

6.2.4 Water and Waste Removal

Water

MKSS contracts with a trucking company to deliver potable water from Hilo to Hale Pōhaku and the summit observatories, in 5,000-gallon-capacity (18,900 l) tank trailers owned by MKSS. Each observatory stores its own water and is responsible for maintenance of its water tanks. Data from MKSS indicates that the Hale Pōhaku facilities (food, lodging, VIS) currently require approximately 30,000 gallons (113,500 l) of water weekly (Nahakuelua 2008). Water is trucked to the summit about twice a week for an annual total of approximately 502,500 gallons (1,902,000 l) (Koehler 2008).

Wastewater

Each observatory owns an individual wastewater system (e.g., septic tank, cesspool) that has been permitted by the Hawai'i State Department of Health (DOH). Currently there are a total of eight septic systems and three small capacity cesspools in the summit area. Restroom facilities at the summit available for visitor use include four portable toilets and the restrooms located in the Keck Observatory. The portable toilets are located at two different parking areas and can be moved between the sites depending upon need. Portable toilets are serviced weekly and pumping is done on-site.

Hale Pōhaku has three small capacity cesspools and six septic systems. The three small capacity cesspools are used for dormitory A, the old construction camp and the utilities buildings. The six septic systems are used at Hale Pōhaku's main common building; dormitories B, C, and D; the new construction camp; and the VIS. The new construction camp and dormitory D each use a leach field for effluent discharge.

Solid Waste

Trash is generated and collected at summit observatories and Hale Pōhaku facilities. All trash containers are required to be covered and secured to prevent providing a food source for invasive fauna and to reduce the possibility of escaping debris, which can occur during periods of high winds that occur regularly. The observatories are responsible for removing their trash from the summit. Trash from Hale

Pōhaku and the dormitories is taken off the mountain daily by the MKSS housekeeping staff and brought to the main Hilo office where it is removed by sub-contractors (Wilson 2008).

Hazardous Materials

Solid and liquid hazardous materials are used in routine observatory operations and generate waste after their use. Each observatory has a written procedure for safely handling and disposing of hazardous materials and emergency procedures for attending to spills. Licensed contractors are used to transport wastes to a state-approved, off-site disposal facility in Hilo. There have been no documented spills of hazardous materials since 2004 (see Table 6-2).

Telescope operations may require glycol coolants; diesel fuel for emergency generators; hydraulic fluid; lubricants; compressed gases (e.g., carbon dioxide, helium, oxygen, nitrogen); mercury; mirror decoating acids (e.g., hydrochloric acid, potassium hydroxide, copper sulfate, hydrofluoric acid); and paints and solvents. The amounts used vary by facility, although data shows the Keck Observatory to be using and storing the largest amount, by volume, of hazardous materials (NASA 2005).

Hale Pōhaku has three underground storage tanks: one housing 11,500 gal (43532 l) of diesel and two housing 2,000 gal (7570 liters) and 4,000 gal (15,140 liters) of gasoline. Tanks are located underground in front of the maintenance utilities shop and are believed to be approximately 25 years old. Due to the lack of secondary containment, in 1997 the tanks were retrofitted with a 24-hour a day sensor monitoring system that is checked daily (Nahakuelua 2008).

Mirror washing

Five observatories (Keck, CFHT, Gemini, Subaru, and UH 2.2m) have their own facilities to conduct mirror washing activities (stripping aluminum from the reflecting surface of the mirror) at the summit. The other observatories bring their mirrors to one of those five for washing and recoating activities (McNarie 2004). At the Subaru telescope, wastewater generated when mirrors are washed has always been contained for off-site disposal, but from 1971 until 2001, the other observatories either disposed of the wastewater in either their onsite domestic wastewater disposal systems (UH, Keck I & II, Gemini) or in an open drain leading to the ground (CFHT). In 2001, wastewater management protocols were changed in response to concerns from community groups about the potential impact of this wastewater on the surrounding environment. All mirror washing effluent is now collected and trucked off the mountain for off-site treatment and disposal (McNarie 2004).

Concerns have been raised about potential impacts to natural resources that could have been caused by chemicals (e.g., aluminum, mild acid solution, alcohol, detergents) that may have been disposed of with mirror washing wastewater during 1971–2001. It is estimated that the total amount of aluminum used on one 3-meter diameter mirror is approximately 15 grams (0.5 ounce) (Koehler 2008). Limited analysis conducted on the fate and transport of metals contained in the effluent wastewater derived from mirror washing during the period it was discharged onsite found no substantial impacts (NASA 2005). However, the fate, transport and potential impacts to downgrade waters from metals and other contaminate byproducts previously discharged into the septic systems, cesspools, and dry swales is unknown due to uncertainties regarding capture rates of byproducts in the waste systems, and the hydrogeologic properties of the area.

As part of the mirror re-aluminizing process, telescope mirrors must be removed from their protective ring girdle; a few of the girdle systems house mercury. There have been seven documented mercury spills associated with mirror washing. The majority of the spills were of small quantities, and all occurred

indoors and were successfully cleaned up. There have been no documented spills of mercury since 1998 (see Table 6-2). No mercury has been released to the outside environment.

6.2.5 Safety

Mauna Kea is a remote locale with no public accommodations. At 13,796 feet (4,205 m) the summit is subject to severe weather conditions. The road above Hale Pōhaku is steep, rough, winding, and particularly dangerous in bad weather. Only four-wheel-drive vehicles are recommended beyond the visitor center. In addition to safety concerns due to weather, the summit altitude may also cause acute altitude sickness, especially for those who do not take time to acclimate at Hale Pōhaku. Rangers are charged with helping to provide some safety related services to visitors including conveying safety information, rescuing lost or stranded hikers and assisting those with adverse reactions to the altitude.

A number of emergency responses that may occur on Mauna Kea could adversely affect biological and historical properties. It is difficult to predict the specific requirements of any emergency, but detailed safety plans regarding general topics such as chemical or fuel spills, removal of displaced vehicles, and evacuation of persons (including by helicopter), have been developed. Evacuation of sick or injured people (workers and visitors) is coordinated by MKSS. Safety procedures in response to emergencies related to observatory operations are developed and coordinated by each observatory individually.

While emergency procedures have been detailed in order to prevent loss of life and in the event of any type of hazardous spill, it is important for emergency response personnel to understand protocols for reducing the negative effects of any ground disturbing activities and to culturally significant sites. OMKM has site maps of historic properties to be given to emergency personal in order to avoid site disturbance. Additional information on emergency response procedures and recommendations for revisions of the emergency response plan are provided in Section 7.4.1.

6.2.6 Future Land Uses

Proposed plans for future astronomical development on the summit are described in the 2000 Master Plan (Group 70 International 2000). In addition to the potential construction of new observatories, other possible changes to the astronomy facilities include redevelopment of existing sites (i.e., dismantling an existing facility and replacing it with a new one on the existing footprint), upgrades to or expansions of existing observatories, and removal of some obsolete observatories. Changes could also involve improving utility service. Any future development would occur within the Astronomy Precinct portion of the UH Management Areas, as delineated in the 2000 Master Plan (Group 70 International 2000). The 2000 Master Plan also recommends protecting all of the major undeveloped *pu'u* and the intervening areas from development. Construction could involve use of hazardous materials; generation of dust and debris; increased traffic and use of heavy equipment; noise and vibrations from jackhammers, wrecking balls and other equipment; excavation and disposal of excavated material; grading and filling; drilling and pouring concrete for piles, piers, footings and foundations; and installation of structures (e.g., antennas, buildings).

Table 6-2. Hazardous Material and Sewage Spills Associated with Astronomy Operations on Mauna Kea

Data from (NASA 2005; Koehler 2008)

Date	Location	Material(s)	Incident/Response
1979 (estimated)	CFHT Facility (indoors)	Hydraulic fluid	A hydraulic system filter clogged, leading to the backfilling of a drain, which overflowed and caused roughly 0.5 gal (1.9 l) of hydraulic fluid to spill onto an optical tube. There is also anecdotal recollection of a spill and cleanup related to a burst hydraulic pump in the early years of observatory operation.
1982	Now known as the summit area construction staging area	Diesel fuel	During a biological survey, Howarth and Stone (1982) noted an 194 ft^2 (18 m^2) area of staining on the ground near a temporary generator and suspected a diesel fuel spill. The generator has since been removed.
1989	NASA IRTF (indoors)	Mercury	A 20 lb (9 kg) mercury spill onto the concrete floor resulted from the puncture of the primary mirror support ring. Cleanup was performed in accordance with written observatory procedures using commercial products designed for mercury recovery.
October 3,1990	CFHT Facility (indoors)	Mercury	Mercury spill from a pinched secondary mirror support bladder. Facility was evacuated temporarily during cleanup. Approximately 0.41 lbs (180 g) spilled but fully contained within the observatory building.
1995	W.M. Keck Observatory (indoors)	Mercury	Three mercury spills have occurred at the observatory: – August 10, 1995, while working on f/15 secondary, resulting in a 1 tsp (5 ml) spill. – September 15, 1995, while working on f/15 secondary mirror, resulting in a 7 tbsp (100 ml) spill. – November 6, 1995, while transferring mercury between containers, resulting in a spill of 1 to 2 tsp (5 to 10 ml). All three spills occurred in the mirror handling room, and were cleaned up promptly. None resulted in any mercury seepage into the ground or the septic system. As a result of these incidents, the observatory revised mercury handling and response procedures. No subsequent mercury spills have occurred.
November 3, 1995	Mauna Kea Access Road near Very Long Baseline Array	Diesel fuel, engine and hydraulic oil	Truck involved in construction of SMA overturned, causing fuel tank and engine lines to rupture, releasing approximately 60 gal (227 l) of fluids onto surface cinder; impacted media were excavated and removed by truck owner within 24 hours.
September 3, 1996	Subaru Telescope	Ethylene glycol	Release occurred when a pallet carrying two 55 gal (208 l) containers failed, and the containers fell to the cinder and ruptured. Cleanup was performed immediately to recover free liquid and excavate affected cinder. All contaminated materials were bagged and disposed of.
1998 (estimated)	UH 2.2-m Telescope facility (indoors)	Mercury	A few drops of mercury escaped on several occasions while the mirror support ring was being drained or refilled during the recoating process. These were cleaned up according to the UH mercury cleanup procedures.
January 15, 1998	Subaru Telescope	Sewage	Improper installation of septic tank led to freezing, which created a clog and a spill of about 2 gal (7.6 l) on the ground and snow. A plumber repaired the clog, and the observatory added cinder atop the septic system to insulate against freezing.

Date	Location	Material(s)	Incident/Response
June 5, 1998	CFHT facility (indoors)	Mercury	In order to align a lens, a pool of mercury was lifted to the bottom of the lens to create a reflected image. During the procedure about a "thimble full" of mercury spilled from an overflow dish to the concrete floor. The mercury was cleaned up quickly. Afterward, recommendations were made for additional training and better equipment for containment.
1990 to 2000 (date estimated)	Caltech Submillimeter Observatory	Hydraulic fluid	On a few occasions, small amounts of hydraulic fluid seeped out of joints in the dome hydraulic system and dripped onto the concrete pad under the dome. No fluid traveled beyond the concrete pad. An ongoing hydraulic system inspection program detects any seepage source. The source is eliminated, and all traces of fluid on the concrete pad were immediately cleaned up.
2003 (date estimated)	Hale Pōhaku	Crankcase oil and hydraulic fluid	Crankcase oil and hydraulic fluid leaked from a piece of equipment. The soil was excavated, tested, and sent to a landfill in compliance with state health department regulations. The facility has taken measures to reduce the likelihood of this type of spill recurring.
2003	Hale Pōhaku	Transmission oil	Two oil drips beneath an old truck used to transport mirror for the Joint Astronomy Center. Total amount of the leakage estimated at less than 1 qt (950 ml). The Joint Astronomy Center dug out cinders under drip areas and removed them for disposal. Absorbent pads were used to stop further drips; the truck was removed.
2003	Smithsonian Astrophysical Observatory Submillimeter Array	Hydraulic fluid	Hydraulic leak onto asphalt, about 0.5 qt (473 ml), caused by decayed seals. Cleaned using approved "pig-mat" absorbent material, which was disposed of appropriately.
1998 to 2004	Caltech Submillimeter Observatory	Sewage	Five overflows of the domestic wastewater system occurred over a 16-year period. The overflows were accidental and small, on the order of several liters (gallons).
February 2004	Smithsonian Astrophysical Observatory Submillimeter Array	Diesel fuel	Diesel leak onto asphalt, less than 4 qt (3.8 l), caused by decayed seals. Cleaned using approved "pig-mat" absorbent material, which was disposed of appropriately.
March 30, 2004	W.M. Keck Observatory	Propylene glycol	The spill occurred during testing of an auxiliary glycol cooler when one of the hoses accidentally became dislodged from its barbed fittings. Spill estimated between 20 to 30 gal (76 to 114 l), with approximately two-thirds escaping outside the facility. The CARA Safety Officer handled spill response; affected cinder was contained, removed, and disposed of at a local landfill. The observatory notified OMKM, which advised on disposal.
March 22, 2008	Hale Pōhaku	Sewage	Approximately 500-1,000 gallons of sewage overflowed onto the ground from the VIS septic tank – due to some blockage. The incident was reported to DOH. The waste on the ground was quickly absorbed and back to normal within a few days.

Other potential land uses include projects to support the various other uses of Mauna Kea. Hale Pōhaku provides supporting infrastructure and services to support observatories, visitor use, and scientific research. Although no specific plans have been proposed, the 2000 Master Plan suggests some changes to these facilities including removal of some of the older construction camp buildings; use of the Subaru construction camp facilities to support education and research activities; expansion of the visitor center to include a larger interpretive center, an observatory, and ranger facilities; and expanded parking (Group 70 International 2000). Growing visitor numbers have prompted discussion about improved facilities to support recreational users to the summit, including a rest area in the snow play area at the base of 'Poi Bowl', designated scenic lookouts, designated visitor parking within the Science Reserve, and additional visitor parking at Hale Pōhaku (Group 70 International 2000). There are no current plans to pursue any of these changes.

6.3 Threats to Resources

The overall impacts of human activities (combined with those of natural events such as weather patterns) are often greater than the sum of their individual parts. Each activity that occurs on Mauna Kea may have multiple impacts. Table 6-3 shows the interrelationships between the activities that occur on Mauna Kea outlined above and the potential impacts to natural and cultural resources. This table demonstrates the need for a comprehensive approach to management, as simply controlling one activity is unlikely to eliminate the associated threats. When attempting to reduce the impact of a threat, all sources of the threat must be examined and if found to be significant, addressed. Other threats, such as climate change, act over a longer time frame and are more difficult to quantify and correlate with specific impacts; however as a high-elevation alpine system, Mauna Kea is likely to experience some ecosystem level changes resulting from climate change. The range of threats and their potential impacts on resources is summarized below.[4]

The high elevation ecosystems and cultural sites found on Mauna Kea are unique and easily disturbed. Observatory and infrastructure maintenance and construction can impact natural and cultural resources through physical disturbance, habitat removal, and accidental release of debris, chemicals and waste products. Many of the human use impacts stem from uneducated visitors and loosely regulated and minimally managed access. Concerns related to access extend to all types of users, including those associated with the observatories and other scientific activities, recreational and commercial users, and those participating in cultural practices. Potential impacts from development and human uses include: pollution, construction activities (dust, traffic, water use), visual disruption, habitat alteration (including disturbance of previously undisturbed natural areas), disturbance of cultural sites, and use conflicts. Threats from various user groups will vary in type and intensity, factors that must be considered when developing management recommendations. Increased emphasis on educating all users (including observatory personnel) through outreach and on-site programs, along with stricter access management has the potential to reduce the severity of threats and their impact on natural resources. A brief description of the main impacts of concern and the threats that cause them follows.

[4] Note that a few items can be considered to be both threats and impacts.

Table 6-3. Threats and Potential Impacts

Threat	Potential Impact									
	Cultural Site Disturbance	Habitat Disturbance	Air pollution	Contaminants	Erosion	Debris	Noise Pollution	Invasive Species	Population Decline	Fire
Lack of information on resources	X	X		X	X			X	X	
Lack of education and sensitivity	X	X	X	X	X	X	X	X	X	X
Uncontrolled access[5]	X	X	X	X	X	X	X	X	X	X
Astronomical research (operations)	X	X	X	X	X	X	X	X	X	
Infrastructure (maintenance and construction)	X	X	X	X	X	X	X	X	X	X
Scientific research	X	X		X	X		X	X	X	
Debris	X	X	X	X	X			X	X	X
Emergencies (ground disturbing)	X	X	X	X	X	X		X	X	X
Lack of management capacity	X	X		X	X	X		X	X	
Lack of enforcement	X	X	X	X	X	X	X	X	X	X
Fire	X	X	X		X			X	X	
Invasive species	X	X			X			X	X	X
Climate change		X						X	X	X

6.3.1 Cultural Site Disturbance

The major threats that can lead to the degradation of cultural sites include visitor disturbance, damage from off road vehicles, ground disturbing activities (construction, maintenance, and emergency procedures), scientific research, debris and lack of enforcement of existing rules and policies. Astronomy development also has an impact on cultural sites as most of the observatories are located within the summit TCP.

Visitor disturbance. Unrestricted access has the potential to cause damage to cultural sites simply due to large numbers of visitors. Uninformed curious visitors may damage cultural sites without even realizing it. This may include trampling over sites, removing items, discarding trash and other inappropriate behavior. Some visitors may intentionally damage sites, for example by making markings or moving items around, if enforcement personnel are not present to deter them.

Off road vehicles. Off road vehicles can cause damage by directly running over historic properties, but also provide greater access to remote properties.

Ground disturbing activities. Ground disturbing activities range from large projects such as building new facilities to small projects such as removing trash or invasive species. While the daily maintenance currently being carried out in the UH Management Areas is not likely to affect cultural sites, larger projects associated with continued maintenance can if the project is located near a cultural site. Examples of this are repair of underground utility lines, roadwork, any maintenance involving hazardous materials

[5] Includes recreational users, commercial users, off-road vehicle use, and cultural and religious practices.

and its disposal. Construction of new facilities may also inadvertently disturb previously undiscovered cultural sites during excavation. If care is not taken, materials (such as cinder) shifted while excavating new sites may also cover or disturb historical sites.

Burials present in the summit area are protected under state law. All of the previously identified Native Hawaiian burials have been recorded and disposition of any previously identified Native Hawaiian human burial remains will be made by the HIBC in consultation with recognized lineal and cultural descendants and other Native Hawaiian organizations as required by law. However, there is a potential of inadvertently encountering human remains during ground disturbing work or simply due to the erosion of substrate. These are called "inadvertent discoveries" and the treatment and disposition will be made by SHPD pursuant to Chapter 6E, HRS and Title 13-300-40, HAR.

Debris. Scattering of unsecured debris such as litter, construction materials and abandoned snowplay items has the potential to damage historic sites as well as the visual integrity of historic features. In addition, removal of debris has the potential to cause damage from people trampling on and around historic sites.

Lack of enforcement of existing rules and policies. Lack of enforcement personnel or personnel that have not been properly trained make enforcement of established rules and policies difficult.

6.3.2 Habitat Disturbance

Large scale or frequent habitat disturbance can lead to alteration that may threaten native communities by directly removing habitat (through development) or changing it to the extent that the occupying species are no longer able to live there. In the UH Management Areas, the main activities that cause habitat disturbance include construction and infrastructure, vehicles (on and off road), and off trail hiking by recreational users, cultural practitioners and researchers. At both Hale Pōhaku and the UH Management Areas, habitat alteration occurs through development of astronomy facilities and support structures (such as parking lots), everyday use and introduction of invasive species.

Cinder disturbance due to construction, vehicle use and hiking. One of the main issues contributing to habitat disturbance in the UH Management Areas is cinder disturbance. The surfaces of cinder cones and adjacent lava fields on Mauna Kea are vulnerable to morphologic alterations caused by direct human contact. Construction of new facilities alters the area occupied by the facility, and causes habitat disturbance to the surrounding area. Continued walking or driving over an area crushes small, individual pieces of cinder, leaving trails that have not only visual impacts that are offensive to some cultural practitioners and may negatively affect the view shed, but also create dust-sized particles that are prone to entrainment by wind. Fugitive dust generated off of trails, unpaved road sections, and other exposed areas, as well as from construction activities is an ongoing concern to resource managers.

Off road vehicles. Off road vehicles crush cinder, flora and fauna, and create tracks that scar the landscape. Off road vehicles are not permitted in the UH Management Areas. Although instances of off-road use appear to be infrequent, accessibility from adjacent land areas where off road vehicles are permitted is an ongoing concern.

Scientific research. Crushing of cinder and incidental take (the unknowing or accidental killing or removing of an organism) can occur through habitat disturbance by repeated travel to study areas by researchers. Geological and hydrological research that includes excavating or drilling of holes disturbs both surface and sub-surface features, although the total area disturbed is generally small.

Invasive species. Grazing by feral ungulates has resulted in habitat disturbance that has contributed to the decrease in native species and facilitated the increase of invasive plant species. Some invasive plant species disturb habitat by increasing soil erosion or fire frequency.

6.3.3 Air Pollution

Currently the air quality at the summit of Mauna Kea is thought to be quite good, although it is not actively monitored (see Section 5.5.1). Human-caused contributors to air pollution at the summit include vehicle exhaust, chemical fumes from observatory construction and maintenance activities, and fugitive dust from road grading and construction or other activities conducted on unpaved surfaces. Although air pollution is not now considered to be a pressing issue, as vehicular traffic to the summit increases, the impact of vehicles on air quality, from exhaust and dust generation, can be expected to increase as well.

6.3.4 Contaminants

Contamination of soils, substrates, Lake Waiau, groundwater, and aquifers is a potential side effect of a variety of human activities on the mountain. Depending on the volume and location, contaminant releases may have adverse effects on biological and water resources, human health, and visual resources (e.g., discoloring). Transport of contaminants through the substrate has the potential to impact the quality of both surface water and groundwater. Direct toxic impacts on flora or fauna are also possible. The highest probability of impact is from petroleum products (e.g., fuel for vehicles and backup generators, lubricants, and cleaning fluids) and human waste. The main activities that have potential to result in a release of contaminants include vehicle travel (on and off road) and accidents; release of hazardous material and petroleum product use by observatories and support operations; sewage generation; and transport of hazardous materials and sewage off-site.

6.3.5 Erosion

Erosion is a natural process whereby wind, water or ice detaches soil particles and transports them from their original location. When water, in either solid or liquid phase, is the eroding agent, movement of particles generally follows the force of gravity. However, wind transported particles can be lifted and carried to higher elevations in ascending air parcels, resulting in deposition either upslope or downslope from their original position. Erosion rates are a function of the erodibility of ground surface and erosivity of the agent inducing particle displacement and transport. Human activities that reduce groundcover and concentrate overland flow increase erodibility and erosivity respectively, resulting in increased erosion rates. The summit area of Mauna Kea is subjected to all three agents of erosion. Due to the prevalence of wind on the mountain, exposed areas, including roads and trails are vulnerable to erosion by wind nearly year round. Erosion rates by water at the summit area are regulated in part by the high porosity of the surface cover allowing infiltration of precipitation into the ground surface, and by limited precipitation. In areas where compaction has occurred infiltration is reduced, resulting in increased runoff and erosivity. Below the summit region, in areas such as Hale Pōhaku, where surface conditions are dominated more by soil than volcanic substrate, erosion rates are higher due to the greater erodibility of the soils (Gerrish 1979). Activities that increase the potential for accelerated erosion includes infrastructure maintenance and construction; road grading and vehicle travel; off-road vehicle use and hiking.

6.3.6 Debris

Litter and larger debris impacts the visual aesthetics of the Science Reserve and may negatively affect cultural resources. Debris in the landscape is considered particularly offensive to those who hold Mauna Kea sacred. In addition, it may interfere with deposition of food resources in the aeolian ecosystem, shade out vegetation, and damage geological resources upon impact. Food waste may provide a resource to support pest species and predators of native biota. Collection of debris is also of concern as removal activities may do more harm than the actual debris, if people or vehicles crush cinder in sensitive habitats (Howarth et al. 1999). The main activities and users that produce solid waste include observatories and support facilities (trash); construction (materials); recreational users (litter, snow-play debris); commercial tour groups (litter); and cultural practices (offerings). Construction activities are capable of producing large amounts of debris that can harm the environment if not properly monitored and disposed of.

6.3.7 Noise Pollution

Ambient noise levels at Mauna Kea are low, with vehicle traffic and wind providing the dominant background noise. Observatory operations create minimal noise, while construction activities create intermittent, though sometimes significant, disruptions. The primary receivers that might be disrupted by excessive noise are the human users of the mountain including scientists, cultural practitioners, and recreational users. There is also the potential that noise generated by certain activities or systems would have an impact on biological resources. The main activities that produce noise include vehicle travel, observatory operations, and construction operations (e.g., heavy equipment use, drilling, and excavation).

6.3.8 Invasive Species

Invasive species damage natural ecosystems and native plant and animal communities, cause economic harm, and can impact human health and well-being (National Invasive Species Council 2008). The most common impacts of invasive plants and animals include habitat alteration; increased erosion and substrate compaction; alteration of hydrology and nutrient cycling; increased frequency and severity of fires; changes in visual attributes; competition with native species for space and resources; introduction and spread of disease; and increased predation and parasitism of native species.

Many of the mountain's ecosystems have already been impacted by introduced animals and plants, and introduction of new invasive species remains a continuing threat. Invasive plants and mammals cause the most damage at Hale Pōhaku and the lower regions of the Science Reserve. For the summit region, the biggest threat from invasive species is introduction of predacious non-native invertebrates that could impact the unique native aeolian invertebrate community.

Although the harsh conditions in the subalpine and alpine ecosystems of Mauna Kea do prevent establishment of many invasive species, others are able to take hold and cause considerable damage. Virtually any user, vehicle, equipment, or material that comes to Mauna Kea can be an unintentional carrier. The main activities and uses that may introduce invasive species include vehicles and researchers that frequent Mauna Kea for work at the observatories; materials and equipment used in construction and maintenance; recreational users that may import material on footwear and vehicles; imported gravel used in road grading; landscaping materials used at lower elevations; and cultural practitioners leaving offerings.

6.3.9 Population Decline

Declines in populations of native plants and animals and loss of native biological diversity have been especially profound in the Hawaiian Islands. There are many known causes of population declines and loss of species in the high-elevation ecosystems of Mauna Kea, including habitat loss and disturbance; invasive species impacts (especially grazing by feral ungulates); barriers to species migration; changes in weather patterns and fire regimes; scientific research and collection of specimens. Often it is the combination of one or more of these threats that causes the decline or extinction of a species. Because UH Management Areas contain several species that are listed as endangered, threatened or species of concern, population decline should be managed to avoid the threat of extinction.

Habitat disturbance and alteration. Habitat disturbance and alteration can effect populations by limiting available resources and changing the ecological features on which species rely.

Competition, predation and parasitism from introduced species. Competition from non-native introduced species for food, water, shelter and reproduction locations has contributed to the population decline of native species on Mauna Kea. Predation and parasitism by non-native species are contributing factors to mortality of native species on Mauna Kea.

Grazing by feral ungulates. The decline of native plant populations on Mauna Kea due to grazing by feral ungulates is well documented. Browsing not only reduces native plant abundance but also facilitates an increase in invasive plant populations. This results in habitat changes that may lead to further population decline due to increased competition for resources.

Scientific Research (sample collection and incidental take). Human activities on Mauna Kea can result in the reduction of plant and animal populations through both sample collection and incidental take. Sample collection occurs mainly as the result of scientific research. In addition amateur collectors and tourists also occasionally collect plants and animals. For example, some research activities (e.g., trapping, collection of botanical samples) may result in the death or removal of the organism being studied. Arthropod sampling often results in the death of the specimens, even when researchers use live trapping methodologies (Englund et al. 2002; Englund et al. 2007). Most studies endeavor to employ sampling methodologies designed to minimize direct and incidental take, but some take does occur.

Barriers to species migration. Barriers to species migration can prevent species from migrating to more favorable conditions if their current habitat becomes degraded or altered (though development, use patterns, or climate change). Examples of barriers to migration include habitat alteration through development, presence of invasive species, low dispersal rates or small population sizes of the migrating species, and missing species in the new habitat (such as prey items, or symbiotic species).

Fire. Fire may contribute to population decline through direct mortality or alteration of habitat. Historically, wildfires occurred infrequently on Mauna Kea and, unlike many invasive plant species, native species have not adapted mechanisms allowing them to be fire tolerant.

6.3.10 Fire

Although there are few vegetated areas susceptible to fire in the UH Management Areas, fire is a potential threat to habitat in the subalpine zone at Hale Pōhaku. Prior to the introduction of invasive grass species, wildfires were most likely infrequent in the subalpine zone (Hess et al. 1999). The growing populations of invasive grasses have increased the risk of fire in the subalpine zone by providing a source of continuous fine fuels in areas that previously had naturally discontinuous fuel beds, due to the patchy nature of the

subalpine communities (Smith and Tunison 1992; Hess et al. 1999). These risks have also become greater with the reduction in animal populations that once fed upon the invasive grasses.

Fires in the subalpine zone could destroy mature māmane trees, which are the main food source for the endangered Palila. Depending on the intensity of the fire, māmane trees could lose all above ground biomass. Although some may be able to resprout, it would take several years until the trees were mature enough to produce the seed pods on which the Palila rely.

Potential sources of ignition include vehicle accidents, improperly disposed cigarettes and matches, sparks from automobile catalytic converters (especially on unpaved hunting roads), arson, camp fires at lower elevations, lightning, and military training activities at Pōhakuloa Training Area. Three major fires have been documented by MKSS, all located on the southern slopes of Mauna Kea, five to ten miles east of the Summit Access Road and below 9,000 feet (Koehler 2008). Control efforts were provided by the County Fire Department, the State Department of Forestry and Wildlife, and PTA. MKSS donated water to the State Department of Forestry and Wildlife to help control these fires.

6.3.11 Climate Change

Climate change scenarios predict an overall warming in the Hawaiian Islands and that the higher-altitude areas on the islands will see greater gains in temperature than lower-altitude areas (Giambelluca and Luke 2007; Hamilton 2007). Some climate change models predict an increase in rainfall and, possibly an increase in snowfall in the higher elevations. Other climatologists predict that conditions in high-elevation areas in the Islands will become much drier due to changes in the trade wind inversion such as have been observed in the last several decades (Giambelluca and Luke 2007). Increased temperatures in high elevations may move the tree line upslope, moving plant and animal communities along with it. However, the kind of impact that climate change may have on high-elevation ecosystems will depend greatly on whether up slope areas get drier or wetter. Increased drought may make germination and survival of plants, especially māmane trees, more difficult. Changes in snowfall or wind patterns at the summit could threaten the aeolian community. Invasive species compound the problem by competing with native species for habitat and resources. Invasive plants may block native species from moving up or down the mountain as they seek their preferred rainfall and temperature conditions.

It is unlikely that the human-use activities on Mauna Kea are contributing proportionally more to climate change than they are at any other elevations in Hawai'i, or at other locations on the Earth. That is, all human activities that involve the consumption of fossil fuels are contributing to global climate change, and any activities that can reduce this consumption will help reduce the impacts of climate change.

7. MANAGEMENT COMPONENT PLANS

This section describes the management actions needed to address the various management needs identified during the process of developing this CMP. Management actions are organized by topic into component plans, as shown below. All component plans were developed using the best available scientific and cultural information and community input, to support the mission to preserve, protect and enhance the cultural and natural resources within the UH Management Areas. Each component plan emphasizes coordination with other agencies, adjacent landowners, and other stakeholders, including cultural practitioners and families with lineal or genealogical connections to Mauna Kea; development of collaborative initiatives; gathering input from the community; and incorporating Native Hawaiian cultural values and traditional knowledge into management planning and activities.

Section	Component Plan
7.1	Understanding and Protecting Mauna Kea's Resources
7.1.1	Native Hawaiian Cultural Resources
7.1.2	Natural Resources
7.1.3	Education and Outreach
7.1.4	Astronomy Resources
7.2	Managing Access and Use
7.2.1	Activities and Uses
7.2.2	Permitting and Enforcement
7.3	Managing the Built Environment
7.3.1	Infrastructure and Maintenance
7.3.2	Construction Guidelines
7.3.3	Site Recycling, Decommissioning, Demolition and Restoration
7.3.4	Considering Future Land Use
7.4	Managing Operations
7.4.1	Operations and Implementation
7.4.2	Monitoring, Evaluation, and Updates
7.5	1995 Management Plan Controls

Each component plan is organized into five sections:

1. *Desired Outcome,* which summarizes the goal(s) of the component plan.
2. *Current Status*, which summarizes the background information and any existing management activities, as well as problems or impediments to reaching the desired outcome.
3. *Need,* which provides background information on what type of management actions are needed to achieve the desired outcome and why they are needed. To achieve the desired outcomes, management needs were developed in four areas: education, information gathering, management measures, and rules and enforcement.
4. *Management Actions,* which provides specific aspects of program development and management actions required to meet the management needs and achieve the desired outcome.
5. *Additional Considerations for Management Actions,* which provides additional detail on developing and implementing the management activities.

The component plans also identify areas where management needs overlap and management actions can be shared, while still accomplishing the desired outcome of each component plan. Cross-references are made to related component plans as needed.

7.1 Understanding and Protecting Mauna Kea's Cultural and Natural Resources

7.1.1 Native Hawaiian Cultural Resources

This section provides information and management actions to protect, preserve, and enhance the cultural resources of the UH Management Areas. As described in Section 5 cultural resources include historic properties and cultural practices and beliefs. Historic properties include archaeological sites and traditional cultural properties.

CMP management actions are based on a comprehensive archaeological survey and fieldwork of the UH Management Areas conducted between 2005 and 2008 and consultation with the major stakeholders, including the Native Hawaiian community, cultural practitioners, families with lineal connections to Mauna Kea, astronomers, and other interested parties. See Section 4.3.

Desired Outcome

Increase understanding and appreciation of Native Hawaiian history and cultural practices related to Mauna Kea to ensure that these practices are protected and respected. Identify, document the condition of, and protect cultural resources and historic properties in the UH Management Areas.

Current Status

A summary of the cultural resources found in the UH Management Areas is presented in Section 5.

Mauna Kea is a culturally significant site and is considered sacred by many Hawaiians. The summit region is designated as a historic district by the SHPD and is also eligible for listing on the National Register of Historic Places. In 2000, SHPD designated two areas within the UH Management Areas, Kūkahau'ula and Pu'u Līlīnoe as TCPs. Some in the Hawaiian community have suggested that the entire area above 6,000 ft (1,829 m) should be designated a TCP. There are Native Hawaiians who continue to access the UH Management Areas to exercise traditional and customary practices, including the gathering of mamake, ko'oko'olau, and māmane, and others who access through the area for contemporary cultural practices and subsistence uses, burying the *piko* of their children, religious observances, scattering of ashes and visiting of *na iwi* kupuna. Mauna Kea continues to be a living resource.

Archaeological surveys and fieldwork identified and recorded 223 historic properties, of eleven types, within the UH Management Areas – including three, possibly four sites within the boundaries of the Astronomy Precinct – and one historic site complex at Hale Pōhaku (see Section 5.4).[1] All of the known historic properties and their locations in the UH Management Areas have been catalogued. This information will serve as baseline documentation against which any alteration or damage can be compared. The historic properties located within the 19.3-acre parcel at Hale Pōhaku have been mitigated through detailed site recording, collection of surface artifacts, and excavations. The road corridor under UH management has not been completely surveyed for culturally significant sites. No new sites were

[1] The Astronomy Precinct is contained within the boundaries of the UH Management Areas and is further defined in Section 3.1.1. One of the sites is near a boundary line and without a surveyed boundary of the Astronomy Precinct, it is difficult to discern the exact location of the site relative to the boundary.

found in an archaeological survey of a 100-foot wide corridor on both sides of the road from Hale Pōhaku to the parking lot below Pu'u Hau Kea (Williams 1987).

The archaeological survey and fieldwork for the UH Management Areas identified several confirmed burial sites, many other probable burials, and a large number of shrines.[2] How many of the burials and shrines are visited by family members is unknown, but family visitation is a cultural practice that must be protected and considered in the management of the UH Management Areas. Based upon the information gathered for the CMP, there are no known burials within the Astronomy Precinct. Treatment and disposition of previously identified Native Hawaiian burials are determined by the Hawai'i Island Burial Council (HIBC). Chapter 6E-43.6 (HRS) and administrative rule 13-300-40 outline the procedures for dealing with inadvertently discovered human remains.

Tampering with ancient sites is prohibited under State historic preservation law. Chapter 6E, HRS, protects historic properties from alteration or destruction.

Access to areas on Mauna Kea and the right to engage in traditional and customary practices is not only accepted and supported, it is a right protected under the Hawai'i constitution.[3] Traditional and customary cultural practices are taking place in the summit region as a whole, as well as at specific locations within the boundaries of the UH Management Areas (see Section 5).

Unrestricted access is one factor contributing to the degradation of cultural resources on Mauna Kea (see Section 6.3). It has been recognized that signage related to the protection of historical sites and appropriate cultural practices is needed (see Condition 13 of the 1995 *Revised Management Plan for the UH Management Areas on Mauna Kea* (DLNR 1995)). To date, these signs have not been placed.

One of the entities created by the 2000 Master Plan is Kahu Kū Mauna (Guardians of the Mountain). The nine member council advises MKMB, OMKM, and the UH-Hilo Chancellor on matters of Hawaiian culture affecting the UH Management Areas. The council comprises individuals from the Native Hawaiian community (see Section 3.3.1). Members of the council are consulted and their advice taken under strong advisement when uses or management actions are proposed for the UH Management Areas.

Need

The cultural resources are subject to actual and potential degradation. Without planned protections and a commitment to implement plans, irreversible damage to Mauna Kea's cultural resources is likely to continue. This CMP contains guidelines for long-term management of cultural resources and outlines a range of strategies and activities for their protection, identification, documentation, preservation, interpretation, and traditional use. The CMP also contains guidelines for consultation and education regarding cultural resources. These strategies reflect a series of general guidelines including:

- Recognizing that Mauna Kea is sacred to Native Hawaiians.
- Recognizing the need to continue consulting with the Native Hawaiian community, including cultural practitioners and families with lineal and historic connections to Mauna Kea, when formulating plans, protocols, and policies.
- Recognizing that cultural practices evolve over time and that management needs may change.

[2] Known Native Hawaiian burials within the UH Management Areas are, according to State historic preservation law, termed "previously identified," in that they have been recorded either through previous archaeological surveys or by other types of site visits, or through information provided by Native Hawaiian organizations to SHPD or the island burial council (cf. §6E-43.5(e)(2) and HAR §13-300-24(B)).

[3] Hawaii Revised Statutes, Sections 1-1 and 7-1, and Article XII, Section 7 of the Hawaii State Constitution protect traditional and customary practices, including gathering rights and access.

- Ensuring a balanced approach between traditional customary practices related to cultural properties and the need to protect natural resources and historic properties.

A consistent theme of the CMP management component plans is that culturally sensitive and appropriate educational information is the most effective and efficient method of protecting cultural and natural resources. Visitors to Mauna Kea should be educated regarding the cultural landscape of Mauna Kea, including cultural practices, historic properties and their sensitivity to damage, and the rules and regulations regarding the protection of historic properties. For example, pointing out to visitors and cultural practitioners the impacts of leaving offerings will likely result in a reduction of this activity by those who are not engaging in it for religious practice or tradition. Section 7.1.3 describes educational and awareness needs and management actions in more detail.

Accurate and complete information is a critical component in management planning. Baseline documentation on all known historic properties within the UH Management Areas has been virtually completed. HAR §13-277-6 (8) requires monitoring of historic properties in order to ensure their long term preservation. A monitoring program for historic properties is needed to track changes over time, providing a valuable tool for resource protection.

Documenting and monitoring historic properties captures only part of the cultural history and resources related to Mauna Kea. Of equal importance is a need to recognize and document traditional and customary cultural practices. Culture is dynamic, and it is likely that new practices will evolve in the future. Efforts to compile information and conduct new cultural research about Mauna Kea, including more oral history documentation, must continue. This will ensure that such information is not lost, that the range of practices is captured as culture evolves, and that policies and procedures that are developed for resource protection do not impede traditional and customary practices. Some cultural practitioners may be reluctant or refuse to discuss their beliefs and practices, potentially limiting the ability to identify every single belief and practice and variations between practitioners.

It is imperative that the management plan not adversely affect the constitutionally protected right to access for the exercise of traditional and customary practices. In order to ensure this, it is important to identify the access needs for cultural, religious, and spiritual practices. As the advisory body on cultural matters, Kahu Kū Mauna or the Hawaiian Cultural Committee of the MKMB shall invite and consult with families with lineal and historic connections to Mauna Kea, *kūpuna*, cultural practitioners, the Office of Hawaiian Affairs and other Native Hawaiian groups on developing culturally appropriate protocols to ensure access for engaging in traditional and customary practices while minimizing adverse impacts to cultural and natural resources.

Like the protection of access to traditional and customary practices, protection and preservation of human burials and cultural resources will be paramount. Full compliance with the Burial Laws (HRS, Chapter 6E), including the preparation of a Burial Treatment Plan for the known and potential Native Hawaiian human burial remains, will be strictly adhered to. Future activities and uses within the UH Management Areas involving construction or other ground-disturbing work have the potential of encountering human burials. All applicable rules and regulations pertaining to "inadvertent discoveries" shall be followed (see Section 6.4). Procedures related to cultural resources should be clearly explained to any contractors and to all staff of OMKM and other University entities that participate in any future construction activities. It should be possible to preserve the historic properties in the Astronomy Precinct through avoidance and the establishment of buffers. Buffer zones around historic properties will help maintain their integrity. Monitoring during construction activities is addressed in Section 7.3.2.

Management plans are not static. To provide adequate protection of cultural resources, continual reevaluation of policies and procedures within organizations and coordination among agencies is

necessary. The University and all University organizations associated with Mauna Kea, such as OMKM and MKSS, must coordinate with DLNR, SHPD, and in some cases, the HIBC and local law enforcement, in order to successfully implement protective measures for the historical and cultural resources of the UH Management Areas. In addition, because the boundaries of the cultural landscape extend outside of the UH Management Areas, UH must work closely with DLNR to develop policies and implement procedures to monitor cultural resources. As the advisory body on cultural resources, Kahu Kū Mauna shall be consulted about all issues that may require their counsel.

Enforcement personnel such as rangers not only help deter actions that may damage cultural resources or that are illegal; they can also serve in an educational capacity. OMKM rangers currently maintain a presence on the mountain, but because they lack enforcement authority, they are limited in their effectiveness. The presence of enforcement personnel is critical to the protection of resources and to visitor safety (see Section 7.2.2). Rules must be established to protect and preserve the resources of Mauna Kea. Enforcement of rules is a critical element of future management.

A variety of federal and state laws cover the effects of proposed actions on historic properties and cultural practices (see Section 3.4). In general, it is likely that activities that do not require ground disturbance or alteration of existing environments may not require a permit. Conversely, in the Conservation District, research activities, construction, observatory-related projects, or any other project that may result in ground disturbance or impacts to historical sites or cultural practices, may require some type of permit. A sufficient number of enforcement personnel are necessary to ensure that rules and regulations are followed as directed by permits (see Section 7.2.2 and Section 7.4.1) or the CMP.

Management Actions

The BLNR has previously identified management actions to address the needs described above.[4] This CMP adopts those management actions where appropriate as follows:

1. There shall continue to be an Office of Mauna Kea Management and a Mauna Kea Management Board, whose mission shall continue to be:

   > Achieve harmony, balance and trust in the sustainable management and stewardship of the Mauna Kea UH Management Areas through community involvement and programs that protect, preserve and enhance the natural, cultural and recreational resources of Mauna Kea while providing a world-class center dedicated to education, research and astronomy.

   The Mauna Kea Management Board shall include, but not be limited to, a representative of the Department and Native Hawaiian interests, environmental interests, and the business community. The Office of Mauna Kea Management shall regularly consult with and seek advice from Native Hawaiians, Native Hawaiian organizations, and environmental organizations.

2. The Office of Mauna Kea Management shall oversee compliance with the permit and report any known or suspected non-compliance or violations to the Department.

[4] BLNR previously imposed the following management actions when they granted the Outrigger Telescopes CDUP. The CDUP was subsequently reversed by Judge Hara. However, the BLNR's management actions are consistent and applicable to the CMP. Accordingly, the following conditions have been cited verbatim except where the reference was to the "Outrigger Telescopes permit" and has been replaced with the generic term "permit."

3. On June 30 of each year, the Office of Mauna Kea Management shall submit to the Board of Land and Natural Resources a written report detailing its activities generally, and with particularity its activities with respect to its responsibilities under the permit.

4. All persons involved with construction activities, including, but not limited to, the construction manager, contractors, supervisors, and all construction workers, and all persons involved in operation and maintenance activities, including, but not limited to, scientists and support staff, shall be educated about the historical and cultural significance of the Mauna Kea summit area, and shall be given training as to what constitutes respectful and sensitive behavior while on the summit area. A detailed plan for complying with this condition (including both the content of training and the procedures for implementation, including, but not limited to, a means for certifying persons who have completed the training program) shall be developed by the Office of Mauna Kea Management following consultation with Kahu Kū Mauna or other Native Hawaiians or Native Hawaiian organizations known to have cultural ties to Mauna Kea, and reviewed and approved by the Department. A specialist or specialists in the field of Native Hawaiian culture shall be selected by the Office of Mauna Kea Management with the concurrence of the Department for the purpose of implementing the compliance plan, including, but not limited to, the conduct of educational and training programs for all persons described in this condition. To be qualified for appointment to this position(s), a person shall have worked as a Native Hawaiian cultural specialist and shall be knowledgeable of the types of cultural resources and practices relating to the summit of Mauna Kea. The criteria or qualifications for the cultural specialist shall be developed in consultation with Kahu Kū Mauna, in consultation with faimilies with lineal and historic connections to Mauna Kea, *kūpuna*, cultural practitioners, the Office of Hawaiian Affairs, and other Native Hawaiian groups.

5. During all periods of construction (including, but not limited to, the delivery of construction materials to the site or to staging areas), there shall be on-site a construction monitor, whose responsibility shall be to monitor compliance with the terms and conditions of the permit as related to construction activities.

   The on-site construction monitor shall have the authority to order that any or all construction activity must cease if and when, in the construction monitor's judgment, (a) there has been a violation of the permit that warrants cessation of construction activities, or (b) that continued construction activity will unduly harm cultural resources; provided that the construction monitor's order to cease construction activities shall be for a period not to exceed seventy-two (72) hours for each incident. All orders to cease construction issued by the construction monitor shall be immediately reported to the Chairperson and the Office of Mauna Kea Management. The Chairperson may issue a cease and desist order to extend the period of time that construction activity is prohibited, or such other order as the Chairperson deems appropriate.

   The construction monitor shall be selected by the Office of Mauna Kea Management with the concurrence of the Department. The construction monitor shall have experience and be knowledgeable in construction management. Prior to assuming on-site duties, the construction monitor shall have completed the educational and training program above.

6. Whenever construction, operations or maintenance activities include earth movement or disturbance, a trained archaeologist, selected by the Office of Mauna Kea Management and approved by the Department, shall be on site to monitor any impacts, real or potential, of construction activity on archaeological and historical resources. The archaeological monitor shall be funded by the project.

7. In addition to the statutory requirements of Hawai'i Revised Statutes chapter 6E, if an inadvertent discovery of any human burial is discovered in the course of construction, operation or maintenance of the project, the person making the discovery shall seek the advice and recommendation of either the Hawaii Island Burial Council or Kahu Kū Mauna, recognized lineal or cultural descendant, for treatment of the inadvertently discovered burial.

Pursuant to the legal requirements under the Hawai'i Supreme Court's ruling in *Ka Pa'akai*, access to UH Management Areas for Native Hawaiian traditional and customary practices shall not be restricted, except where safety, resource management, cultural appropriateness, and legal compliance considerations may require reasonable restrictions:

1. Access for traditional and customary practices, including the gathering of cultural resources, including but not limited to mamake, ko'oko'olau, māmane, 'awa, and ōwī.
2. Access for families to visit *na iwi kupuna* (the bones of their ancestors).
3. Access to scatter *'ohana* ashes.
4. Access through the trails located within the UH Management Areas for subsistence gathering and hunting.
5. Access for families to continue to bury their *'ohana piko*.
6. Access for traditional and customary practices, including religious and spiritual observances, pilgrimage, offerings, and prayers.
7. Access for families to gather water from Lake Waiau for religious and spiritual purposes.
8. In the event of disputes or determination of appropriateness of traditional and customary practices, including cultural, historical, and natural resources, Kahu Kū Mauna and/or the MKMB Hawaiian Cultural Committee in consultation with families with lineal and historic connections to Mauna Kea, *kūpuna*, cultural practitioners, the Office of Hawaiian Affairs and other Native Hawaiian groups shall provide cultural guidance on the appropriateness of the practice and appropriate cultural protocols.

The following table lists additional management actions to address the needs described above. For items identified with an asterisk, additional considerations are described after the table.

Table 7-1. Management Actions: Native Hawaiian Cultural Resources

Management Action	
	Management
CR-1*	Kahu Kū Mauna shall work with families with lineal and historical connections to Mauna Kea, *kūpuna*, cultural practitioners, the Office of Hawaiian Affairs and other Native Hawaiian groups, including the Mauna Kea Management Board's Hawaiian Culture Committee, toward the development of appropriate procedures and protocols regarding cultural issues.
CR-2	Support application for designation of the summit region of Mauna Kea as a Traditional Cultural Property, per the National Historic Preservation Act of 1966, as amended, 16 U.S.C. 470 et seq. in consultation with the larger community.
CR-3	Conduct educational efforts to generate public awareness about the importance of preserving the cultural landscape.
	Cultural Practices
CR-4*	Establish a process for ongoing collection of information on traditional, contemporary, and customary cultural practices.
CR-5*	Develop and adopt guidelines for the culturally appropriate placement and removal of offerings

	Management Action
CR-6*	Develop and adopt guidelines for the visitation and use of ancient shrines.
CR-7*	Kahu Kū Mauna shall take the lead in determining the appropriateness of constructing new Hawaiian cultural features.
CR-8*	Develop and adopt a management policy for the UH Management Areas on the scattering of cremated human remains.
CR-9*	A management policy for the culturally appropriateness of building ahu or "stacking of rocks" will need to be developed by Kahu Kū Mauna who may consider similar policies adopted by Hawai'i Volcanoes National Park.
	Historic Properties
CR-10*	Develop and implement a historic property monitoring program to systematically monitor the condition of the historic district and all historic properties, including cultural sites and burials.
CR-11	Complete an archaeological survey of the portions of the Summit Access Road corridor that are under UH management.
CR-12*	Consult with Kahu Kū Mauna about establishing buffers (preservation zones) around known historic sites in the Astronomy Precinct, to protect them from potential future development.
CR-13*	Develop and implement a burial treatment plan for the UH Management Areas in consultation with Kahu Kū Mauna Council, MKMB's Hawaiian Culture Committee, the Hawai'i Island Burial Council, the Office of Hawaiian Affairs, recognized lineal or cultural descendants, and SHPD.
CR-14	Immediately report any disturbance of a shrine or burial site to the rangers, DOCARE, Kahu Kū Mauna Council, and SHPD.

Additional Considerations for Management Actions

CR-1. Appropriate procedures regarding cultural issues

Culturally appropriate protocols developed in consultation with Kahu Kū Mauna, families with lineal and historic connections to Mauna Kea, cultural practitioners, *kūpuna*, the Office of Hawaiian Affairs and other Native Hawaiian individuals and organizations may describe culturally appropriate practices and what may be considered culturally disrespectful behaviors that should either be discouraged or, perhaps, banned altogether. Subject to compliance with the legal requirements for access to traditional and customary practices of the State Constitution, no restrictions shall be placed on any Native Hawaiian cultural observance except those observances that are considered culturally inappropriate by a collective consensus of Kahu Kū Mauna, the MKMB Hawaiian Culture Committee, families with lineal and historic connections to Mauna Kea, *kūpuna*, cultural practitioners, the Office of Hawaiian Affairs and other Native Hawaiian groups. Access shall not be denied or unduly restricted for Native Hawaiians wanting to visit sites such as burials or shrines or exercise their religious and spiritual practices within the UH Management Areas. Public tours of burial sites shall be prohibited. The rangers or other management staff shall be notified of visits to burial sites prior to the visits for security and safety reasons.

CR-4. Collection of information on traditional and customary cultural practices

Several methods may be used to establish a process for the ongoing collection of information on traditional and customary cultural practices and their significance. OMKM should partner with educational institutions such as the UH-Hilo and Hilo Community College, to establish an oral history program that would memorialize the traditional and customary practices associated with Mauna Kea. Native Hawaiian families or communities that have a connection to Mauna Kea shall be invited to work with OMKM to identify traditional and customary practices associated with Mauna Kea and ensure those practices are protected and respected (see Section 7.1.3).

CR-5. Guidelines for the culturally appropriate removal of offerings
One practice that has become a major management issue in many places in Hawai'i is the placement of offerings on altars. Offerings include both biodegradable items (e.g., leis and foods such as bananas) and a variety of other objects, including unmodified stones, artifacts, prayer flags, and crystals. Accumulations of offerings can have an adverse effect on the integrity of historic properties as well as on natural resources. In most cases, to protect resources, offerings must be removed; however, this process must be done in a culturally appropriate manner. Guidelines will include a stipulation that food offerings be removed immediately following the ceremony, and a means of handling non-food offerings during and after removal. Consultation with cultural practitioners is critical to the development of these guidelines. A culturally trained staff person or a specially designated individual shall be responsible for the removal of offerings.

CR-6. Guidelines for the visitation and use of ancient shrines
Guidelines for the visitation and use of ancient shrines are necessary to provide a mechanism that allows for access and use by modern cultural practitioners yet preserves their integrity and the underlying meaning they had for the ancestors that built them. Guidelines shall include the provision that access shall not be denied or unduly restricted for any Native Hawaiian wanting to visit the shrines within the UH Management Areas. No restrictions shall be placed on any observance or practice that is deemed culturally appropriate (see *CR-1 Appropriate procedures regarding cultural issues*), as long as the practice does not violate Chapter 6E, which prohibits the alteration of historic properties. Practitioners shall be informed of the same general rules and precautions as are all public users. A program to regularly monitor the condition of ancient shrines shall be established and if effects of heavy use become apparent, measures will be considered to control access (see CR-9, CR-13, and CR-14).

CR-7. Determining the appropriateness of constructing new Hawaiian cultural features
This is an extremely sensitive issue as most Native Hawaiians will be the first to say that it is not their *kuleana* to judge the cultural practices of another Hawaiian. However, the intent of this management measure is to develop a process to determine culturally appropriate protocols. Kahu Kū Mauna and/or the MKMB's Hawaiian Cultural Committee in consultation with families with lineal and historic connections to Mauna Kea, *kūpuna,* cultural practitioners, the Office of Hawaiian Affairs and other Native Hawaiian groups will work in collaboration to develop these protocols. Guidelines should be adopted to assist in formulating culturally appropriate protocols (e.g., to determine which kinds of features and locations are appropriate or inappropriate, as well as if and when a regulatory review process is necessary). Construction of new features will be evaluated to determine whether a CDUP is required. New construction not complying with the applicable protocols, the conditions imposed by guidance provided by Kahu Kū Mauna, MKMB, and/or the MKMB Hawaiian Cultural Committee or administrative rules, if/or when adopted, will be dismantled.

CR-8. Management policy on the scattering of cremated human remains
The scattering of the ashes of cremated human remains and the burial of urns in the summit area of Mauna Kea are on-going cultural practices. These private affairs are not well known or documented, but they may impact historic properties. One recommendation is to adopt a policy similar to that recently instituted at Hawai'i Volcanoes National Park, with the following considerations:

> The scattering of cremated human remains requires a special use permit. A death certificate is required to obtain a special use permit. Conditions of the permit include: scattering must take place in a such a manner and in such a location that the ashes will not be located and identified as human remains; no memorials, plaques, photos or flowers may be left behind; the permittee recognizes and is aware of the sensitivity of this activity and agrees to perform it in a discrete and private manner; all local, state, and county rules and regulations must be followed; violation of

the terms and conditions of the permit may result in the immediate revocation of the permit and/or other law enforcement action.[5]

However the ultimate determination will be based upon appropriate cultural consultation and applicable rules.

CR-9. Management policy on the piling and stacking of rocks

Ahu, which are created by placing single rocks or stacks of rocks on boulders and outcrops, dot the landscape in the summit area of Mauna Kea. Most of the 336 "find spots" recorded in the 2005–2007 archaeological survey are piled and stacked rocks. Such features, which are widespread in Hawai'i, may have as their basis a traditional cultural practice, but whose purpose and meaning have probably changed over time. At the same time, there is reason to believe that a large number of the single rock features and small concentrations of piled or stacked rocks on Mauna Kea are modern and that many were constructed by non-Hawaiian visitors in the last decade or so.

The management policy for piling and stacking rocks could be similar to that recently instituted at Hawai'i Volcanoes National Park (Kubota 2005). A culturally trained staff person will be responsible for the culturally appropriate removal of rock piles that are made on Mauna Kea. Visitors to and users of Mauna Kea will be educated about the importance of preserving the cultural landscape, with particular attention to prohibitions on the piling and stacking of rocks.

CR-10. Historic Property Monitoring Program

A historic property monitoring program would provide a plan for monitoring the condition of identified historic properties within the UH Management Areas. The primary purpose of monitoring these sites is to determine what uses, if any, are affecting historic properties and the degree and frequency of these effects. This information would, in turn, help in developing ways to prevent or minimize the occurrence of damaging uses. The long-term effects of human activities and natural processes on historic properties shall be monitored and management policies adjusted, as needed. Inventories of areas that have not yet been surveyed, such as the road corridor, should be a priority. In addition, new discoveries and Hawaiian cultural features that are newly erected should be described and their locations recorded, so that they can be protected and monitored as part of this program. The recording and monitoring of new cultural features may depend on what guidelines or policies are adopted for new cultural features. While the recording of new features should be done, to continue the process of developing a baseline, the monitoring of all features, which already number over 300, would be an overwhelming and expensive task and would need to be sensitive to the desire of some Hawaiians to not have their features recorded. The findings of the historic property monitoring program will be used to inform management decision-making.

CR-12. Establishing buffer zones around historic sites

In order to protect all known historic sites within the Astronomy Precinct, a specified buffer shall be established around each site, if and when a specific set of development plans is proposed. OMKM and Kahu Kū Mauna will work with DLNR, including SHPD and appropriate divisions, on establishing buffers. Each buffer would vary in size based on the area of potential effect, which is defined as the geographic area or areas within which an action may affect historic properties. HAR §13-277-4 requires buffer zones to be established to ensure that the integrity and context of historic properties are preserved. Establishing and marking buffers with fences, the most common type of buffer, would draw attention to the sites, and is not recommended unless a site needs to be identified for a particular activity.

To mitigate potential visual impacts associated with buffers, their use will be limited to historic sites threatened by a specific activity. If the threat is temporary, such as nearby construction using heavy

[5] Derived from http://www.nps.gov/havo/parkmgmt/scattering-of-ashes.htm

equipment, the buffer will be removed after the activity is complete. If the threat is permanent, such as from a hiking trail near a shrine, a permanent buffer will adhere to design standards similar to those for interpretive signage and blend with the natural landscape as well as any associated interpretive signage. Permanent buffers will be designed to achieve the desired protective effect with minimal introduction of foreign materials to the environment or alteration of the environment. Where appropriate, buffers will mark critical portions of the buffer zone rather than create a barrier to entry.

CR-13. Burial Treatment Plan
Components of the burial treatment plan should include documenting inadvertently exposed burials and reburial sites for inclusion in the historic property catalogue; appropriate treatment protocols for human remains exposed due to natural causes; and monitoring protocols for burial sites. The burial treatment plan must adhere to all state laws and shall be approved by SHPD in consultation with the HIBC and where appropriate, recognized lineal and cultural descendants, and Kahu Kū Mauna. Determinations on the treatment and disposition of inadvertent discoveries of human remains fall to the DLNR and SHPD, in consultation with the HIBC, the Office of Hawaiian Affairs, and any known descendants (cf. §6E-43.6, HRS, and HAR 13-300-40). Although circumstances for each inadvertent burial find may differ, the procedures specified in §6E-43.6(a) through (c) should always be followed. Depending on the results of consultation with Kahu Kū Mauna and other stakeholders, including the HIBC and any known descendants, treatment measures may also include the covering up or securing of any exposed skeletal remains.

7.1.2 Natural Resources

This section provides information and management recommendations to ensure the protection, preservation, and enhancement the natural resources of the UH Management Areas.

While past management planning for the Mauna Kea area has focused on development planning (i.e., *2000 Mauna Kea UH Management Areas Master Plan* (Group 70 International 2000)) and guiding uses of the area (i.e., *1995 Revised Management Plan for the UH Management Areas on Mauna Kea* (DLNR 1995), which focused on public access), the CMP addresses the protection and preservation of natural resources in the UH Management Areas. The CMP is based on a comprehensive review of existing scientific studies, biological and physical resource inventories, and historical documentation. The CMP also examines human uses of the area, with particular emphasis on their current and potential impacts on natural resources. The CMP was developed with the following concepts in mind:

1. The high-elevation areas of Mauna Kea represent a unique global resource that should be preserved for future generations.
2. Management activities shall be focused on limiting the impacts of human activities on natural resources.
3. The planning and execution of natural resources management programs will involve input from the larger community, including scientists, educators, volunteers, and the public—as well as from natural resource managers.
4. Long-term global environmental factors such as climate change must be taken into account when planning natural resource management activities.
5. Natural resources management planning will use an ecosystem approach.[6]

[6] An ecosystem consists of the plants, animals, and microorganisms within an area; the environment that sustains them; and their interactions. Ecosystem can be as tiny as an isolated wetland containing only a few species or as huge as a tropical rainforest containing thousands of species.

6. Adaptive management techniques will be used.
7. The biological and physical resources found in high elevation areas of Mauna Kea and the unique ecosystems that encompass them deserve further study by researchers and managers.

Desired Outcome

Increase understanding of the status of natural resources (biotic and abiotic), and identify threats to these resources in order to better protect and preserve unique geological features, ecosystem functions, subalpine and alpine habitats, and biological communities through adaptive management of stressors and threats.

Current Status

There are many unique geological features and biological communities within the UH Management Areas. The summit area consists of an alpine stone desert with scattered *pu'u* (cinder cones) that support a unique aeolian invertebrate community that includes the wēkiu bug. Below the summit lie the alpine grasslands and shrublands where the Mauna Kea silversword is found. Remnant subalpine māmane woodlands in the area of Hale Pōhaku support the Palila and other native birds, as well as unique insect communities. A review of the natural resources found in the UH Management Areas is presented in Section 5.2 of this CMP.

Threats to the natural resources found in the UH Management Areas are reviewed in Section 6.3. Not all of these threats are of the same magnitude, and not all threats are currently impacting resources on the mountain. For example, air pollution and noise pollution are currently considered to be minor threats in high-elevation areas on Mauna Kea. This may change with time, and so, for completeness, all known potential threats are addressed in the CMP. The threats to natural resources currently considered to be of the highest priority for management action include habitat alteration, invasive species, population decline, and climate change. Table 7-2 lists the sections in the CMP that address each threat.

Table 7-2. Potential and Known Threats to Natural Resources in the UH Management Areas

Resource	Threat	CMP Section
Habitat	Habitat alteration and loss	7.1.2 7.1.3 7.3.3 7.3.4
Air	Air pollution	7.3.2
Water	Groundwater contamination	7.3.1
Soil	Soil contamination Erosion Solid Waste	7.3.1 7.3.1 7.3.1
Auditory Environment	Noise	7.3.2
Flora and Fauna	Invasive species Population decline and loss of diversity Scientific research and sample collection Fire Climate change Barriers to species migration	7.1.2 7.1.2 7.2.1 7.4.1 7.1.2 7.1.2

Need

Natural resources are subject to actual and potential degradation. Without planned protections and a commitment to implement plans, irreversible damage to Mauna Kea's natural resources is likely to continue. This CMP contains guidelines for the long-term management of natural resources and outlines a range of strategies and activities for their protection.

Sustainable management of the UH Management Areas should allow for multiple uses and activities including astronomy and other scientific research, education, recreation, and cultural practices. Sustainable management requires establishment of programs that protect, preserve, and enhance the natural resources of Mauna Kea. The following management measures are necessary to accomplish this goal:

- *Preservation of sensitive habitats and unique high-elevation ecosystems in UH Management Areas, including within the Astronomy Precinct.* One of the most efficient ways of preserving a sensitive ecosystem is to limit future development in the area. This objective has been met, to a large extent, by the establishment of the 525-acre Astronomy Precinct at the summit (Group 70 International 2000) as further defined in Section 3.1.1. Development is allowed only within the Astronomy Precinct and at Hale Pōhaku (19.3 acres). The 2000 Master Plan sets aside 10,760 acres for the preservation of natural and cultural resources. An additional measure of protection for sensitive habitats within the Astronomy Precinct can be achieved by prohibiting development of any currently undeveloped *pu'u* at the summit.
- *Enhancement of existing native communities and unique habitats.* Enhancement refers to projects, programs, or management activities that contribute to the conservation of natural resources through such means as landscaping, establishing native gardens, and outplanting native species in sensitive habitats or in unique natural areas, to increase plant density and species diversity. Enhancement activities should be conducted primarily in high-use areas where native biological communities may have become degraded or disturbed.
- *Mitigation for planned damage to sensitive ecosystems.* Mitigation is the planned creation of new habitat or the restoration of existing habitat, to replace habitat that is destined to be destroyed or disturbed by development. All proposed new land uses (such as development) that will damage or permanently destroy sensitive habitats should address the need for mitigation and propose suitable mitigation activities.
- *Rehabilitation of damaged ecosystems.* Rehabilitation is the repair of habitat following an unplanned disturbance, such as a vehicle accident, hazardous materials spill, or erosion event. Rehabilitation emphasizes the repair of ecosystem processes, productivity, and services.[7] Rehabilitation differs from mitigation in that it occurs only as-needed and cannot necessarily be planned for.
- *Restoration of damaged ecosystems.* Ecosystem restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed (Society for Ecological Restoration International Science & Policy Working Group 2004). The goal of ecosystem restoration is to return an ecosystem to its historic condition, including physical structure, soil development, hydrological processes, species composition, and biodiversity. Restoration can occur on a variety of scales, from a small, localized effort to a project encompassing an entire

[7] Ecosystem services are the processes by which the environment produces resources that we rely on, such as clean water, timber, and pollination of native and agricultural plants. For more information, see the Ecological Society of America web site, http://www.esa.org/ecoservices/comm/body.comm.fact.ecos.html.

mountaintop. In most cases, funding and time are the limiting factors preventing large-scale restoration. In addition to general ecosystem restoration, cinder habitat shall be restored following decommissioning of telescopes at the summit (see Section 7.3.3). Cinder habitat on summit *pu'u* shall be restored following the removal of telescopes and that this will be funded by the entity that controls the telescope.

Several federal and state laws apply to management and protection of natural resources (see Section 3.4). All management actions and activities must comply with these laws and regulations.

Enforcement personnel such as rangers are necessary to ensure that rules and regulations are followed as directed by law and permit requirements (see Section 7.2.2 and Section 7.4.1). OMKM rangers currently function in an interpretative capacity only, as they have no enforcement power. OMKM rangers help deter user actions that may damage resources or that are illegal, but they cannot issue citations or enforce regulations pending legislative enforcement authority. It is recommended that rangers be deputized, so that they can more effectively protect the natural resources in the UH Management Areas. This is discussed in more detail in Section 7.2.2.

OMKM is the entity designated in this CMP with responsibility for monitoring tenant observatories for compliance with the conditions of their CDUPs (see Section 7.2.2), and twice a year, rangers shall conduct compliance inspections at each observatory, to verify that the provisions of its CDUP are being met. Continued inspections are necessary to ensure that environmental safeguards are implemented.

Natural resource management activities and policy development should be conducted so as to protect the rights of Native Hawaiian cultural practitioners. This may mean allowing access, as needed, to otherwise closed sensitive areas for specific cultural uses. Consultation with Kahu Kū Mauna on cultural issues related to site access and permitted activities shall continue.

Management Actions

The BLNR has previously identified management actions to address the needs described above.[8] This CMP adopts those management actions where appropriate as follows

1. All persons involved with construction activities, including, but not limited to, the construction manager, contractors, supervisors, and all construction workers, and all persons involved in the operation and maintenance activities, including but not limited to, scientists and support staff, shall be educated about the environment, ecology and natural resources of the Mauna Kea summit area, and shall be given training as to what constitutes appropriate behavior while on the summit area for the protection for the natural resources. A detailed plan for complying with this condition (including both the content of training and the procedures for implementation including, but not limited to, a means for certifying persons who have completed the training program) shall be developed by the Office of Mauna Kea Management following consultation with scientist and environmental organizations knowledgeable about the Mauna Kea summit area, and reviewed and approved by DLNR.
2. Prior to entry into the Mauna Kea UH Management Areas, all construction materials, equipment, crates, and containers carrying materials and equipment shall be inspected by a trained biologist, selected by the Office of Mauna Kea Management and approved by the DLNR, who shall certify that all materials, equipment, and containers are free of any and all flora and fauna that may potentially have an impact on the Mauna Kea summit ecosystem.

[8] See footnote 4.

3. Whenever construction activities include earth movement or disturbance, a trained entomologist, selected by the Office of Mauna Kea Management and approved by the DLNR, shall be on site to monitor any impacts, real or potential, of construction activity on the wēkiu bug.

The following table lists management actions to address the needs discussed above. For items identified with an asterisk, additional considerations are described after the table.

Table 7-3. Management Actions: Natural Resources

	Management Action
	Threat Prevention and Control[9]
NR-1*	Limit threats to natural resources through management of permitted activities and uses.
NR-2*	Limit damage caused by invasive species through creation of an invasive species prevention and control program.
NR-3*	Maintain native plant and animal populations and biological diversity.
NR-4*	Minimize barriers to species migration, to help maintain populations and protect ecosystem processes and development.
NR-5*	Manage ecosystems to allow for response to climate change.
NR-6	Reduce threats to natural resources by educating stakeholders and the public about Mauna Kea's unique natural resources.
	Ecosystem Protection, Enhancement, and Restoration
NR-7*	Delineate areas of high native diversity, unique communities, or unique geological features within the Astronomy Precinct and at Hale Pōhaku and consider protection from development.
NR-8	Consider fencing areas of high native biodiversity or populations of endangered species to keep out feral ungulates (applies to areas below 12,800 ft elevation).
NR-9*	Increase native plant density and diversity through an outplanting program.
NR-10*	Incorporate mitigation plans into project planning and conduct mitigation following new development.
NR-11*	Conduct habitat rehabilitation projects following unplanned disturbances.
NR-12*	Create restoration plans and conduct habitat restoration activities, as needed.
	Program Management
NR-13*	Increase communication, networking, and collaborative opportunities, to support management and protection of natural resources.
NR-14	Use the principles of adaptive management when developing programs and methodologies. Review programs annually and revise any component plans every five years, based on the results of the program review.
	Inventory, Monitoring and Research
NR-15	Conduct baseline inventories of high-priority resources, as outlined in an inventory, monitoring, and research plan.
NR-16*	Conduct regular long-term monitoring, as outlined in an inventory, monitoring, and research plan.
NR-17	Conduct research to fill knowledge gaps that cannot be addressed through inventory and monitoring.
NR-18	Develop geo-spatial database of all known natural resources and their locations in the UH Management Areas that can serve as baseline documentation against change and provide information essential for decision-making.

Additional Considerations for Management Actions

NR-1. Limit threats to natural resources through management of permitted activities and uses
Management of uses and activities is discussed in Section 7.2.1.

[9] See Table 7-2 for sections in the CMP that discuss management actions to prevent and control threats not addressed here. These include habitat alteration, air pollution, contamination of groundwater and soil, erosion, solid waste, noise pollution, scientific research and sample collection, and fire.

NR-2. Limiting damage caused by invasive species
Management tools to deal with invasive species include preventing new species from becoming established and controlling established species. Monitoring is a necessary component of both these tools. Prevention and control measures for invasive species to consider include

- Work with neighboring land managers to control invasive plants and animals that occur near property borders.
- Remove or control populations of invasive species at the developed areas of Hale Pōhaku and along Summit Access Road, to prevent spread into the UH Management Areas.
- Remove any species or individuals that appear to have been intentionally introduced to the UH Management Areas. Report any observation of intentional introductions to USDA Animal and Plant Health Inspection Service and DLNR.
- Request that everyone who comes up the mountain brush down their clothes and shoes to remove invasive plant seeds and invertebrates (see Section 7.1.3).
- Require wash-down of all construction vehicles and heavy equipment before they enter Hale Pōhaku or the UH Management Areas (see Section 7.3.2).
- Evaluate installation of a vehicle wash-station, to remove invasive plant seeds and invertebrates from vehicles.

NR-3. Minimizing population decline and loss of native biodiversity
The goal of maintaining native plant and animal populations and biological diversity in the UH Management Areas can be accomplished through the following objectives: 1) minimizing human-induced population declines or loss of biodiversity; 2) detecting changes in population size of rare or protected native species; 3) determining causes of population declines; and 4) restoring declining populations through adaptive management. Causes of population declines may include invasive species, habitat alteration, hunting and sample collection, wildfires, pollution, loss of pollinators and seed dispersers, genetic bottlenecks (inbreeding depression), small population size, and climate change.

NR-4. Minimizing barriers to species migration
Barriers to migration may include habitat alteration through development, the presence of invasive species, low dispersal rates or small population sizes of the migrating species, and missing species in the new habitat, such as prey items or symbiotic species. For example, if development is blocking the movement of a native plant species, a potential management action would be to conduct outplanting and restoration projects on the other side of the development (downslope, if species are moving to lower elevations, or upslope, if species are moving to higher elevations).

NR-5. Addressing climate change
Detecting the impacts of climate change will require monitoring of changes in climate and natural resource abundance and distribution. Monitoring climate change is a global, collaborative effort to which the University could contribute by collecting weather data at Hale Pōhaku and in the UH Management Areas and providing it as a public resource for use in climate change modeling and other studies.

The goal of managing ecosystems to allow for response to climate change can be accomplished through 1) detecting the impacts of climate change through long-term monitoring; 2) understanding the impacts of climate change on natural resources; 3) aiding or supplementing natural migration of communities using adaptive management (see NR-11); and 4) collaborating with other landowners and managers on Mauna Kea.

NR-7. Delineating areas for protection
Areas considered for protection may include

- Cultural and historical resources
- Unique geological features ((Lockwood 2000)
    - Undeveloped *pu'u*
    - Glacial features (high standing rock outcrops)
    - Sub-glacial lava-ice contact features
- Habitat for important, rare, threatened, or endangered native species, including
    - Wēkiu bug
    - Mauna Kea silversword
    - Palila
    - Hawaiian hoary bat
    - Māmane trees

NR-8. Fencing plan to control feral ungulates
Non-native feral ungulates feed on the native flora and fauna in the UH Management Areas. Fencing areas of high native biodiversity or populations of endangered species in areas below the 12,800 foot elevation will help protect natural resources from feeding activity. A fencing plan will identify priority areas for fencing protection when funds become available, and should consider whether a CDUP or other approval is necessary before fences can be constructed.

NR-9. Increasing native plant density and diversity through an outplanting program
Native plant density and diversity can be increased by planting greenhouse- or field-grown plants in sensitive or unique habitats, using native plants in landscaping at Hale Pōhaku, and by creating educational native gardens. The native gardens will also help educate the public by providing living examples of unique and rare plant species found in the area. Only plants grown from locally obtained seeds or stock should be used. All plantings must be first cleared through DLNR.

NR-10. Mitigation planning
All future development in the UH Management Areas should include mitigation plans for preventing or repairing damage to sensitive habitats caused by construction and development activities. Any habitat that will be permanently removed should be replaced on at least a one-to-one basis, through either creation of new habitat, restoration of degraded existing habitat, or by permanent protection of similar unique habitats.[10] Mitigation plans should be paid for and prepared by the project proposer, but should be reviewed and approved by the University and DLNR. If the disturbed habitat contains protected species or other critical habitats, mitigation plans may also have to be approved by state and federal agencies. Mitigation projects should include a minimum of two to five years follow-up monitoring, to assess the results of the project. The length of time that monitoring must occur will depend on the scale of the project and the organisms for which the habitat is being mitigated. Mitigation projects on the summit should focus on creation of new wēkiu bug habitat. Mitigation projects conducted at Hale Pōhaku should focus on restoration or enhancement of existing māmane woodlands.

[10] Mitigation projects that result from a planned impact to critical habitat or threatened or endangered species will have different requirements, which will be determined by the USFWS. The ratio of disturbed to restored land in mitigation projects required by the USFWS depends on a number of factors, including the quality of the habitat destroyed, the type of habitat destroyed, and the quality of the restored habitat. Hale Pōhaku lies within Palila critical habitat.

NR-11. Habitat rehabilitation
Rehabilitation activities should be conducted when unintentional damage occurs. If desired, habitat can be restored rather than rehabilitated. Examples of rehabilitation projects include cleanup of contaminant spills, roadside repair projects following vehicle accidents, and erosion repair projects.

NR-12. Restoration
The goal of restoring damaged ecosystems can be achieved through the following objectives: 1) creating restoration plans, 2) conducting restoration activities, and 3) monitoring and maintaining restoration projects. Examples of restoration projects to conduct in the UH Management Areas include: restoration of wēkiu bug habitat in disturbed areas (e.g., near trails and existing observatory facilities); roadside restoration projects; silversword restoration projects; māmane woodland restoration through fencing, invasive species control, and out-planting; and habitat restoration following observatory decommissioning (see Section 7.3.3).

It is recommended that plans be coordinated with other agencies. Many of these agencies have existing restoration programs or projects that might be expanded to include UH Management Areas, provide assistance or funding, or provide guidance and techniques for restoration planning.

NR-13. Increasing collaboration and cooperation between OMKM and state and federal agencies
Currently there is no mechanism for integrated or coordinated management of Mauna Kea's natural resources, including lands outside of the UH Management Areas. No regular meetings are held between the governmental agencies with management responsibilities for Mauna Kea. Increasing communication between the stakeholders on the mountain and identification of opportunities for collaboration can be achieved in part through the development of an interagency working group involving all entities that are responsible for, or involved in, natural resource management in high elevation areas (above 6,200 ft, or 1,900 m)[11] on Mauna Kea, including the University, state and federal agencies, non-profit organizations, and other agencies and persons involved in the day-to-day management of Mauna Kea lands.

NR-16. Conducting regular, long-term monitoring
The results from monitoring and research programs should be used to adjust management policies, as needed, to better manage the resources (adaptive management). Long-term monitoring should include monitoring of enhancement, mitigation, and restoration projects to determine whether projects have been successful and to provide guidance for future management activities.

7.1.3 Education and Outreach
The purpose of this section is to provide information and management recommendations to improve upon its education and outreach efforts. Education includes providing information about natural, cultural, and astronomical resources to the public, through on-site and off-site materials and programs. Outreach includes activities to increase public participation in the stewardship of Mauna Kea, through community consultation and community involvement in resource management activities, through volunteer based programs.

[11] For simplicity's sake, the working group, at least in the beginning, should focus on the high elevation areas. The cutoff (6,200 ft) was chosen because it is recognized as the boundary above which subalpine vegetation begins on Mauna Kea (Mueller-Dombois and Fosberg 1998). However, the working group may decide to change the area covered once it convenes.

Desired Outcome

Build and maintain a constituency to engage in active and meaningful stewardship of Mauna Kea, through education and involvement of the public, to support, enhance conservation, and sustain the natural, cultural, and astronomical resources of Mauna Kea.

Current Status

Education

Visitors to Mauna Kea have access to a range of educational opportunities, but none is required of those visiting the mountain. Other users of the mountain, such as astronomers and other scientists, construction workers, and maintenance staff, also may or may not be educated about resources not directly related to their reason for being on the mountain. Some of the astronomy facilities have conducted education and awareness training for their staff, focusing primarily on cultural resources. OMKM rangers and staff and volunteers at the VIS are familiar with the mountain's history, natural and cultural resources, and uses. They provide an essential repository of information.

Visitor Information Station Facilities. The VIS provides static and interactive educational resources, most of which focus on the observatories. One of the most up-to-date and useful sources of information is the set of videos on safety, natural resources, cultural resources, and astronomy, some of which are available in Japanese.

Brochures. Informational brochures include two safety handouts (*Mauna Kea Hazards* and *Visiting Mauna Kea Safely and Responsibly*); a description of the cultural landscape (*Mauna Kea, Ka Piko Kaulana O Ka ʻĀina*); a brief overview of natural resources focusing on the Palila, wēkiu bug, and Hawaiian and English names for astronomical and geological features; and a leaflet on the ʻImiloa Astronomy Center. Most of these have been developed over the past few years, by OMKM, and are available at the VIS.

Signage. Health and safety signage is prominently featured on the approach to Hale Pōhaku, along the Summit Access Road, and at the VIS. Posted on the outside of the VIS is information about winter hazards; general hazards related to altitude when traveling above Hale Pōhaku; a map; and information about littering and not disturbing the landscape. Other than at the VIS, there is no "interpretive" signage in the UH Management Areas. Signage identifying the boundary of the Mauna Kea Ice Age Natural Area Reserve is visible from the roadway.

Botanical Enclosure. The DLNR botanical enclosure, next to the VIS picnic tables, presents an excellent opportunity for increased visitor education. This area contains native subalpine vegetation not found in the unfenced areas of Hale Pōhaku, including several Mauna Kea silverswords. This area could be an excellent source of information and education for visitors, but is currently not managed in a way to accomplish this. For example, it lacks signage explaining what the area is and what features it contains.

Web Site. OMKM's Web site, http://www.malamamaunakea.org serves as a central resource for information on Mauna Kea. The Web site provides information about the management and operations of OMKM and MKMB. It also contains copies of current and past newsletters, meeting minutes, information on public safety, stories of interest, and astronomy education links. The VIS web site, http://www.ifa.hawaii.edu/info/vis/ has a wealth of resources for visitors, including directions to points of interest and information about facilities, health and safety, VIS programs, volunteer programs, hiking, tours, astronomy, and the natural and cultural resources of Mauna Kea.

Newsletter. OMKM produces hard-copy and electronic newsletters that provide regular updates about board members and activities, ongoing research, planning efforts, and other happenings related to Mauna Kea.

Educational Programs. The mission of the 'Imiloa Astronomy Center of Hawai'i, located in Hilo, is educating people about the connections between Hawaiian culture and astronomy. There is also a display illustrating a mound of stone flakes found in the adze quarry. The exhibits contain little information about Mauna Kea's terrestrial natural resources. 'Imiloa recently received a grant from the Moore Foundation to provide free admission and transportation to Big Island elementary students to 'Imiloa.

Outreach

Community members are engaged in aspects of Mauna Kea management through participation on advisory groups and committees, and through community consultations, surveys, and volunteer activities.

Advisory Groups and Committees. Several advisory groups and committees made up of community members advise OMKM, including the MKMB, Kahu Kū Mauna, the MKMB's Hawaiian Cultural Committee and Environment Committee, Wēkiu Bug Scientific Committee, and the Public Safety Committee. A description of these committees is provided in Section 3.3.1.

Community Consultations. Currently OMKM does not engage with community groups on a regular basis, but plans to initiate periodic meetings to update the community on the status of Mauna Kea. When legally mandated review processes occur (e.g., under NEPA, HRS 343, rule-making), OMKM (or the entity or group producing the document) shall invite and encourage the public to review all management plans, proposed rule changes, environmental impact statements and environmental assessments. See Section 4 for a discussion of the community consultation process engaged in to develop this CMP.

Surveys. OMKM has used surveys to learn the general public's views concerning how to preserve and protect Mauna Kea, with a particular focus on managing access. The results of the surveys are used by OMKM to inform management and decision-making. (See Appendix A3).

Community Participation and Volunteer Opportunities. Currently the only community participation and volunteer opportunities that exist for the public at Mauna Kea are astronomy related, and include staffing the VIS and running the evening star-gazing programs.

Need

Education

Lack of education has been identified as a source of unintentional human impact to Mauna Kea's unique cultural and natural resources. Up to the present time, education and research in the UH Management Areas have focused largely on astronomy (Group 70 International 2000). The educational and outreach program should be more well rounded, and a range of issues to target for education has been identified, including sensitivity to cultural resources; the status and condition of natural resources, including biotic and physical elements; threats to resources; prohibition of off-road vehicle use; health and safety concerns; rules and regulations; and rangers as a resource. An overwhelming majority of people participating in the community consultation process supported, at a minimum, a cultural orientation video or program before accessing Mauna Kea to culturally sensitize the visitors to cultural, historical and natural resources. [12]

[12] Stakeholders referred to orientations similar to those provided at USS Arizona, Hanauma Bay, and Kaho'olawe.

Education efforts should be aimed at raising awareness and appreciation of the area being experienced, for both those who visit and for those who work at Mauna Kea (Hughes and Morrison-Saunders 2002). Many people are unaware of the current status of the natural and cultural resources on the mountain and why certain management activities may be necessary. Efforts at public outreach and education that address community concerns and needs, while highlighting measures developed to protect Mauna Kea's resources, will increase support for management activities. Visitors to and users of, Mauna Kea who understand the significance of the resources on the mountain will contribute to more effective protection of them. Most damage to historic properties and natural resources is done inadvertently or in ignorance. Providing people with adequate information on how to recognize historic properties and natural resources and on their appropriate treatment should help reduce these effects.

Education regarding personal safety and the potential hazards of visiting the mountain is also essential. In addition to protecting the well-being of visitors, education helps conserve management time and resources by reducing the number of instances requiring a response by the support staff, such as calls for search parties or medical assistance.

Outreach

There is a need for additional outreach activities that focus on involving the community in the management decision-making process. Outreach activities should have two major components, community consultation and community involvement.

Community Consultation

Increased effort at community consultation is needed, to address concerns by some in the community that the decision-making process is not transparent and that they have not been involved. Community consultations should take place for a range of activities, including management planning, rule-making (see Section 7.2.2), development of cultural protocols (see Section 7.1.1), historic preservation, and environmental analyses for new projects.

To ensure that everyone is represented, community consultations should involve a range of public and private constituents in decision-making process for management of Mauna Kea, including the Native Hawaiian community. The Native Hawaiian community should be involved through direct consultation, in addition to their representation in the entities that advise on management, such as Kahu Kū Mauna. Such consultations can aid in developing information bases containing accurate information concerning historical and cultural resources for use in management and for interpretive needs. This would help ensure accurate use of the Hawaiian language in exhibits and signs, and assist in developing policies directed at protecting Native Hawaiian sacred sites and traditional practices.

Community Involvement

There is a need to encourage and coordinate community participation in the stewardship of Mauna Kea through protection and conservation of Mauna Kea's cultural and natural resources. Community involvement will require educating and informing the public about activities at Mauna Kea, including management programs, as well as providing means for the community to become involved.

On the other end of the spectrum, the local community has repeatedly expressed a desire for IfA and the astronomy community to become more involved in the greater Hawaiian community in which they operate and live. Community involvement should include support for education and outreach programs focused on astronomy (such as astronomy scholarships and school field trips to 'Imiloa).

Program Development

A well-developed education and outreach program is needed to address the identified education and outreach needs. The first step would be to outline and prioritize education and outreach activities. The education and outreach program should be designed and implemented to build awareness about Mauna Kea and to involve the community in education, volunteer projects, and research aimed at protecting cultural and natural resources. A major aspect of the plan will be the development of an orientation program for visitors and workers on the mountain that will address cultural, environmental, and safety concerns.

Management Actions

The following table lists management actions to address the needs discussed above. For items identified with an asterisk, additional considerations are described after the table.

Table 7-4. Management Actions: Education and Outreach

	Management Action
	Program Development
EO-1*	Develop and implement education and outreach program.
	Education
EO-2*	Require orientation of users, with periodic updates and a certificate of completion, including but not limited to visitors, employees, observatory staff, contractors, and commercial and recreational users.
EO-3*	Continue to develop, update, and distribute materials explaining important aspects of Mauna Kea.
EO-4*	Develop and implement a signage plan to improve signage throughout the UH Management Areas (interpretive, safety, rules and regulations).
EO-5	Develop interpretive features such as self-guided cultural walks and volunteer-maintained native plant gardens.
EO-6*	Engage in outreach and partnerships with schools, by collaborating with local experts, teachers, and university researchers, and by working with the 'Imiloa Astronomy Center of Hawai'i.
	Outreach
EO-7*	Continue and increase opportunities for community members to provide input to cultural and natural resources management activities on Mauna Kea, to ensure systematic input regarding planning, management, and operational decisions that affect natural resources, sacred materials or places, or other ethnographic resources with which they are associated.
EO-8*	Provide opportunities for community members to participate in stewardship activities.

Additional Considerations for Management Actions

EO-1. Education and Outreach Program Development

The Educational and Outreach Program should focus on increasing public understanding and appreciation of Mauna Kea and on involving people in education, volunteer projects, and in research aimed at protecting the cultural and natural resources. A preliminary step will be creation of an education and outreach plan that should address visitor and user education; Mauna Kea as an educational and scientific resource; outreach activities; and implementation. Program needs and management activities for these four topics are discussed in further detail below.

Visitor and User Education: A major goal of the Education and Outreach Program is to educate both visitors and workers about the cultural and natural significance of the mountain, including its sacredness. It would also teach them how to minimize their impact on Mauna Kea and would reduce uninformed behavior that can lead to inadvertent damage to resources. Education and outreach activities should be developed to promote a greater knowledge base and understanding of cultural resources; Hawaiian

cultural practices; and the significance of archaeological sites, place names, and geophysical elements such as cinder cones and glacial deposits. Native Hawaiian values and cultural information should be integrated into the program, and all users should be provided with specific guidelines for culturally appropriate behavior on Mauna Kea (see Section 7.1.1). In addition to increasing cultural awareness, educational activities should provide users with information on the unique biological and geological resources found in the subalpine and alpine zones on Mauna Kea, and the best ways to protect these resources.

The Education and Outreach Plan should identify ways to enhance the visitor experience at Hale Pōhaku and the summit and to increase off-site education of interested people and potential visitors. It should also educate a larger community, including non-residents, about Mauna Kea. This can be accomplished by using a range of mechanisms for education, including rangers, docents and volunteers, videos, brochures, displays, school programs, and public meetings and forums. Multiple venues for education and outreach activities, and providing key material in languages in addition to English (e.g., Hawaiian, Japanese), will ensure greater accessibility by the community and allow educational efforts to reach a wider audience. Incorporating media such as newspapers, DVDs, the internet, and podcasts[13] into educational efforts will also increase coverage. School programs are a valuable way to ensure that Hawaii's children learn about the importance of Mauna Kea. The development of school programs is discussed further in *EO-6, Outreach and partnerships with schools.*

The need for a mandatory visitor orientation, similar to what is required at Hanauma Bay, Oahu, has been identified on several occasions (Group 70 International 2000; Conant et al. 2004). The education and outreach plan should outline the process and discuss a venue for mandatory visitor orientation, and community consultations should play a part in development the orientation program. More information is provided below, in *EO-2, Mandatory Visitor Orientation.*

Because VIS staff, volunteers, and rangers are important information sources for visitors to the mountain, the plan should also address education and training needs for these personnel. Staff training materials should provide background information on cultural, archaeological, historical, and natural resources and they should promote cultural sensitivity. Field trips should be incorporated into the training process, in order to improve ability of staff to identify and locate cultural and natural resources. Commercial tour operators are also an important source of information to a subset of visitors, and the education and outreach plan should include the development of training requirements for professional tour guides. At minimum, educational materials should ensure the quality and accuracy of information tour guides give to visitors.

Another important part of the education and outreach program will be development of materials to educate people on health and safety issues and applicable laws, rules, and regulations. Using information in Section 3.4, which is a summary of applicable laws and regulations, materials can be developed to educate users on rules, regulations, and policies regarding protected natural resources and historic properties and the penalties for disturbing these resources. For example, users should be made aware that disturbance (injuring, destroying, or altering) of archaeological sites is prohibited by law (HRS, §6E-11). The plan should also discuss additional signage needs, to reduce emergency incidents on the summit and the summit access road (see *EO-4, Development of a signage plan*, below), and should address developing additional materials to provide information on health and safety concerns and how to safely approach the summit.

[13] A podcast is a series of audio or video digital-media files which is distributed over the Internet to portable media players and personal computers. A podcast is distinguished from other digital-media formats by its ability to be syndicated, subscribed to, and downloaded automatically when new content is added.

Outreach Activities: The Plan should address development of outreach activities including gathering public opinion through community consultations and encouraging community stewardship of Mauna Kea. See *EO-10, Community input* and *EO-8, Considerations for providing volunteer opportunities*, below.

EO-2. Mandatory Visitor Orientation

One method to ensure that all visitors receive the information they need in order to better protect Mauna Kea's cultural and natural resources is to require everyone who visits the summit to participate in an orientation. The easiest form of orientation would be a video. There are several details that must be worked out before implementing an orientation program, including how often individuals would be required to attend the orientation (e.g., for each visit, annually, every five years, or each time video is updated); location of orientation (at VIS, elsewhere at Hale Pōhaku, 'Imiloa, commercial operator's vans, on the internet); and whether there will be any exceptions to requirements for an orientation. It is recommended that, at minimum, commercial tour operators and existing and potential future observatory facilities staff be required to incorporate the orientation video into their program. This requirement can be included in the tour operators' permit conditions. Other details include working out how proof of attendance will be provided. Options include maintenance of a database of registered users, a colored armband or bracelet, a pin or button, a rear-view mirror tag, or a printed certificate with name and date of completion.

Contents of the orientation video must also be determined. At a minimum, the video should include information on health and safety, rules and regulations, concerns regarding sensitivity of cultural and natural resources, the NAR, rangers as a resource, litter and debris control, prohibitions on off-road vehicle use, and emergency procedures. To protect cultural resources, the video should inform visitors to not alter or disturb cultural artifacts, and should provide specific guidelines for culturally appropriate behavior on Mauna Kea (e.g., piling and stacking of rocks may be prohibited because it is disrespectful and "because the piles don't belong there"). Consideration should be given to providing a short reenactment of traditional cultural activities associated with Mauna Kea, as a way to increase visitor awareness of the significance of Mauna Kea to the Hawaiian people. It is recommended that the community (particularly *kūpuna*) be consulted in development of cultural aspects of the video. To protect natural resources, the video should inform visitors to stay on marked trails, to avoid crushing cinders, and to pack out all trash. It should also provide tips on preventing the spread of invasive species (e.g., instructing people to brush down clothes and shoes in a designated area at Hale Pōhaku prior to hiking or visiting the educational gardens). To increase public safety, the video should orient visitors to the potential hazards of high altitude environments, recommend acclimation time at the VIS, and educate drivers by including information on safe driving on the Summit Access Road.

Mandatory orientation training for tour operators, rangers, VIS staff, and volunteers should be required, regardless of whether mandatory orientation for the general public is implemented. This training program should be implemented immediately, and no rule-making authority is required to implement it.

EO-3. Development and distribution of educational materials

Educational materials in a variety of formats can be used on and off site to explain important aspects of Mauna Kea. While printed brochures are useful for visitors on site and can be distributed from various outlets (e.g., VIS, Hale Pōhaku, IfA/OMKM office in Hilo, 'Imiloa, commercial tour operators), web-based products are more interactive and can reach a broader audience. OMKM shall continue to develop, update, and distribute educational material, including newsletters, videos, and brochures on topics such as safety, cultural resources, natural resources, and recreational activities. OMKM should provide educational materials to commercial tour operators, to ensure the quality and accuracy of the information they provide to visitors. A high quality educational video (DVD) on the unique cultural and natural resources of Mauna Kea should be produced. The DVD could be sold in the VIS and 'Imiloa gift shops

for a nominal fee (to cover manufacturing expenses) and be provided to tourists by tour operators as part of the tour package. Copies should be donated to local schools and libraries, and be made available on the internet.

Web sites are an effective means of broadly distributing information. OMKM's website, www.malamamaunakea.org, should be updated regularly to include information on the natural and cultural resources found at Mauna Kea, and on visiting the mountain safely and responsibly. It should also contain video or printable versions of brochures available at VIS, and (if/when implemented) entrance requirements and rules and regulations. The website and an email list-serve can be used to distribute information pertinent to the community, to keep the public informed. Such information shall take the form of newsletters, announcements of public meetings and educational opportunities, and the MKMB minutes. Podcasts and web-casts should be added to the website to highlight Mauna Kea's unique resources. It may be possible to involve students at UH-Hilo and other local colleges or universities in their production. Subjects could include the orientation video, historical and cultural review, natural resources review, self-guided tour of the trail system (including information on cultural resources, native plants and animals, and physical resources), self-guided tour of the summit (showing the telescope facilities and discussing the unique ecosystem at the summit), and a self-guided tour of the DLNR botanical enclosure.

As a general policy, Hawaiian and English languages should both be used for signs, pamphlets, videos and other material developed for the general public and, where practical, the Hawaiian language should be given the position of prominence in the communication format (Group 70 International 2000).

EO-4. Development of a signage plan
The education and outreach plan should include development of a signage plan, which should address sign development and design and installation requirements.

Sign development addresses needs for "Do Not" signage, health and safety information, trail markers, and interpretive signs. "Do Not" signage provides information on prohibited activities such as alcohol consumption, tampering with historical sites, littering, or hiking off-trail. Condition 13 of the 1995 Management Plan stipulates that "There shall be signs about the protection of historic sites as well as discouraging people from making ahus, subject to funding" (DLNR 1995). Signage pertaining to historic sites within the UH Managed Areas should reference HRS §6E-11, indicating that "it is a civil and administrative violation for any person to take, appropriate, excavate, injure, destroy or alter any historic property or aviation artifact located upon lands owned or controlled by the State."

Health and safety signage should include signage in the summit area to reinforce awareness of safety issues and hazards (e.g., speeding, using 4-wheel drive and low gear, underage children, pregnant women and persons in poor health, proper clothing); providing safety signs or information posters at the VIS in English, Hawaiian, and Japanese languages and including universal symbols for health and safety issues.

Interpretive signs include trail markers for primary trails; signage alerting people to areas of sensitive cultural and natural resources and instructing them to stay on trails; and educational signage providing information to the visitor on what they are seeing. Consideration should be given to the development of educational areas (such as pull-outs along the Summit Access Road), with interpretive signage informing visitors about unique geological, meteorological, biological, and cultural features and ways to protect them. Another use of interpretive signage would be the labeling of key native and invasive plant species near the VIS and within the DLNR botanical enclosure.

Sign design considerations: Signs must be made from materials that can withstand severe weather (wind, snow, sun). Signage should use traditional Hawaiian place names and, whenever possible, include the

Hawaiian language along with English. A subset of the signs should also contain Japanese translations. Consideration should be given to producing brochures summarizing the information provided on signage in a variety of languages.

Sign installation: Sign installation must comply with applicable rules and contain appropriate references to rules, including the requirements in HAR §13-277-7. The natural and cultural setting should be considered when locating signs. Establishing signage and trail markers in the UH Management Areas may lead to an increase in visitor use both on- and off-trail. There are cultural sensitivity concerns relating to continued disturbance of the summit environment and impacts on sacred land resulting from the installation of structures and visual distractions. Any signage installed in the summit region must be sensitive to cultural concerns and coordinated with Kahu Kū Mauna. It is possible that improving interpretive information at the VIS will eliminate the need for interpretive signage in the summit region.

The University signage program will consider the threats to specific historic properties that could inadvertently be created by the inappropriate or excessive use of information signage. Accordingly, rather than attempting to guide visitors to each historic property, the focus of the signage program will be on alerting visitors entering the UH Management Areas to the presence of protected historic properties and measures they should take to prevent damaging those resources. In general, signage actually marking historic properties will only be considered when there is a defined risk to a site, such as may occur near marked trails or in areas likely to be frequented by visitors.

The signage program will consider the threats to specific sensitive habitats that could inadvertently be created by information signage. Rather than trying to guide visitors to all sensitive habitats, the signage will focus on alerting visitors entering the UH Management Areas to the presence of sensitive species and their habitats and advising them of the measures they should take to prevent damaging those resources. In general, signage actually marking sensitive habitats will only be considered when there is a defined risk to a habitat, such as may occur near marked trails or in areas likely to be frequented by visitors.

EO-5. Development of interpretive features

Cultural resources: OMKM should work with SHPD to designate historic properties suitable for public visitation. Brochures or maps showing locations of sites can also provide information on these sites and encourage visitation through self-guided tours or docent-guided tours. This will provide opportunities for visitors to see and learn about cultural sites, while guiding them away from sensitive or unsuitable sites.

Natural resources: OMKM should work with DLNR to improve the DLNR botanical enclosure at the VIS, to support education, restoration, and volunteer involvement. This can be achieved through installation of interpretive signage and with volunteer-based restoration activities. Other possibilities for interpretive features include a self-guided tour (using brochures or podcasts) of geological resources at the summit and development of small pull-out gardens along the Summit Access Road, from Hale Pōhaku to the Summit, planted with representative vegetation and accompanying interpretive signage, to illustrate change of vegetation communities with an increase in elevation.

EO-6. Outreach and partnerships with schools

OMKM should work with local public and private schools, and universities to develop educational programs to be presented at local schools. For example, OMKM could work with the UH College of Education on developing a science curriculum revolving around Mauna Kea, and with ʻImiloa and the Na Pua Noʻeau Program, at UH-Hilo, to develop an educational curriculum for Mauna Kea.

The school programs should focus on the cultural and natural resources found in high-elevation areas on Mauna Kea, and should incorporate field trips to Hale Pōhaku and the UH Management Areas. Field trip

locations and activities should be age-appropriate, as young children should not visit the summit for health safety reasons. Consideration should be given to establishment of "Star Camps," where students learn about natural and cultural resources during the day and star-gaze in the evening. This may require access to facilities such as the dormitories and cafeteria, at Hale Pōhaku.

EO-7. Community input
OMKM shall continue and expand efforts to ensure diverse community representation during community input opportunities, to ensure systematic input regarding planning, management, and operational decisions. Outreach efforts shall include contacting local civic and environmental groups, local experts in natural and cultural resources, families with lineal and historic connections to Mauna Kea, *kūpuna*, cultural practitioners, the Office of Hawaiian Affairs and other Native Hawaiian groups. Input should be gathered during both public meetings and more informal private consultations with the above community members. OMKM shall maintain a list of interested individuals, families, and organizations who should be notified and consulted when individual development projects requiring regulatory review are proposed (e.g., under Section 106, NEPA, HRS 343) or when other issues arise that may be a concern. Although Web sites and email list-serves should be used to distribute information pertinent to the community and to keep the public informed, other mechanisms, such as telephone, regular mail, and meetings may be required to reach all interested parties. Establishing means for collecting and addressing feedback, suggestions, questions, and concerns will help ensure that the entire community is included in consultation efforts. This should include a web-based forum and a comment box at the VIS, for both management and project related information, as well as for visitors to Mauna Kea.

EO-8. Providing opportunities for community members to participate in stewardship of Mauna Kea
Methods that can be used to encourage public involvement in the stewardship of Mauna Kea's resources include public meetings, workshops, citizen advisory groups, "friends" groups, and volunteer opportunities. Community involvement efforts should also include school programs, to get children involved.

Volunteer opportunities are a great way to inform more people about Mauna Kea and to encourage greater community participation in the protection of cultural and natural resources. There is already a very successful volunteer program to support the astronomy component. A docent program could be developed to provide guided tours highlighting cultural and natural resources. Service projects that fulfill stewardship objectives while also providing education and enjoyment to volunteers should be developed. Projects related to natural resources should include basic maintenance (trash pick-up and inspection for damage to facilities or signs); care of the botanical enclosure (weeding, watering, and inspecting the enclosure); enhancing native plant communities (weeding, outplanting, and care of native species around VIS and dormitories); trail maintenance and development; and restoration projects for native plant communities. Projects related to cultural resources should include training of archaeology students in field methods during the monitoring of historic properties. OMKM should cooperate and collaborate with other state and federal agencies that run volunteer-based projects, to increase the volunteer pool and conduct larger-scale projects.

7.1.4 Astronomy Resources

Mauna Kea's unique environment makes it a premiere location for astronomical observation (see Section 6.1.1).

Desired Outcome
Astronomical resources shall also be protected. The University's lease of the summit area provides that the scientific reserve shall be operated as a buffer zone to prevent the intrusion of activities incompatible

with the use of the land as a scientific complex or observatory. The lease specifically recognizes light and dust interference as well as certain types of electronic interference as incompatible.

Need
Astronomical resources are subject to actual and potential degradation from other incompatible uses of the summit. Without planned protections and a commitment to protect astronomical resources, damage may occur. Measures to protect other resources in the UH Management Areas, such as natural and cultural resources, will also protect astronomical resources.

Management Actions
The following table lists management actions to address the needs discussed above. For items identified with an asterisk, additional considerations are described after the table.

Table 7-5. Management Actions: Astronomical Resources

Management Action	
	Protection of Astronomical Resources
AR-1*	Operate the UH Management Areas to prohibit activities resulting in negative impacts to astronomical resources.
AR-2*	Prevent light pollution, radio frequency interference (RFI) and dust.

Additional Considerations for Management Actions

AR-1. Operate the UH Management Areas to Prohibit Activities Resulting in Negative Impacts to Astronomical Resources
The UH Management Areas were originally intended to act as a buffer to prevent negative impacts on astronomical resources. Management actions to protect other resources in the UH Management Areas will also protect astronomical resources.

AR-2. Prevent light pollution, radio frequency interference (RFI) and dust.
The use of outside lights in the UH Management Areas shall be discouraged and minimized, and the use of outside lights in the Astronomy Precinct shall be prohibited. All management activities should coordinate with federal, state and county agencies to control light pollution from sources within the UH Management Areas and, to the extent feasible, in areas outside the UH Management Areas.

The use of fixed radio transmitters shall be prohibited, as shall any other sources of radio frequency interference.

Uses causing the emission of dust shall be discouraged and minimized. If any activities cause the emission of dust in the Astronomy Precinct, appropriate dust control measures shall be required.

7.2 Managing Access, Activities and Uses

7.2.1 Activities and Uses

Activities occurring in the UH Management Areas include scientific research, cultural and religious activities, and recreation. The best known and most prominent activity in the UH Management Areas is astronomical research. Other types of scientific research also occur including geology, meteorology, and

biology and archaeology. Cultural and religious practices associated with the mountain include prayer, burial, and other rituals, and construction of small shrines. Recreational activities in the UH Management Areas include sightseeing, star gazing, skiing and snow-play, hiking, biking, and hunting. Visitors come for the natural beauty, scenic vistas, and accessible high peaks. A summary of the range of activities that take place in the UH Management Areas, levels of use, and their potential impacts on, and threats to cultural and natural resources is presented in Section 6 of this CMP.

This section provides information and management actions to protect, preserve and enhance the resources of the UH Management Areas, while providing for visitor use and safety as well as scientific research. Activities and uses by cultural practitioners are covered in Sections 5 and 7.1.1 and therefore are not discussed at length in this section.

Desired Outcome

To retain and enhance recreational and cultural activities, ensure regulation of commercial activities, and support scientific studies while maintaining adequate protection of resources, educating users regarding resource sensitivity, and ensuring the health and safety of those visiting or working at Mauna Kea.

Current Status

The University lacks administrative authority to develop, implement and enforce rules and regulations for public activities within the UH Management Areas (see Section 7.2.2). The current policies and conditions governing activities and use on Mauna Kea are outlined in the *Revised Management Plan for the UH Management Areas on Mauna Kea* (DLNR 1995), referred to below as the 1995 Management Plan. This plan is the most recently approved management plan by the BLNR, and covers permitted and prohibited public, commercial, educational, and scientific activities, as well as conditions tied to those uses. The UH Management Areas on Mauna Kea is classified as a resource subzone of the State conservation district lands. As such, all permitted uses must be consistent with Conservation District use regulations (HAR Chapter 13-5). Generally, any ground-disturbing activities and uses require approval by BLNR (see Section 7.2.2).

Public access to all of the UH Management Areas is currently unrestricted, except at the private sleeping and eating areas at the mid-level facilities at Hale Pōhaku. During severe weather, such as heavy snow or high winds, road and site conditions may require closure of the road or certain sections of the mountain to ensure public safety. University retains the right to control or restrict use of the areas under its control during times of inclement weather, as well as during times of heavy visitor use. Rangers attend to the health and safety of visitors including hikers, sightseers, and stranded motorists. Rangers also provide visitor information for the Mauna Kea Ice Age NAR as many users of the NAR access it through the UH Management Areas. General access conditions are summarized in Table 7-6.

Recreational activities include hiking, sight-seeing, amateur astronomy, snow-play, biking and hunting (see Section 6.1.3). Table 7-7 details the permitted and prohibited recreational and tourism uses and the general conditions these activities are subject to. The 1995 Management Plan restricts recreational hiking to existing roads and trails. Improved distribution of trail maps would educate recreational users regarding these restrictions. In order to dissuade people from walking on un-established trails, rangers may rake cinder over the trail to hide it. For safety reasons, hikers are asked to register at the VIS.

Hunting of wild sheep and goats on Mauna Kea has a long history, and hunting of non-native game birds has recently become more popular. Commercial hunting operations are prohibited in the UH Management

Areas under the 1995 Management Plan. Ungulate populations have declined in the last few decades through active control efforts by DLNR.

Commercial activities are defined to mean the transport of passengers to and from the premises by a commercial entity holding a permit in authorized vehicles for the purposes of viewing, walking and touring the premises, including sightseeing and stargazing. In January 2005 the UH Board of Regents accepted the responsibility of regulating commercial tour activities from BLNR. On November 28, 2006 the University president delegated authority to sign permits for commercial tour activities to the UH-Hilo chancellor. Permittees must comply with all of the condition specified or the permit may be revoked and fines imposed. During periods of heavy use, the University and DLNR reserve the right to limit the number of commercial vehicles allowed on the mountain at one time. Currently this limit is set at 18. Permitted activities of commercial tours are outlined in Table 7-8.

Conditions for commercial tours are set forth in the University of Hawai'i OMKM Mauna Kea Commercial Tour Use Permit Requirements. The permit clearly explains applicable fees, required security deposit and insurance, conditions for revocation of a permit, duties of caring for public safety, compliance with existing regulations, and general rules to be observed while on University leased lands. All commercial tour operators currently holding permits had permits from DLNR at the time University took over the commercial tour permitting process. Permits are reviewed and issued yearly by OMKM.

Efforts for scientific research not related to the astronomy facilities, gains information that will help manage and protect Mauna Kea's resources. These activities are permitted within the UH Management Areas as long as they do not interfere with the on-going astronomy operations or otherwise conflict with the terms of the University lease. Research activities taking place in the UH Management Areas are regulated through the State Conservation District Use permitting process administered by DLNR. Data collection is a permitted use in these two areas under Conservation District regulations because they are classified as Resource Subzones. The level of permit required for data collection depends primarily on the degree of ground-disturbing activities involved in the research.

Need

Public use of Mauna Kea has increased since the construction of the Summit Access Road. A managed access policy will help protect resources, enhance visitor safety and maintain the unique qualities of Mauna Kea. Some of the impacts that can be minimized by a managed access policy are damage to archaeological sites, habitat disturbance, erosion, debris, noise and air pollution, and introduction and spread of invasive species (see Section 6.3). A managed access policy provides an opportunity to monitor public use and supply the public with the appropriate orientation, guidance and warnings. Current policies governing activities and use on Mauna Kea are stated in the 1995 Management Plan, and additional policies shall be considered and adopted as appropriate.

One of the best methods of minimizing damage to resources is through education. Visitors to Mauna Kea and the astronomy personnel working there must be educated regarding the mountain's sensitive natural and cultural resources, permitted and prohibited activities and their potential for impacts on resources, and any applicable rules and regulations. Education may be accomplished through interpretive programs and self guided tours, videos, distribution of printed material, and through signage. Visitor registration will provide an opportunity to distribute educational and safety information to everyone. Section 7.1.3 describes educational needs and related management actions in more detail.

Table 7-6. Permitted General Uses[14]

Permitted Uses	Stated Restrictions on Use	Conditions	Responsibility
Public Access	During daylight hours (30 min before sunrise and 30 min after sunset).	University may install gates or chains to prevent unauthorized vehicles, after-hours access to the summit. Barrier will be located in such a way that visitors may safely turn around.	DLNR/University
Vehicles	"Until the entire road is paved" all commercial and astronomy related vehicles must be 4-wheel drive.	4-wheel drive recommended for public vehicles. University reserves right to require all vehicles to be 4-wheel drive and/ to require chains to proceed to upper elevations during hazardous conditions.	University
Access Restricted/ Unscheduled Road Closures	University may close roads or restrict access above Hale Pōhaku.	Access may be controlled/or restricted due to: general maintenance, hazardous driving conditions, snow removal, heavy use, transport of equipment, road maintenance. After unscheduled closings, official vehicles shall have priority over private or commercial vehicles. University will keep public informed via media and recorded message.	University
Snow Days	University may close the area early during snow days to allow stragglers to return down mountain.	Access may be controlled/or restricted due to hazardous driving conditions, snow removal, or heavy use	University
Snow-Play Controls	DLNR and University may request National Ski Patrol assistance.[15]	Ski Patrol will be outwardly identified and may be used to assist in crowd control and during emergencies. Public must yield to patrol and shall not hinder emergency actions.	DLNR/University
Alcohol Use	Prohibited above Hale Pōhaku (public and commercial).		University
Fire	No outdoor fires allowed in University Management Areas.		University
Historic, Archaeological and Cultural Sites	Tampering with sites is prohibited (Chapter 6E-11 HRS).	Personnel may and/ should inform violators of the law, instruct them to desist and report incident. Exception: development with permit.	DLNR/University
Visitor Registration		Voluntary (book located at VIS).	University
Visitor Use Monitoring		Suggests (not required) bi-monthly reports from rangers, so DLNR and MKSS can identify problem areas and solutions before damage is done, and to determine if commercial use should be restricted.	University
Visitor Waiver		Right to require waiver of liability from each driver (commercial & private) to access upper elevations.	University

[14] Permitted uses, restrictions and conditions outlined in Table 7-5 through 7-7 are described in the most recently approved management plan for Mauna Kea (*1995 Revised Management Plan for the UH Management Areas on Mauna Kea* (DLNR 1995)), unless otherwise noted.

[15] While the right to enlist the help of the National Ski Patrol is stated in the 1995 Management Plan, this organization no longer exists in Hawai'i.

Table 7-7. Permitted Public Uses

Permitted Uses	Stated Restrictions on Use	Conditions	Responsibility
Skiing, Sledding, Snow-Play		May be restricted due to number of participants or inclement weather. Visitors are encouraged to visit the VIS for hazard warnings (at own risk).	DLNR
Hiking	To existing roads and trails.	Hikers are encouraged to visit the VIS for hazard warnings (at own risk).	DLNR
Sightseeing	To existing roads and must not interfere with astronomy activity.	Access may be controlled or restricted due to heavy visitor use, inclement weather or unique events (eclipse). Visitors are encouraged to visit the VIS for hazard warnings (at own risk).	DLNR
Amateur Astronomy	Permitted at VIS.	Permitted at summit on case-by-case basis, subject to approval by University IfA.	University
Hunting	Limited to established DLNR hunting areas	Daytime hunting permitted pursuant to the rules and regulations of BLNR.	DLNR
Telescope Visits		Permitted during University sponsored tours or by permission of individual facilities. University and astronomy users associated with Mauna Kea Observatories will manage and control visitor activities involving tours.	University
Nature Study Tours	Permitted to study with same controls as recreationalists.	Trips to NAR subject to conditions and regulations of NAR Commission.	DLNR
VIS Programs (at Hale Pōhaku)		Sponsored, free programs for schools and public, including evening star-gazing are permitted. Private groups may be permitted to use VIS after closing for similar uses. After-hours activities require permission from MKSS.	University
Cultural Activities[16]	Must be consistent with rest of plan and not involve physical impacts.[17] Restricted to daylight hours.	Special permission may be granted by DLNR and University for night activities.	DLNR/University
Scientific Activities[18]	Depending on the type of project, may or may not require a permit from DLNR or BLNR (i.e., site plan approval, departmental permit, or Conservation District Use Permit.	Non-astronomy related scientific activities permitted within the UH Management Areas as long as those activities are not inimical to astronomy operations.	DLNR/University

[16] Refers to activities engaged in by cultural practitioners or other cultural groups.

[17] Originally referred to 1995 Management Plan; will now be applicable to the CMP.

[18] Permitted use under the General Lease between UH and BLNR. Not addressed in the 1995 Management Plan.

Table 7-8. Permitted Commercial Uses

Permitted Uses	Stated Restrictions on Use	Conditions	Responsibility
Commercial Tours	All commercial operators must obtain a permit that requires compliance with relevant restrictions and controls.	Commercial tours will be monitored to determine if the number of operators at the summit at one time or total number of permits issued should be limited. Commercial permits shall be set for a term and subject to renewal. Permits will have a consistent fee basis.	University
Hiking/ Bird Watching/ Nature Study	All commercial operators must obtain a permit that requires compliance with relevant restrictions and controls.	Activity involves paid guide and commercial transport.	DLNR/University
Sight-seeing/ Photography and Picnicking	All commercial operators must obtain a permit that requires compliance with relevant restrictions and controls.	Includes tours that stop at VIS and continue up the mountain but do not enter buildings at summit.	DLNR/University
Daytime Tours of Facilities	All commercial operators must obtain a permit that requires compliance with relevant restrictions and controls.	Granted on case-by-case basis with permission from University and facilities.	University
Night time Activities at Hale Pōhaku	All commercial operators must obtain a permit that requires compliance with relevant restrictions and controls.	Granted on case-by-case basis with permission from University or MKSS.	University
Film Making	All requests for commercial film making shall be reviewed by OMKM.	Granted on case-by-case basis with permission from University, DLNR, and Film Branch of State Dept. of Business and Economic Development and Tourism.	DLNR/University DBEDT
Concessions at University Facilities	Permitted by University IfA or MKSS at VIS or other facilities.		University
Shuttle Service to Summit	Permitted by University IfA or MKSS at VIS or other facilities.		University
Snow Tours: Downhill Skiing, Snowplay/ Sledding, Cross-country Skiing	Only when there is sufficient snow to allow the activity.	Permitted activity includes transport of individuals or groups to area for a fee. A guide may accompany. Shall include staging areas to be identified. Not permitted in areas of known archaeological sites.[19]	DLNR/University
Ski Meets, Races and other Snow-Play Events	All commercial operators must obtain a permit that requires compliance with relevant restrictions and controls.	Permitted on a case-by-case basis. (Even if sponsored by a non-profit group, required permits are the same as for commercial operators).[20]	DLNR/University

[19] Currently permitted under the 1995 Management Plan. Commercial snow-play tours shall not be permitted under the CMP (see ACT-11, below).

[20] Currently permitted under the 1995 Management Plan. Commercial ski meets and snow-play events shall not be permitted under the CMP (see ACT-11, below).

Data on the number of visitors to Mauna Kea and the activities they are engaging in is valuable information for management planning. This information can be used, for example, to help identify periods and areas of high use and changes in use over time. There is a need to continue tracking this information (see Section 6.1). Visitor registration at Hale Pōhaku will provide a method of collecting information such as the number of visitors, the purpose of their visit, and where they came from. Potential impacts of visitor activities on cultural and natural resources must be monitored over time against baseline conditions to refine management measures.

While each of the activities occurring on Mauna Kea may be addressed by specific policies, there are also general guidelines and policies that apply to all. There is a need for a coordinated partnership with the managers of adjacent lands, specifically the NAR and Forest Reserve, to clearly state permitted and prohibited uses in the upper-elevation areas of Mauna Kea, provide education to users and if necessary provide or assist with enforcement.[21] Involving user groups in the decision-making process will help to ensure compliance. Recreational opportunities need to be provided in a manner consistent with the protection of resources. There is a need to develop a separate process for other potential commercial activities such as one-time events, cultural tours and eco-tours.

Rules and regulations regarding visitor activities and use are necessary to limit impacts on resources. The policies and conditions stipulated in the 1995 Management Plan shall be maintained (see Table 7-6 – Table 7-8). To establish and enforce access and use policies, the University would need to obtain legal authority through administrative rules (see Section 7.2.2). The University could designate OMKM as the entity responsible for enforcing rules and citing violators, which would give OMKM the ability to, for example:

- Restrict public access to the summit (e.g., based on vehicle type, weather, limit numbers, set hours of operation);
- Restrict public access to biologically, geologically and culturally sensitive areas;
- Register visitors;
- Require mandatory educational and safety information for visitors;
- Regulate observatory vehicles (e.g., number of trips);
- Enforce speed limits;
- Require vehicles to have a valid safety inspection sticker;
- Cite violators of conservation district rules (such as for intentional removal of artifacts);
- Continue management of commercial permits and activities (see Section 6.1.4).

Management Actions

The following table lists management actions to address the needs discussed above. For items identified with an asterisk, additional considerations are described after the table.

Table 7-9. Management Actions: Activities and Uses

	Management Action
	General Management
ACT-1*	Continue and update managed access policy of 1995 Management Plan.
ACT-2*	Develop parking and visitor traffic plan.
ACT-3*	Maintain a presence of interpretive and enforcement personnel on the mountain at all times to educate users, deter violations, and encourage adherence to restrictions.

[21] While the CMP does not extend to lands outside the UH Management Areas, there is a need to coordinate with adjacent land managers to clearly identify, for the public, management boundaries and any similarities or differences in management policies.

	Management Action
ACT-4*	Develop and enforce a policy that maintains current prohibitions on off-road vehicle use in the UH Management Areas and that strengthens measures to prevent or deter vehicles from leaving established roads and designated parking areas.
	Recreational
ACT-5*	Implement policies to reduce impacts of recreational hiking
ACT-6*	Define and maintain areas where snow-related activities can occur and confine activities to slopes that have a protective layer of snow.
ACT-7	Confine University or other sponsored tours and star-gazing activities to previously disturbed ground surfaces and established parking areas.
ACT-8*	Coordinate with DLNR in the development of a policy regarding hunting in the UH Management Areas.
	Commercial
ACT-9*	Maintain commercial tour permitting process; evaluate and issue permits annually.
ACT-10*	Ensure OMKM input on permits for filming activities
ACT-11*	Seek statutory authority for the University to regulate commercial activities in the UH Management Areas.
	Scientific Research
ACT-12*	Ensure input by OMKM, MKMB, and Kahu Kū Mauna on all scientific research permits and establish system of reporting results of research to OMKM.

Additional Considerations for Management Actions[22]

ACT-1. Managed access policy

The permitted uses and controls as set forth in the 1995 Management Plan shall be maintained (see Table 7-6 – Table 7-8 and Section 7.5). Additional rules will be instituted to better manage access and protect resources. To establish or enforce access policies, University would need to obtain statutory authority to adopt administrative rules (see Section 7.2.2).

A key component of a managed access policy will be visitor registration and orientation to ensure that all who work at or visit Mauna Kea are taught about its unique, sensitive landscape, potential impacts of activities, health and safety issues, and rules and regulations. An entrance control protocol shall be developed to manage the summit road and the number of visitors at the summit. Access to the summit region would be managed through a control point, with registration required for travel beyond Hale Pōhaku. The logistics of this process need further refinement, but would include establishment of an entrance kiosk at Hale Pōhaku. Signage stating hours of operation and access policies shall be displayed prominently at the entrance kiosk. Information regarding rules, safety and leave-no-trace practices shall be distributed. An orientation will ensure visitors are educated on safety and resources issues as well as on prohibited uses (see Section 7.1.3). Provisions will include that repeat users only attend the mandatory orientation only at certain time intervals (i.e., once per year). Consideration of adopting an entrance fee will be left open as an option if the University obtains rule making authority. Fees could be charged either per person or per vehicle.

Users shall be provided with information on historic properties, restrictions that protect historic properties and the historic district, and penalties. Users shall be informed that invasive species may be carried on clothes, boots and vehicles and areas for cleaning shall be provided. Advice for minimizing erosion caused by hiking off trail and by vehicles shall be given. Visitors will be advised that high winds, which occur regularly, can scatter unsecured debris and personal belongings across the landscape, possibly

[22] Many of the considerations described in this section cannot be implemented without rule-making authority. The specifics will need to be further evaluated and incorporated during the rule-making process.

damaging natural and cultural resources. Simply informing users on the effects of disturbance caused by actions such as hiking off trail, the cumulative effects of the introduction of invasive species and erosion and the locations of trash receptacles, restrooms, and parking lots may help minimize disturbance.

Other considerations not currently covered in existing policies:

- Require permits for large groups (>15) to go 'off road' (but not in vehicles) in the UH Management Areas. Permits would be subject to fees and orientation requirements.
- Except for certified assistance animals for the disabled, such as hearing guide and seeing eye dogs, no animals shall be permitted out of vehicles within the UH Management Areas.
- Control the use of "air conveyance" by requiring special use permits for scattering ashes by helicopters and planes, and for aerial photography, and filming.
- Evaluate restricting travel to the summit to 4-wheel-drive vehicles for all users. Currently policy states that until the entire road is paved, all commercial and astronomy related vehicles must be 4-wheel-drive. This stipulation is not required for individual visitor vehicles. [23]

Certain visitor activities shall be confined to designated areas or allowed only under certain conditions. Activities taking place on the summit cones, which have been identified as traditional cultural property should be conducted in a manner that does not further alter the current condition and integrity of the summit cones. Visitors engaged in hiking, sightseeing and nature studies shall confine activities to designated roads and trails. Snow-play activities, such as skiing, sledding etc., shall be confined to areas where there is sufficient snow to allow the activity.[24] Snow-play activities are not permitted in areas of known archaeological sites. Certain activities may be prohibited altogether within the Astronomy Precinct.

"Extreme sports" is a relative new kind of recreational activity that was not addressed in the 1995 Management Plan, but was discussed in the Master Plan (2000), where it was defined as "recreational activities that seek dangerous and unusual thrills" (Group 70 International 2000). Prior to the acceptance of the Master Plan, DLNR reviewed and denied a request to conduct an extreme sports event on Mauna Kea because of the potential for significant harm to the environment and insensitivity to the cultural significance of the mountain. The University has determined that extreme sports shall be a prohibited activity.

Any management actions regarding access by Native Hawaiians shall consider or adopt policies such as those in use by the U.S. National Park Service at Haleakala National Park or Volcanoes National Park.

ACT-2. Parking

Visitor parking on the shoulder of the Summit Access Road and in other undesignated areas may negatively impact resources and cause erosion. A plan to provide adequate parking for visitors must be devised. As visitor use increases the use of a shuttle may be necessary to reduce the overall number of vehicles on the road to and at the summit. MKSS (or other concessioner) would operate a shuttle service between the VIS (or an alternative location)[25] and the summit. This would help minimize parking issues and safety issues resulting from too many vehicles on the summit road. If visitor use is consistently high, a daily shuttle service may be available, or shuttles may be used only during times of high traffic such as

[23] Reevaluate this policy if shuttle service is developed. For cultural, research, education, special recreation and other approved special uses private 4-wheel-drive vehicles may be used in the UH Management Areas, with passes, even if the shuttle is developed.

[24] Snow-play involving the use of snow designed equipment will be allowed on the steep slopes of cinder cones. Snow-play will be prohibited on the steep slopes of cinder cones when snow pack at a representative location is eight inches (203 mm) or less.

[25] During the community consultation process, several members of the Native Hawaiian community suggested the DHHL Humu'ula Sheep Station as an alternate site for shuttle service.

on snow days and during special events such as an eclipse or meteor shower. University also has the option to ask other agencies for extra enforcement staffing to help handle days when visitor use is high and has the right to restrict the number of visitors in the UH Management Areas.

ACT-3. Interpretive and enforcement personnel
The ranger program has been successful in providing a presence on the mountain for operational and visitor support. If and when University receives rule making authority, it will need enforcement personnel, and rangers may be able to perform those duties. One potential option would be for the rangers to be cross-deputized as officers of DLNR DOCARE. It may not be necessary for all rangers to have enforcement responsibilities; the program could support a mix of enforcement and interpretive rangers. OMKM personnel with enforcement authority should maintain a presence at Hale Pōhaku and the summit region to deter violations and encourage adherence to restrictions. Interpretive personnel such as rangers, VIS staff and volunteers, shall be present on the mountain during operating hours.

ACT-4. Off-road vehicle use policy
Off-road vehicle use has the potential to irreversibly damage cultural and natural resources (see Section 6.3). The use of off-road vehicles is prohibited in the UH Management Areas, however there is a need to develop an official policy that also details any exceptions. The policy shall prohibit the operation of all motorized and unmotorized land vehicles except on roads or trails specifically designated for their use. Vehicles shall be restricted to designated parking areas, whether paved or unpaved. Existing guardrails and boulder barriers shall be maintained and new barriers installed as determined by a road safety inspection (see Section 7.3.1). Mitigation measures to restore or obscure off-road tracks created by unauthorized vehicles shall be devised and implemented as needed. Any policy will include the conditions contained in the NAR administrative rule on off-road vehicles. Permits for otherwise prohibited activities, such as ATV use, for purposes such as research, education and management shall be issued on a very limited basis and in consideration of the overall effects and benefits. Use of off-road vehicles will be permitted for emergency response and evacuation.

It is important that the off-road vehicle policy for the UH Management Areas be advertised widely. Visitors to the mountain shall be educated about the policy in orientation materials (see Section 7.1.3). OMKM shall coordinate with DLNR to ensure that all off-road vehicle users of the adjacent land areas are informed of the policy. OMKM and DLNR shall consider establishing a working group with surrounding land owners and the user-community to educate users and manage ATV use in the region.

ACT-5. Minimizing impacts of recreational hiking
A maintained trail network will help to reduce the formation of new unwanted trails. Proposed creation of any new, formalized trails or substantial alteration of an existing route will be subject to review by SHPD. The trail network shall be delineated on maps, marked with signs, and patrolled by rangers. Hikers will be requested to self-register at the VIS and be provided with maps. They will also be informed that hiking off trail is prohibited and about safety concerns, including that hiking alone at high elevations is dangerous and discouraged. All unwanted trails shall be removed through restoration. The creation of self-guided tours and regular guided tours will help to reduce potential impacts by focusing visitation on specific areas. Having a guide present will help to monitor visitor activities.

ACT-6. Snow-play activities
Snow-play is defined as skiing, sledding, snowboarding or other recreational activities involving snow. Users shall be informed of designated snow-play areas through maps, temporary signs or directions given by rangers. Areas with consistently deep layers of snow will be delineated on maps for future reference, to create snow-play maps and to monitor these areas for any effects once the snow is gone. Snow-play activities shall be confined to areas with a layer of snow deep enough to provide protection to resources (a

minimum of eight inches). Rangers shall regularly patrol snow-play areas to ensure visitor safety and protection of resources. Shuttle service to the summit may be made available during times of high use or during periods of heavy snow that require frequent plowing.

ACT-8. Hunting in the UH Management Areas

University and DLNR shall work together to establish a clear policy regarding recreational hunting. Because access to hunting areas may not require hunters to pass through Hale Pōhaku, where information about prohibited areas is available, getting this information to hunters is a challenge that this policy-making effort must address. Development of partnerships with hunting associations and other land stewards in devising and disseminating information on the hunting policy will improve compliance with established rules for the UH Management Areas. Hunters shall be provided with maps of designated hunting and parking areas. They will also be informed on prohibitions regarding off-road vehicles, the requirement to remove any debris created while hunting, the threats of invasive species and accelerated erosion and methods of prevention, and information on historic properties and need to avoid them.

ACT-9. Commercial tour permitting

The commercial tour permitting process shall be reviewed at regular intervals to determine any changes that should be made. Relevant information relating to permit violations or impacts to cultural and natural resources will be considered during the review process. Commercial tour permits shall be updated to include a requirement for an orientation if that policy is implemented (see Section 7.1.3). Brochures or maps distributed by commercial operators must be approved by OMKM. The current policy of commercial permit funds being collected by OMKM and deposited into a revolving fund used to support management of the mountain shall be maintained.

ACT-10. Film policy

OMKM shall have input on all permits for activities in the UH Management Areas initiated through the Hawai'i Film office. OMKM shall consult with observatories and MKSS, as appropriate, to ensure that the proposed filming activity would not interfere with their operations. OMKM receives about 30 requests for filming every year. Rangers educate film crews on Mauna Kea and minimize potential negative impacts on the mountain's resources. Permits shall not be required for filming related to news coverage and astronomical activities.

ACT-11. Other commercial activities

Various commercial activities have been proposed in the UH Management Areas, including concessions, resource extraction, and special events. The University currently has no express statutory or regulatory authority to issue permits for such activities. Statutory amendments allowing the University to control these activities in a manner consistent with this CMP would be beneficial. Special one-time or yearly events (e.g., conferences, cultural festivals or other permitted organized gatherings) should require a permit limiting the number of participants, fees, and other conditions imposed on daily commercial operators such as insurance requirements. Fees generated from other commercial projects, such as one-time events, should be deposited into the revolving fund used to support management of the mountain (see *ACT-9, Commercial Tour Permitting*). Requests for potential commercial activities should also be subject to review and approval by OMKM and DLNR. Commercial events expected to draw a large number of visitors, or that will be ongoing should also be subject to community input. Cultural and eco-tours will be subject to the same conditions as currently permitted commercial tours (see *ACT-9, Commercial Tour Permitting*). Cultural tour operators will be required to consult with Kahu Kū Mauna and SHPD to determine which sites are appropriate for visitation. Permits should also be required for and the location for such concessions should be limited to the VIS or other facilities. Commercial permits shall not be granted for snow-play tours, ski meets or any snow-play events.

ACT-12. Research permits and proposals
Currently, research activities in the Conservation District are regulated by the DLNR and/or BLNR pursuant to the Conservation District rules. DLNR and BLNR shall consult OMKM, MKMB and/or Kahu Kū Mauna, as appropriate, regarding permit applications for research in the UH Management Areas. If research is proposed near known historical or cultural sites, SHPD and Kahu Kū Mauna shall be consulted, as appropriate. Research activities must be consistent with the CMP and the Conservation District rules. Appropriate and enforceable conditions may be placed on permits to help regulate and monitor any type of disturbance and incidental take or damage. All permits relating to the study of cultural, archaeological or natural resources shall contain a condition requiring that the results be reported to OMKM for inclusion in OMKMs database or to establish baseline information. Research projects that contribute to improved management decisions, address existing data gaps, and further the objective of protecting natural and cultural resources should be approved if in compliance with this CMP and the Conservation District rules.

Research shall be conducted as to have minimal impact on cultural and natural resources. Potential effects include inadvertent alteration of shrines, other archaeological sites, or burial sites by researchers; alteration of the landscape by installing permanent equipment or instruments; visual intrusion by installed equipment or instruments in the historic district; habitat disturbance through access and sampling, and the potential for introduction or spread of invasive species. Research must use best practices to minimize negative effects on cultural, archaeological and natural resources. In order to minimize effects on astronomical research, projects must control dust and light conditions near the summit. The use of equipment or instruments that emit radio or sound waves shall be prohibited, unless special permission is granted after consultation with IfA and OMKM. In evaluating requests for incidental take related to research projects the reviewer shall consider whether the resources to be collected can be obtained elsewhere and whether collection will severely deplete or damage the integrity of the resource.

7.2.2 Permitting and Enforcement

Successful stewardship of Mauna Kea will come, in part, from balancing development and public access with the enforcement of rules. Although many of the management actions presented in this plan do not require rule-making authority to implement, others are contingent on the University obtaining rule-making authority, developing rules, and having the authority to enforce those rules. The inability to obtain this authority will continue to impede the University's ability to protect Mauna Kea's cultural and natural resources. However, even without rule-making authority, many of the management actions presented in the CMP can be implemented as permit conditions of CDUPs from DLNR or Commercial Tour Permits from OMKM. Failure to comply with such conditions could result in enforcement action or revocation of the permit. In the absence of the University obtaining rule-making authority, OMKM can report violations of the CMP to DLNR, which will still be responsible for enforcement of existing rules and regulations.

This section provides information and recommendations to ensure knowledge of and compliance with rules and regulations, as well as enforcement. Current permitted uses, rules and statutes are discussed in Sections 3.4 and 7.2.1.

Desired Outcome

Achieve compliance with existing and any new policies and regulations designed to manage and minimize human impacts, to preserve and protect Mauna Kea's resources.

Current Status

OMKM is responsible for the management of the UH Management Areas. Since the University does not have rule-making authority, DLNR currently has the primary management and regulatory authority over a number of activities occurring on UH Management Areas. Because the University lacks statutory authority to promulgate administrative rules, there are currently no rules that specifically cover public access management or control within the UH Management Areas. Administrative rules pertaining to Conservation District use and the *Revised Management Plan for the UH Managed Area on Mauna Kea* (DLNR 1995) provide the current framework.

The UH Management Areas are designated part of the resource subzone of the State Conservation District lands. As such, land use and activities are regulated by HAR Chapter 13-5.[26] BLNR requires approval of a site plan, departmental permit or a CDUP or in some cases a management plan for certain activities. DLNR has included environmental protection requirements as permit conditions. The University is responsible for monitoring activities, and DLNR is responsible for enforcing regulations and permit conditions on Mauna Kea. University monitors the activities of the observatories for conformance with the conditions of their CDUPs. OMKM has been designated the entity responsible for monitoring holders of CDUPs, and twice a year, rangers inspect each observatory for compliance with its CDUP. DLNR's OCCL is ultimately responsible for enforcing conservation district regulations and permit conditions. Monitoring of historic sites during construction or maintenance is required as determined by consultation with SHPD.

Enforcement of general Conservation District rules and state and county and laws is currently handled by DLNR's DOCARE in coordination with County police officers. DLNR personnel do not maintain a regular presence on Mauna Kea. State and county personnel are alerted to potential violations by on-mountain personnel, such as rangers. Rangers monitor activity in the summit region and inform visitors of rules and appropriate behavior, as well as assist with visitor safety. Although rangers do not have any enforcement authority, the mere presence of uniformed personnel will often act as a deterrent to vandalism and promote adherence to rules.

OMKM rangers have been preparing to assist with management of the Mauna Kea Ice Age NAR by reporting violations, educating visitors and participating in rescue operations. Recently, BLNR, DLNR's DOFAW-NARS and OMKM have tentatively agreed in concept to enter into a cooperative agreement to formalize the continuation of these efforts, to the benefit of all parties. Under the proposed agreement, DOFAW-NARS will remain primarily responsible for land management and the OMKM Rangers will provide an on-site presence at the summit and information about the NAR to visitors and report illegal activities. The proposed agreement also addresses cooperative research and management of natural and cultural resources.

Permits for commercial tour operations are issued by OMKM (see Section 6.1.4 and 7.2.1). All commercial operators must obtain a permit that requires compliance with established rules and requirements. Commercial tour permits are set for a certain term and subject to issuance. Failure to comply with permit conditions may result in revocation of the permit and/or a fine.

[26] Management activities must be compliant with HRS 183C-1, which dictates that land within the state land use conservation district shall be managed to "conserve, protect, and preserve the important natural resources of the State through appropriate management and use to promote their long-term sustainability and the public health, safety and welfare." Permitted activities must comply with HAR 13-5 and be approved by DLNR or one of its divisions.

Need

Permitting and enforcement are essential tools for regulating activities. A 2005 audit by the State of Hawai'i criticized DLNR and University for not following through on their responsibility to ensure that the cultural and natural resources of Mauna Kea are preserved and protected (Office of the Legislative Auditor 2005). The University has determined that the best way to meet this need is for the University to obtain statutory rule-making authority for the UH Management Areas and enter into a rule-making process.[27]

All federal, state, and local laws and regulations must be followed for all activities and uses (see Section 6.4). In addition, the rules, terms and conditions of any commercial use permits, and management controls must be adhered to (see Section 7.2.1). An enforcement presence must be maintained in the UH Management Areas to ensure adequate protection of resources and enforcement of rules and regulations (see Section 7.2.1). Education of all users of the UH Management Areas as to applicable rules, regulations, and permit requirements will help deter violations (see Section 7.1.3). An adaptive management approach requires the ability to update management strategies, including rules, as new information on resource status, and conditions and threat levels is obtained. On-mountain personnel are the front line of defense, and may be the first to detect new threats or impacts. They should be consulted regularly, to assess the effectiveness of management strategies.

Management Actions

The following table lists management actions to address the needs discussed above. For items identified with an asterisk, additional considerations are described after the table.

Table 7-10. Management Actions: Permitting and Enforcement

Management Action	
	Laws and Regulations
P-1*	Comply with all applicable federal, state, and local laws, regulations, and permit conditions related to activities in the UH Management Areas.
P-2*	Strengthen CMP implementation by recommending to the BLNR that the CMP conditions be included in any Conservation District Use Permit or other permit.
P-3*	Obtain statutory rule-making authority from the legislature, authorizing the University of Hawai'i to adopt administrative rules pursuant to Chapter 91 to implement and enforce the management actions.
P-4	Educate management staff and users of the mountain about all applicable rules and permit requirements.
	Enforcement
P-5*	Continue coordinating with other agencies on enforcement needs.
P-6*	Obtain legal authority for establishing, and then establish, a law enforcement presence on the mountain that can enforce rules for the UH Management Areas on Mauna Kea.
P-7*	Develop and implement protocol for oversight and compliance with Conservation District Use Permits.
P-8*	Enforce conditions contained in commercial and Special Use permits.

[27] The rule-making process would be conducted pursuant to HRS Title 8, Chapter 91, which outlines the rule-making procedures for agencies.

Additional Considerations for Management Actions

P-1. Compliance with all applicable laws, regulations and permit conditions
Section 6.4 of this CMP details laws, regulations and permit conditions applicable to all activities and uses in the UH Management Areas. Responsibility for compliance rests with the University (the lessee), observatories (sub-lessees), permittees, permit applicants, and the public. Responsibility for internal enforcement rests with the University, and externally with appropriate regulatory authorities.

P-2. Strengthen CMP implementation through Conservation District Use Permit conditions
Once approved by BLNR, this CMP will be the approved management plan for the UH Management Areas. Subject to HAR 13-5, in order to ensure regulatory compliance with specific management actions set forth in the CMP designed to protect Mauna Kea's cultural and natural resources, the University will recommend that the BLNR include the applicable CMP provisions as a condition of approval in future CDUPs approved by BLNR. Additionally, subject to DLNR approval, similar conditions shall be considered for inclusion in future subleases or Operating and Site Development Agreements, as appropriate (see Section 7.3.4) (Group 70 International 2000).

P-3. Obtaining rule making authority for the University
The University must balance the enforcement of rules and the granting of public access in order to protect resources. The University will pursue administrative rule making authority as well as enforcement authority, to equip OMKM to meet its mission of sustainable management and stewardship of the UH Management Areas. Adopting administrative rules specific to the UH Management Areas will help simplify the overall enforcement effort in that all the required procedures, prohibitions, and penalties applicable to all resources and uses on the mountain will be available in one document, and would be enforceable by the University (see *P-7, Obtain legal authority for a law enforcement presence on the mountain*). Rules, regulations and fines will ensure accountability for actions and deter violations necessary for resource protection.

P-5. Coordination with other agencies regarding enforcement needs
Management and enforcement responsibilities are described in Sections 7.2. Management entities must be aware of rules and regulations for adjacent lands, since resources available for on-mountain management are limited. Management entities shall work to develop and enforce consistent policies for access and use, to limit confusion for users of the high elevation areas of Mauna Kea.[28] OMKM has tentatively agreed in concept to enter into a cooperative agreement with the Mauna Kea Ice Age NAR to address some of these issues (see *Current Status*, above). Modification to this proposed agreement may become necessary, if and when the University obtains legal authority to have law enforcement personnel (see *P-7, Obtain legal authority for a law enforcement presence on the mountain*).

P-6. Establish a law enforcement presence on the mountain
Effective enforcement is an essential component to protecting resources and managing visitor use and safety. If and when the University receives the statutory authority to promulgate rules, they will need to designate enforcement personnel. OMKM Rangers may be able to perform these duties, and it might be feasible to have the rangers cross-deputized as DLNR DOCARE officers, so that they would also have the authority to oversee activities and respond to violations in the Mauna Kea Ice Age NAR. In addition, enforcement personnel must maintain up-to-date training on all relevant issues (see Section 7.4.1). Formal agreements between agencies would enhance effective law enforcement on the mountain.

[28] It is recognized that landholders have different priorities and mandates for managing lands under their jurisdiction. Coordinated policies are not intended to change these, but rather to facilitate consistency as much as possible.

P-7. Protocol for oversight of Conservation District Use Permit compliance
DLNR, the University and OMKM shall continue to oversee compliance with all terms and conditions of CDUPs. Known or suspected non-compliance or violations shall be reported to DLNR. In the absence of monitoring for compliance with CDUP conditions there is a risk of damage to the summit, and other areas of the UH Management Areas. Moreover, tenant violators should bear the full consequences of their infractions, including taking corrective actions and paying fines. Observatories shall be reminded annually, in writing that violations of permit conditions may result in permit cancellation and closure of facilities by BLNR. OMKM shall establish and enforce a permit and sublease monitoring system to promote responsible stewardship, prevent damage to Mauna Kea, and report infractions to DLNR, which has statutory authority to pursue enforcement in the conservation district as well as enforcement of permit conditions.

P-8. Commercial and Special Use permits
All permits issued by OMKM require the user to comply with all of the conditions specified or the permit may be revoked and fines imposed. Commercial permits currently apply to tour operations (see Section 7.2.1). Permits shall be required for certain activities within the UH Management Areas, including research, one-time commercial events, and activities such as scattering of remains (see Section 7.1.1 and 7.2.1). OMKM, MKMB, and in some cases Kahu Kū Mauna shall review permit applications to determine if the permit should be granted. OMKM shall use technical experts, when necessary, to determine the potential effects of issuing commercial or special use permits. Permits shall be consistent with the provisions of the CMP, including a mandatory orientation, if implemented (see Section 7.1.3). Special conditions attached to any issued permit shall be clearly stated. Permittees shall be made aware that failure to comply with all conditions of the permit may result in fines, administrative action, or revocation of permit.

7.3 Managing the Built Environment

7.3.1 Infrastructure and Maintenance

This section provides management recommendations focusing on the maintenance needs of the existing infrastructure and other components of the built environment.[29] The infrastructure of the UH Management Areas includes observatories, support facilities, and associated support elements (e.g., roadways, electric power supply, communications network). Activities to maintain infrastructure are on-going, so minimizing the impact to resources from maintenance activities is essential.

Desired Outcome

Manage the built environment by implementing an Operations, Monitoring and Maintenance Plan (OMMP) containing specific maintenance strategies and protocols that will result in minimal disruptions to activities and uses, minimize impacts to the resources, and ensure that permittees remain compliant with their CDUP requirements.

Current Status

A summary of the infrastructure, the roles and responsibilities of IfA and OMKM, and some of the maintenance activities conducted within the UH Management Areas is presented in Section 6.2. The 2000

[29] The built environment refers to areas containing manmade structures or features that support human uses.

Master Plan identified many details of practices and strategies necessary for infrastructure maintenance that were adopted into this CMP (Group 70 International 2000).

Construction of facilities at Hale Pōhaku and in the summit region of Mauna Kea began in the 1960's (see Section 5.1.1). Since that time, the IfA has been responsible for project planning, environmental analysis, and oversight of the observatories and support facilities. Future infrastructure needs, including those of the summit observatories and Hale Pōhaku support facilities, are discussed in the 2000 Master Plan (Group 70 International 2000). CDUPs are issued for each land use (see Section 3.4), and OMKM is responsible for oversight of permit compliance for sub-lessees (see Section 7.2.2).

MKSS currently maintains and administers contracts for day-to-day operations involving infrastructure and all buildings at Hale Pōhaku and all roadways in the UH Management Areas (see Section 6.2). Routine activities include water delivery, solid waste removal, building maintenance, handling of hazardous materials, and road maintenance. Observatories are responsible for maintenance of their facilities, with efforts coordinated through MKSS. In turn, MKSS works closely with OMKM to evaluate the potential impacts of infrastructure and maintenance needs on cultural and natural resources. Both IfA and MKSS function as liaisons with OMKM on behalf of the observatories. Plans and actions involving infrastructure and maintenance operations are reviewed by the MKMB prior to their implementation. MKMB makes recommendations and requires mitigating measures if maintenance operations present potential adverse effects to cultural or natural resources.

The construction of observatories, buildings, and other structures has changed the cultural and natural landscape of the summit region, and their presence and use present continuing impacts (see Section 6.3). Direct impacts include extensive damage to cinder cones from removal, side casting, and crushing of cinder particles during observatory construction, resulting in loss of habitat and scarring of the physical and cultural landscape. Another direct impact is the discharge of effluent wastewater into the environment via the cesspools and septic tanks used by observatories and facilities at Hale Pōhaku. However, as discussed in Section 6.3, the impacts to the environment from these were found to be minimal. Indirect impacts relating to the on-going use of the observatories include dust generation from traffic and road grading, and generation of solid waste. Public concerns focus, in part, on activities associated with the ongoing facility operations, including production of trash, disposal of wastewater in the summit region, and potential hazardous materials contamination of substrate and groundwater.

To date, the use of sustainable technologies has not been a focus of infrastructure and maintenance activities at the UH Management Areas on Mauna Kea. However, it is an expressed community concern that the University improves its stewardship of lands on Mauna Kea by employing sustainable practices both in terms of on-going operations and potential future development. Sustainable practices range from strategies to reduce vehicular trips up and down the access road, to using more earth friendly materials.

Need

In general, there is a need to minimize the impacts of facilities and the maintenance actions required to keep them operating and in compliance with their CDUP. OMKM must work closely with the observatories and MKSS to identify strategies and protocols that reduce impacts to resources associated with infrastructure and maintenance practices.

Maintenance actions range from basic tasks such as painting buildings to tasks that are more complex and involved, such as, installing septic tanks. All actions have the potential to cause adverse impacts to the environment and users. An OMMP that identifies maintenance actions and schedules, and which, to the extent possible, minimizes or mitigates the adverse impacts, is needed. An OMMP is a concise planning

document that contains all management strategies, protocols, schedules, necessary to conduct maintenance and the locations of facilities and infrastructure.

Education efforts targeted at maintenance staff and observatory personnel are necessary to provide an understanding of the resources and applicable regulations, potential harmful effects of routine maintenance activities, and ways to minimize impacts. Section 7.1.3 elaborates on management recommendations for education and outreach.

Observatories are legally required to comply with terms of their CDUPs. OMKM shall ensure that CDUP conditions are met (see Section 7.2.2). Operational and maintenance activities must be compliant with applicable historic preservation review requirements set forth by SHPD and applicable regulations pertaining to wastewater disposal and management of hazardous materials.

Management Actions

The following table lists management actions to address the needs discussed above. For items identified with an asterisk, additional considerations are described after the table.

Table 7-11. Management Actions: Infrastructure and Maintenance

	Management Action
	Routine Maintenance
IM-1*	Develop and implement an OMMP.
IM-2	Reduce impacts from operations and maintenance activities by educating personnel about Mauna Kea's unique resources.
IM-3*	Conduct historic preservation review for maintenance activities that will have an adverse effect on historic properties.
IM-4*	Evaluate need for and feasibility of a vehicle wash station near Hale Pōhaku, and requiring that vehicles be cleaned.
IM-5*	Develop and implement a Debris Removal, Monitoring and Prevention Plan.
IM-6*	Develop and implement an erosion inventory and assessment plan.
IM-7	Prepare a plan, in collaboration with the Department of Defense, to remove military wreckage from a remote area of the UH Management Areas, while ensuring protection of natural and cultural resources.
	Infrastructure
IM-8*	Assess feasibility of paving the Summit Access Road.
IM-9*	Evaluate need for additional parking lots and vehicle pullouts and install if necessary.
IM-10	Evaluate need for additional public restroom facilities in the summit region and at Hale Pōhaku, and install close-contained zero waste systems if necessary.
	Sustainable Technologies
IM-11*	Encourage existing facilities and new development to incorporate sustainable technologies, energy efficient technologies, and LEED standards, whenever possible, into facility design and operations.
IM-12*	Conduct energy audits to identify energy use and system inefficiencies, and develop solutions to reduce energy usage.
IM-13*	Conduct feasibility assessment, in consultation with Hawaii Electric Light Company, on developing locally-based alternative energy sources.
IM-14*	Encourage observatories to investigate options to reduce the use of hazardous materials in telescope operations.

Additional Considerations for Management Actions

IM-1. Operations, Monitoring, and Maintenance Plan
The OMMP is a document that coordinates all maintenance plans, activities and schedules. It identifies personnel necessary to conduct tasks, monitoring requirements to ensure compliance, and reporting procedures to document the actions that were implemented. The OMMP should address existing maintenance tasks carried out by MKSS and the observatories, as contained in their CDUP, along with new recommendations presented in the CMP.

IM-3. Historic preservation review for maintenance activities
Daily operations and routine maintenance operations occur throughout the UH Management Areas, along the Summit Access Road, in the summit area, and at Hale Pōhaku. Many of these activities carried out by MKSS and the observatories will not affect historic properties and need not be subject to historic preservation review. This includes all types of activities that do not involve ground disturbance and those occurring in highly altered areas. Certain maintenance activities will, however, be subject to required historic preservation review. The SHPD review process would stipulate one or more of the following: no survey, consultation or monitoring needed; consultation with Kahu Kū Mauna and other Native Hawaiian community members required; or monitoring of specific activities needed. In consultation with DLNR, OMKM will develop a list of routine maintenance activities that can be excluded from the historic preservation review process and a list of routine maintenance activities requiring review. An agreement between DLNR and OMKM should be developed for a prescribed list of activities and could be incorporated into the OMMP (see *IM-1, Operations, Monitoring, and Maintenance Plan*).

A useful tool in the evaluation of the potential impacts of routine management activities will be maps that show previously altered areas, including degree of disturbance, and maps of areas potentially affected by activities requiring review.

IM-4. Vehicle wash station
The need for and feasibility of establishing a vehicle wash-station near Hale Pōhaku to prevent the transport of invasive plants and animals should be evaluated. Several scenarios were presented to account for different types of visitors and vehicles:

1. Provide a voluntary vehicle wash-station and signage along Mauna Kea Access Road, at the southern border of Hale Pōhaku. Operators with vehicles used off road and/or on dirt roads will be encouraged by signs to clean their vehicles.
2. Require that the undercarriages of all vehicles that routinely access the summit be power washed on a weekly basis.
3. Require that all construction and road grading equipment be washed down prior to arrival at the mountain, preferably using a pressure washer.
4. Coordinate with Pōhakuloa Training Area on the use of their vehicle wash station for large construction vehicles.

IM-5. Debris Removal, Monitoring and Prevention Plan
A *Debris Removal, Monitoring and Prevention Plan* should be developed to address fugitive trash, which could impact cultural resources directly, through impact, and indirectly, through clean-up activities. The plan also should be developed to limit alteration of the viewscape, direct and indirect damage to surfaces, and attraction of invasive species. Key elements that should be contained in this plan include assignment of responsibilities for regular trash maintenance (observatories: dumpsters, MKSS: trash receptacles, Rangers: fugitive trash); provision of adequate, secured receptacles, including temporary receptacles during high-use periods; a post-snow-season inspection and clean-up at high use areas; discussion of

potential impacts to cultural and natural resources; provision of a map of sensitive areas, to limit impacts to cultural and natural resources; and an educational component, to address potential threats of trash, methods to prevent escape, and a "pack it in, pack it out" strategy (see Section 7.1.3).

IM-6. Erosion Inventory and Assessment Plan

Potential impacts from erosion are discussed in Section 6.3 of this CMP. An erosion inventory and assessment plan will identify areas of accelerated erosion or other disruptions associated with the movement of sediment, prioritizing those that are either safety-related or that have the potential to negatively affect cultural or natural resources. The plan should include designs for site-specific solution and general recommendations for minimizing impacts of erosion.

IM-8. Paving Summit Access Road

The feasibility of paving the Summit Access Road needs to be evaluated based on known considerations related to safety; road maintenance costs (including direct costs, as well as indirect costs such as wear and tear on State vehicles); potential adverse environmental impacts from dust, cinder movement, and erosion; and the potential impacts from paving on natural and cultural resources. An archaeological inventory of the road corridor has not been completed (see Section 7.1.1), nor have baseline natural resource surveys (see Section 7.1.2). Road paving would be a major endeavor and would require a separate environmental analysis.

IM-9. Parking and pullouts

As recommended in the 2000 Master Plan, options for expanding the parking area in the vicinity of the VIS should be evaluated and implemented if necessary, to provide a safe and convenient environment for visitors (Group 70 International 2000). For safety reasons, all parking should be on the same side of the road as the existing Hale Pōhaku facilities. To minimize erosion, low impact development practices should be employed. Vehicle pullouts may be recommended as part of the road safety inspection. Safety and view plane criteria should be considered if pullouts are installed. Pullouts are also ideal sites to erect interpretive signage (see Section 7.1.3) and to conduct demonstration habitat restoration projects (see Section 7.1.2). Although parking does become challenging in the summit region on high-use snow days, no formal visitor parking lots are being recommended for the summit region. Rangers shall continue current practice of establishing a one-way loop system to keep cars flowing during periods of high traffic, including high-use snow days. Parking areas shall be designated by unobtrusive signs, temporary signs when needed, and on maps distributed to public users.

IM-11-14. Sustainable technologies

Options for using sustainable technologies should be explored for both existing and potential new facilities. Sustainable technologies can be used to reduce demand for water and electricity and to minimize the direct and indirect impacts of facility operations. In particular, since water needs to be trucked to the summit facilities, and wastewater disposal is a concern, all efforts to reduce water use and contain waste will benefit the resources. Potable water use should be reduced by installing low use water fixtures at Hale Pōhaku facilities. Close-contained, zero-discharge human waste systems shall be used for any future development in the summit region, from portable toilets to observatories if feasible. Water harvesting systems and systems that separate grey waste water from sewage waste should be explored to provide water for irrigation, especially for habitat restoration efforts. Solar water heaters could provide hot water for use at Hale Pōhaku facilities. An energy audit would identify energy use and system inefficiencies, setting the baseline for developing solutions to reduce energy use and investigating forms of locally-based alternative energy production. Sources of alternative energy could include a photovoltaic array or a wind farm near Hale Pōhaku to offset current electricity use. Since the use of hazardous materials is of particular concern, observatories should be encouraged to investigate options to reduce the use of these materials in telescope operations.

7.3.2 Construction Guidelines

This section provides information and management recommendations focused on construction activities. Construction activities have the potential for direct and indirect impacts to resources, but careful planning can minimize these impacts. Plans and protocols are especially important since construction workers are temporary, unfamiliar with the site, and have to conduct activities over short durations, often under difficult conditions.

Desired Outcome

Minimize adverse impacts to resources during all phases of construction, through use of innovative best management practices.

Current Status

Construction activities can be associated with new construction or changes to existing facilities in the UH Management Areas. They may be of either short or long duration, depending on the project. Minor, routine construction activities are addressed under infrastructure and maintenance (see Section 7.3.2). This section focuses on construction associated with large projects, including new buildings, site recycling, demolition, and site restoration. Some of these activities may be conducted in the near-term, while others will need to consider these recommendations in future planning (see Section 7.3.4).

Construction guidelines for activities permitted under a CDUP are promulgated by DLNR and the County of Hawai'i. Permits issued by either DLNR, as part of the CDUP, or by the County, may require the development of an approved Best Management Practices (BMP) plan or identify safeguards to protect resources prior to authorizing construction activities. Protection of cultural resources is ensured through the development of a site-specific archaeological monitoring plan, as required by SHPD.

OMKM evaluates proposed activities, including standard construction protocols, as part of their design review process for both large and small projects. During this process, OMKM may identify special requirements to ensure protection of cultural and natural resources. Special BMPs can also be developed, to identify particular methods (e.g., Low Impact Development) and criteria (e.g., sustainable design) to meet specific requirements related to working in the unique, sensitive environment on Mauna Kea. While not legally mandated, OMKM works with project proposers to ensure that these considerations are implemented during the construction phase if the project is approved. These considerations could be incorporated as mitigation measures, into permit conditions, or into sub-leases (see Section 7.3.4) (Group 70 International 2000).

Need

There is a need to implement a series of precautions and procedures to minimize adverse effects and prevent or reduce adverse impacts to resources during construction projects.

Education efforts targeted at construction workers are necessary to provide an understanding of the resources, potential harmful effects of construction activities, and ways to minimize impacts. Since construction workers may not be familiar with the significance of Mauna Kea, the unique and sensitive cultural and natural resources, and the challenges of working in a high-elevation environment, education will provide essential information before they begin work on Mauna Kea. Section 7.1.3 elaborates on management recommendation for education and outreach.

Information gathering is important during the construction phase, to identify processes and procedures that are working and those that are not, so that construction is completed in a timely and compliant manner. For example, it may be found that equipment being used to move rock is not efficient and that a different type of equipment would expedite the work. It is also possible to continue building OMKM's database on the status and condition of resources, the type and level of construction activities, and potential effects of these activities on cultural and natural resources. Soil boring log sheets completed by the contractor contain information on substrate composition and physical parameters that may be useful for resource management. Ensuring that construction contractors transmit relevant information such as recorded data and field notes arising from their activities, is a low-cost method for data acquisition.

Although construction activities may impact resources, it is possible, through careful planning and strict adherence to guiding documents, to minimize adverse impacts. Construction activities will be analyzed as part of the environmental analysis phase of a project. An independent construction monitor is needed to ensure that OMKM receives regular updates and evaluations concerning whether the construction activities are meeting the imposed conditions.

Once a project is issued a notice to proceed, the construction entity shall be required to comply with all provisions contained in its permits, including those issued under the CDUP administered by DLNR, SHPD rules and regulations, those issued by the County of Hawai'i.

Management Actions

The following table lists management actions to address the needs discussed above. For items identified with an asterisk, additional considerations are described after the table.

Table 7-12. Management Actions: Construction Guidelines

	Management Action
	General Requirements
C-1*	Require an independent construction monitor who has oversight and authority to insure that all aspects of ground based work comply with protocols and permit requirements.
	Best Management Practices
C-2*	Require use of Best Management Practices Plan for Construction Practices.
C-3*	Develop, prior to construction, a rock movement plan.
C-4*	Require contractors to provide information from construction activities to OMKM for input into OMKM information databases.
C-5*	Require on-site monitors (e.g., archaeologist, cultural resources specialist, entomologist) during construction, as determined by the appropriate agency.
C-6*	Conduct required archaeological monitoring during construction projects per SHPD approved plan.
C-7*	Education regarding historical and cultural significance
C-8*	Education regarding environment, ecology and natural resources
C-9*	Inspection of construction materials

Additional Considerations for Management Actions

C-1. Independent construction monitor

During all periods of construction (including, but not limited to, the delivery of construction materials to the site or to staging areas), there shall be on-site a construction monitor, whose responsibility shall be to

monitor compliance with the terms and conditions of any CDUP as related to construction activities, as well as any terms and conditions agreed to between the constructing entity and OMKM.

The on-site construction monitor shall have the authority to order that any or all construction activity under a CDUP cease if and when, in the construction monitor's judgment, (a) there has been a violation of the terms or conditions of the CDUP that warrants cessation of construction activities, or (b) that continued construction activity will unduly harm natural or cultural resources; provided that the construction monitor's order to cease construction activities shall be for a period not to exceed seventy-two (72) hours for each incident. All orders to cease construction issued by the construction monitor shall be immediately reported to the Chairperson of BLNR and the OMKM. The Chairperson may issue a cease and desist order to extend the period of time that construction activity is prohibited, or such other order as the Chairperson deems appropriate.

The construction monitor shall be selected by the OMKM with the concurrence of the DLNR. The construction monitor shall have experience and be knowledgeable in construction management. Prior to assuming on-site duties, the construction monitor shall have completed the educational and training programs as provided in C-7 and C-8, below.

The construction monitor will be funded by the project.

C-2. Best Management Practices Plan for Construction Practices

Each project proposer shall prepare a *Best Management Practices Plan for Construction Practices* that covers a range of topics and incorporates sustainable practices. The project proposer will bear all costs of implementing the BMPs. BMPs should minimize construction time (for example, by scheduling construction work so that, to the extent possible, the activity schedule includes concurrent work); water use; traffic; use and transport of toxic materials, including petrochemicals; disturbance to ground surface and dust generation; noise; and transport of invasive species. A protocol for construction vehicle wash down and inspection shall be established. The wash down station should be located outside of the UH Management Areas and have a capture area to contain wash down effluent. The wash down procedure ensures that vehicles are free of plants and animals alien to the UH Management Areas. BMPs shall include vehicle inspections that focus on ensuring safety and identifying any mechanical issues such as leaks. In addition to vehicle inspections, the BMP plan should require inspection of construction materials, equipment, crates, and containers carrying materials and equipment by a trained biologist, selected by OMKM and approved by DLNR. The biologist shall certify that all materials, equipment, and containers are free of flora and fauna that may impact the Mauna Kea summit ecosystem. As part of an adaptive management approach, OMKM should study past projects to learn which BMPs were most successful, and should be used for future projects.

C-3. Rock Movement Plan

Any future construction in the summit region, including new development or site demolition and restoration, may require the movement of rock material. Excess excavated cinder shall be placed within the UH Management Areas after consultation with the SHPD and with the prior approval of the OMKM and the DLNR. Use of areas within the UH Management Areas as construction staging or storage areas shall be confined to areas already developed, improved, or previously disturbed provided that the use of such area shall be coordinated with, and shall require the prior approval of, the OMKM and the DLNR.

As part of the process to obtain approval from OMKM, the project proposer shall develop a rock movement plan that: identifies the location and type of the source material, estimates the volume of material to be moved, details the extraction and movement process (employing appropriate construction BMPs), and identifies storage or disposal locations. Any future rock movement in the summit region of

Mauna Kea will need to consider the source of material used for site restoration or, for potential new construction, the logistics of storing extracted material for future use.[30] Important considerations include assessing the cultural sensitivity of the rock material (e.g., use of non-summit material on the summit); the visual impacts of the extraction site, the stored material, and any restored site using rock material; preventing the side-casting of cinder and other materials into wēkiu bug habitat; and the potential for transport of invasive species if rock material is moved to the summit from lower elevations. It is possible that sturdy barriers, able to withstand 100 mile-per-hour winds, will be needed to contain stockpiled cinder (Pacific Analytics 2000).

Whenever construction activities include earth movement or disturbance, OMKM shall consult with DLNR to determine whether a trained biologist selected by the OMKM and approved by the DLNR, shall be on site to monitor any impacts, real or potential, of construction activity on the wēkiu bug. The trained biologist shall be funded by the project.

Whenever construction activities include earth movement or disturbance, OMKM shall consult with DLNR to determine whether a trained archaeologist, selected by the OMKM and approved by the DLNR, shall be on site to monitor any impacts, real or potential, of construction activity on archaeological and historical resources. The archaeological monitor shall be funded by the project.

C-4. Information

As part of routine construction activities, information and data on environmental conditions are recorded in accordance with construction quality assessment and quality control documentation and for use in engineering analysis. These construction activities often provide opportunities for resource managers to acquire information that otherwise would not be collected. It is recommended that as part of maintenance and construction practices OMKM require submittal of field logs, laboratory analyses, and other construction documents that contain information on the biotic and abiotic environmental variables documented.

C-5. On-site monitors during construction

The need for on-site monitors during construction activities will be determined by the appropriate agency (e.g., SHPD, DLNR). Primarily for those activities involving earth movement or disturbance, experts (e.g., archaeologist, cultural resource specialist, entomologist), selected by OMKM and approved by the appropriate agency, shall be on site to monitor any impacts, real or potential, on resources. All independent on-site monitors shall be funded by the project.

C-6. Archaeological Monitoring Plan

The project proposer, in consultation with OMKM, shall consult with SHPD about whether archaeological monitoring is required during a construction project. Should SHPD require archaeological monitoring during any construction project, an acceptable archaeological monitoring plan will be prepared for review and approval by SHPD, prior to the start of any ground-disturbing work. Monitoring will be conducted according to the plan. In the event of an inadvertent discovery of any human burial during construction, the permittee shall stop work in the immediate area of the burial and contact SHPD, OMKM, and Kahu Kū Mauna. SHPD has jurisdiction over inadvertently discovered human remains.

C-7. Education regarding historical and cultural significance

All persons involved with the construction and installation of any future facilities including, but not limited to, the construction manager, contractors, supervisors, and all construction workers, and all persons involved in the operation and maintenance of future astronomy facilities, including, but not

[30] Any excavations involved in the dismantling of the observatories will be filled with natural cinder from an approved source.

limited to, scientists and support staff, shall be educated about the historical and cultural significance of the Mauna Kea summit area, and shall be given training as to what constitutes respectful and sensitive behavior while on the summit area. A detailed plan for complying with this condition (including both the content of training and the procedures for implementation, including, but not limited to, a means for certifying persons who have completed the training program) shall be developed by OMKM following consultation with Kahu Kū Mauna, families with lineal and historic connections to Mauna Kea, *kūpuna*, cultural practitioners, the Office of Hawaiian Affairs, and other Native Hawaiian groups, and reviewed and approved by the DLNR. A specialist or specialists in the field of Native Hawaiian culture shall be selected by OMKM with the concurrence of the DLNR for the purpose of implementing the compliance plan, including, but not limited to, the conduct of educational and training programs for all persons described in this condition. To be qualified for appointment to this position(s), a person shall have worked as a Native Hawaiian cultural specialist and shall be knowledgeable of the types of cultural resources and practices relating to the summit of Mauna Kea.

C-8. Education regarding environment, ecology and natural resources
All persons involved with the construction and installation of any future astronomy facilities in the UH Management Areas, including, but not limited to, the construction manager, contractors, supervisors, and all construction workers, and all persons involved in the operation and maintenance of the future astronomy facilities, including, but not limited to, scientists and support staff, shall be educated about the environment, ecology and natural resources of the Mauna Kea summit area, and shall be given training as to what constitutes appropriate behavior while on the summit area for the protection of the natural resources. A detailed plan for complying with this condition (including both the content of training and the procedures for implementation including, but not limited to, a means for certifying persons who have completed the training program) shall be developed by OMKM following consultation with scientists and environmental organizations knowledgeable about the Mauna Kea summit area, selected by OMKM, and reviewed and approved by DLNR.

C-9. Inspection of construction materials
Prior to entry into the UH Management Areas, all construction materials, equipment, crates, and containers carrying materials and equipment shall be inspected by a trained biologist, selected by OMKM and approved by the DLNR, who shall certify that all materials, equipment, and containers are free of any and all flora and fauna that may potentially have an impact on the Mauna Kea summit ecosystem.

7.3.3 Site Recycling, Decommissioning, Demolition, and Restoration

This section provides general guidance on site recycling, decommissioning, demolition and restoration for facilities in the UH Management Areas. Although primarily designed to address telescope facilities, these considerations should also be applied to the Summit Access Road as well as the support facilities at Hale Pōhaku as infrastructure needs in that area change.

Recycling is used to describe any action involving an existing structure that houses equipment or is used in support of research that is reused, retrofitted, or rebuilt. Recycling limits the impact area to the existing footprint covered by the structure, and can include either modifying the exterior building or upgrading the interior facilities. In addition to limiting the disturbance of habitat areas, culturally important sites, and landforms, it is more cost effective to reuse previously modified sites and previously existing structures when current equipment becomes antiquated or reaches the end of its service life (Group 70 International 2000). *Decommissioning* relates to the process when a facility is deemed obsolete and a determination has been made by the facility lessee to remove the telescope and restore the site. *Demolition* pertains to the actions that result when a structure is no longer needed and the user must remove all equipment and infrastructure from the site, including the structure. *Restoration*, as presented in this section, refers only to

those remedial actions that take place following demolition of observatories or other facilities. Restoration of natural systems is addressed in Section 7.1.2.

Three levels of restoration have been identified: minimal, moderate, and full. *Minimal restoration* would be the removal of all man-made materials and the grading of the site. *Moderate restoration* would include the above and enhancing the structure of the physical habitat to benefit the arthropod community. *Full restoration* would return the site to its original topography. The decision as to which level is executed will be determined after careful analysis of the impacts of each level and shall be approved by OMKM, DLNR, University, and the observatory. If less than full restoration is implemented, the observatory may be required to undertake other mitigation measures or fund Mauna Kea management.

Desired Outcome

To the extent possible, reduce the area disturbed by physical structures within the UH Management Areas by upgrading and reusing buildings and equipment at existing locations, removing obsolete facilities, and restoring impacted sites to pre-disturbed condition.

Current Status

Existing infrastructure in the UH Management Areas is described in Section 6.2, and includes the observatories in the UH Management Areas, support facilities at Hale Pōhaku, and the Summit Access Road. Infrastructure changes will either be proposed by observatories or, in the case of visitor and support facilities by University (OMKM, IfA, MKSS). While IfA provides guidance with regard to the astronomy community on Mauna Kea, OMKM is responsible for reviewing project designs and ensuring that any proposed project is consistent with the 2000 Master Plan and the CMP.

The University's lease for the UH Management Areas continues through 2033, with the stipulation that the permitted "improvements" be removed at the end of the lease or sooner, unless approval from the Chairman of BLNR allows them to remain. The existing observatories have various agreements with the University with different provisions for disposition of the facilities in the event of termination or expiration of their tenancies. In general, agreements require observatories to surrender to University, subject to the approval of University and the Chairman of BLNR or remove the facilities and restore the property at the expense of the observatory.

During the CMP process, Dr. Rolf-Peter Kudritzki, Director of IfA, addressed the issue of telescope removal and site restoration. In Dr. Kudritzki's letter he refers to a 2006 report he submitted to the Hawaii State Legislature that discusses the long term development of observatory sites on Mauna Kea (Kudritzki 2006). This 2006 report states that "our new plan is to demolish the old facility, to clean the site and recreate the site in a stage as it was, before the facility had been built." He goes on to say "that Operating and Site Development Agreements – the contracts between University and the telescope partners on Mauna Kea – require that the costs for such reestablishment of the site in its original status have to be paid by the telescope partners." (See Appendix A9). There are currently no specific plans for restoration in terms of what might physically happen at any particular site, although the observatories are aware that they will need to comply with the terms specified in their agreements.

Need

Each observatory will need to identify what course of action they will pursue when the life expectancy of their technology is reached and it becomes obsolete, or when the lease expires. While OMKM shall be responsible for overseeing compliance of these activities with the CMP, the process needs to be a collaborative effort between OMKM, DLNR, the University, and the observatories.

This CMP adopts the three-level restoration strategy identified above. Appropriate strategies shall be developed to address restoring the land to its original condition, as required by the lease. In particular, any plan to restore habitat needs to be analyzed at the landscape level, rather than as only the footprint of a single observatory. A cost-benefit analysis will need to be conducted by the observatories to determine what level of restoration is appropriate for their site.

Management Actions

The following table lists management actions to address the needs discussed above. For items identified with an asterisk, additional considerations are described after the table.

Table 7-13. Management Actions: Site Recycling, Decommissioning, Demolition and Restoration

Management Action	
	Site Recycling, Decommissioning, Demolition, and Restoration
SR-1*	Require observatories to develop plans to recycle or demolish facilities once their useful life has ended, in accordance with their sublease requirements, identifying all proposed actions.
SR-2*	Require observatories to develop a restoration plan in association with decommissioning, to include an environmental cost-benefit analysis and a cultural assessment.
SR-3*	Require any future observatories to consider site restoration during project planning and include provisions in subleases for funding of full restoration.

Additional Considerations for Management Actions

From a cultural perspective there are many Native Hawaiians who have commented that once a site or *pu'u* has been developed it can never be fully restored as the *mana* (divine power) of the site has been destroyed forever. Although for many people in the Hawaiian community site restoration can never be fully attained, from a responsible management standpoint the CMP needs to address and provide guidance to OMKM and users on site restoration.

SR-1&2, Existing Observatories, Site Recycling, Decommissioning, Demolition, or Restoration

Each observatory has specific provisions in its agreement related to what is to become of the structure at the end of its term. Unless and until existing observatories revise their agreements, they need only comply with existing terms. It is possible that some observatories will be upgraded or demolished prior to the end of the term. Demolition would be the responsibility of the terminating observatory. Observatories will be required to develop plans in coordination with IfA, to be approved by OMKM, for site recycling, demolition and restoration. The plans will require compliance with terms and conditions identified by OMKM and the CMP, including all maintenance and construction management actions. The plans will need to consider the range of issues related to decommissioning including the impacts of demolition, waste management, substrate contamination, removal of underground storage tanks, habitat restoration, and cost. In the event one or more observatory facilities consider decommissioning of their facility before the end of the State lease, the University in consultation with DLNR and OMKM shall initiate discussion on a decommissioning and site restoration plan to allow adequate time for decision-making, community input, and review process.

Each observatory has provided written confirmation to IfA and OMKM that it understands and will comply with the conditions of its agreement related to site recycling or demolition (see Appendix A9). In some cases, it may be beneficial to negotiate termination arrangements different from those specified in the agreement. For example, resources that would have been used for certain required aspects of removal

and restoration could be applied instead to other things that are considered more beneficial. Such modifications in termination requirements will need the approval of OMKM, DLNR, the University, and the observatory.

SR-3, Potential Future Observatories, Restoration
New observatories have the advantage of knowing that they need to plan for restoration while developing construction plans, so this might play a role in certain design considerations. It will be possible to impose specific conditions on any future observatories with respect to site restoration and funding assurances. Such conditions should be incorporated into their agreement.

7.3.4 Considering Future Land Use

It needs to be emphasized that the CMP manages resources; it does not advocate or promote new telescope development. Nonetheless it is not only appropriate but necessary to proactively address issues related to new land uses or activities and their potential impacts on the resources. Future land use is not confined to telescope development but it could include roadway upgrades, improvements to Hale Pōhaku, or a cultural facility such as a *hale* for Hawaiian navigation or astronomy. As discussed in Section 2.1.4, this CMP does not address development plan issues related to future observatories, including whether new observatories should be located on Mauna Kea to support the astronomy program or if observatories should have their leases extended or be decommissioned. The University's official position on proposed observatory and support facility development for the period of 2000-2020 was outlined in the 2000 Master Plan (Group 70 International 2000). The role of the CMP in considering future land use is to guide the evaluation of proposed projects from the standpoint of potential impacts to cultural and natural resources, and to provide management actions that can be adopted by BLNR as special conditions in any CDUPs that it may issue. The Board of Land and Natural Resources shall have final approval over all land uses on conservation lands pursuant to the Conservation District Use Permitting Process.

Desired Outcome

To protect cultural and natural resources in the assessment of future projects.

Current Status

The UH Board of Regents and the President retain project approval and design review authority over all major developments within the UH Management Areas. The 2000 Master Plan established a set of guidelines for project review and design, to ensure that proposed projects conform to and implement the concepts, themes, development standards and guidelines set forth in the 2000 Master Plan (see Section XI, (Group 70 International 2000)). In response to the 2000 Master Plan, a Design Review Committee was established to interpret the guidelines to ensure that proposed projects conform to the goals and objectives of the 2000 Master Plan and are consistent with the design guidelines established in the plan. OMKM, MKMB, and Kahu Kū Mauna are also charged with reviewing projects to ensure that they conform to the 2000 Master Plan.

As specified in the 2000 Master Plan, each redevelopment or proposed new facility, including non-astronomy facilities, will undergo individual project reviews, that will include an environmental analysis pursuant to Chapter 343, HRS, and a comprehensive analysis of the potential cultural impact. In general, the review process is applicable to any project involving 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 that may be undertaken in association with these procedures (Group 70 International 2000). The 2000 Master Plan leaves to the President of the University the final determination on whether projects are major or minor. However, the

operating definition considers construction activities – including excavation or the construction of new buildings – to be "major projects," while considering "minor projects" to be small structures such as a weather tower on a previously modified surface, or an emergency staircase. The 2000 Master Plan established separate review processes for minor and major projects. Minor project review ends with the University President, while major projects require formal approval by the Board of Regents. OMKM functions as a liaison to ensure consistency in the project review process.

As the local management body for the UH Management Areas, OMKM will assess proposed land uses to ensure compatibility with recommendations in approved management plans, with the goal of protecting cultural and natural resources. During the review process, OMKM will have to work with other entities, including DLNR.

There is also a need, during the project design review process, for OMKM to provide clear facility planning guidelines to project proposers that address siting and design considerations, and to enforce them, so that proposed facilities result in minimal impacts to cultural and natural resources and the astronomical qualities of the Science Reserve. Many of these considerations have been developed in the 2000 Master Plan, although there are additional management needs set forth in this CMP. Adequate bonding may be required for to ensure site restoration.

There are two aspects of facility planning location and design that need to be considered in order to protect cultural and natural resources. Location refers to the siting of facilities, while design refers to characteristics of the physical structure, and both of these must be directed at minimizing impacts to resources. Section XI of the 2000 Master Plan provides design guidelines to direct development for both renovations of existing facilities and new construction in a manner that would integrate development into the summit environment. Topics addressed include: facility siting, scale, height and width, color, surface texture and material, roofs, fences, roadways and parking.

The 2000 Master Plan divided the UH Management Areas into two areas, the Natural/Cultural Preservation Area, which encompasses 10,760 acres, and the Astronomy Precinct, which is 525 acres. New observatory development will be allowed only in the Astronomy Precinct, except on the undisturbed summit *pu'us*. Section XI of the 2000 Master Plan contains design guidelines for facilities that reflect the sensitivity of Mauna Kea's cultural and natural resources (Group 70 International 2000). These guidelines should be used in association with this CMP. As new information becomes available, the criteria against which to evaluate a project may need to be expanded. Specific siting criteria for locating facilities within the Astronomy Precinct include:

1. Minimal impact on existing facilities, including maintaining a clear line of site to approximately 12 degrees above the horizon in a full circle.
2. Minimum impact of wēkiu bug habitat; only the existing disturbed locations on *pu'u* or areas outside of the wēkiu bug habitat will be considered as potential siting areas.
3. Avoidance of archaeological sites, including at least a 200 foot buffer from the clustered group of shrines found outside the Precinct boundary on the northern slope.[31]
4. Suitability for observations, including acceptable obscuration and wind flow conditions.
5. Minimum visual impact from significant cultural areas, including no interference with the visual connections between the major *pu'u* and the shrine complexes.
6. Avoid or minimize views from Waimea, Honoka'a and Hilo.
7. Close to roads and existing infrastructure, to minimize disturbance to the natural terrain.

[31] This setback distance is 10 times the setback distance required by the Hawai'i Island Burial Council for development near existing burials. The buffer zone could be larger, depending on the design plans.

Using these criteria, the 2000 Master Plan updated designated telescope siting areas within the Astronomy Precinct for existing observatories, proposed redeveloped facilities, and potential new facility sites. The most probable scenarios will be to site all new proposed astronomy facilities in the area within the Astronomy Precinct identified as the north plateau. Although the archaeological fieldwork of the UH Management Areas has been virtually completed, no specific guidelines have been developed to create buffer zones around the archeological resources (see Section 7.1.1). In addition, any potential siting of new observatories in the summit region needs to consider potential impacts to the cultural landscape, which includes both landforms and the recognized cultural significance of summit region (see Section 5).

Need

There is also a need, during the project review process, for clear facility planning guidelines to project proposers that address and enforce siting and design considerations, so that proposed facilities result in minimal impacts to cultural and natural resources and the astronomical qualities of the UH Management Areas. Many of these considerations have been developed in the 2000 Master Plan, although there are additional management needs set forth in this CMP.

Management Actions

The following table lists management actions to address the needs discussed above. For items identified with an asterisk, additional considerations are described after the table.

Table 7-14. Management Actions: Considering Future Land Use

Management Action	
	Facility Planning Guidelines
FLU-1*	Follow design guidelines presented in the 2000 Master Plan.
FLU-2*	Develop a map with land-use zones in the Astronomy Precinct based on updated inventories of cultural and natural resources, to delineate areas where future land use will not be allowed and areas where future land use will be allowed but will require compliance with prerequisite studies or analysis prior to approval of Conservation District Use Permit.
FLU-3*	Require cataloguing of initial site conditions for use when conducting site restoration.
FLU-4*	Require project specific visual rendering of both pre- and post-project settings to facilitate analysis of potential impacts to view planes.
FLU-5	Require an airflow analysis on the design of proposed structures to assess potential impacts to aeolian ecosystems.
FLU-6	Incorporate habitat mitigation plans into project planning process.
FLU-7*	Require use of close-contained zero-discharge waste systems for any future development in the summit region, from portable toilets to observatory restrooms, if feasible.

Additional Considerations for Management Actions

FLU-1. Master Plan Design Guidelines

Section XI of the 2000 Master Plan contains a set of design guidelines to direct development of renovations of existing facilities and new construction in a way that integrates the facility into the landscape (Group 70 International 2000). General goals address: facility siting; scale; heights and widths; colors; surfaces, textures and materials; parking; roadway and utility development; roofs; fences, walls and barriers; and signage. These guidelines shall be conveyed to project proposers, to guide project

development, and shall be used in the evaluation of projects by OMKM. Additional guidelines relating to sustainable technologies are included in Section 7.3.1.

In addition to outlining facility needs to support astronomy, the 2000 Master Plan addressed support facilities to meet the operational needs for activities not related to the observatories. These would include activities such as VIS renovations, parking and road improvements, construction or renovation of restrooms, and construction of a staging area for commercial operators. It is important to maintain compatibility and consistency of recommendations between the 2000 Master Plan and the CMP, to ensure that identified facility needs and designs are consistent with the overarching management plan put forth in the CMP (see Section 7.2.1).

FLU-2. Land use zones
Any potential future observatories will be located inside the Astronomy Precinct. The goal of this process is to refine telescope siting areas defined in the 2000 Master Plan based on updated cultural and natural resource information (see Section 7.1.1 and Section 7.1.2). Land use zones will be developed that will delineate areas where future land use will not be allowed and areas where future land use will be allowed, but where compliance with prerequisite studies or analyses prior to approval of a CDUP, will be required. When assessing proposed infrastructure expansion, additional consideration will be given to the location of current infrastructure and previously disturbed areas (see Section 7.3.1). New land uses should be located close to existing infrastructure or previously disturbed areas, to reduce impacts on undisturbed areas and to minimize unnecessary damage to geological features. As stated in the 2000 Master Plan, all major undeveloped cinder cones and their intervening areas will be protected from future development by astronomical or other interests. These include the following *pu'u*: Ala, Hoaka, Kūkahau'ula, Līlīnoe, Māhoe, Mākanaka, Pōepoe, Poli'ahu, and Ula.

FLU-3. Cataloguing initial site conditions
Site restoration is defined in Section 7.3.3. In order to have a baseline for use during the restoration process, the initial conditions at a development site must be catalogued. Necessary information to collect would include topography, substrate composition, and presence/absence and densities of species. This information should be retained by OMKM and the project proposer for use when preparing site restoration plans.

FLU-4. Visual rendering
New development projects shall use architectural designs, color schemes, and materials that are compatible with the background landscape in order to minimize impacts to viewplane and other aesthetics. Visual rendering shall be a required element of any major project proposal, and shall be included as part of the public review process for proposed future land uses. Project specific visual rendering of both pre- and post-project settings will facilitate analysis of potential impacts to the view-shed, including minimizing impacts to views from significant cultural areas and avoiding or minimizing views of built facilities from down-slope communities. The natural forms of the summit can be used to shield views of built facilities. Incorporate to the extent possible technologically advanced methodologies, for example paint that can help to disguise a facility.

FLU-7. Close-contained zero-discharge waste systems
For several reasons close-contained zero-discharge waste systems are ideal for use in the high elevation, dry Mauna Kea summit region. These systems are evaporative and require less water input than conventional waste systems, thereby reducing the amount of water needing to be trucked to the summit and the amount of waste needing to be trucked off the mountain. The closed systems are fully contained and will not result in the discharge of any material into a cesspool, septic tank, or leach field, effectively

eliminating a potential source of cinder and groundwater contamination. They should be used where feasible.

7.4 Managing Operations

7.4.1 Operations and Implementation

This section provides recommendations relating to implementation of the CMP and on emergency procedures. The CMP applies to the UH Management Areas. While the CMP does not apply to other state lands in the upper mountain region, coordination with other entities will be required to implement the full range of management actions.

Desired Outcome

Conduct effective operations to support management that is focused on resource protection, education, and public safety.

Current Status

Since its establishment in 2000, OMKM has been responsible for the day-to-day management of the UH Management Areas as defined in Section 3.1.1. Operations currently overseen by OMKM include management of natural and cultural resources, permitting of commercial activities, development and enforcement of management policies, and the ranger program. MKSS conducts general facilities maintenance and support services for the UH Management Areas. The current policies governing activities and use on Mauna Kea are discussed in Section 7.2.1, as outlined in the *Revised Management Plan for the UH Management Areas on Mauna Kea* (DLNR 1995). OMKM also functions as a referral and facilitative agency for issues that are related to the mountain but outside OMKM's authority. As the entity overseeing the management of the UH Management Areas, OMKM continues its program development as it defines its responsibilities and expands its services. One of the most significant challenges OMKM faces is that the University lacks the authority to promulgate and enforce administrative rules regarding public access for the UH Management Areas. Since OMKM and the University do not have regulatory authority, DLNR currently has the primary management and regulatory authority over hunting and recreation occurring in University management lands (see Section 7.2.2).

In addition to its day-to-day management of the UH Management Areas, OMKM also participates in emergency response activities. Because the summit area of Mauna Kea is far from any local community, response times by the standard emergency response agencies can be long. Thus, the various groups and agencies that operate in the surrounding area must cooperate in emergency response activities. The existing medical emergency system involves MKSS, the observatories, the military, county emergency services, and hospitals.

Need

A strong operational foundation is needed in order to support management goals, including sufficient funding, staffing, and facilities. The importance of having a greater staff presence in the summit region, as enforcers and resource managers, cannot be over emphasized. Day-to-day operations and implementation of the CMP will require that OMKM personnel, VIS staff, and volunteers receive proper training in safety, emergency response, visitor orientation, and cultural and natural resource protection.

OMKM will need to work with various stakeholders, including University entities (e.g., IfA, MKSS) and federal and state agencies and local landowners in the region, to define policies and procedures relating to the CMP and coordinate management planning and implementation of the CMP. See Section 3.3 for more information on the current relationships and responsibilities of entities managing Mauna Kea.

Gathering input from the community, federal and state agencies, and other stakeholders has also been identified as a need for implementation of the CMP. Community outreach is discussed in Section 7.1.3. Feedback on the effectiveness of the CMP will be received from stakeholders via comments on the five-year outcome analysis report and through interagency meetings conducted annually (see Section 7.4.3). Additionally, OMKM should establish a grievance procedure to address problems and issues as they arise, so that community concerns can be addressed in the periods between CMP updates.

Another need that has been identified for operations is an update of current emergency response procedures. OMKM should work with neighboring landowners and appropriate federal and state agencies to plan for coordinated response to range of emergency situations, to ensure rapid response, and to minimize impacts to cultural and natural resources.

Operations must comply with the various federal, state, and county laws and regulations that apply to the UH Management Areas and to the various activities and uses of the mountain (see Sections 3 and 7.2). The University will have to obtain rule-making authority to implement certain aspects of the CMP (see Section 7.2.2).

Management Actions

The following table lists management actions to address the needs discussed above. For items identified with an asterisk, additional considerations are described after the table.

Table 7-15. Management Actions: Operations and Implementation

	Management Action
OI-1*	Maintain OMKM, MKMB, and Kahu Kū Mauna in current roles, with OMKM providing local management of the UH Management Areas, and MKSS providing operational and maintenance services.
OI-2*	Develop training plan for staff and volunteers.
OI-3*	Maintain and expand regular interaction and dialogue with stakeholders, community members, surrounding landowners, and overseeing agencies to provide a coordinated approach to resource management.
OI-4*	Establish grievance procedures for OMKM, to address issues as they arise.
OI-5*	Update and implement emergency response plan.

Additional Considerations for Management Actions

OI-1. Local management of the UH Management Areas

OMKM is the local management entity responsible for the UH Management Areas. Ensuring consistent implementation of the CMP, as the approved management plan for the area, will be its primary responsibility. Implementation of the CMP will require that OMKM work with the range of agencies, committees, and stakeholders with responsibility for the UH Management Areas and their neighboring properties (see Section 3). The CMP recommends additional program development on a range of topics. OMKM shall work with the current boards, councils, and committees, which will continue their advisory roles, providing expertise and guidance in developing the management program. As proposed in the 2000

Master Plan, to centralize operations and management responsibilities, portions of MKSS functions and personnel should be transferred to OMKM, subject to negotiations with IfA and current tenants.[32]

OI-2. Training Plan

A training plan for employees and volunteers should be developed. Training needs to be addressed in the plan include specialized ranger training, field-personnel training, volunteer training and general staff training. General training requirements include review of applicable laws and regulations (see Section 7.1.3), basic cultural and natural resources orientation, and standard procedures for documenting potential violations (for non-enforcement personnel). Training requirements for all OMKM personnel involved in field-based management activities include general safety training, 4-wheel drive vehicle operation, orientation to working at high elevations, emergency response, CPR and first aid, Global Positioning System (GPS) operation, and recognition of culturally significant areas and items and protected flora and fauna. All staff who access the mountain should receive safety orientation and basic cultural and natural resources training. It is also advisable to provide basic emergency response training (including CPR and first aid) to all VIS staff. Education and training requirements for the Cultural Resource Coordinator (CRC) include gaining an intimate familiarity with the written literature on Mauna Kea's cultural resources, including historic properties and cultural practices, and detailed knowledge of the location and status of historic properties on the UH Management Areas.

Rangers. OMKM Rangers should receive high-level training in emergency response, including CPR and first aid. They should also receive in-depth cultural and natural resources training, to enable them to better understand and protect the resources. Rangers should be trained in a variety of monitoring techniques to enable them to recognize and record changes to the most accessible and frequently visited areas, such as the summit. Although thorough monitoring of the cultural landscape will require the services of qualified professional archaeologists, rangers can serve an important function because they are always present on Mauna Kea. Rangers will require training on how to relocate sites using GPS units and how to read and interpret archaeological site maps to determine whether any changes in a site have occurred since the site was first recorded or last visited. If a decision is made to have the rangers continue to monitor activities affecting cultural resources along the road, some additional training in the reporting of incidents may be required. A training program would also be required if a policy or protocols are developed relating to cultural practices. This assumes that the rangers would be the ones most directly involved on a day-to-day basis in the enforcement of a policy. In particular, they should receive training in recording damage to historic properties, such as that given national park rangers.

OI-3. Coordinated Management

The principles of ecosystem management require that neighboring landowners and OMKM work together, guided by well-established management goals and visions, to protect, enhance or restore natural and cultural resources. Overlapping and adjacent jurisdictions at the high elevations of Mauna Kea involve multiple agencies in management and decision-making. OMKM will serve as the focal point for coordinating actions related to the management of the UH Management Areas, including cross-boundary issues. OMKM will communicate issues and concerns that it receives to the appropriate agencies and will follow through in their resolution. OMKM should formalize management objectives and cross jurisdictional activities with memorandums of agreement or understanding similar to the recently proposed cooperative agreement between the BLNR and the University with respect to the Mauna Kea Ice Age NAR (see Section 7.2.2).

[32] 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 or agreement holders.

It is also recommended that OMKM lead or participate in the development of an interagency working group involving all entities that are responsible for or involved in resource management in high elevation areas (above 6,200 ft, or 1,900 m) on Mauna Kea. These would include OMKM, state and federal agencies, non-governmental organizations (NGOs), and other agencies and persons involved in the day-to-day management of Mauna Kea lands. The working group should develop an interagency set of mountain-wide management goals based on the principles of ecosystem management. Goals will need to take into account the participants' differing approaches to resource management, their policy foundations, and the decision criteria used by different institutions involved in multi-agency planning processes. This working group should hold meetings at a minimum, once a year.

OI-4. Grievance Procedures

OMKM should establish grievance procedures to address issues as they arise. All grievances should be presented to the OMKM director, who will determine the best way to resolve the issue. If the issues represent broad planning or policy questions beyond the management authority of OMKM, the director should refer the questions or questioner to specific contacts at the appropriate agencies, usually DLNR, the UH-Hilo Chancellor, the President, or the University Board of Regents as appropriate. OMKM should follow the progress of the grievance and assist where it is able. When the grievance concerns management issues or items within the jurisdiction of OMKM, the director will receive and respond to the questions. If the issue requires management, operational, or other changes by OMKM, the director will research the question and bring it before the MKMB for review. All grievances should be handled in a sensitive and timely manner (Group 70 International 2000).

OI-5. Emergency Response Plan

The emergency response plan should address response procedures for a variety of emergency types. Procedures should include means for protecting natural and cultural resources during emergency responses; resource repair or restoration after damage caused by emergency responses; management activities to reduce likelihood of emergencies occurring; and health and safety protocols. It should outline potential impacts on resources, establish response protocols, and detail reporting protocols. The existing emergency response plan should be reviewed and updated to reflect additional safety and resource protection measures provided in the CMP. All staff members stationed at Hale Pōhaku or in the UH Management Areas should receive emergency response training (see *OI-2, Training Plan*). OMKM staff should review emergency plans at the beginning of each winter season.

The section on emergency response procedures should begin by identifying types of emergencies that could occur in the UH Management Areas (e.g., fires, chemical or petroleum spills, rescue of injured and lost visitors or employees, skiing accidents, vehicle accidents, and injured construction workers) and locations where these emergencies could occur. For each emergency category, the plan should determine the procedures for coordinated emergency response. The plan should also determine procedures for response to accidental or negligent pollution events, including identification of who will respond. OMKM should take the lead in assisting and coordinating with responding agencies, and should contact DLNR-SHPD, county fire and police departments, and military units at Pōhakuloa, when appropriate. Procedural descriptions should include identification of staging areas, preferred helicopter landing areas, development of an emergency evacuation plan, and establishment of follow-up reporting protocols to SHPD and Kahu Kū Mauna. Use of vehicles off road may be permitted, to assist in emergency response (see Section 7.2.1).

The section concerning protection and recovery of cultural and natural resources should begin with identification of areas containing sensitive resources needing protection. With the virtual completion of a major portion of the archaeological field work, OMKM now has location maps for historic sites, which should be used in determining the best plan for avoiding impacts to historic properties during an

emergency situation. Activities in these areas should be limited, in order to reduce the likelihood of an incident resulting in damage to the resources. The section should also identify potential impacts to resources from various accident types and develop methodologies to minimize impacts to resources (such as habitat disturbance) resulting from emergency response activities. Response activities to be addressed include retrieval of large objects; response to collapse of road embankment or cinder cone face; need to create a detour road; and chemical or fuel spills (including hazardous materials). Additionally, the section should detail a process to assess cultural and natural resource damages and conduct repair or restoration projects following an incident. Assessment activities to determine the extent of damage from a particular emergency event should be coordinated with applicable federal and state resource damage assessment programs.

The emergency prevention section should outline management activities to reduce frequency of accidents (e.g., signage, limiting ignition sources for fires, spill prevention plans, inspection of roads, and installation of additional guard rails, if needed) and to establish strict standards to prevent pollution from operations in the UH Management Areas. This may be addressed, in part, through development of a spill prevention control and countermeasure plan and a fire protection plan. The fire plan should cover visitor education (see Section 7.1.3), establishment of a trained volunteer fire crew, emergency procedures, and a habitat management plan for the Hale Pōhaku māmane forest (Group 70 International 2000).

Because it is OMKM's responsibility to coordinate medical emergency response activities in the UH Management Areas, the health and safety section of the emergency response plan should detail OMKM's procedures for coordinating responses to medical emergencies. It should incorporate the educational and health and safety management activities identified in the CMP to reduce threats to public health, including response procedures for medical emergencies. Rangers should have ready access to first-aid supplies, including oxygen, and be trained in emergency rescue procedures (see *OI-2, Training Plan*). Education of visitors regarding the dangers associated with visiting high elevations is addressed in Section 7.1.3. Management activities relating to public safety (such as road closures during severe weather) are addressed in Section 7.2.1.

7.4.2 Monitoring, Evaluation, and Updates

This section outlines the process for monitoring, evaluating, and updating the CMP.

Desired Outcome

Determine whether management actions are achieving the goals of the CMP and provide a process for improving and updating management strategies through evaluation and revisions of the CMP.

Current Status

The CMP was developed based on the state of knowledge as of December 2008, on the status of the resources, activity levels, and most-appropriate management actions.

Need

Adaptive management allows resource managers to improve strategies and plans as new information becomes available, and requires that management plans undergo regular review, to reduce uncertainty, incorporate lessons learned, new data and information from monitoring, ecosystem science, surveys, and traditional knowledge. Comprehensive evaluation to develop or refine management actions requires

collection of specific data to be analyzed. To accomplish this, performance evaluation measures must be identified, and data collected on achievement of these performance measures.

Regular monitoring and evaluation of the CMP is needed to determine if management actions are effective over time and are meeting management needs, and to ensure that the best possible protection is afforded Mauna Kea's resources. Results from monitoring and evaluation can be used to determine any need for changes in management strategies. Additionally, while the cultural resources in the UH Management Areas have been well documented, a great deal remains unknown about the status of the natural resources on these properties. The CMP will need to be reviewed and revised as new, pertinent information becomes available about the resources being managed.

Monitoring and evaluation of the effectiveness of the CMP should occur annually, and an annual progress report should be prepared. A major review and revision of the CMP should occur every five years, using information contained in the annual reports. Five-year evaluation and revision should include consultation with federal and state agencies and the local community, to inform stakeholders on program progress, and to gather input on changes or additions to management activities. The CMP must also be updated to comply with any requirements or conditions imposed by the BLNR on the CMP upon acceptance of the plan.

Management Actions

The following table lists management actions to address the needs discussed above. For items identified with an asterisk, additional considerations are described after the table.

Table 7-16. Management Actions: Monitoring, Evaluation and Updates

	Management Action
MEU-1*	Establish a reporting system to ensure that the MKMB, DLNR, and the public are informed of results of management activities in a timely manner.
MEU-2*	Conduct regular updates of the CMP that reflect outcomes of the evaluation process, and that incorporate new information about resources.
MEU-3*	Revise and update planning documents, including the master plan, leases, and subleases, so that they will clearly assign roles and responsibilities for managing Mauna Kea and reflect stewardship matters resolved with DLNR.

Additional Considerations for Management Actions

MEU-1. Reporting system

A variety of annual and five-year reports are required as part of the evaluation process for the CMP.

Annual Reports

At the end of each year OMKM shall produce an annual progress report (Progress Report) describing in detail the management goals, objectives, and actions for the year and what progress was made towards meeting them. The Progress Report should also describe actions to be taken to improve the program for the next year(s). The Progress Report is not intended to be a status report on the resources in the UH Management Areas; rather, it is meant to inform management and stakeholders of the progress of the program and direction it is to take in the future.

On June 30 of each year, OMKM shall submit to BLNR a written report detailing its activities generally, along with the Progress Report. Reports may also be submitted to various state and federal agencies, if required.

Five-Year Outcome Analysis Report

In preparation for the CMP five-year revision, OMKM shall prepare a Five-Year Progress Report that describes the state of the resources, the status of the various management programs, progress towards meeting CMP goals, and other relevant information. This report should be based on information obtained from Progress Reports, and any other pertinent sources.

The first section of the Five-Year Progress Report will discuss the state of the cultural and natural resources in the UH Management Areas. This section will summarize data collected during monitoring, research, restoration, and threat prevention and control activities conducted over the preceding five years. This portion of the report will analyze trends in cultural and natural resources, and the impacts (positive, negative, or neutral) that management actions have had on them. It will also summarize what future management actions are needed to protect, enhance, or restore Mauna Kea's natural resources.

The second section of the Five-Year Progress Report should include a summary of the progress of the programs towards meeting management goals, objectives, and actions, as outlined in the CMP. This analysis will be based on information in the annual progress reports from the last five years.

The report will be reviewed and approved internally and will then be submitted to the stakeholders and agencies participating in the review process, allowing ample time before the meeting for the agencies to review it. This report, along with feedback received from stakeholders, will be used to conduct the five-year update of the CMP (See *MEU-4. Update and revision process*, below).

MEU-2. Update and revision process

Once the CMP is approved by BLNR, it will be considered the approved management plan for UH Management Areas, supplementing the 1995 Management Plan (see Section 7.2.2). OMKM will be responsible for implementing the CMP and ensuring adherence to its provisions (see Section 7.4.1). The CMP should be updated every five years, based on data collected during various program management activities (e.g., natural or cultural resources monitoring, research projects), analysis of program strengths and weaknesses, and relevant new laws, regulations, and policies that have come into effect since the last update. Conditions under which a significant revision of the CMP would be required at an interval of less than five years include changes to the University lease with DLNR lands for Mauna Kea Lands, new development, or changes to state and federal laws and regulations with direct impact in UH Management Areas.

During the update process, OMKM should solicit recommendations for modifications to the management plan from the wide range of stakeholders including agency partners and community members. It is recommended that stakeholders first be given a copy of the five-year progress report, so that they are aware of program successes, failures, and ongoing activities, as well as updated on the current status of the resources. Comments received on program needs and recommended management activities can then be addressed in the update of the CMP.

MEU-3. Revising and updating planning documents

The 2000 Master Plan was adopted by the University Board of Regents as the policy framework for the responsible stewardship and use of University-managed lands on Mauna Kea. This plan provides a long-term vision for facilities planning on Mauna Kea. When this plan is updated, it should incorporate and

reference the CMP. In addition, if and when leases or agreements are renegotiated, they should be updated to be consistent with the CMP.

7.5 1995 Management Plan Controls

This CMP supersedes and replaces the 1995 Management Plan while at the same time incorporating most controls from that document to ensure they continue in full force and effect.

The following general controls from the 1995 Management Plan shall continue in full force and effect as part of this CMP and are applicable to all visitors, whether members of the public or commercial tours:

- **Hours of Operation**
  Mauna Kea Science Reserve. Public recreational activities within the Mauna Kea Science Reserve will be allowed from one-half hour before sunrise to one-half hour after sunset. During times of heavy ski and snowplay activity, the area may be closed earlier to allow designated personnel to make a sweep of the mountain for stragglers and be able to reach lower altitude by dark. *See also* Table 7-6.

  Because lights from autos interfere with astronomical observations, UH may install a gate or chain across the Mauna Kea Road at night to prevent unauthorized after-hours vehicles from reaching the summit area. This barrier will be located in such a way that visitors can safely turn around and return to lower elevations. *See also* Table 7-5.

  Hale Pōhaku. Hours for activities at the Visitor Information Station can vary, depending on events scheduled. Both UH and commercial stargazing tours will be permitted. Groups may be permitted to use the Information Station after closing hours, for approved reasons, by obtaining a temporary permit from Mauna Kea Support Services (MKSS). Unauthorized use of the Information Station in prohibited. *See also* Table 7-8.

- **Mauna Kea Science Reserve Access Controls**
  Periods of Controlled Access. UH and/or DLNR Enforcement Officers will control access, as required, during periods of heavy usage, transportation of heavy equipment and during certain road maintenance activities. All visitors must comply with their directives. *See also* Table 7-6.

  Unscheduled Closings of the Access Road. UH may close any or all portions of the road between Hale Pōhaku and the summit if it is determined that hazardous conditions exist. The road will be closed when it is being cleared of snow and when it is being otherwise worked on due to snow conditions. UH will keep the public informed of the status of the road through the local media and through a recorded telephone message. *See also* Table 7-6.

  Following unscheduled closings, no private or commercial tour vehicles will be allowed access above the Onizuka Center for International Astronomy (OCIA) until two-lane traffic is established and the road is opened by UH Mauna Kea Support Services (MKSS) personnel. During and immediately after snow removal and road maintenance activities, official vehicles (those identified as being associated with UH and the telescopes) shall have priority over private vehicles or those of commercial operators. *See also* Table 7-6.

- **Visitor Vehicles**. Until the entire road is paved, all commercial vehicles and those used in astronomy-related activities must be 4-wheel-drive. Four-wheel drive is also strongly recommended for private vehicles. UH reserves the right to require 4-wheel drive on all vehicles

proceeding to the upper elevations of Mauna Kea when driving conditions are hazardous. Off-road use of vehicles is prohibited. Drivers must handle their vehicles in a safe manner. They must obey all posted sighs and any directives given by UH or DLNR personnel. If violations are flagrant, Hawaii County Police may be called in to assist. *See also* Table 7-6. (Underscore in original Plan).

- **Waiver of Liability**. Visitors will be warned that if they proceed up the mountain it will be at their own risk. UH reserves the right to require a waiver of liability from each driver (commercial and private) before the vehicle is allowed to proceed to the upper elevations. *See also* Table 7-6.

- **Alcoholic Beverages**. No drinking of alcoholic beverages is permitted above Hale Pōhaku. Commercial operators must guarantee that their clients will not use alcoholic beverages within the Science Reserve. *See also* Table 7-6.

- **Archaeological Sites Within the UH Management Areas**. All activities covered by this Plan shall be conducted in accordance with Chapter 6E-11 HRS, which states: *"It shall be unlawful for any person, natural or corporate, to take, appropriate, excavate, injure, destroy or alter any historic property located upon lands owned, or controlled by the State...except as permitted by the Department (DLNR)."* If UH personnel observe visitors tampering with the sites, they will, at their discretion, inform them of the law and instruct them to desist. They will log and report all such incidents to the DLNR Historic Preservation and/or Enforcement Division for appropriate action in accordance with Chapter 6E HRS. *See also* Table 7-6.

- **Mauna Kea Ice Age Natural Area Reserve.** Features within the Natural Area Reserve (NAR) will be managed by the Natural Area Reserves Commission and DLNR according to the Management Plan for that area. Information and regulations on the NAR will be available at the Information Station.

- **General Controls at Hale Pōhaku.** Visitors to the Information Station will be informed of the dangers of fire to the flora and fauna in the Hale Pōhaku area by means of signs and published information. No outdoor fires (hibachis, etc.) will be allowed. Visitors will also be cautioned against littering, which may attract predators that could endanger the fauna in the area, and urged to walk only on designated paths so as not to disturb the flora. *See also* Table 7-6.

The general control in the 1995 Management Plan relating to assistance rendered by the National Ski Patrol is eliminated in its entirety, as the National Ski Patrol does not maintain a presence in the UH Management Areas.

In addition, the following controls from the 1995 Management Plan, applicable to specific public activities and commercial operators shall also continue in full force and effect as part of this CMP:

Management and Control of Specific Public Activities

- **Astronomy.** UH and the other astronomy users associated with the Mauna Kea Observatories will manage and control visitor activities involving tours of the telescopes. *See also* Table 7-7.

- **Hiking.** For their safety, all hikers will be encouraged to visit the Information Station prior to proceeding upslope. At that time they will be warned of the hazards of high-altitude hiking and given a copy of the regulations for public use of the Science Reserve. *See also* Table 7-7.

- **Sight-seeing and Snow Activities.** The public will be encouraged to stop at the Information Station to obtain information on precautions which must be taken and rules to be followed when driving upslope. They will be warned that proceeding up the mountain will be at their own risk; drivers may be required to sign a waiver of liability. *See also* Table 7-7.

- **Hunting.** Hunting on Mauna Kea will be allowed only in areas designated for that purpose by DLNR. The activity is allowed pursuant to the applicable regulations of the Department of Land and Natural Resources. *See also* Table 7-7.

Management and Control of Commercial Activities
In addition to the controls and rules specified for the general public, the following conditions apply to all commercial operators. It should be noted that all commercial operators who use the Visitor Information Station, the Mauna Kea Access Road and the parking areas, even though the activity they sponsor does not actually take place within the UH Management Areas, are subject to these controls.

- Commercial use will be monitored. In the future it may be necessary to limit the number of commercial operators at the summit at one time and/or limit the total number of permits issued.

- All commercial operators are required to:
  - use four-wheel drive vehicles only,
  - be familiar with the general conditions for high-altitude driving,
  - register at the Information Station to inform UH of their presence on the mountain,
  - park in specific parking areas when told to do so,
  - pick up all rubbish generated by the activities and carry it back to their base operations, and
  - ensure that their clients comply with all regulations.

- The maximum size commercial vehicle allowed at the Information Station and above will be 14-passenger vans – unless special arrangements for larger vehicles are made with UH on a case-by-case basis.

- The number of commercial vehicles allowed at any one time to park at the Information Station or on the adjacent roadways will be set by UH.

- During the periods of heavy use—usually during weekends when there is snow—the number of commercial vehicles allowed in the Mauna Kea Science Reserve will be limited to a number determined by UH in consultation with DLNR. Initially this number will be 18.

- Commercial operators, drivers and guides will be provided with guidelines on mountain driving and emergency procedures when they receive their permits. Operators will be required to warn their clients of the dangers of altitude sickness and other hazards of traveling to high elevations.

- Ski and snowplay operators shall be required to identify suitable staging areas in their permit applications. These areas shall not be located near known archaeological sites.

- Ski and snowplay operators may be required to carry reasonable emergency rescue equipment in their vehicles for emergency rescues.

- The operator will be responsible for ensuring that his/her clients are clothed appropriately and have adequate liquids and food.

- If the commercial activity engaged in above the OCIA requires toilet facilities, the commercial operator must provide, operate, and maintain pre-positioned portable toilets for the clients' use.

- Except in the case of emergency, access to the OCIA buildings shall be limited to the designated public areas.

- Radio transmitters, including cellular telephones, will be restricted to emergency use only with the Science Reserve.

The permitted public uses in the 1995 Management Plan are summarized in Table 7-7 and the permitted commercial uses are summarized in Table 7-8.

The following prohibited uses in the 1995 Management Plan shall continue to be prohibited:

- ***"Off-Road" Vehicles***
  Recreational activities involving "off-road" vehicles are not allowed. This restriction applies to both the general public and commercial tour operators and their customers. These vehicles include: motorcycles, dune buggies, snowmobiles, and 4-wheel-drive passenger vehicles, vans and trucks. Note: this restriction only applies to recreational activities. Vehicles such as snowmobiles and 4-wheel drives can be driven "off-road" for emergency rescue and medial purposes.

- ***Commercial Hunting Tours***
  Hunting tours are not allowed within the UH Management Areas.

Appendix A. Community Engagement Process

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Appendix A1. List of Individuals and Groups Consulted

LAST	FIRST	AFFILIATION	CATEGORY
Abercrombie	Neil	Congressman	Legislative
Abreu	Al	Individual	Community
Agor	Ron	BLNR Member	State
Akaka	Moanikeala	Individual	Community
Armandroff	Taft	W. M. Keck Observatory	Scientific
Baybayan	Chad Kalepa	Kahu Kū Mauna	Cultural
Bergin	Billy	Waimea Resident/former UH BOR	Community Leader/Cultural
Bergin	Pat	Mauna Kea Management Board	Community Leader/Cultural
Bracken	Sherry	Island Issues - Radio Show	Media
Brock	Daniel	West Hawai'i Today - Reporter	Media
Burnett	John	Individual	Community
Callejo	Sam	UH - VP for Aministration	UH
Carlson, Jr.	Carl	UH BOR	UH
Carter	Yvonne	Cultural practitioner/Waimea resident	Cultural
Carter	Keoki	Cultural practitioner/Waimea resident	Cultural
Case	Lloyd	Subsistence hunter - Wildlife Conservation of Hawai'i	Cultural
Catterall	Lee	Star Bulletin - Editorial Board	Media
Chang	Jerry	Representative	Legislative
Chinn	Linda	Department of Hawaiian Home Lands	State
Cho	Henry	Former DHHL Commissioner	Cultural/Community Leader
Chu	Roberta	Sr. VP & Manager BOH	Cultural/Community Leader
Cody	Nicole	Student	Cultural/Educational
Coleman	Paul	IFA - Manoa	Cultural/Scientific
Colley	Steve & Carmen	Individual	Community
Cordell	Susan	Environmental Committee of MKMB	Environmental
Crabbe	Moses	MKMB Hawaiian Culture Committee	Cultural/Community Leader
Cross	John	MKMB	Scientific
David	Reggie	Environmental Committee of MKMB	Environmental
DaMate	Leimana	Aha Kiole	Cultural/Community Leader
DeMello	Gerald	Relations Director	UH
Dillard	Orpheus	Individual	Community
Edlao	Jerry	BLNR Member	State
Evans	Cindy	Representative	Legislative
Evans	Kim	Individual	Community
Fergerstrom	Blaine	Individual	Cultural
Fergestrom	Hanalei	Temple of Lono	Cultural
Fisher	Scott	Gemini Telescopes	Scientific/Educational
Flickinger	Reed	West Hawai'i Today - Editor	Media
Flores	Miliaka & Joe	Individual	Community
Flynn	Rory	Kukuipahu Energy LLC (w/John Ray)	Business
Freitas	Rockne	Hilo Community College Chancelor	Educational
Fujihara	Gary	IFA - Hilo	Educational/Scientific
Gaines	James	UH - Vice President for Research	Educational
Gon	Sam	The Nature Conservancy/BLNR Member	Cultural/State

LAST	FIRST	AFFILIATION	CATEGORY
Green	Josh	Representative	Legislative
Ha	Richard	Hamakua Springs Country Farms	Cultural/Community Leader
Hamabata	Matt	The Kohala Center	Community Leader
Hanabusa	Colleen	Senator	Legislative
Hanoa	Pele	Kūpuna - Hawai'i Island Burial Council	Cultural
Hanohano	Faye	Representative	State
Hapai	Marlene	UH BOR; Former Executive Director of Imiloa	Educational/Cultural
Hadway	Lisa	Department of Land and Natural Resources; MKMB	State
Harden	Cory	Sierra Club	Environmental
Hayashi	Masa	Subaru Telescope	Scientific
Heen	Walter	Office of Hawaiian Affairs	OHA
Helfrich	Paula	Individual	Community
Herkes	Bob	Representative	Legislative
Heyer	Inge	Individual	Scientific
Hiura	Arnold	OMKM media relations specialist	Media/State
Hoke	Arthur	Kahu Kū Mauna - Hilo Hawaiian Civic Club	Cultural/Community Leader
Hong	Lea	Hawai'i Trust for Public Lands	Legal/Environmental
Hoover	Jacqui	Hawai'i Leeward Planning Conference	Business
Ikawa	Allan	Big Island Candies - Former Board of Regent	Community Leader
Ishibashi	Wally	ILWU - Hilo	Cultural/Community Leader
Ito	Ken	Representative	Legislative
Johns	Tim	BLNR Member	State
Kahawaiola'a	Patrick K.	Kea'aukaha Hawaiian Homesteads	Cultural/Community Leader
Kakalia	Tiffnie	Kahu Kū Mauna	Cultural/Educational
Kalamau	Jo-Ann	Individual	Community
Kalua	Herring	MKMB - former Hawaiian Homes Commissioner	Cultural/Community Leader
Kamakawiwoole	Reynolds	Hawaiian cultural practitioner	Cultural
Kamakawiwoole	Kalei	individual	Cultural
Kanahele	Pua	Cultural practitioner - Kumu Hula - Hilo Community College	Cultural/Educational
Kanehailua III	Ernest	Royal Order of Kamehameha	Cultural
Kaneha'ilua	Brenda	Individual	Cultural
Kanui	John	Individual	Community
Kapono	Eric	Individual	Community
Kauahikaua	Jim	MKMB Environmental Committee, Hawai'i's Volcanoes National Park	Community Leader/Cultural
Kennedy	Jim	MKMB	Educational
Kenoi	Billy	Mayor	County
Kikuchi	Bill	Individual	Community
Kim	Harry	County of Hawai'i - Mayor, Hawai'i County	County
Kim	Millie	Individual	Community
Kimura	Ka'iu	Imiloa	Cultural/Educational
Kimura	Larry	Kahu Kū Mauna - University of Hawai'i at Hilo	Cultural/Educational
Kinchla	Joan	Kona Hiking Club	Environmental
Kinimaka	Kaniu	Alternative Technologies in Power	Cultural/Community Leader
Kitamura	Mike	Senator Akaka's State Director	Legislative
Kokubun	Russell	Senator	Legislative
Kudritzki	Rolf-Peter	IFA - Manoa	Scientific/UH
Landrum	Vivian	Kona-Kohala Chamber of Commerce	Business
Lee	Nani	Individual	Cultural/Educational

LAST	FIRST	AFFILIATION	CATEGORY
Leialoha	Julie	Environmental Committee of MKMB	Cultural/Scientific
Lemmo	Sam	Department of Land and Natural Resources	State
Levine	Andy	County of Hawai'i - Mayor's Assistant	County
Lindsey	Robert	OHA Trustee	Cultural/Community Leader
Lovell	Kawika	RCUH	Cultural/State
Lucas	Carolyn	Reporter West Hawai'i Today	Media
Lyon	Kendal	Individual	community
Maberry	Mike	IFA - Maui	Scientific/UH
Mahi	Arthur	Kūpuna	Cultural
Mallow	Antoinette	Kahu Kū Mauna	Cultural/Educational
Marks	Barry	Individual	Community
Masuda	Robert	UH - Special Assistant	Community
Matthews	Amy	Individual	community
McClain	David	University of Hawai'i President	Educational
McDonald	Ruby	Office of Hawaiian Affairs - Hawaiian Civic Club	Cultural/Community Leader
McGuffie	Mark	Hawai'i Island Economic Development Board	Business
McKeague	Kawika	Group 70 consultant	Cultural
McLaren	Robert	IFA - Manoa	Scientific
McLoud	Pablo	Former Ranger OMKM	community
McNett	Mark	individual	community
Mercier	Tyler	individual	community
Mills	Peter	Individual	community
Moon	Alice	Consultant	Community
Nagata	Stephanie	Associate Director - Office of Mauna Kea Management	State
Naleimaile	Sean	Kahu Kū Mauna	Cultural/Educational
Namuo	Clyde	Administrator Office of Hawaiian Affairs	OHA
Nelson	Dickie	I Mua Group - Hawaiian Homestead Association	Cultural/Community Leader
Nishimura	Tetsuo	Subaru Telescope	Scientific
Oi	Cynthia	Star Bulletin - Editorial Board	Media
Omphroy	Leilehua	Kahu Kū Mauna	Cultural
Oshiro	Marcus	Representative	Legislative
Ostrander	Gary	Vice Chancellor for Research, UH Mānoa Campus	Educational
Ota	John	Individual	community
Pacheco	Robert	BLNR Member	Busness/State
Panoke	Kaho'onei	Hawaiian Civic Club	Cultural/Community Leader
Pisciotta	Kealoha	Mauna Kea Anaina Hou	Cultural
Poole	Mary	Star Bulletin - Editorial Board	Media
Putland	Stuart	Individual	commuity
Ray	John	Waimea Resident/Kukuipahu Energy LLC	Business/Community leader
Rice	Koa	Gemini Telescopes	Cultural/Scientific
Rogers	Helen	UH Hilo	State
Sabas	Jennifer Goto	U.S. Senator Daniel K. Inouye's Office	Federal
Sakamoto	Norman	Senator	Legislative
Salmol	Derrick	Individual	Community
Say	Calvin	Representative	Legislative
Schaefer	Barbara	Individual	community
Sherlock	Ululani	Former Kahu Kū Mauna and OMKM	Cultural/Community Leader
Sing	David	Na Pua No'eau	Cultural/Educational
Spencer	Margie	Kūpuna	Cultural

LAST	FIRST	AFFILIATION	CATEGORY
Springer	Hannah	Kahu Kū Mauna - cultural practitioner	Cultural/Community Leader
Stanton	Chas	Individual	community
Steffey	Eric	Individual	community
Stevens	Ed	Kahu Kū Mauna - cultural practitioner	Cultural
Stevens	Mercedes	Individual	community
Stone	Fred	Individual	community
Stormont	Bill	former Director OMKM	State
Sur	Peter	Hawai'i Tribune Herald	Media
Tajiri	Harvey	UH Board of Regent	State
Takami	Hideki	Individual	community
Takamine	Dwight	Representative	Legislative
Tam	William	Attorney	Legal
Taniguchi	Barry	MKMB - KTA Super Stores	Business/Community leader
Terry	Ron	MKMB; Environmental Consultant	Environmental
Thielen	Laura	Chairperson of Board of Land and Natural Resources	State
Thomas	Don	MKMB Environmental Committee	Community
Tolentino	Mabel	Kūpuna	Cultural
Tseng	Rose	UH Hilo Chancellor	State
Tsuji	Clift	Representative	Legislative
Tzimeas	Ruby	Kona Hiking Club	Environmental
Veillet	Christian	MKMB - Canada France Telescopes	Scientific
Walker	Alice	Kona Hiking Club	Environmental
Ward	Deborah	Sierra Club	Environmental
Warren	DeeDee	Individual	community
Watts	Joy	Individual	community
Wilson	Ross	consultant	Media
Wuddell	Alan	Individual	community
Yeh	Thomas	Attorney	community
		Hawaiian Agencies Organizations	Cultural, educational, social, and community
		Kanaka Council	Cultural and community
		Ahahui Ka'ahumanu Society	Cultural
		Royal Order of Kamehameha	Cultural
		Hawai'i Island Economic Development Baord, Gov't Affairs	Business and community
		Mauna Kea Observatory Directors	Scientific
		Kona-Kohala Chamber of Commerce, Gov't Affairs Committee	Business and community
		OHA Beneficiary Advocacy and Empowerment Committee	Cultural and community
		University of Hawai'i at Hilo - Hawaiian Studies Faculty/Students	Cultural and educational
		OHA's Native Hawaiian Historic Preservation Council	Cultural and community
		Association of Hawaiian Civic Clubs	Cultural and community

Appendix A2. Public Meetings

May 2008 Meeting Announcement

COMMUNITY INVITED TO PROVIDE INPUT FOR MAUNA KEA COMPREHENSIVE MANAGEMENT PLAN

Ku'iwalu, a consultant firm working in collaboration with the Office of Mauna Kea Management, is holding a series of public meetings to seek input on the development of a Comprehensive Management Plan (CMP) for the Mauna Kea Science Reserve.

The goal of the CMP is to protect and preserve the natural and cultural resources on Mauna Kea by responsibly and appropriately managing the uses and activities on Mauna Kea. We welcome the community's input or mana'o on this very important project affecting your community.

Tuesday, May 6, 2008
5-7 p.m. @ Waimea Community Center

Wednesday, May 7, 2008
6-8 p.m. @ Kealakehe Elementary School

Tuesday, May 13, 2008
5-7 p.m. @ Hilo High School

Input is also being accepted online at **www.MaunaKeaCMP.com**

*For more info, logon to **www.MaunaKeaCMP.com** or call (808) 539-3580*

May 2008 Meeting Attendance Lists

Mauna Kea CMP Waimea Community Meeting, Waimea Community Center, May 6, 2008

First Name	Last Name
Al	Abreu
Taft	Armandroff
Herring	Kalua
John	Kanui
M	Kapuniai
Nani	Lee
Mike	Maberry
Bob	Masuda
Kawika	McKeague
Koa	Rice
Derrick	Salmol
Barbara	Schaefer
Mercedes	Stevens
Mabal	Tolentino
Christian	Vallet
DeeDee	Warren

Mauna Kea CMP Kona Community Meeting, Kealakehe Elementary School, May 7, 2008

First Name	Last Name
Orpheus	Dillard
Miliaka & Joe	Flores
Brenda	Kaneha'ilua
Ernest	Kaneha'ilua, III
Carolyn	Lucas
Mike	Maberry
Arthur	Mahi
Bob	Masuda
Ruby	McDonald
Kawika	McKeague
Koa	Rice
Betty	Stevens
Ed	Stevens
Ross	Wilson

Mauna Kea CMP Hilo Community Meeting, Hilo High School, May 13, 2008

First Name	Last Name
Moanikeala	Akaka
John	Burnett
Nicole	Cody
Steve & Carmen	Colley
Kim	Evans
Blaine	Fergerstrom
Faye	Hanohano
Cory	Harden
Masa	Hayashi
Paula	Helfrich
Inge	Heyer
Arthur	Hoke
Patrick L.	Kahawaiola'a
Jo-Ann	Kalamau
Reynolds & Kalei	Kamakawiwoole
Eric	Kapono
Jim	Kennedy
Kendal	Lyon
Amy	Matthew
Aloha & Mark	McGuffie
Kawika	McKeague
Pablo	McLoud
Mark	McNett
Tyler	Mercier
Peter	Mills
John	Ota
Stuart	Putland
Koa	Rice
Chas	Stanton
Eric	Steffey
Fred	Stone
Hideki	Takami
Barry	Taniguchi
Ron	Terry
Deborah	Ward
Joy	Watts
John	Williamson
Thomas	Yeh

November 2008 Meeting Announcement

COMMUNITY INVITED TO REVIEW AND PROVIDE INPUT ON THE DRAFT COMPREHENSIVE MANAGEMENT PLAN FOR MAUNA KEA

Ku'iwalu, a consultant firm working in collaboration with the Office of Mauna Kea Management, is holding a second round of public meetings for the community to review the draft Comprehensive Management Plan (CMP) for the Mauna Kea Science Reserve.

The goal of the CMP is to protect and preserve the natural and cultural resources on Mauna Kea by responsibly and appropriately managing the uses and activities on Mauna Kea. We welcome the community's input or mana'o on this very important project.

Friday, Nov. 14, 2008
5-8 p.m. @ Kealakehe Elementary School

Monday, Nov. 17, 2008
5-8 p.m. @ Waimea Community Center

Tuesday, Nov. 18, 2008
5:30-8:30 p.m. @ Keaukaha Elementary School

Input is also being accepted online at **www.MaunaKeaCMP.com**

ADA accommodations are available upon request.
For more info, logon to **www. MaunaKeaCMP.com** or call (808) 539-3580

November 2008 Meeting Attendance Lists

Mauna Kea CMP Kona Community Meeting, Kealakehe Elementary School, November 14, 2008

First Name	Last Name
Richard	Akiona
Charles	Flaherty
Richard	Ha
Marni	Herber
Theresa	Jokiel
Charlotte	Lyman
Alfredo	Martinez
Ross	Wilson

Mauna Kea CMP Waimea Community Meeting, Waimea Civic Center, November 17, 2008

First Name	Last Name
Billy	Bergin
Pat	Bergin
Charles	Bohannan
Lloyd	Case
Andrew	Cooper
Liz (?)	Field-Gomes
Bob	Goodrich
M	Kapuniai
Betty	Lau
Pete	Lindsey
Barney	Magrath
Kihei	Niheu
Barbara	Schaefer
Riley	Smith
Joseph	Sulla
Ron	Terry
C	Veillet
Florian	Veillet

Mauna Kea CMP Hilo Community Meeting, Keaukaha Elementary School, November 18, 2008

First Name	Last Name
Alex	B
Dane	Byrne
Ikaika	D
Hanalei	Fergerstrom
Cory	Harden
Kaniu	K
Patrick	Kahanaiola'a
Reynolds	Kamakawiwoole
John	Kanui
Manu	Kauhi
Luana	Kawelu
Dave	Korlinski
Rose	Kuami
Bobby	Lee, Jr.
Pete	Lindsey
James	Mary
Pablo	McLoud
Anakura	Melemai
Akaka	Moanikeala
Terence	Nakamura
Helen	Napeahi
Maile	Napoleon
Eugene	Nishimura
John	Ota
Tom	Peek
Kealoha	Pisciotta
Samantha	Puluole-Mitchell
Stuart	Putland
David	Shinn
Judi	Steinman
Hideki	Takami
Deirdre Moana	Tavares
Lehua	Waipa AhNe
Diane	Ware
Jessie	Wenner

Appendix A3. Statewide Survey

Mauna Kea Study

Prepared for:
Ku'iwalu/University of Hawaii
April 2008

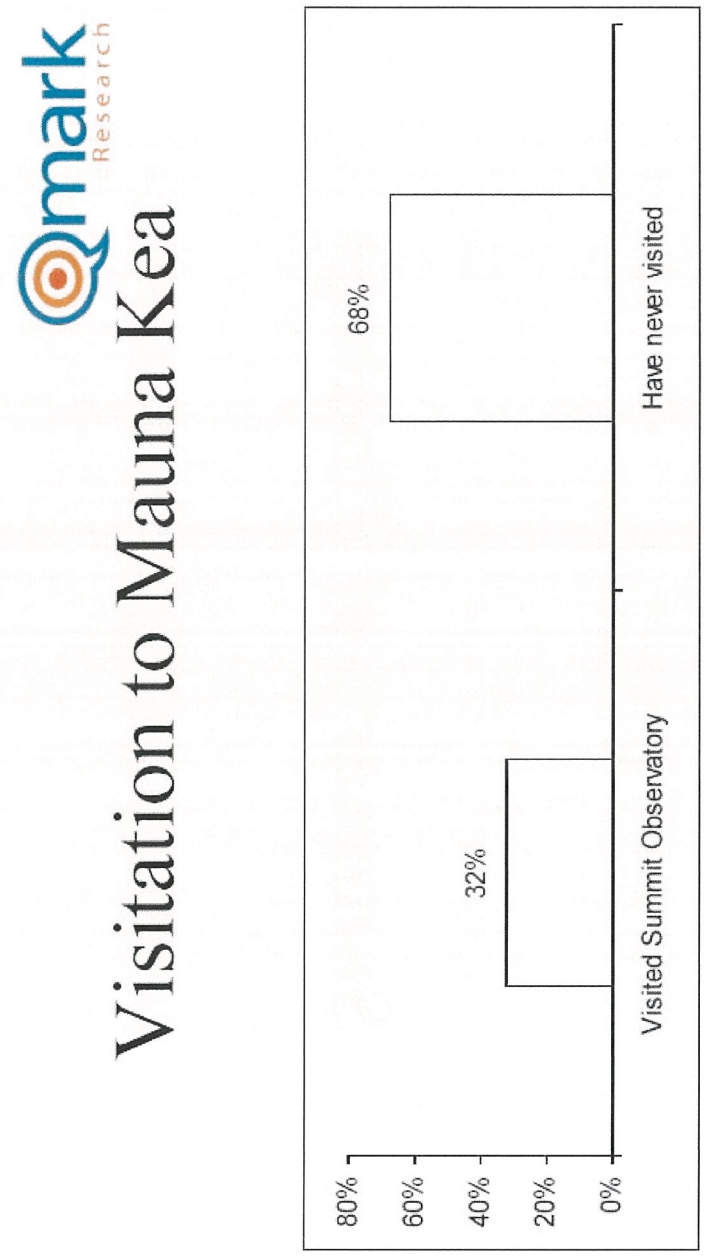
Background & Methodology

- Field dates: March 19 to April 1, 2008
- 635 telephone interviews conducted with Hawaii residents statewide. The sample was stratified with the following number of surveys in each area (150=Oahu/ 135=Kona/ 139=Hilo/111=Maui/ 100=Kauai).
- 164 Hawaiians were included in the total sample.
- The initial sample was randomly generated using QMark Research & Polling's proprietary Random Digit Dialing Software.
- The data was weighted in order to show state-wide totals proportional to the population on each island
- The data was input and compiled using SPSS.
- The margin of error for a sample of this size (n=600) is +/- 4.00 percentage-points with a 95% confidence level.

Objectives

- To measure respondents' awareness and perception of Mauna Kea.
- To gain insight into respondents' knowledge and opinions on the issues surrounding Mauna Kea.
- To determine respondents' level of support of programs and management of Mauna Kea.

Summary of Findings


Visitation to Mauna Kea
Qmark Research
80%
60%
40%
20%
0%
32%
68%
Visited Summit Observatory
Have never visited

Awareness of Reputation

Each respondent was asked if they were aware that Mauna Kea is considered a premier location for astronomical observation and research and that the University of Hawaii's Institute for Astronomy is one of the top programs of its kind in the world.

	OVERALL
Yes, aware of this fact	80%
Not aware	20%

Very high level of awareness of the importance of Mauna Kea Observatory

Level of Knowledge

Each respondent was asked to rate their overall, general level of knowledge of the issues related to telescopes on the summit of Mauna Kea

	OVERALL
4=Very knowledgeable	3%
3=Somewhat knowledgeable	28%
2=Not too knowledgeable	31%
1=Not knowledgeable at all	38%
Don't know	0%
MEAN	2.0

Most residents do not consider themselves to be knowledgeable

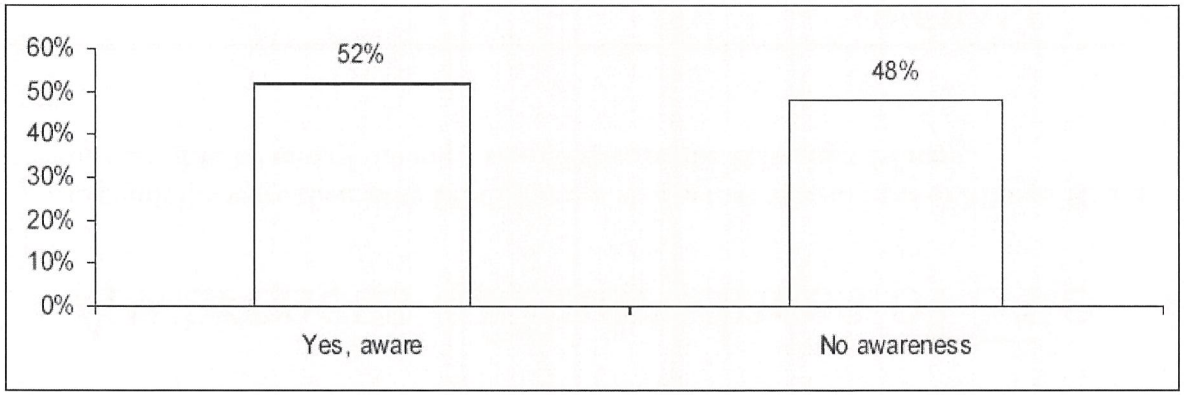
Awareness of Sacredness of Site

Respondents were then asked if they were aware that the summit of Mauna Kea is considered to be one of the most sacred sites in the Hawaiian Islands.

	OVERALL
Yes, aware of this fact	44%
Not aware	56%

Awareness of Current Issues

Each respondent was asked if they were aware that there is a current ongoing discussion between some people who want to place new and larger telescopes on the summit of Mauna Kea and other people who want cultural beliefs and practices to be followed which could require removal or relocation of the telescopes off the summit.



Awareness of Current Issues

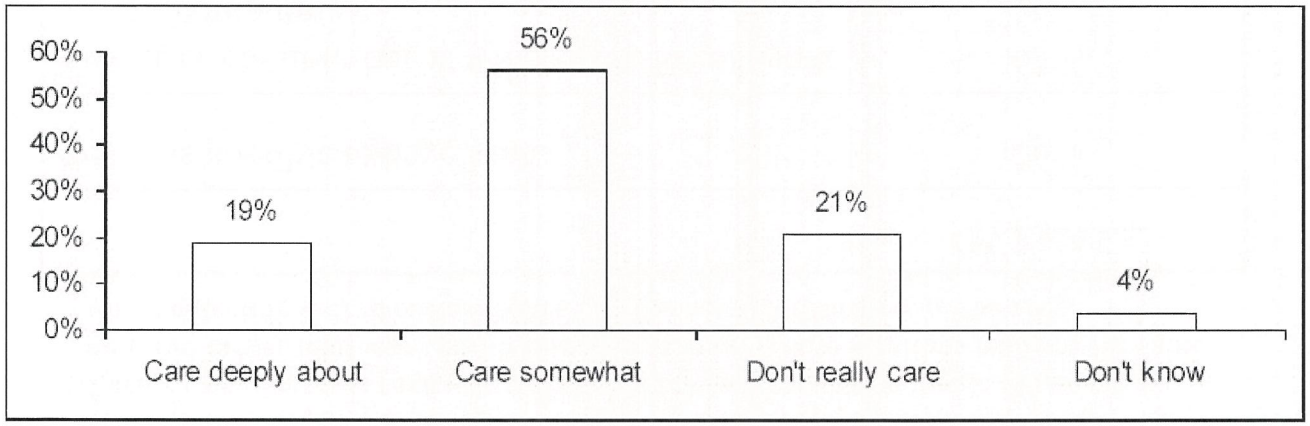
Each respondent was then asked if they felt it was possible to juggle the desire for new and larger telescopes on Mauna Kea at appropriate locations while at the same time protecting sacred cultural sites and the natural resources of the area.

	OVERALL
Yes, it is possible to have both	26%
Yes, it is possible but it will take a lot of work and compromise	64%
No, it will not be possible to do both	6%
Don't know	5%

Almost all residents (90%) feel it will be possible, with work and cooperation, to have new and larger telescopes on Mauna Kea while protecting cultural and natural resources

Level of Concern

Each respondent was asked if this was an issue they cared deeply about.



Personal Perceptions of Mauna Kea Telescopes

Each respondent was read three statements related to this issue and then asked to choose the one that best exemplified their own, personal views.

	OVERALL
I favor new and larger telescopes	26%
Favor placing new and/or larger telescopes only if cultural concerns can be addressed	42%
I favor removing or relocating telescopes	10%
Don't know	18%
Don't care	4%

Resources

Respondents were presented with four ways in which people perceive the resources that Mauna Kea has to offer. After being read each one they were asked to quantify its importance to them personally using a four-point rating scale with four being it is a very important resource and one being it is very unimportant.

	Very Important	MEAN
Scientific/ Educational Resources	66%	3.6
Cultural/ Education Resources	59%	3.5
Cultural/ Environmental Resource	47%	3.3
Recreational Resource/ Visitor Attraction	28%	2.9

Wekiu Bug

After being presented with information on the wekiu bug, they were then read three statements related to this issue and asked which they felt best exemplified their own personal views.

	OVERALL
I agree that the construction of observatories may jeopardize the future of the Wekiu Bug and should not be allowed to exist on Mauna Kea	10%
I am not concerned with the future of the Wekiu Bug and observatories should be allowed to exist on Mauna Kea	16%
I believe the Wekiu Bug and observatories can co-exist on Mauna Kea with the right research and approach	64%
Don't know/ Refused	10%

Issue Statements

Respondents were presented with five descriptive statements directly related to the Mountain and its potential development. They were asked to quantify their perceptions using a four-point rating scale with "strongly agree" being assigned a value of four and "strongly disagree" being assigned a value of one.

	Strongly agree	MEAN
New development of telescopes should be allowed on the summit, provided developments follow all applicable laws	48%	3.3
No new telescopes can be constructed on the summit, but as old telescopes become obsolete, new telescopes can be recycled or constructed within the site of the original telescope, even on the summit	42%	3.2
Telescopes that have become obsolete should be removed and new telescopes may be located at lower, less sacred elevations on the mountain	22%	2.6
New telescopes can be added but only at lower, less sacred elevations of the mountain	14%	2.4
The telescopes should be removed completely as the State lease expires (year 2033) and future development of telescopes should not be allowed on Mauna Kea	8%	1.8

Ceded Lands

- Each respondent was read the following statement:

  Mauna Kea is ceded lands. "Ceded lands" refers to 1.2 million acres of land that belonged to the Hawaiian monarchy prior to January 17, 1893 and is currently owned by the State of Hawaii. The Office of Hawaiian Affairs (OHA) is the organization that manages the revenue generated by ceded lands and determines which programs to fund for the benefit of Native Hawaiians. OHA normally receives 20 percent of revenue generated from ceded lands.

  The Board of Land and Natural Resources leases the 11,300-acre Mauna Kea Science Preserve to the University of Hawaii for $1 a year. Annually, the University of Hawaii, Institute for Astronomy (UH) receives several million dollars in usage fees from various government agencies, universities, corporations, and other countries to use or operate the telescopes on Mauna Kea to support their programs and the management of the area.

- After being presented with this information they were then asked how they felt about the idea of 20% of the monies generated by those using the summit be used to benefit Native Hawaiians. They were asked to quantify their perceptions using a four-point rating scale with they strongly agree with this idea being assigned a value of four and they strongly disagree with it being assigned a value of one.

Ceded Lands

	OVERALL
Strongly agree	48%
Somewhat agree	29%
Somewhat disagree	9%
Strongly disagree	11%
Don't know	3%
MEAN	3.2

Fairness of Ceded Lands Policy

Respondents were asked to rate the fairness of the University of Hawaii paying $1 per year to lease the ceded lands on Mauna Kea. They were asked to quantify their perceptions using a four-point rating scale with it is a very fair deal being assigned a value of four and it is very unfair being assigned a value of one.

	OVERALL
Very fair	16%
Somewhat fair	17%
Somewhat unfair	21%
Very unfair	37%
Don't know	9%
MEAN	2.1

Over half (58%) feel the current lease arrangement is unfair

Public Access to Mauna Kea

Respondents were read four proposals aimed at improving the visitor experience on Mauna Kea and were asked how effective they felt each might be.

	Very Effective
Requiring all visitors to view an informational video to provide a cultural and safety orientation before accessing Mauna Kea	67%
Developing informational brochures to be handed out to visitors at the mountain at Hale Pohaku, the visitors station	48%
Setting a capacity limit on how many visitors, including recreation and commercial, can be on the mountain at any given time	44%
Posting more rangers on the mountain	41%

Cultural Practitioners

Respondents were asked to rate their perceived importance of the input of cultural practitioners as it relates to development atop Mauna Kea.

	OVERALL
Very valuable	50%
Somewhat valuable	38%
Not valuable at all	6%
Don't know	6%

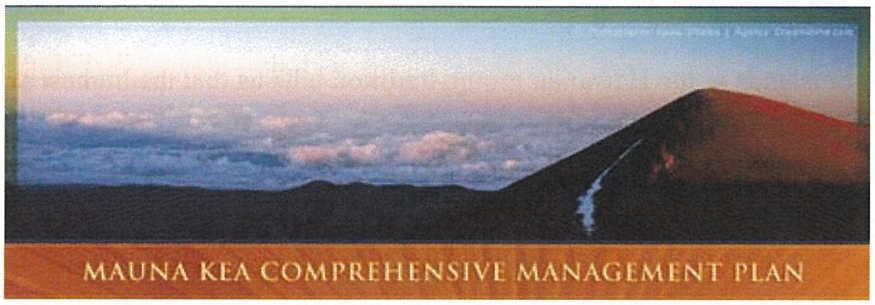
Recap

At the conclusion of the research respondents were asked their opinions once again regarding the future of telescopes on Mauna Kea.

OVERALL	Pre-Survey	Post-Survey	Net – Change +/(-)
I favor new and larger telescopes	26%	27%	1.0
Favor placing new and/or larger telescopes only if cultural concerns can be addressed	42%	55%	13.0
I favor removing or relocating telescopes	10%	8%	(2.0)
Don't know	18%	7%	(11.0)
Don't care	4%	2%	(2.0)

We see an increased acceptance of new and larger telescopes if cultural concerns are properly addressed.

Appendix A4. Website: www.maunakeacmp.com



Community input is critical to ensuring that the CMP accurately reflects the community's concerns and recommendations. We will be conducting a series of public meetings to discuss the development of a CMP for Mauna Kea.

- Waimea on Tuesday, May 6th from 5 to 7 pm at Waimea Community Center;
- Kona on Wednesday, May 7th from 6 to 8 pm at Kealakehe Elementary School;
- Hilo on Tuesday May 13th from 5 to 7 pm at Hilo High School.

If you are unable to attend any of the public meetings but would like to send us your comment or have any questions, you may contact us at 539-3580 or online through www.MaunaKeaCMP.com.

CULTURAL SIGNIFICANCE OF MAUNA KEA

Sacredness of Mauna Kea

'O Mauna Kea ko kākou kuahiwi la'a (Mauna Kea our sacred mountain) expresses the feelings that modern day Hawaiians and non-Hawaiians alike have for this wahi pana, or legendary place. As with other cultures throughout the world, early Polynesians believed their highest points of land were the most sacred.

Of the four major islands in the Hawaiian group, tradition tells us that the highest and most sacred places were Mauna Wai'ale'ale on Kaua'i; Mauna Ka'ala on O'ahu; Mauna Haleakalā on Maui; and Mauna Kea on Hawai'i. Mauna Kea, being the highest point throughout Pacific Polynesia, has been considered by many Hawaiian practitioners to be the most sacred of all. Standing tall over the island of Hawai'i, Mauna Kea was host to early Hawaiian traditions that included, among other things, religious practices, study of the heavens, and tool making in the Keanakāko'i Adze Quarry.

The Highest Portal to the Hawaiian Universe

Mauna Kea is the mountain altar of Wākea, also known as the celestial father. Wākea is the sire of the indigenous Hawaiian race. The tallest mountain in the world, Mauna Kea is the highest portal to the Hawaiian Universe, and is therefore the pillar of native consciousness. Additionally, Mauna Kea is a Ko'a, the magnet through which all life flows. Like the fishing ko'a (traditional fishing grounds), ko'a Mauna (mountain ko'a) are shrines that are fed and maintained over many generations to ensure that the links to all life are not threatened.

A Sacred Spiritual Burial Ground

Many traditional Hawaiian eulogies speak to the "ho'i i Ka-houpo-o-kāne," or returning into the heart of Kāne. Mauna Kea contains burials of the most sacred chiefs, known as the descendants of Wākea and Papahānaumoku - who gave birth to the islands. It is believed that Mauna Kea is where some of the spirits of the deceased returned. Specifically, Kahoupookāne, a female spring and rivulet, is the spirit entrance into the mountain's energy. Mauna Kea is known as the piko (umbilical connection to the Universe) of Hawai'i. Even today, many families continue to bury the umbilical cords of their children on the mountain as a way of certifying indigenous birth. Family shrines are also established on the mountain to serve as a portal for direct spiritual communication with Wākea.

The Source of Life

Mauna Kea makes up a large part of the island's aquifer; it is believed that Poli'ahu (snow), Lilinoe (mist) and Waiau (ice) are the female waters in perpetual intercourse with Wākea for the furtherance of all life.

Archeological Sites Found on Mauna Kea

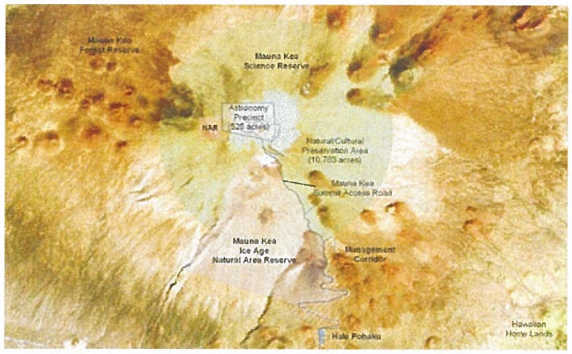
There are hundreds of archaeological sites (e.g., traditional cultural properties, shrines, burials and culturally significant landscape features) within the summit area of Mauna Kea. The State of Hawaii Historic Preservation Division has designated three areas as traditional cultural properties (TCPs): the summit (Kūkahau'ula) and Pu'u Lilinoe in the MKSR and Lake Waiau in the Mauna Kea Ice Age Natural Area Reserve. A large area on the summit of Mauna Kea has been determined to be eligible for listing on the National Register of Historic Places as a historic district.

Keanakāko'i Adze Quarry

Concentrated between 11,000 and 12,500 feet within the Mauna Kea Ice Age Natural Area Reserve is an area of very fine-grained, dense basalt rock formed when lava erupted and flowed beneath the glacial ice caps. These unique rock outcrops were discovered by Hawaiians and quarried for use in the manufacture of adzes (*ko'i*), traditional stone implements used for chopping and carving wood. Keanakāko'i is the single largest basalt quarry area in all of Polynesia. The complex also contains shrines, trails, rock shelters and petroglyphs. The Adze Quarry was placed on the National Register of Historic Places in 1962 as a National Historic Landmark.

JURISDICTIONAL RESPONSIBILITIES ON MAUNA KEA

Conservation Lands



Credit: SRGII

The lands of Mauna Kea from about 6,000 feet to the summit are classified as 'conservation district' *(Hawai'i Revised Statutes (HRS) §205-2)*. The Department of Land and Natural Resources (DLNR) through the State Office of Conservation and Coastal Lands has the authority to regulate and enforce the uses of conservation district lands *(HRS §183C-3)*. Within the conservation district, DLNR has established five subzones: protective, limited, resource, general, or special *(Hawai'i Administrative Rules (HAR) §13-5-10)*. The Mauna Kea Science Reserve (MKSR) lands fall within the purview of these resource subzones *(HAR §13-5-13)*.

Lease of conservation lands between BLNR and University of Hawai'i

In 1968, the BLNR approved a 65-year lease (from January 1, 1968 to December 31, 2033) to the University of Hawai'i (UH) *(General Lease No. S-4191)* for an area comprising approximately all lands above 12,000 feet. The leased area, known as the Mauna Kea Science Reserve (MKSR), is an approximately circular area (2.5 miles in radius, centered on the UH 2.2m telescope near the summit), except for those areas that were withdrawn and designated as part of the Mauna Kea Ice Age Natural Area Reserve (NAR) in 1981. The boundary on the northeast side of the MKSR has three lobes that extend further down the mountain to include Pu'u Makanaka and two other large cinder cones.

Presently, the area of the MKSR is 11,288 acres, of which 10,763 acres has been designated a Natural/Cultural Preservation Area and 525 acres as an Astronomy Precinct. (*2000 Master Plan*). The lease identified the "specified use" as "a scientific complex, including without limitation thereof an observatory, and a scientific reserve being more specifically a buffer zone to prevent the intrusion of activities inimical to said scientific complex."

Leased lands also include a 19.3-acre parcel (Lease No. S-5529) at Hale Pōhaku. The facilities at Hale Pōhaku include the Onizuka Center for International Astronomy (OCIA) (mid-elevation support facilities), the Visitor Information Station (VIS), and an old construction laborer camp.

Some of the cabins in the old camp are now used by the OMKM rangers, VIS staff, volunteers, and researchers.

Subleases Between University of Hawai'i and Telescopes Facilities

UH subleases portions of the MKSR to telescope facilities, except for those that are considered part of UH (UH 0.6m telescope, UH 2.2m telescope). Conservation District Use Permits are required for each facility.

DLNR Forest Reserve

The DLNR Mauna Kea Forest Reserve lands encompass approximately 52,500 acres above 7,000 ft elevation up to the MKSR boundary. The forest reserve contains mamane forest, habitat for the endangered palila bird. Hunting is allowed in accordance with DLNR regulations (Title 13, Chapter 123). The forest reserve is under the jurisdiction of the Department of Land and Natural Resources, Division of Forestry and Wildlife.

Natural Area Reserve

The Mauna Kea Ice Age Natural Area Reserve (NAR) is comprised of two parcels surrounded by and adjacent to the MKSR. A 143.5-acre square parcel around Pu'u Pohaku, is located to the west of the summit area. Fossil ice left behind by glaciers has been found within in its boundaries. The larger 3,750-acre triangular shaped parcel extends from approximately 10,070 feet up to 13,230 feet at the tip of the parcel. Within this larger area are several unique features: Lake Waiau, the only high-elevation alpine lake in the state; the Mauna Kea Adze Quarry; and geomorphic features created by glaciers such as moraines, and glacial till. The NAR area is under the jurisdiction of the Department of Land and Natural Resources, Natural Area Reserves Commission.

Credit: SRGII

Department of Hawaiian Home Lands

The Department of Hawaiian Home Lands has jurisdiction over approximately 53,000 acres of the lands of Humuula Mauka that were designated by the Hawaiian Homes Commission Act of 1920 to be made available for homesteading purposes. This land was held under leases by Parker Ranch from 1914 to 2002. Today, limited ranching of cattle continues on Humu'ula, under a permit issued by the DHHL. DHHL is currently working, along with beneficiaries and applicants for pastoral lease lands, on a plan for land stewardship and lessee opportunities on Humu'ula lands near the junction of Saddle Road and the MK Observatory Access Road.

Pōhakuloa Training Area

Pōhakuloa Training Area (PTA) is located in the saddle area between Mauna Loa and Mauna Kea. Totaling 108,792 acres, PTA extends up the lower slopes of Mauna Kea to approximately 6,800 feet in elevation and to about 9,000 feet on Mauna Loa. PTA lands are within the conservation district general, limited, and resource subzones. As the largest military training area in Hawaii, PTA is used for nearly all of the diverse types of training conducted by the armed forces and includes impact areas, firing ranges, an airfield, and maneuver areas.

MANAGEMENT OF THE MAUNA KEA SCIENCE RESERVE

Office of Mauna Kea Management

The Office of the Mauna Kea Management (OMKM) is charged with the day-to-day management of the Mauna Kea Science Reserve as prescribed in the 2000 Master Plan. OMKM works closely with the Mauna Kea Management Board (MKMB) and the Kahu Kū Mauna Council and several advisory committees. The Mauna Kea Management Board (MKMB) is composed of seven members of the community who are nominated by the UH Hilo Chancellor and approved by the UH Board of Regents. The MKMB guides the operations of OMKM and advises the Chancellor on activities, operations and development. Kahu Kū Mauna (Guardians of the Mountain), a nine-member council named by the MKMB, advises the MKMB, OMKM and the UH Hilo Chancellor on Hawaiian cultural matters. Other advisory councils include the MKMB Environment Committee, formed to advise the MKMB on environmental issues; the MKMB Hawaiian Culture Committee; the Astronomy Education Committee; the Public Safety and Conduct Committee; and the Wēkiu Bug Scientific Committee.

Rangers

OMKM manages a ranger program to facilitate visitor safety and education on Mauna Kea. Rangers advise visitors of weather conditions and potential hazards associated with ascending the mountain (e.g. altitude sickness, road conditions). They recommend approaches to safely visiting Mauna Kea and provide emergency assistance when necessary. Educational responsibilities are an important component of the rangers' daily activities. They distribute the safety brochure, provide information on the unique natural and cultural resources, identify the various observatories, direct visitors to established hiking trails, and educate visitors on prohibited or destructive activities. Rangers perform site maintenance activities, including coordination of litter removal ("an ever-present responsibility") and trail maintenance. Daily patrols document the activities of the general public, observatory personnel, and commercial tour operators. Rangers also assist OMKM with compliance matters, including semi-annual inspections of all observatories for compliance with their respective conservation district use permits and compliance with the conditions imposed by the MKMB on specific projects.

Mauna Kea Observatories Support Services

The Mauna Kea Observatories Support Services (MKOSS) is responsible for providing support to the observatory facilities, managing the facilities at Hale Pōhaku; maintaining the summit access road, including road and snow removal; providing utility support, and safety and emergency services; and maintaining the communication network. MKOSS also manages the Visitor Information Station.

Management and Master Plans for Mauna Kea

Management of the MKSR is pursuant to the policies set forth in the General Lease S-4191 between BLNR (lessor) and UH (lessee), the DLNR Administrative Rules Title 13, and the conditions imposed by BLNR on various conservation district use permits.

A series of plans have been prepared for Mauna Kea since the 1970s, including development plans, master plans and management plans. The *1977 DLNR Mauna Kea Plan* was developed to serve as "a policy framework for the management of Mauna Kea". This plan was superceded by the *1985*

University of Hawai'i Mauna Kea Management Plan and, later, by the *1995 Revised Management Plan for the UH Management Areas on Mauna Kea*, the current BLNR-approved plan for Mauna Kea. These management plans were designed to assign management and enforcement responsibilities for public and commercial use and institute commercial use and management controls for the area.

The *2000 Mauna Kea Science Reserve Master Plan* was adopted by the UH Board of Regents as the policy framework for the responsible stewardship and use of university-managed lands on Mauna Kea. The master plan created a new management structure, housed within the University of Hawai'i at Hilo as the local management authority over Mauna Kea. The master plan also delineated an astronomy precinct, which confines astronomy development to 525 acres within the MKSR.

Year	Description of Management Plan	Approved by
1977	*Mauna Kea Plan.* Adopted by DLNR to serve as policy framework for the management of Mauna Kea. The plan divided Mauna Kea into five management areas and described acceptable uses and management controls for each area. (1998 audit report).	BLNR
1980	*Hale Pōhaku Master Plan.* Prepared by DLNR to address the mid-level facility at Hale Pōhaku. Served as a guide to UH in the design and construction of the astronomy mid-level facility. The plan incorporated the needs of the six telescopes in the operation at that time, allocated space for public restoration and set controls for future expansion. (1998 audit report).	
1982	*Research Development Plan (RDP) for the Mauna Kea Science Reserve and Related Facilities.* UH approved the RDP as its own research development plan for the Mauna Kea Science Reserve and Hale Pōhaku facilities. The RDP was to serve as a programmatic master plan for the continued development of the Mauna Kea Science Reserve.	UH Board of Regents
1983	*Mauna Kea Science Reserve Complex Development Plan.* UH developed this plan to facilitate the implementation of the specific research facilities identified in the plan. The plan consisted of two components. The first component was a complex development plan to provide the physical planning framework to implement the UH Research Development Plan. The objective of the document was to guide and control development in order to preserve the scientific, physical, and environmental integrity of the mountain. The second component was the environmental impact statement to evaluate the general impact of implementing the actions proposed in the complex development plan and propose mitigating actions for potential negative impacts. (1998 audit report).	UH Board of Regents
1985	*University of Hawai'i Mauna Kea Management Plan.* Revised management plan to address concerns from DLNR and the public. BLNR retained management control over the commercial activities. (1998 audit report)	BLNR
1995	*Revised Management Plan for the UH Management Areas on Mauna Kea.* Adopted by UH and DLNR to improve control over commercial uses in the summit area. All management responsibilities, except those related directly to astronomical facilities or the summit road, are transferred back to DLNR. This plan replaced and superseded the 1985 Management Plan. (1998 audit report)	BLNR
2000	*UH Mauna Kea Science Reserve Master Plan.* Adopted by the UH Board of Regents as the policy framework for the responsible stewardship and use of university managed lands on Mauna Kea. Master Plan created a new management structure, housed within the University of Hawai'i at Hilo, as the local management authority over Mauna Kea. UH also established the astronomy precinct, which confines astronomy development to 525 acres within the MKSR. (2000 audit report).	UH Board of Regents

FLORA AND FAUNA OF MAUNA KEA

High elevation areas on Mauna Kea can be divided into two basic types: the subalpine ecosystem (5,600 ft to 9,500 ft elevation), and the alpine ecosystem (above 9,500 ft). Hale Pōhaku occurs in the upper reaches of the subalpine ecosystem, while the Mauna Kea Science Reserve occurs in the alpine ecosystem.

Subalpine Flora and Fauna (Hale Pōhaku and Access Road)

The subalpine plant community found at Hale Pōhaku consists of clumps of māmane trees interspersed with open areas of bare soil or rocky outcroppings. Native understory plants include grasses (alpine hairgrass and pili uka); shrubs ('āheahea, pūkiawe and nohoanu); ferns (kalamoho, 'iwa'iwa, and olali'i); and vines (littleleaf stenogyne and mā'ohi'ohi). Hawai'i catchfly, a threatened species under the Endangered Species Act (ESA), has been observed there as well. A variety of invasive weed species such as grasses and common mullein also inhabit the area, and appear to be increasing in abundance.

Māmane woodlands once stretched from sea level on the leeward side of Mauna Kea to the tree line but have been greatly reduced due to habitat alteration at lower elevations; uncontrolled grazing at the higher elevations by feral sheep, mouflon sheep, and goats; and the presence of invasive plant species that inhibit māmane regeneration.

Māmane woodlands are home to a wide variety of native arthropods (insects, spiders), and several native bird species, including the palila, 'amakihi, 'apapane, 'elepaio, 'akiapola'au, and 'i'iwi. Māmane trees are the primary food source for birds in the region, providing nectar and seeds on a seasonal basis. The māmane woodlands are also inhabited by many species of non-native birds and mammals (e.g. cats, rats, barn owls, and mongoose) that have a direct impact on native bird populations.

Perhaps the most notable bird species in the māmane woodlands is the palila (*Loxioides bailleui*), an endangered species under the ESA. These unique endemic birds were once common in dry forests on several of the Hawaiian Islands. Habitat alteration, first by humans, and subsequently by grazing mammals, has reduced the palila's range to a small band of māmane woodlands that stretches around Mauna Kea. Palilas eat māmane seeds and moth larva found in the seedpods, and so are dependent on the survival of the māmane woodlands.

Alpine Flora and Fauna (Mauna Kea Science Reserve)

As you travel up the mountain towards the summit, the vegetation decreases in diversity, density and size. Alpine plant communities on Mauna Kea begin just above the treeline, at approximately 9,500 ft, and rise to the summit of the mountain at 13,796 ft. The alpine plant communities can be divided into shrublands, grasslands, and stone desert, though there are no sharp lines of delineation between them and all are characterized as being predominantly barren rock and cinder with scattered sparse vegetation.

Alpine Shrublands and Grasslands

Alpine shrublands are inhabited mainly by low-lying shrubby species (e.g., pūkiawe, ōhelo, and Mauna Kea dubautia); scattered grasses (e.g. Hawaiian bentgrass and pili uka); and native ferns (e.g., Douglas' bladderfern, kalamoho, 'olali'i, and 'iwa'iwa). Historically common, but now rare,

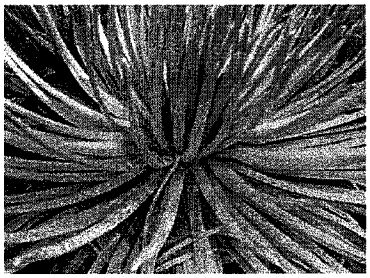
species found in this community include ʻāhinahina (Mauna Kea Silversword), lava dubautia, ʻōhelo papa (Hawaiian strawberry), ʻena ʻena, nohoanu and alpine tetramolopium. Several non-native plant species (e.g., hairy cat's ear, sheep sorrel, common mullein, and fireweed) have invaded the alpine shrublands.

Alpine grasslands replace the shrublands around 11,000 ft in elevation, although pūkiawe shrubs can be found in all habitats, all the way to the summit. The alpine grasslands on Mauna Kea, which occur up to 12,800 ft in elevation, are dominated by two native grasses: Hawaiian bentgrass and pili uka.

Relatively few native animal species utilize alpine shrublands and grasslands as habitat. Invertebrates have not been well studied at these locations. Heavy grazing by feral ungulates has decimated the plant communities in the alpine shrublands and grasslands, and invasive plant species now compete with native plants for limited resources such as water and sheltered growing locations.

Mauna Kea Silversword

At one time, the Mauna Kea Silversword, or ʻāhinahina, dominated the alpine landscape on Mauna Kea from 6,000 – 12,300 ft. ʻĀhinahina is a spectacular plant with thick sword-shaped silvery-green leaves growing in a rosette. The population size of the Mauna Kea silversword was drastically reduced through grazing by feral sheep, goats, mouflon sheep and cattle. Recovery efforts for the Mauna Kea silversword are underway through the efforts of federal and state agencies. Recently a new population of Mauna Kea Silverswords was discovered in the MKSR.



Credit: SRGII

Mauna Kea Summit – Alpine Stone Desert

Although it may appear barren to the casual observer, the summit of Mauna Kea supports an interesting variety of species, many of which are found nowhere else in the world. The summit of Mauna Kea (12,800 – 13,795 ft) is considered an alpine stone desert. This plant community consists of mosses, lichens, and algae, and a limited number of vascular plants, predominantly the same species found in the alpine shrublands and grasslands (e.g., Hawaiian bentgrass, pili uka, ʻiwaʻiwa, and Douglas' bladderfern). Most of the species of plants found in the region are endemic (occurring only in Hawaiʻi) or indigenous (native to Hawaiʻi but occurring elsewhere). A few non-native plant species (e.g., hairy cat's ear and common dandelion) have also become established in the summit region at low densities.

Lichens and mosses dominate the alpine stone desert in terms of diversity and abundance. A survey of lichens on the summit of Mauna Kea identified 21 species (plus five possible other species). Around half of the lichen species found on Mauna Kea are endemic (found only in Hawaiʻi), two of which (*Pseudephebe pubescens* and *Umbilicaria pacifica*) are limited to Mauna Kea alone. The remaining species are indigenous to the Hawaiian Islands. *Lecanora muralis* is the most abundant lichen on Mauna Kea; other common species on the summit are *Lecidea skottsbergii* and *Candelariella vitellina.*

Mosses at the summit occur in protected places where water availability is more consistent, such as under overhanging rocks and in shaded crevices or caves where snow melts slowly. A survey of the mosses on the Mauna Kea summit area (above 13,000 ft) identified approximately 12 species (some could not be identified with certainty to the species level), most of which are indigenous to the Hawaiian Islands. Two moss species, *Bryum hawaiicum* and *Pohlia mauiensis*, are endemic. The most common species of moss include a previously undescribed species of *Grimmia* and *Pohlia cruda*.

The animal community at the summit is dominated by arthropods (e.g., insects and spiders). Other than man, very few vertebrate species venture this high. The arthropod community on the summit of Mauna Kea can be divided into two parts: those species that are blown up the mountain from lower elevations by the wind and die there in the cold (referred to as aeolian drift), and those cold-adapted species that are permanent residents, that feed on the aeolian drift or on one-another. The arthropod community on the summit is highly unusual in that it is mostly made up of predators and scavengers, and there are very few species that rely on plants as their sole food source.

Through the various studies conducted at the summit of Mauna Kea, 21 resident species, and 14 species of undetermined origin (unknown if they are resident or aeolian) have been recorded as occurring in the alpine stone desert. Native resident species include the Wēkiu bug, a noctuid moth, a hide beetle, a large wolf spider, three sheet-web spiders, three species of springtails, two species of mites, a bark louse and a centipede. Non-native resident species include a book louse, big-eyed bug, a hunting spider, a sheet-web spider, and an unidentified jumping spider. It is thought that the non-native spiders may be negatively impacting the native arthropods, but their true impact is unknown.

Wēkiu Bug


Credit: Jesse Eiben

The Wēkiu bug (*Nysius wekiuicola*) is the best-studied invertebrate at the summit – there is little information available regarding the habits of most of the other summit species. The Wēkiu bug is a federal candidate species, meaning that it is being considered for listing as threatened or endangered under the ESA, but has not yet been listed. The Wēkiu bug was first recognized as a new species in 1979. It is a true bug in the family Lygaeidae (order Heteroptera), and is approximately the size of a grain of rice. Wēkiu bugs reside in the cinders on the summit of Mauna Kea, where they use their straw-like beaks to suck the hemolymph (blood) from dead and dying insects in the aeolian drift. Wēkiu bugs mainly reside on or near the crater rims of cinder cones that formed nunataks (ice free areas rising above the surrounding glacier) or that lay at the glacier limit during the last glaciation, and are most abundant on the north- and east-facing slopes (and on slopes shaded by local topography), where seasonal snow remains the longest. Wēkiu bugs can often be seen foraging on the edge of snow banks. Crests of glacially overridden cones and inter-cone expanses of glacial till appear to lack suitable Wēkiu bug habitat. Research continues into aspects of the Wēkiu bug's population size and distribution, life history, and genetics.

PHYSICAL RESOURCES OF MAUNA KEA

Rising nearly 33,000 feet from the ocean floor, with a peak elevation of 13,796 feet, Mauna Kea is the highest point in the Pacific Basin and the highest island-mountain in the world. Mauna Kea was listed as a National Natural Landmark in 1972. One of the reasons given for placing the mountain on this register by the National Park Service is that Mauna Kea is the "Most majestic expression of shield volcanism in the Hawaiian Archipelago, if not the world." Other unique geologic features of Mauna Kea include numerous cinder cones (pu'u) that rise above lavas of the upper plateau, and evidence of glaciers that covered nearly 27-square miles of the summit region during the Pleistocene Epoch (Ice Ages) approximately 18,000 years before present.

Credit: SRGII

Geology

'Hawaiian Hotspot' magmas, pushed up through the oceanic crust, began building Mauna Kea approximately 750,000 years ago. Throughout its building stages, a'a and pahoehoe lavas flowed from three main rift zones, forming a volcano resembling a warrior's shield. Towards the end of the post-shield stage eruptions became more explosive, discharging magma referred to as tephra. These eruptions created the numerous cinder cones dotted across the highest elevations of Mauna Kea. The lavas and other volcanic material comprising the mountain yield clues as to how volcanic processes occur and how those processes relate to the formation of our continental crust.

Three cinder cones (*pu'u*) make up the summit of Mauna Kea (Pu'u Hau'oki, Pu'u Wēkiu, Pu'u Haukea), collectively referred to as Pu'u o Kūkahau'ula, a traditional deity associated with fisherman families. There are additional cinder cones (e.g., Pu'u Keonehehe'e, Pu'u Makanaka, Pu'u Poepoe, Pu'u Poli'ahu, Māhoe, and Pu'u Waiau) below the summit that also have traditional cultural significance and associations with Hawaiian deities.

During the Pleistocene Epoch (Ice Ages) the summit region of Mauna Kea, above approximately 12,500 feet, was covered with glaciers. Scientists agree that at least three different glaciers, referred to as members, were presented during the time span of 150,000 to 18,000 years before present. The movements and melting of the glaciers contributed to the unique land shapes and features of the upper mountain, leaving behind glacial moraines and accumulations of glacially transported and deposited rock, ash, and cinder, which can be observed down to elevations as low as 9,875 feet. In addition it is believed that melting of the glaciers was the first source of water for Lake Waiau.

Climate

Above 7,000 feet, the upper slopes and summit region of Mauna Kea are classified as high alpine desert, above the trade wind inversion, where the air is dry and cool. During winter months (November-April) low-pressure systems tend to inhibit formation of the inversion layer, permitting increased precipitation, including snowfall at the summit. Annual precipitation ranges from 7-18 inches in the summit area to 12-20 inches at Hale Pōhaku.

Hydrology

There are seven watersheds with upper boundaries that extend into the MKSR. Water flow in the gulches and streams within the MKSR is ephemeral, and surface flow occurs only during periods of rapid snow melt or during infrequent high magnitude rainfall events. There are several springs along the gulches located below approximately 12,000 feet.

Situated in the adjacent Mauna Kea Natural Area Reserve at an elevation of 13,020 ft, Lake Waiau is one of the world's highest alpine lakes. Approximately 7.5 feet deep at capacity, hydrologic studies of Lake Waiau have determined that snow melt within the crater of Pu'u Waiau and rainfall landing both in the pu'u and on adjacent upslope lands located inside the MKSR are the primary sources of water in the lake. This small body of water holds great traditional significance for many Hawaiian families.

Credit: SRGII

ACCESS

Vehicular Access

The summit of Mauna Kea is accessible from Saddle Road, Route 200, which connects Hilo to Māmalahoa Highway. From Saddle Road at Pu'u Huluhulu, a paved road extends approximately six miles to Hale Pōhaku. From there, the summit access road extends to and loops around the summit for 10 miles. The first 4.6 miles of the road above Hale Pōhaku is unpaved.

There are parking areas near Hale Pōhaku and the Visitor Information Station (VIS). There are three visitor parking areas along the summit access road: just after the paved road begins, near the trailhead to Lake Wai'au, and just past the junction of the access road and the summit loop. Parking is also available at the summit in the vicinity of the telescopes.

Public Access

The public can access the summit of Mauna Kea via the summit access road and hiking trails. There is no restriction to access except when the road is deemed too dangerous because of weather conditions or when there is snow or ice on the road. Hikers are requested to register at the VIS and inform rangers of their travel plans.

Safety

Mauna Kea is a remote locale with no public accommodations. At 13,796 feet the summit is subject to severe weather conditions. This altitude may also cause acute mountain sickness, especially for those who do not take time to acclimate at Hale Pōhaku. The road above Hale Pōhaku is steep, rough, winding, and particularly dangerous in bad weather. Most rental car companies do not permit their cars on Saddle Road (Route 200) or up to the top of Mauna Kea. Only four-wheel-drive vehicles are recommended beyond the visitor center.

UTILITIES

Water and Wastewater

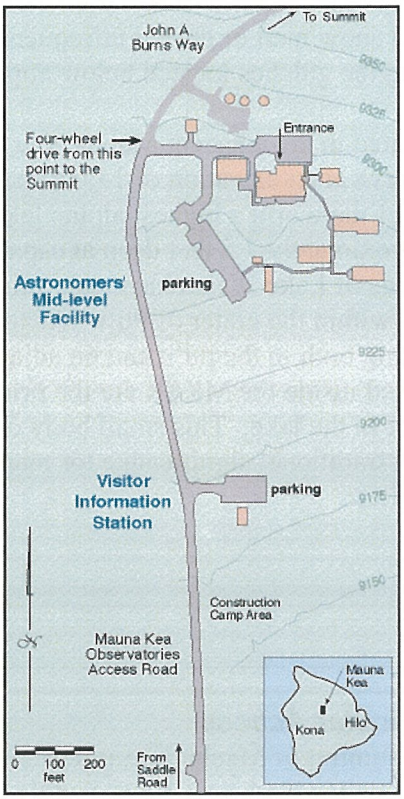
Water is trucked to Hale Pōhaku and the summit from Hilo several times a week.

All sewage disposal and treatment is handled by individual wastewater systems (cesspools and septic tank/leaching field) servicing each facility.

Electricity and Communication

Power and communication lines have been installed underground and support facilities at both Hale Pōhaku and the summit. Electricity for Mauna Kea is presently fed via a 69KV overhead radial feed system to Hale Pōhaku Substation. From this substation there is an underground 12.47KV dual-radial feed system that essentially loops around the Mauna Kea summit.

In the mid-1990s fiber optic lines were installed to provide high-speed communication capability to the Mauna Kea observatories.



Credit: UH Institute for Astronomy

TELESCOPES ON MAUNA KEA

There are currently thirteen telescopes near the summit of Mauna Kea. Nine of them are for optical and infrared astronomy, three are for submillimeter wavelength astronomy and one for radio astronomy. They include the largest optical/infrared telescopes in the world (the Keck telescopes), the largest dedicated infrared telescope (UKIRT) and the largest submillimeter telescope in the world (the JCMT). The westernmost antenna of the Very Long Baseline Array (VLBA) is situated at a lower altitude two miles from the summit *(UH Institute for Astronomy).*

Mauna Kea Telescopes (2008) (http://www.ifa.hawaii.edu/mko/telescope_table.htm)

	Name	Mirror	Owner/Operator	Year Built
Optical/Infrared				
UH 0.6m	UH 0.6-m telescope	0.6m	University of Hawai'i	1968
UH 2.2m	UH 2.2-m telescope	2.2m	University of Hawai'i	1970
IRTF	NASA Infrared Telescope Facility	3.0m	National Aeronautics and Space Administration/ UH	1979
CFHT	Canada-France-Hawaii Telescope	3.6m	Canada/ France/ UH	1979
UKIRT	United Kingdom Infrared Telescope	3.8m	United Kingdom	1979
Keck I	W. M. Keck Observatory	10m	Caltech/ University of California/NASA	1992
Keck II	W. M. Keck Observatory	10m	Caltech/ University of California/NASA	1996
Subaru	Subaru Telescope	8.3m	Japan	1999
Gemini	Gemini Northern Telescope	8.1m	USA/ UK/ Canada/ Argentina/ Australia/ Brazil/ Chile	1999
Submillimeter				
CSO	Caltech Submillimeter Observatory	10.4m	Caltech/ National Science Foundation	1987
JCMT	James Clerk Maxwell Telescope	15m	UK/ Canada/ Netherlands	1987
SMA	Submillimeter Array	8x6m	Smithsonian Astrophysical Observatory/ Taiwan	2002
Radio				
VLBA	Very Long Baseline Array	25m	National Radio Astronomy Observatory/ National Science Foundation/ Associated Universities, Inc.	1992

Mauna Kea's Unique Environment for Astronomical Research

The summit of Mauna Kea hosts the world's largest ground-based astronomical observing site, considered to be the finest in the world. Physical characteristics that set Mauna Kea apart from other sites include high altitude, atmospheric stability, minimal cloud cover, low humidity, dark skies (resulting from remoteness from urban development and the County of Hawaii's island-wide lighting ordinance), and the transparency of the atmosphere to infrared radiation. A tropical inversion layer about 2,000-ft thick, between 5,000-7,000 ft, provides the upper atmosphere with a buffer from the lower moist maritime area, keeping it clear, dry and free of atmospheric pollutants. Due to the location of the Hawaiian Islands within the northern hemisphere tropics, astronomers can observe the entire northern sky and nearly 80 percent of the southern sky.

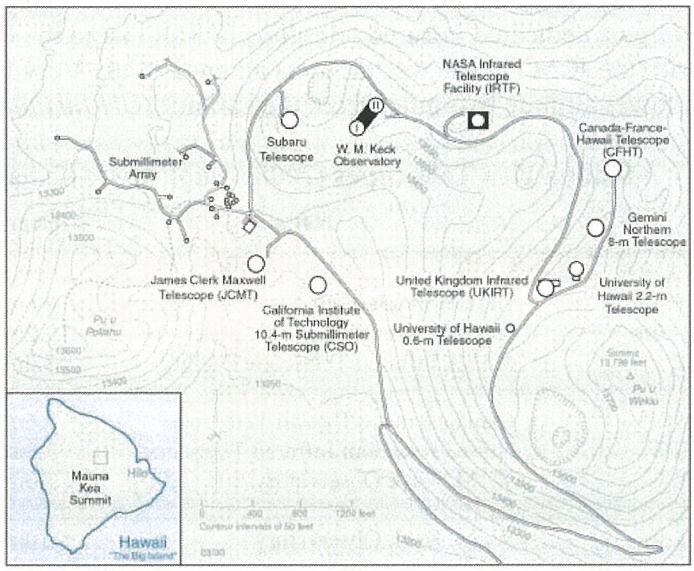
Discoveries Made by Mauna Kea's Telescopes

Over the years, Mauna Kea's telescopes have contributed to a better understanding of our planet and the universe. Following are news articles that highlight some of Mauna Kea's more recent discoveries:

Hawai'i's Mauna Kea Observatory Aids Discovery of Largest Transiting Extrasolar Planet Found Around A Distant Star
The Honolulu Advertiser
November 7, 2007
http://snipr.com/MaunaKea1

Web of dark matter spans space
The Vancouver Sun
February 21, 2008
http://snipr.com/MaunaKea2

UH scientists observe flipping star
The Honolulu Star-Bulletin
February 19, 2008
http://snipr.com/MaunaKea3



Credit: UH Institute for Astronomy

Viewing Time

The University of Hawai'i receives 10 to 15 percent of each telescope's viewing time in place of a monetary rental fee. This telescope time is allotted to UH scientists to conduct research. Telescope organizations pay for operational and infrastructure development costs on Mauna Kea, such as roadway improvements, installation of fiber optics, operation of the Visitor Information Station, and snow removal.

Education

To live and work under the sky of Hawai'i is an extraordinary privilege. The University of Hawai'i's unmatched access to the telescopes and instruments on Mauna Kea represent a unique resource for education and research. The University of Hawai'i at Mānoa offers both a masters and doctorate degree in astronomy and the University of Hawaii at Hilo offers a bachelors degree. The program is designed for students with a strong background in physical science and focuses on training professional astronomers for academic and research positions.

'Imiloa Astronomy Center

Framed by Hawai'i's rich Polynesian tradition of exploration, 'Imiloa Astronomy Center, is Hawai'i's premier facility for interpreting the deepest mysteries of the universe by the Mauna Kea observatories; 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. 'Imiloa explores the connections between Hawaiian cultural traditions and the science of astronomy. (*'Imiloa Astronomy Center*)

INSTITUTE FOR ASTRONOMY'S LONG-TERM DEVELOPMENT OF OBSERVATORY SITES ON THE SUMMIT OF MAUNA KEA

The Role of Astronomy in Hawai'i

The Institute for Astronomy (IfA) is one of the most respected astronomy institutes in the world. It attracts highly talented faculty and promising students from around the world. It owes this success, in large part, to its access to the world-class observatory complex on Mauna Kea. Rather than expend enormous financial resources to build and maintain these telescope facilities, the University, following the initiative and leadership of IfA, entered into scientific partnerships with national and international partners. Through these scientific partnerships, the observatory organizations provide the funds to build and operate the facilities. The University receives a guaranteed share of observing time at no cost. Most of this is used by IfA astronomers and students (Response to HCR 314, Regular Session of 2006, by Rolf-Peter Kudritzki, Director, Institute for Astronomy, Dec. 1, 2006).

A Modified Plan for Long-Term Astronomical Development on Mauna Kea

It is IfA's goal to sustain Hawai'i's reputation as the premier facility of ground-based astronomy study in the world. This achievement will not only benefit UH as an educational and research institution, but will also have broad educational and economic benefits to the entire state. IfA's modified plan includes the following for the next 20 years:

Submillimeter Array (SMA)

The 2000 Master Plan originally proposed 12 more antennas and 24 new concrete pads for the array; the new modified plan proposes 2 more antennas and two pads. UH is also working on relocating two existing antenna pads located at the base of Pu'u Poli'ahu, a culturally significant site, pursuant to request by Kahu Kū Mauna.

UH Hilo Instructional Telescope

The 2000 Master Plan originally proposed to build a new observatory site on the summit ridge for the UH Hilo instructional telescope. Instead of building on a new site, IfA gave UH Hilo the use of the UH 24 in (0.6 m) telescope site for its instructional telescope.

Pan-STARRS Observatory

Pan-STARRS uses completely new technology to detect killer asteroids that threaten to collide with the Earth. IfA is proposing to redevelop the site of the existing UH 2.2 meter Telescope for Pan-STARRS.

Thirty-Meter Telescope (TMT)

With its 30m-diameter mirror, TMT will be the largest telescope in the world. It will be able to detect the most distant galaxies in the universe, seeing them in a stage when the universe was still very young, just after the Big Bang. Mauna Kea is being considered as a candidate site for the TMT, along with locations in Mexico and Chile. The proposed site for this observatory will be on the northern plateau below the summit ridge. The TMT is a one billion dollar project – the most ambitious project in modern astronomy – and will have an enormous scientific, educational and economic impact. If Hawai'i is chosen as the location, the TMT will secure leadership of Hawai'i in astronomical science for the next few decades.

Obsolete Telescopes

IfA is proposing to demolish some of the old facilities and conduct site restoration.

MAUNA KEA COMPREHENSIVE MANAGEMENT PLAN: FAQs

What is the Comprehensive Management Plan (CMP) for Mauna Kea?

State law defines a management plan as a comprehensive plan for carrying out multiple land uses. The CMP for Mauna Kea, therefore, is a management plan that will specifically address multiple land uses on those lands managed by the University of Hawai'i (UH) on Mauna Kea. The CMP will provide a management framework for the Office of Mauna Kea Management (OMKM) to address existing and future activities on these conservation lands, with the goal of protecting Mauna Kea's significant cultural and natural resources.

What is the management area covered by the CMP?

The CMP will address UH-managed lands on Mauna Kea, including the Mauna Kea Science Reserve (MKSR) (11,288 acres); the 19.3-acre site at Hale Pōhaku (including the Onizuka Center for International Astronomy (OCIA), the Visitor Information Station and cabins); and the summit access road from Hale Pōhaku to the MKSR boundary at the approximately 12,000-feet elevation, including a corridor approximately 400 yards on either side of the improved road (except for portions of this corridor which fall within the boundary of the Natural Area Reserve).

What is the land-use zoning for the CMP management area?

The summit of Mauna Kea is located in the resource subzone of conservation district lands that fall under the jurisdiction of the Department of Land and Natural Resources (DLNR). Conservation district lands are regulated to conserve, protect and preserve the important natural resources (i.e., plants; wildlife; cultural, historic and archaeological sites) through appropriate management that promotes long-term sustainability, public health, safety and welfare. Per Hawaii Administrative Rules, Chapter 13-5, the objective of a resource subzone is to develop, with proper management, areas to ensure sustained use of natural resources.

Astronomy projects proposed in the resource subzone require a management plan. Pursuant to a recent ruling by the Honorable Judge Glenn Hara, the management plan must be comprehensive in scope and is a condition of the conservation district rules for granting a permit for astronomical use within the MKSR.

Have other CMPs been developed for Mauna Kea?

No. This will be the first Comprehensive Management Plan for Mauna Kea.

What are the 1995 Revised Management Plan for Mauna Kea and the 2000 Master Plan, and how do they differ?

The *1995 Revised Management Plan for the UH Management Areas on Mauna Kea*, is the current BLNR-approved plan for Mauna Kea. This plan assigns management and enforcement responsibilities of public and commercial use and institutes commercial use and management controls for the UH Management Areas on Mauna Kea.

The *UH Mauna Kea Science Reserve Master Plan* 2000 Master Plan was adopted by the UH Board of Regents as the policy framework for the responsible stewardship and use of university-managed lands on Mauna Kea.

How will the CMP differ from the 1995 Revised Management Plan for Mauna Kea and the 2000 Master Plan?

The CMP will build upon the previous management and master plans to update the management strategies for the range of activities on and uses of Mauna Kea. The CMP will include detailed information about natural and cultural resources, including management recommendations to ensure their protection, by incorporating plans currently being prepared by OMKM consultants. It will also consider how to process and manage existing and potential future uses of and activities on Mauna Kea, such as astronomy, recreational and commercial activities, scientific research, and cultural and religious activities.

What is the proposed schedule for completion of the CMP?

It is anticipated that a draft of the CMP will be available for public review in October 2008. After public review, the CMP will be submitted to the Mauna Kea Management Board for review in November, and then submitted to the BLNR in December 2008 for final review and approval.

Will there be community meetings for the public to give input on the CMP?

Yes. There will be both traditional large public meetings as well as local style talk story sessions throughout the CMP planning process. Meeting dates, times, and locations for the public meetings are posted on the 'Upcoming Meetings' page. The CMP project team is meeting with key stakeholders from various groups throughout the state to receive input. Please contact Ku'iwalu at 539-3580 or via the website if you would like to have a presentation before your organization.

Who will approve of and accept the CMP?

The draft CMP will be available to the community for their review and comment. Thereafter, the CMP will be submitted to the Mauna Kea Management Board for review, and then to the Board of Land and Natural Resources (BLNR) for final submission and approval.

Who will implement the CMP?

The Office of Mauna Kea Management will implement the CMP. The CMP process may include recommendations for consideration by other entities, including the Department of Land and Natural Resources.

Will the CMP consider Native Hawaiian practices?

Yes. The CMP will seek to honor and respect Mauna Kea as a culturally significant site. The CMP will address concerns regarding the multiple uses of Mauna Kea (e.g., telescopes, human access) as they impact the cultural resources of Mauna Kea. Through community engagement, culturally appropriate management recommendations will be identified to manage the uses of and activities on Mauna Kea in order to sustain the cultural integrity of Mauna Kea. The CMP will contain strategies to preserve and protect native Hawaiian traditional and customary practices, culturally significant resources, and access to them.

Will the CMP address visitors and their impact on the summit's environment?

Yes. In addition to being a sacred cultural site, a unique natural environment, and a place of astronomical study, Mauna Kea is a frequent stop for tourists and recreational visitors. The CMP will recommend management measures designed to minimize the impact of visitors on Mauna Kea's sensitive environment.

Will the CMP address the future of telescopes on Mauna Kea?

The CMP will provide guidelines and recommendations for evaluating potential future land uses and ensuring that potential impacts to cultural and natural resources are minimized. In addition, the CMP will address issues related to locations for new developments, decommissioning of telescopes, and site restoration.

Is the CMP being driven by the proposed new telescope developments, i.e. Pan STARRS and TMT (Thirty Meter Telescope)?

No. For OMKM a CMP is necessary for managing activities on and uses of Mauna Kea whether or not new development occurs. OMKM and the MKMB need a CMP to guide them in the review of any future project that is submitted for review. Any future land use, including PanSTARRS or TMT, will be required to comply with all federal, state, and county regulatory requirements, including DLNR conservation district use permits and environmental laws set forth in Hawaii Revised Statutes, Chapter 343.

Appendix A5. Media Coverage

Hawaii Tribune Herald

Local News

No stop, no top of mountain

Enforced orientation is proposed for all Mauna Kea visitors

By Peter Sur
Tribune-Herald Staff Writer
Published: Friday, October 31, 2008 10:57 AM HST

All visitors going to Mauna Kea would be required to undergo an orientation, according to a summary of a draft management plan released earlier this month.

The draft Mauna Kea Comprehensive Management Plan will come out by the end of the year for public review, said Dawn Chang, the principal of consultant Ku'iwalu. The company is preparing the management plan for the University of Hawaii, which holds the lease on Mauna Kea's summit region.

"Nothing is set in stone," Chang said.

Chang, a former state deputy attorney general, said the "voluminous" draft CMP would not likely be ready for review by the time a series of public meetings are held around the Big Island in mid-November. She said the 10 pages of recommendations in the summary distilled the essence of the draft, and would be sufficient to get feedback.

"We're taking this plan out to the community through public meetings," Chang said. She has also spoken to smaller groups; on Thursday, Chang was interviewed by phone just after leaving a Kona-Kohala Chamber of Commerce meeting.

Following the publication of the draft recommendations and the public meetings, comments gathered in the process will be incorporated into a final version. The state Board of Land and Natural Resources must give final approval to the plan, which is required before any new telescopes can be built on Mauna Kea.

At a series of public meetings earlier this year, speakers favored some kind of cultural and environmental orientation for those visiting Mauna Kea.

Chang said such an orientation would include a 30-minute video presentation, similar to what visitors have to see before arriving at the USS Arizona Memorial or Hanauma Bay on Oahu, before going up Mauna Kea.

Many questions about implementing an orientation program remained unresolved, Chang said, including how to pay for it, whether anybody would be exempt and whether visitors would be charged a fee. Chang said those were management decisions that would be addressed by the UH Office of Mauna Kea Management and the broader community, not by the plan.

The draft will also propose that people going up regularly be re-certified by having to watch the video on an annual basis. Visitors might be issued a card, good for a year, Chang said.

It's unclear where this video would be seen. The Mauna Kea Visitor Information Station at the 9,200-foot elevation would need to be enlarged to accommodate the visitors and observatory staff. The 'Imiloa Astronomy Center of Hawaii is large enough, but it would be impractical to require West Hawaii residents to drive to Hilo before being allowed to reach the summit.

Other highlights of the draft plan's recommendations include:

-- Having Kahu Ku Mauna, the advisory council, work with Hawaiian leaders regarding access and traditional and customary cultural practices.

-- Defining and maintaining a trail network with signage, and areas where snow-related activities can occur. Prohibiting commercial tours and tournaments involving snow play, "extreme sports," camping and the building of fires in UH-managed areas.

-- Considering the feasibility of paving the entire summit access road.

-- Developing a plan to remove, monitor and prevent trash from building up on the mountain.

-- Requiring an independent construction inspector, funded by the project, to ensure all aspects of construction comply with protocols and permit requirements, and an on-site monitor during construction activity.

-- Requiring observatories to develop plans to recycle or demolish facilities once their useful life has ended.

-- Developing a map with land-use zones in the Astroomy Precinct to mark out areas where future land use will not be allowed.

The summary document does not address specific telescopes, such as the proposed Thirty Meter Telescope and the Pan-STARRS asteroid-finding telescope. The TMT's Environmental Impact Statement, now under development, is dependent on the approval of the management plan.

The summary remains silent on what will happen when the UH lease expires in 2033, the thorny issue of ceded land payments to and other political issues not directly connected to resource management.

OMKM Interim Director Stephanie Nagata could not be reached for comment.

Chang was encouraged by the Association of Hawaiian Clubs' recent adoption of a resolution urging the BLNR to approve a management plan and another urging the Legislature to grant OMKM rule-making authority.

This last point is critical for the full implementation of the management plan. As the summary document states:

"Many of the management actions identified in this plan are contingent on the University of Hawaii obtaining rule-making authority, developing rules, and having the authority to enforce those rules. The inability to obtain this authority will continue to impede the university's ability to protect Mauna Kea's cultural and natural resources."

On the Internet: http://www.maunakeacmp.com

E-mail Peter Sur at psur@hawaiitribune-herald.com.

How to comment

1. Review a summary of the draft Mauna Kea Comprehensive Management Plan at http://www.maunakeacmp.com.

2. Attend one of the following public meetings:

-- 5-8 p.m. Friday, Nov. 14, at Kealakehe Elementary School

-- 5-8 p.m. Monday, Nov. 17, at Waimea Civic Center

-- 5:30-8:30 p.m. Tuesday, Nov. 18, at Keaukaha Elementary School

3. Submit your comments at the meeting, or by fax (808 539-3581), Internet (http://www.maunakeacmp.com/contact), e-mail (comments@maunakeacmp.com) or mail (Ku'iwalu, 1003 Bishop St., 27th Floor, Honolulu, HI, 96813). The deadline to submit written comments for the draft CMP is Nov. 26, although comments will continue to be accepted after that.

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Star Bulletin

FRIDAY NOVEMBER 7, 2008 • HAWAII'S OLDEST DAILY NEWSPAPER, SINCE 1882 • 50¢

Mauna Kea visitors might need a class

By Rod Thompson
rthompson@starbulletin.com

HILO >> A draft summary of a comprehensive management plan for Mauna Kea, which includes mandatory education for users of the mountain, has been released by the University of Hawaii and related agencies.

"The preferred approach to managing the cultural and natural resources is based upon education," the 11-page summary says.

That education would "require orientation of users, with periodic updates and a certificate of completion, including but not limited to visitors, employees, observatory staff, and commercial and recreational users."

How extensive such an orientation would be for casual visitors driving up the mountain is not clear, but it would include advice on "culturally appropriate behavior," contact with Mauna Kea rangers, and use of signs and brochures.

Mauna Kea, a prime astronomy site because of the thin atmosphere at the 13,796-foot summit, is considered sacred in Hawaiian culture. According to Malama Mauna Kea, the mountain has 76 ancient shrines and was host to religious practices, observation of the heavens and tool-making.

The plan is being written in response to a 2006 ruling by Hilo Circuit Judge Glen Hara in a lawsuit brought by Hawaiian and environmental groups against six relatively small "outrigger" telescopes proposed for construction around the two giant Keck telescopes on Mauna Kea.

Hara ruled the outriggers could not be built until a comprehensive master plan was written.

UH, which controls the 525-acre summit area, adopted a Mauna Kea Science Reserve Master Plan in 2000. But Hara ruled that the management section was not detailed enough. The current management draft does not propose any new limits on the number of telescopes on Mauna Kea.

However, it recommends a new map showing what portions of the summit area may be developed. It also recommends requiring observatories "to develop plans to recycle or demolish facilities once their useful life has ended."

The recommendations are at www.maunakeacmp.com. Click on "Review CMP Recommendations."

Meetings on the recommendations will be held:
>> next Friday, Kealakehe Elementary School in Kona, 5 to 8 p.m.
>> Nov. 17, Waimea Civic Center, 5 to 8 p.m.
>> Nov. 18, Keaukaha Elementary School in Hilo, 5:30 to 8:30 p.m.

West Hawaii Today

Public input sought on Mauna Kea management

by Daniel Brock
West Hawaii Today
dbrock@westhawaiitoday.com
Sunday, November 9, 2008 7:17 AM HST

Got an idea for Mauna Kea? Now would be a good time to mention it.

The Office of Mauna Kea Management and the University of Hawaii, through its consultant Kuiwalu, will be holding a second round of public meetings throughout Hawaii Island to let the community review draft recommendations being considered in the Mauna Kea Science Reserve's Comprehensive Management Plan.

Three forums will be held around the Big Island: 5 to 8 p.m. Nov. 14 at Kealakehe Elementary School; 5 to 8 p.m. Nov. 17 at Waimea Civic Center; and 5:30 to 8:30 p.m. Nov. 18 at Keaukaha Elementary School.

In the first round of meetings, the public was asked to provide comments on the major management issues and concerns regarding Mauna Kea.

Now residents will have an opportunity to offer feedback on the proposed management recommendations before the plan is presented to the Mauna Kea Management Board for review and ultimately submitted to the Board of Land and Natural Resources for final approval.

"The first reason comprehensive managemen plan is need needed, is because Mauna Kea is a significan cultural and natural resouce and there is currently no plan to protect the resources," Kuiwalu principal Dawn Chang said.

Officials from the Office of Mauna Kea Management were not available for comment.

Among the multiple uses of Mauna Kea addressed by the draft recommendations are existing and potential development within the Mauna Kea Science Reserve, decommissioning and restoration of obsolete telescopes and access for traditional and customary practices.

Throughout the planning process, Kuiwalu engaged in discussions and exchanged ideas with community leaders, community organizations, Native Hawaiian groups, landowners, public agencies, elected officials and concerned residents.

"This is an issue that been of a concern of Big Island residents – in particular – many native Hawaiians," Chang said. "It's important to seek their opinion because Mauna Kea is important to everyone on the Big Island, and the community doesn't feel they've been involvded in the management process. That's why it's important that we engage the community."

According to the plan's Web site, it will address University of Hawaii-managed lands on Mauna Kea, including the 11,288-acre Mauna Kea Science Reserve; the 19.3-acre site at Hale Pohaku – including the Onizuka Center for International Astronomy, Visitor Information Station and cabins – and the summit access road from Hale Pohaku to the reserve boundary at the approximately 12,000-feet elevation. It will also include an approximately 400-yard corridor on either side of the improved road, except for portions of the corridor that fall within the boundary of the Natural Area Reserve.

State law defines a management plan as a comprehensive plan for carrying out multiple land uses. The comprehensive management plan for Mauna Kea will specifically address multiple land uses in those areas on Mauna Kea managed by the University of Hawaii.

The plan will provide a management framework for the Office of Mauna Kea Management to address existing and future activities on those conservation lands, with the goal of protecting Mauna Kea's significant cultural and natural resources.

It will the first Comprehensive Management Plan for Mauna Kea, and it comes after a 2006 legal battle in which Judge Glenn Hara ruled that astronomy facilities on Mauna Kea – which is a conservation district -- need a a comprehensive management plan.

"It's the right time for the (management plan,)" Chang said. "The Office of Mauna Kea Management has been working on this for several years. And because of the judges decision and the culmination of their work, we are now prepared to seek communinty input on the the draft comprehensive management plan recommendations."

Appendix A6. Mauna Kea CMP Newsletter

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MAUNA KEA COMPREHESIVE MANAGEMENT PLAN

Additional Concerns And Comments

We were glad to receive an array of additional comments from members of the community, many of which had never been brought to our attention before. This unexpected input proved the value of the public outreach component of the CMP process. Following are some of the variety of concerns and comments raised by those we spoke with.

Native Hawaiian Scholarships
Many who participated in the outreach effort felt the astronomy facilities and the university need to provide greater educational opportunities to the Hawaiian community, either through college scholarships or by developing science and math curriculum utilizing Mauna Kea for our elementary schools.

Enforcement Powers
The lack of enforcement authority for Mauna Kea Rangers was seen to be detrimental for the mountain. Many understand how important the role of the Rangers is in protecting Mauna Kea's cultural and natural resources but questioned how Rangers are expected to do their job effectively when their power is extremely limited.

Hunting and Gathering
We also heard from the subsistence hunters and native Hawaiian cultural practitioners who use Mauna Kea to hunt and gather for cultural or subsistence purposes. Their concern was how the CMP will affect their rights to access.

Legal Issues
Concerns were raised over the legalities and potential conflict of having the plaintiffs in the Outrigger Telescopes case participate in the CMP process when the University was appealing the case.

Jurisdictional Responsibility
Many were interested in knowing if the CMP will address the different jurisdictional issues between the University of Hawaii at Manoa, University of Hawaii at Hilo, Institute for Astronomy, Office of Mauna Kea Management, Department of Land and Natural Resources, Department of Hawaiian Home Lands, and Pohakuloa, and questioned whether the CMP will include the areas outside the Mauna Kea Science Reserve.

Public Opinion Survey
It was suggested that an island-wide survey be conducted to determine how the community as a whole felt about the issues in question. Those who suggested the survey said it was important to know how those unable to come to the meetings would respond to the issues being raised.

Next Steps for the CMP
Members of the CMP team will review all of the comments received at the public meetings and small talk-story sessions. Our intent is to bring a draft of the CMP to the community for public review in the fall.
Please visit the website, www.MaunaKeaCMP.com to check for updates on meeting announcements and to let us know what you think.

VISIT WWW.MAUNAKEACMP.COM FOR MORE INFORMATION

Aloha Kakou,

After several months of public input, the Mauna Kea Comprehensive Management Plan (CMP) team has learned a great deal about the community's views on how Mauna Kea should be protected and managed as a cultural, environmental, educational and recreational resource. I have personally spoken with many of you in small talk-story conversations or heard your statements at public meetings.

The goal of the CMP is to provide the Office of Mauna Kea Management with recommendations to effectively and efficiently manage the uses and activities on Mauna Kea in a way that will preserve and protect its cultural and natural resources. The objective of the community engagement process is to ensure that the CMP honestly reflects the community's sentiments about how Mauna Kea should be managed.

In undertaking this process, we have made every effort to genuinely reach out to the community in as many different forums as we could offer. This report is our way to honor the comments that have been shared with us to date and to keep you informed on the CMP process. I hope you enjoy this newsletter and encourage you to stay in touch, visit the website (www.MaunaKeaCMP.com), get involved and let us know of any questions or comments.

Sincerely,

Dawn N.S. Chang
Principal, Ku'iwalu

The Community Engagement Process and Approach

The team working on the Mauna Kea Comprehensive Management Plan (CMP) believes that an effective plan requires input and participation of as many stakeholders as we can reach. Accordingly, we undertook a variety of initiatives to reach all types of interested groups and individuals in every part of the community.

This work was done in coordination with the Office of Mauna Kea Management (OMKM), Mauna Kea Management Board (MKMB), the Environmental Committee of the MKMB, and Kahu Ku Mauna. As the prime contractor on the project, Ku'iwalu, represented by company principal Dawn Chang, provided regular updates at MKMB public meetings. The Board of Land and Natural Resources was also briefed on the project and its development.

Aside from these government and officially designated organizations, Ku'iwalu met in local-style small talk-story sessions, beginning in 2007, engaging more than 100 individuals and groups. These groups represented a spectrum of interests, including cultural, astronomical, environmental, and recreational. These sessions will continue until the CMP is completed.

In addition, traditional public meetings were held in Waimea, Kona and Hilo. The participants in these meetings raised a range of ideas and concerns and brought considerable passion to the issues discussed.

To ensure widespread access to all information about the CMP process, we launched a website: www.MaunaKeaCMP.com, which contains an extensive amount of information and materials about Mauna Kea, previous planning efforts and other background that will inform the decision making on the CMP. We urge you to visit the website and let us know what you think.

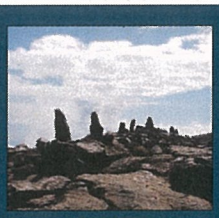
We also worked diligently to ensure the news media was kept informed about the CMP project, since newspapers and radio are sources of information for the majority of Hawaii Island residents. Our media outreach effort included holding meetings with the editorial boards of daily newspapers published on the Big Island and statewide, as well as OHA's Ka Wai Ola. We also participated in an interview on Big Island NPR station Lava105 and appeared on community television station Olelo. We will continue to release all noteworthy information to the news media as events dictate.

Recently, we conducted a statewide telephone survey to obtain opinions from the wide variety of groups and individuals who make up our community. The results will be published soon and posted on our website.

Community Outreach Participants Speak Up

During the community outreach we received a wide range of comments and responses from "take all the telescopes down" to "if we are going to have telescope development, it should be the best in the world." Although the responses were varied, the emotions and passions about Mauna Kea were constant. Many people, especially native Hawaiians, felt angry, hurt, about the lack of respect shown in the development on Mauna Kea. But many also felt a strong desire to find a solution to managing both existing and potential future uses on Mauna Kea, including telescope development, if it will help our young people with educational and economic opportunities.

The issue of ceded lands and why only $1 a year is charged for the use of Mauna Kea elicited a range of opinions from native Hawaiians and non-Hawaiians alike. The degradation of the aquifer by the telescope facilities was an issue that concerned many of the Big Island participants. Others viewed the telescopes on Mauna Kea as a benefit to the island's economy, creating many jobs and opportunities for education and the scientific discoveries.

Specific Public Meeting Questions and Answers

At the public meetng , we asked a series of questions about various management issues based upon our review of past management plans, master plan, public testimonies and statements.

Q: Do you believe that everyone who accesses Mauna Kea (including tourists, astronomers and support staff, commercial tours, etc.) should be required to receive a cultural, environmental and safety orientation before going to the summit?

A: The responses received unanimously supported some form of cultural orientation or training for everyone who visits Mauna Kea. It was suggested the orientation be similar to those required when visiting the USS Arizona, Hanauma Bay, and Kaho'olawe. Although there was no agreement on the location where the orientation should be held, it was agreed that everyone should be required to take part in it.

Education was seen as the first line of defense in protecting the mountain's cultural and natural resources. And there was overwhelming agreement that Native Hawaiians, particularly Kupuna, should be involved in the development of the orientation.

There was a general consensus that visitors do not intend to be disrespectful, but they don't know what behavior is inappropriate or damaging to the environment. Providing education and information to visitors will result in more respectful and conscientious behavior toward Mauna Kea and its resources.

Q: Do you believe that science (i.e., astronomy facilities) and Hawaiian culture can co-exist on Mauna Kea? Do you believe there is room for new development on Mauna Kea, if so where?

A: Undoubtedly this was the most difficult question, as it goes to the heart of the strong feelings held by some in the community about the telescopes on Mauna Kea.

From a cultural standpoint, many Hawaiians feel strongly the summit of Mauna Kea is the most sacred site, the Piko, of the Hawaiian people, not only on the Big Island but throughout Hawaii. The placement of any telescope on the summit was seen by some as deeply disrespectful. Among these individuals are those who would like the telescopes removed from the summit at the end of the lease term in 2033.

There were several comments from Hawaiians and non-Hawaiians who demanded that, before further development is discussed, the UH apologize or acknowledge the disrespect to the Hawaiian community that occurred as a result of telescope development.

Some Native Hawaiians talked about King Kalakaua and his initiative to bring the first telescope to Hawaii. They cited the ties between Hawaiian culture and the study of astronomy, pointing out the importance of the stars for navigation.

The majority of Hawaiians and non-Hawaiians expressed the sentiment that there is a way for some existing and new astronomy facilities to be on the mountain, as long as some of the telescopes are removed from the summit and new construction was undertaken in a culturally sensitive manner. There were many people who indicated that the University of Hawaii should demonstrate its commitment to respecting the Hawaiian culture by developing a plan to decommission older telescopes before new ones are considered.

'Imiloa was identified as a good example of how science and culture can co-exist. It was also suggested that there should be greater community use and access of the facility, especially for children.

A proposal that new telescope development should only occur in the existing footprints of decommissioned telescopes resonated strongly with many participants. Others believe that new development should occur on a new site, a place known as the Northern Plateau, below the summit, under the condition that no Hawaiian burials are disturbed or removed and that identified cultural sites are protected.

Regarding the environment, many said it is too fragile to permit any new development, especially when there are no thorough studies on the effects of the current facilities on Mauna Kea's natural environment.

However, there were many more public comments in support of a solution that could find a place for both science and culture to co-exist on Mauna Kea.

Q: Do you believe that access should be regulated to ensure that the cultural and natural resources are preserved and protected? (It was clearly stated that access for for Native Hawaiian traditional and customary practices, as protected by the Constitution, would not be adversely impacted by the CMP.)

A: There were a wide variety of responses on this question, ranging from no restriction on access, especially for local people, to rules on access that regulate the number of cars and people that access Mauna Kea. Some suggested everyone must park and take a shuttle to the summit from the visitor's center or some other location, including Department of Hawaiian Home Lands Sheep Station at Humu'ula.

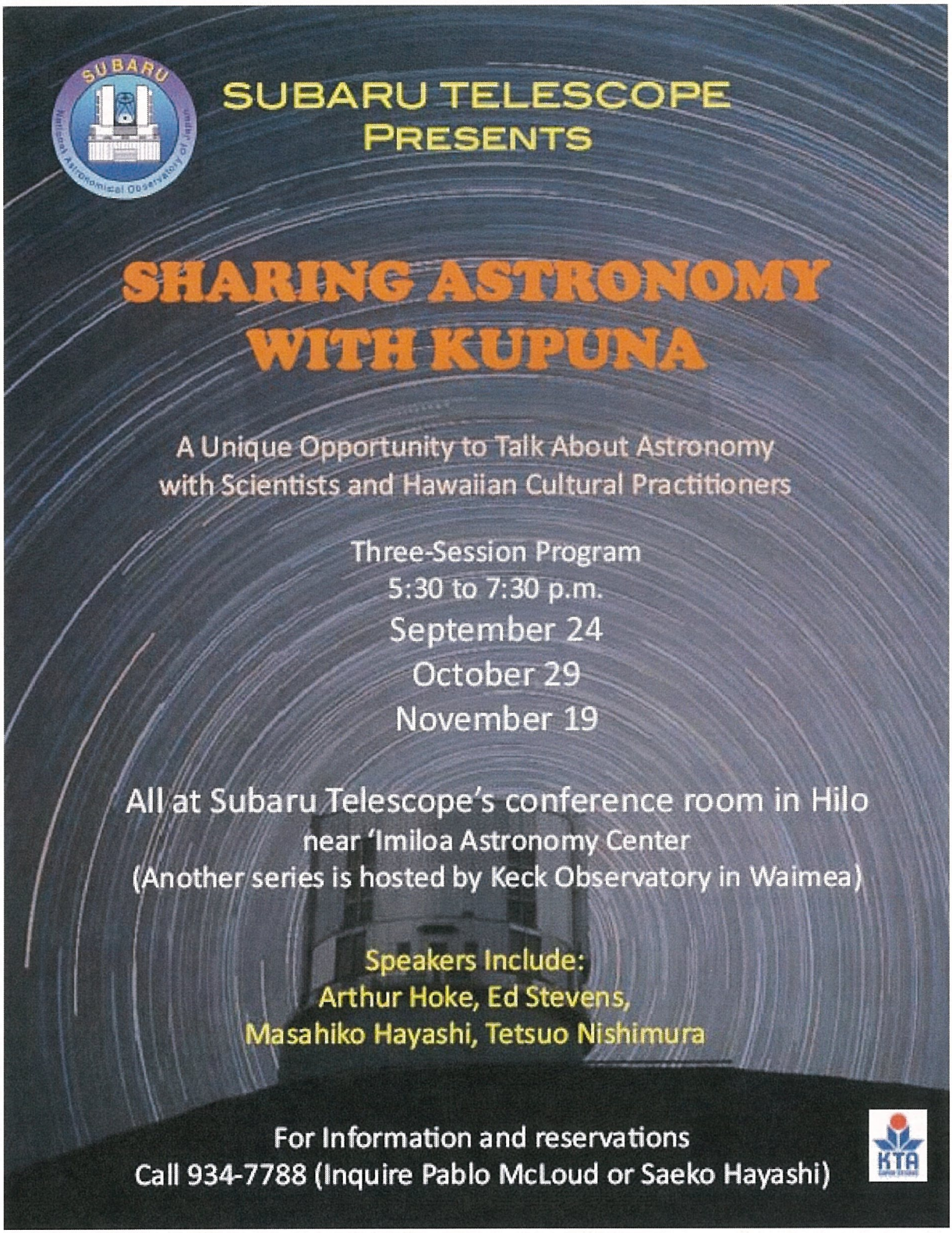
Many expressed the sentiment that something has to be done to regulate access to protect resources, while a few participants suggested charging an admission fee to non-Hawaii residents.

Although there was no consensus, there was strong sentiment that access needs to be managed to ensure that cultural and environmental resources are not adversely impacted.

Many people recommended better signage and interpretative signs so that people would understand why it was important to stay on the trail and road.



Appendix A7. Kūpuna Workshops on Astronomy


SUBARU TELESCOPE
PRESENTS
SHARING ASTRONOMY
WITH KUPUNA
A Unique Opportunity to Talk About Astronomy
with Scientists and Hawaiian Cultural Practitioners
Three-Session Program
5:30 to 7:30 p.m.
September 24
October 29
November 19
All at Subaru Telescope's conference room in Hilo
near 'Imiloa Astronomy Center
(Another series is hosted by Keck Observatory in Waimea)
Speakers Include:
Arthur Hoke, Ed Stevens,
Masahiko Hayashi, Tetsuo Nishimura
For Information and reservations
Call 934-7788 (Inquire Pablo McLoud or Saeko Hayashi)
KTA

SHARING ASTRONOMY WITH KUPUNA

As the International Year of Astronomy 2009 quickly approaches, and the Subaru Telescope passes the ninth anniversary from its dedication this month, Subaru and the W. M. Keck Observatory jointly host a program in each headquarters in Hilo and Waimea, inviting respected community members to find out about the world of astronomy. In Hilo over the next three months, Subaru's base facility will be a gathering place for a talk-story series called "Sharing Astronomy with Kupuna." ***Subaru*** or ***sumaru*** is an ancient Japanese word meaning get together. The program involves a series of informal talks and interactive sessions hosted by Hawaiian cultural practitioners and Hawaii-based astronomers.

During the "Kupuna Series," Subaru astronomers will introduce their latest discoveries, the hot topics in astronomy, and newest cutting-edge technologies. Notable guests from the Hawaiian community will present an overview of Hawaiian heritage and astronomy, celestial navigation and wayfinding, and cultural beliefs and values of Mauna Kea.

The program will occur Wednesday evenings on September 24, October 29, and November 19, 2008. Each session will begin at 5:30 p.m. and will last approximately two hours. The first hour and half of the session will include talk stories and visual presentations. The last half hour will be open for more general questions and answers, with professional astronomers and cultural leaders providing information and assisting with discussion. There is no charge for the program, and light refreshments will be served courtesy of KTA Super Stores. Because seating is limited, please sign up as soon as possible.

Subaru's headquarters is in the University Park complex on the UH-Hilo campus. Situated off Komohana Street, Subaru is located at 650 North A'ohoku Place, a couple hundred yards from and mauka (mountain side) of the 'Imiloa Astronomy Center. Throughout the year, Subaru hosts programs such as the school excursion from elementary to high school classes or groups, trainings for college students or school teachers, and so forth. Public tours at the summit facility are offered during the weekdays' daytime which can be arranged through our web site.

Subaru welcomes kupuna and family members to this interchange of ideas and information. Please call 934-7788 and inquire Pablo McLoud or Saeko Hayashi for further information or to register. On Thursdays following the above Hilo sessions, Keck Observatory hosts a separate session in Waimea, and they can be reached at 881-3854 or through their website at www.keckobservatory.org. More details on the science and research at Subaru Telescope can be found at this website, www.subarutelecope.org.

September 11, 2008

Public Information and Outreach Office
Subaru Telescope
National Astronomical Observatory of Japan

Phone (808) 934-7788 (Inquire Pablo McLoud or Saeko Hayashi)

(attachment) Picture of the Dedication Ceremony at the telescope site, September 17, 1999. (Larger format picture is available upon request.)

Professor Keiichi Kodaira (then the Director General of the National Astronomical Observatory of Japan) addressed the distinguished guests from Hawai'i, the mainland USA, Japan, and other parts of the world, in front of Subaru Telescope.

Appendix A8. Outreach to Engage the Plaintiffs in the Outrigger Telescopes Lawsuit

Ku'iwalu

August 25, 2008

William M. Tam
Alston Hunt Floyd & Ing
ASB Tower, 18th Floor
1001 Bishop Street
Honolulu, Hawai'i 96813

Aloha Bill:

Subject: Mauna Kea Comprehensive Management Plan

In the course of the community engagement process for the Mauna Kea Comprehensive Management Plan (CMP) process, some of the plaintiffs have raised the concern that they did not feel it appropriate to participate in the CMP process so long as the University of Hawai'i was appealing Judge Hara's decision. Now that the University of Hawai'i has decided to withdraw its appeal, I am following up on our telephone conversation, asking your assistance in facilitating a meeting with the Plaintiffs and myself to discuss the CMP.

The Plaintiffs represent a very important segment of the community, in particular the Hawaiian and environmental community, and we value and welcome their input in the development of the Mauna Kea CMP. Accordingly, I would greatly appreciate your assistance in either facilitating this meeting or authorizing me to contact them directly.

Should you have any questions, please do not hesitate to contact me at 539-3583. Your assistance in this matter is greatly appreciated.

Very truly yours,

DAWN N.S. CHANG
Principal

c: Dexter K. Kaiama

Pauahi Tower, 27th Floor · 1003 Bishop Street · Honolulu, Hawaii 96813
PHONE: (808) 539-3580 · FAX: (808) 539-3581 · EMAIL: kuiwalu@kuiwalu.com · WEBSITE: www.kuiwalu.com

Ku'iwalu

March 25, 2008

William M. Tam, Esq.
Alston Hunt Floyd & Ing
1001 Bishop Street
ASB Tower, 18th Floor
Honolulu, Hawaii 96813

Dexter K. Kaiama, Esq.
Dillingham Transportation Building
735 Bishop Street, Suite 419
Honolulu, HI 96813

Julie H. China
Deputy Attorney General
Department of the Attorney General
465 S. King St., Room 300
Honolulu, Hawaii 96813

Lisa Woods Munger, Esq.
Goodsill Anderson Quinn & Stifel
1099 Alakea Street, Suite 1800
Honolulu, Hawaii 96813

Dear Counsels:

Subject: Notice of Land Board Briefing on the Comprehensive Management Plan (CMP) for Mauna Kea

I indicated in previous conversations that I would keep you informed of any matter regarding the CMP for Mauna Kea that we brought before the Land Board. Based upon Judge Hara's decision which requires the Land Board to approve the CMP we have requested an informational briefing before the Land Board at its April 11, 2008 meeting. This will be a joint presentation with the Office of Mauna Kea Management and Ku'iwalu Consulting.

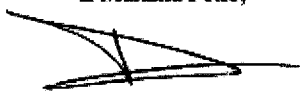
We invite and encourage you and your clients to attend the meeting and share your concerns or comments with the Land Board about the CMP. We intend to present to the Land Board the goals and objectives, the table of contents, and the community outreach planning

Pauahi Tower, 27th Floor · 1001 Bishop Street · Honolulu, Hawaii 96813
PHONE: (808) 539-3580 · FAX: (808) 539-3581 · EMAIL: kuiwalu@kuiwalu.com · WEBSITE: www.kuiwalu.com

process of the CMP, as well as answer any questions that either the Land Board or the public may have regarding the CMP process.

Should you have any questions or want to discuss this matter with me before the Land Board meeting, please don't hesitate to call me at (808) 539-3583.

E Mālama Pono,



DAWN N.S. CHANG
Principal

c: Laura Thielen, Chairperson Board of Land and Natural Resources
Land Board Members
President David McClain, University of Hawai'i
Barry Taniguchi, Mauna Kea Management Board
Bill Stormont, Office of Mauna Kea Management

Appendix A9. Institute for Astronomy's Plans to Remove and Decommission Obsolete Telescopes

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Ku'iwalu

July 11, 2008

Dr. Rolf-Peter Kudritzki
Director, Institute for Astronomy
University of Hawai'i
2680 Woodlawn Drive
Honolulu, Hawai'i 96822

Dear Dr. Kudritzki:

Over the last several months, the Mauna Kea Comprehensive Management Team has been involved in extensive community outreach to gain a better understanding of the community's views on how Mauna Kea should be protected and managed. We have been asking hard questions about the community's view on the co-existence of Hawaiian culture and science, specifically existing and potential future development on Mauna Kea.

This question has generated intense discussion fueled with passion and emotion but a true desire to develop a comprehensive management plan that recognizes and protects the cultural integrity of Mauna Kea while continuing to support the University of Hawai'i as a premier astronomical institution in the world. There are many in the Hawaiian community who recognize the summit of Mauna Kea as one of the most culturally significant sites within the Mauna Kea Science Reserve if not all of Hawai'i. A recurrent theme by both the Hawaiian and non-Hawaiian community is that since the summit of Mauna Kea is so culturally significant, the community would like to see a specific plan that shows the removal of obsolete telescopes from the summit and decommissioning plans for each of the observatories for restoring the summit. In our view, this plan is critical to addressing the cultural concerns that have been consistently raised in our community outreach efforts.

We are aware of your report to the Legislature in 2007 on the Long Term Development of Observatory Sites on the Summit of Mauna Kea. It would be very helpful if you could update your report and provide a specific plan for decommissioning and removal of telescopes.

Your timely attention to this matter is greatly appreciated as we would like to share this information with the community in our future correspondence and public meetings. Should you have any questions, please don't hesitate to contact me at 539-3583.

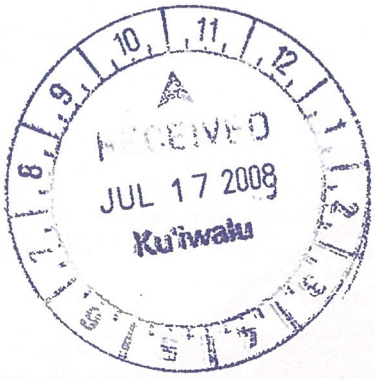
Sincerely,

DAWN N.S. CHANG
Principal

Pauahi Tower, 27th Floor - 1001 Bishop Street - Honolulu, Hawaii 96813
PHONE: (808) 539-3580 - FAX: (808) 539-3581 - EMAIL: kuiwalu@kuiwalu.com - WEBSITE: www.kuiwalu.com

UNIVERSITY OF HAWAI'I AT MĀNOA

Institute for Astronomy
Office of the Director



July 15, 2008

Ms. Dawn N. S. Chang
Principal Ku'iwalu
1003 Bishop Street
Pauahi Tower, 27th Floor
Honolulu, Hawaii 96813

Dear Ms. Chang:

Thank you for your letter dated July 11, 2008. We greatly appreciate the opportunity to address the community's concerns related to telescope development on Mauna Kea.

In December 2006, responding to a request from the Hawaii State Legislature, I as director of the Institute for Astronomy (IfA), submitted a "Report on long-term development of observatory sites on the summit of Mauna Kea". Prior to its submittal, the report was approved by the President of the University of Hawaii. The report describes a long-term development plan that would see a much smaller number of future projects than were described in the UH Master Plan of 2000, but would still maintain Hawaii's world leadership in ground-based astronomy.

The key new developments in this plan are the use of the UH 2.2m telescope site for IfA's new Pan-STARRS observatory and the Thirty-Meter Telescope (TMT) at a new site on the northwest plateau, below the summit ridge. With Pan-STARRS and an appropriate scientific participation in the TMT, and with the present large telescopes on Mauna Kea, the University of Hawaii will be able to retain its world-leading position in astronomical research.

Taking into account the enormous scientific potential of these two new projects for research at UH, the report also addresses the future of the existing facilities:

> *While the Master Plan of the year 2000 assumed that all existing facilities which would not be replaced by new ones would continue to exist for the next 20 years, we do not make this assumption for the new plan. It is clear that newer facilities such as Keck, Gemini, Subaru, Pan-STARRS, the UH Hilo telescope and the SMA will certainly continue to operate over the next 20 years. However, some of the others will not continue with their operation, because other aspects of astronomical observations will become more important. In such cases our plan is not to refurbish all of them but only a few and only in cases where an extremely important scientific case can be made. Otherwise, our new plan is to demolish the old facility, to clean the site and to recreate the site in a stage as it was, before the facility had been built. (It is important to note that Operating and Site Development Agreements—the contracts between UH and the telescope partners on Mauna Kea—require the cost for such reestablishment of the site in its original status have to be paid by the telescope partners). We are confident that in this way the number of observatories on Mauna Kea in 20 years from now will be smaller than now. But with all the new facilities, in particular the TMT, Hawaii will still have the very best in the world.*

2680 Woodlawn Drive, Honolulu, Hawai'i 96822

While this aspect of the report has found substantial support in the community, it has also been noted that the report is not specific about which of the facilities might be replaced or refurbished and which would not, in the event that their current operation ended before the expiration of the sublease with UH. This appears to be consistent with your observations in the community as well.

Accordingly, we present a Revised Plan that addresses this aspect. A fundamental component of our Revised Plan is that Pan-STARRS and the TMT will play a central role in future astronomical research at UH.

Currently, there are four radio telescope facilities on Mauna Kea: the Very Long Baseline Array (VLBA), the Caltech Submillimeter Observatory (CSO), the James Clerk Maxwell Telescope (JCMT) and the Submillimeter Array (SMA). Because of cultural concerns that have been raised about the location of the VLBA, the 2000 Master Plan did not include the VLBA site within the Astronomy Precinct. Therefore, should the operation of the VLBA terminate, or should an alternative site and relocation funding become available, we would not reuse this site for a new project. For the CSO, JCMT, and the SMA, the Revised Plan foresees replacing at most one of these three with a new observatory working preferably in the sub-millimeter or millimeter domain, for which Mauna Kea is well known as the best site in the northern hemisphere. This means that only one of the existing four radio observatory sites would be used in the long term for a new project resulting in possibly three of the radio telescope facilities being removed and those sites restored prior to the expiration of the lease to UH.

There are currently nine optical or infrared observatories on Mauna Kea: the two Kecks, Subaru, Gemini, Canada-France-Hawaii Telescope, NASA Infrared Telescope, United Kingdom Infrared Telescope (UKIRT), UH 2.2m (which if permitted would be replaced by Pan-STARRS, assumed to operate for only 10 years), and the UH 24-inch (which IfA has transferred to UH Hilo as the site for their instructional telescope). Here the Revised Plan is that when the operation of UKIRT comes to an end, the facility will be removed and the site restored.

Sincerely yours,

R. P. Kudritzki

Rolf-Peter Kudritzki
Director

RPK:nll

UNIVERSITY OF HAWAI'I AT MĀNOA

Institute for Astronomy
Office of the Director

July 16 2008

Ms. Dawn N. S. Chang
Principal Ku'iwalu
1003 Bishop Street
Pauahi Tower, 27th Floor
Honolulu, Hawaii 96813

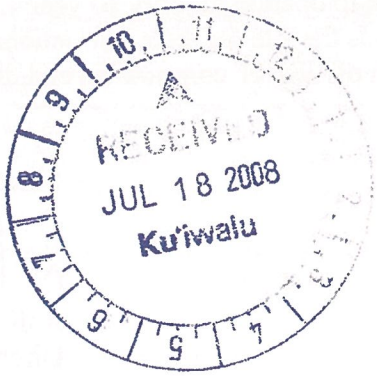
Dear Ms. Chang:

Enclosed for your information are copies of the ten letters we have sent to the Mauna Kea observatory directors asking about their plans for eventual removal and site restoration. We have asked for a response by August 22, 2008.

Sincerely yours,

Rolf-Peter Kudritzki
Director

RPK:nll
encl.



UNIVERSITY OF HAWAI'I AT MĀNOA

Institute for Astronomy
Office of the Director

July 16, 2008

Dr. Christian Veillet
Executive Director
Canada-France-Hawaii
65-1238 Mamalahoa Highway
Kamuela, HI 96743

Dear Dr. Veillet:

Subject: Mauna Kea Comprehensive Management Plan

As you know, the University of Hawaii (UH) is developing a Comprehensive Management Plan (CMP) for the lands on Mauna Kea managed by UH. A very important part of this effort is consultation and dialog with the local community. The CMP team, led by the consulting firm, Ku'iwalu, has undertaken a wide range of initiatives to reach all types of interested groups and individuals in every part of the community. A recurrent theme in these discussions is the question of what will happen with a telescope and its site after the sublease expires, or in the event that a facility closes before the sublease expiration for reasons such as a change in funding agency priorities. There is a concern that telescope structures could remain on the summit after a facility closes, because removal turns out to be technically too complicated and/or too expensive. There are, unfortunately, a number of examples in the history of the State of Hawaii (not related to astronomy), which make these worries understandable. The CMP team wishes to address this issue to the maximum extent possible under the circumstances. To that end, they have asked the Institute for Astronomy to approach each of the Mauna Kea Observatories with the following request for information.

The sublease between UH and the Canada-France-Hawaii Telescope Corporation for the site of the Canada-France-Hawaii Telescope (CFHT) contains two options for the disposition of the facilities in the event of termination or expiration of the sublease:

1) surrender to UH subject to the approval of UH and the Chairman of the Board of Land and Natural Resources
2) removal of the facilities and restoration of the property at the expense of CFHT.

If option 1 is not approved, then option 2 must be exercised.

By this letter we are asking you to confirm that the CFHT is aware of the technical and financial implications of option 2 and that it can guarantee its implementation, should the need arise at some point in the future. We are also asking for whatever information you can provide regarding the expected cost and source of funding for option 2. Both the confirmation of the awareness and the information about cost and anticipated funding are very important for the development of the CMP and its acceptance by the local community.

2680 Woodlawn Drive, Honolulu, Hawai'i 96822

The CFHT is an outstanding facility that continues to deliver important and far-reaching scientific results. That being the case, we understand that this inquiry might seem premature and inappropriate. However, it is vitally important that the University of Hawaii and its partners on Mauna Kea address clearly the legitimate concerns raised by the community, and that we thereby demonstrate our commitment to careful long-term planning that is both environmentally and culturally sensitive.

Please be aware that the information you provide may be made public and included in the CMP. In order to keep the CMP process on schedule, we are asking for at least a preliminary response by August 22.

Thank you very much for your cooperation in responding to this request. Please do not hesitate to call me if you have questions about it.

Sincerely,

Rolf-Peter Kudritzki
Director

RPK:nll

UNIVERSITY OF HAWAI'I AT MĀNOA

Institute for Astronomy
Office of the Director

July 16, 2008

Dr. Alan T. Tokunaga
Division Chief
NASA Infrared Telescope Facility
Institute for Astronomy
2680 Woodlawn Drive
Honolulu, HI 96822

Dear Dr. Tokunaga:

Subject: Mauna Kea Comprehensive Management Plan

As you know, the University of Hawaii (UH) is developing a Comprehensive Management Plan (CMP) for the lands on Mauna Kea managed by UH. A very important part of this effort is consultation and dialog with the local community. The CMP team, led by the consulting firm, Ku'iwalu, has undertaken a wide range of initiatives to reach all types of interested groups and individuals in every part of the community. A recurrent theme in these discussions is the question of what will happen with a telescope and its site after the sublease expires, or in the event that a facility closes before the sublease expiration for reasons such as a change in funding agency priorities. There is a concern that telescope structures could remain on the summit after a facility closes, because removal turns out to be technically too complicated and/or too expensive. There are, unfortunately, a number of examples in the history of the State of Hawaii (not related to astronomy), which make these worries understandable. The CMP team wishes to address this issue to the maximum extent possible under the circumstances. To that end, they have asked the Institute for Astronomy to approach each of the Mauna Kea Observatories with the following request for information.

The sublease between UH and NASA for the site of NASA Infrared Telescope Facility (IRTF) contains two options for the disposition of the facilities in the event of termination or expiration of the sublease:

1) surrender to UH subject to the approval of UH and the Chairman of the Board of Land and Natural Resources
2) removal of the facilities and restoration of the property at the expense of NASA.

If option 1 is not approved, then option 2 must be exercised.

By this letter we are asking you to confirm that the IRTF is aware of the technical and financial implications of option 2 and that it can guarantee its implementation, should the need arise at some point in the future. We are also asking for whatever information you can provide regarding the expected cost and source of funding for option 2. Both the confirmation of the awareness and the information about cost and anticipated funding are very important for the development of the CMP and its acceptance by the local community.

The IRTF is an outstanding facility that continues to deliver important and far-reaching scientific results. That being the case, we understand that this inquiry might seem premature and inappropriate. However, it is vitally important that the University of Hawaii and its partners on Mauna Kea address clearly the legitimate concerns raised by the community, and that we thereby demonstrate our commitment to careful long-term planning that is both environmentally and culturally sensitive.

Please be aware that the information you provide may be made public and included in the CMP. In order to keep the CMP process on schedule, we are asking for at least a preliminary response by August 22.

Thank you very much for your cooperation in responding to this request. Please do not hesitate to call me if you have questions about it.

Sincerely,

Rolf-Peter Kudritzki
Director

RPK:nll

UNIVERSITY OF HAWAI'I AT MĀNOA

Institute for Astronomy
Office of the Director

July 16, 2008

Dr. Gary R. Davis
Director, Hawaii Operations
Joint Astronomy Centre
660 N. A'ohoku Place
Hilo, HI 96720

Dear Dr. Davis:

Subject: Mauna Kea Comprehensive Management Plan

As you know, the University of Hawaii (UH) is developing a Comprehensive Management Plan (CMP) for the lands on Mauna Kea managed by UH. A very important part of this effort is consultation and dialog with the local community. The CMP team, led by the consulting firm, Ku'iwalu, has undertaken a wide range of initiatives to reach all types of interested groups and individuals in every part of the community. A recurrent theme in these discussions is the question of what will happen with a telescope and its site after the sublease expires, or in the event that a facility closes before the sublease expiration for reasons such as a change in funding agency priorities. There is a concern that telescope structures could remain on the summit after a facility closes, because removal turns out to be technically too complicated and/or too expensive. There are, unfortunately, a number of examples in the history of the State of Hawaii (not related to astronomy), which make these worries understandable. The CMP team wishes to address this issue to the maximum extent possible under the circumstances. To that end, they have asked the Institute for Astronomy to approach each of the Mauna Kea Observatories with the following request for information.

The sublease between UH and the Science and Technology Facilities Council (STFC) for the site of the United Kingdom Infrared Telescope (UKIRT) contains four options for the disposition of the facilities in the event of termination or expiration of the sublease:

1) sale to UH
2) sale to a third party acceptable to UH
3) surrender with the approval of the Chair of the Board of Land and Natural Resources
4) removal of the facilities and restoration of the property at the expense of STFC.

If none of options 1 to 3 is available, then option 4 must be exercised.

By this letter we are asking you to confirm that the UKIRT is aware of the technical and financial implications of option 4 and that it can guarantee its implementation, should the need arise at some point in the future. We are also asking for whatever information you can provide regarding the expected cost and source of funding for option 4. Both the confirmation of the awareness and the information about cost and anticipated funding are very important for the development of the CMP and its acceptance by the local community.

2680 Woodlawn Drive, Honolulu, Hawai'i 96822

The UKIRT is an outstanding facility that continues to deliver important and far-reaching scientific results. That being the case, we understand that this inquiry might seem premature and inappropriate. However, it is vitally important that the University of Hawaii and its partners on Mauna Kea address clearly the legitimate concerns raised by the community, and that we thereby demonstrate our commitment to careful long-term planning that is both environmentally and culturally sensitive.

Please be aware that the information you provide may be made public and included in the CMP. In order to keep the CMP process on schedule, we are asking for at least a preliminary response by August 22.

Thank you very much for your cooperation in responding to this request. Please do not hesitate to call me if you have questions about it.

Sincerely,

Rolf-Peter Kudritzki
Director

RPK:nll

UNIVERSITY OF HAWAI'I AT MĀNOA

Institute for Astronomy
Office of the Director

July 16, 2008

Dr. Thomas G. Phillips
Director, Caltech Submillimeter Observatory
Mail Stop 320-47
George W. Downs Laboratory of Physics
California Institute of Technology
Pasadena, CA 91125

Dear Dr. Phillips:

Subject: Mauna Kea Comprehensive Management Plan

As you know, the University of Hawaii (UH) is developing a Comprehensive Management Plan (CMP) for the lands on Mauna Kea managed by UH. A very important part of this effort is consultation and dialog with the local community. The CMP team, led by the consulting firm, Ku'iwalu, has undertaken a wide range of initiatives to reach all types of interested groups and individuals in every part of the community. A recurrent theme in these discussions is the question of what will happen with a telescope and its site after the sublease expires, or in the event that a facility closes before the sublease expiration for reasons such as a change in funding agency priorities. There is a concern that telescope structures could remain on the summit after a facility closes, because removal turns out to be technically too complicated and/or too expensive. There are, unfortunately, a number of examples in the history of the State of Hawaii (not related to astronomy), which make these worries understandable. The CMP team wishes to address this issue to the maximum extent possible under the circumstances. To that end, they have asked the Institute for Astronomy to approach each of the Mauna Kea Observatories with the following request for information.

The sublease between UH and Caltech for the site of the Caltech Submillimeter Observatory (CSO) contains four options for the disposition of the facilities in the event of termination or expiration of the sublease:

1) sale to UH
2) surrender with the concurrence of UH
3) sale to a third party acceptable to UH
4) removal of the facilities and restoration of the property at the expense of Caltech.

If none of options 1 to 3 is satisfactorily completed within twelve months, then option 4 must be exercised.

By this letter we are asking you to confirm that the CSO is aware of the technical and financial implications of option 4 and that it can guarantee its implementation, should the need arise at some point in the future. We are also asking for whatever information you can provide regarding the expected cost and source of funding for option 4. Both the confirmation of the awareness and the information about cost and anticipated funding are very important for the development of the CMP and its acceptance by the local community.

2680 Woodlawn Drive, Honolulu, Hawai'i 96822

The CSO is an outstanding facility that continues to deliver important and far-reaching scientific results. That being the case, we understand that this inquiry might seem premature and inappropriate. However, it is vitally important that the University of Hawaii and its partners on Mauna Kea address clearly the legitimate concerns raised by the community, and that we thereby demonstrate our commitment to careful long-term planning that is both environmentally and culturally sensitive.

Please be aware that the information you provide may be made public and included in the CMP. In order to keep the CMP process on schedule, we are asking for at least a preliminary response by August 22.

Thank you very much for your cooperation in responding to this request. Please do not hesitate to call me if you have questions about it.

Sincerely,

Rolf-Peter Kudritzki

Rolf-Peter Kudritzki
Director

RPK:nll

UNIVERSITY OF HAWAI'I AT MĀNOA

Institute for Astronomy
Office of the Director

July 16, 2008

Dr. Robert L. Dickman
Assistant Director, VLA/VLBA Operations
National Radio Astronomy Observatory
P. O. Box O
Socorro, NM 87801-0387

Dear Dr. Dickman:

Subject: Mauna Kea Comprehensive Management Plan

As you know, the University of Hawaii (UH) is developing a Comprehensive Management Plan (CMP) for the lands on Mauna Kea managed by UH. A very important part of this effort is consultation and dialog with the local community. The CMP team, led by the consulting firm, Ku'iwalu, has undertaken a wide range of initiatives to reach all types of interested groups and individuals in every part of the community. A recurrent theme in these discussions is the question of what will happen with a telescope and its site after the sublease expires, or in the event that a facility closes before the sublease expiration for reasons such as a change in funding agency priorities. There is a concern that telescope structures could remain on the summit after a facility closes, because removal turns out to be technically too complicated and/or too expensive. There are, unfortunately, a number of examples in the history of the State of Hawaii (not related to astronomy), which make these worries understandable. The CMP team wishes to address this issue to the maximum extent possible under the circumstances. To that end, they have asked the Institute for Astronomy to approach each of the Mauna Kea Observatories with the following request for information.

The sublease between UH and the National Radio Astronomy Observatory (NRAO) for the site of the VLBA Antenna contains four options for the disposition of the facilities in the event of termination or expiration of the sublease:

1) removal of the facilities and restoration of the property at the expense of NRAO,
2) sale to UH,
3) sale to a third party, contingent upon the execution of a new Sublease and Operating and Site Development Agreement between the third party and UH,
4) surrender in place.

Options 2, 3, and 4 require the approval of both UH and the Department of Land and Natural Resources. If none of these three alternatives is available, then option 1 (removal and restoration) must be completed within one year.

By this letter we are asking you to confirm that the VLBA is aware of the technical and financial implications of option 1 and that it can guarantee its implementation, should the need arise at some point in the future. We are also asking for whatever information you can provide regarding the expected cost and source of funding for option 1. Both the confirmation of the awareness and the information about cost and anticipated funding are very important for the development of the CMP and its acceptance by the local community.

2680 Woodlawn Drive, Honolulu, Hawai'i 96822

The VLBA is an outstanding facility that continues in the prime of its scientific life. That being the case, we understand that this inquiry might seem premature and inappropriate. However, it is vitally important that the University of Hawaii and its partners on Mauna Kea address clearly the legitimate concerns raised by the community, and that we thereby demonstrate our commitment to careful long-term planning that is both environmentally and culturally sensitive.

Please be aware that the information you provide may be made public and included in the CMP. In order to keep the CMP process on schedule, we are asking for at least a preliminary response by August 22.

Thank you very much for your cooperation in responding to this request. Please do not hesitate to call me if you have questions about it.

Sincerely,

Rolf-Peter Kudritzki

Rolf-Peter Kudritzki
Director

RPK:nll

UNIVERSITY OF HAWAI'I AT MĀNOA

Institute for Astronomy
Office of the Director

July 16, 2008

Dr. Taft E. Armandroff
Director, W. M. Keck Observatory
California Association for Research
in Astronomy
65-1120 Mamalahoa Highway
Kamuela, HI 96743

Dear Dr. Armandroff:

Subject: Mauna Kea Comprehensive Management Plan

As you know, the University of Hawaii (UH) is developing a Comprehensive Management Plan (CMP) for the lands on Mauna Kea managed by UH. A very important part of this effort is consultation and dialog with the local community. The CMP team, led by the consulting firm, Ku'iwalu, has undertaken a wide range of initiatives to reach all types of interested groups and individuals in every part of the community. A recurrent theme in these discussions is the question of what will happen with a telescope and its site after the sublease expires, or in the event that a facility closes before the sublease expiration for reasons such as a change in funding agency priorities. There is a concern that telescope structures could remain on the summit after a facility closes, because removal turns out to be technically too complicated and/or too expensive. There are, unfortunately, a number of examples in the history of the State of Hawaii (not related to astronomy), which make these worries understandable. The CMP team wishes to address this issue to the maximum extent possible under the circumstances. To that end, they have asked the Institute for Astronomy to approach each of the Mauna Kea Observatories with the following request for information.

The sublease between UH and the California Institute of Technology (Caltech) for the site of the W. M. Keck Observatory contains four options for the disposition of the facilities in the event of termination or expiration of the sublease:

1) removal of the facilities and restoration of the property at the expense of Caltech,
2) sale to UH,
3) sale to a third party, contingent upon the execution of a new Sublease and Operating and Site Development Agreement between the third party and UH,
4) surrender in place.

Options 2, 3, and 4 require the approval of both UH and the Department of Land and Natural Resources. If none of these three alternatives is available, then option 1 (removal and restoration) must be completed within one year.

By this letter we are asking you to confirm that Keck is aware of the technical and financial implications of option 1 and that it can guarantee its implementation, should the need arise at some point in the future. We are also asking for whatever information you can provide regarding the expected cost and source of funding for option 1. Both the confirmation of the awareness and the information about cost and anticipated funding are very important for the development of

2680 Woodlawn Drive, Honolulu, Hawai'i 96822

the CMP and its acceptance by the local community.

Keck is an outstanding facility in the prime of its scientific life. That being the case, we understand that this inquiry might seem premature and inappropriate. However, it is vitally important that the University of Hawaii and its partners on Mauna Kea address clearly the legitimate concerns raised by the community, and that we thereby demonstrate our commitment to careful long-term planning that is both environmentally and culturally sensitive.

Please be aware that the information you provide may be made public and included in the CMP. In order to keep the CMP process on schedule, we are asking for at least a preliminary response by August 22.

Thank you very much for your cooperation in responding to this request. Please do not hesitate to call me if you have questions about it.

Sincerely,

Rolf-Peter Kudritzki

Rolf-Peter Kudritzki
Director

RPK:nll

UNIVERSITY OF HAWAI'I AT MĀNOA

Institute for Astronomy
Office of the Director

July 16, 2008

Dr. Masahiko Hayashi
Director, Subaru Telescope
National Astronomical Observatory of Japan
650 N. A'ohoku Place
University Park
Hilo, HI 96720

Dear Dr. Hayashi:

Subject: Mauna Kea Comprehensive Management Plan

As you know, the University of Hawaii (UH) is developing a Comprehensive Management Plan (CMP) for the lands on Mauna Kea managed by UH. A very important part of this effort is consultation and dialog with the local community. The CMP team, led by the consulting firm, Ku'iwalu, has undertaken a wide range of initiatives to reach all types of interested groups and individuals in every part of the community. A recurrent theme in these discussions is the question of what will happen with a telescope and its site after the sublease expires, or in the event that a facility closes before the sublease expiration for reasons such as a change in funding agency priorities. There is a concern that telescope structures could remain on the summit after a facility closes, because removal turns out to be technically too complicated and/or too expensive. There are, unfortunately, a number of examples in the history of the State of Hawaii (not related to astronomy), which make these worries understandable. The CMP team wishes to address this issue to the maximum extent possible under the circumstances. To that end, they have asked the Institute for Astronomy to approach each of the Mauna Kea Observatories with the following request for information.

The sublease between UH and the National Astronomical Observatory of Japan (NAOJ) for the site of the Subaru Telescope contains four options for the disposition of the facilities in the event of termination or expiration of the sublease:

1) removal of the facilities and restoration of the property at the expense of NAOJ,
2) sale to UH,
3) sale to a third party, contingent upon the execution of a new Sublease and Operating and Site Development Agreement between the third party and UH,
4) surrender in place.

Options 2, 3, and 4 require the approval of both UH and the Department of Land and Natural Resources. If none of these three alternatives is available, then option 1 (removal and restoration) must be completed within one year.

By this letter we are asking you to confirm that Subaru Telescope is aware of the technical and financial implications of option 1 and that it can guarantee its implementation, should the need arise at some point in the future. We are also asking for whatever information you can provide regarding the expected cost and source of funding for option 1. Both the confirmation of the awareness and the information about cost and anticipated funding are very important for the development of the CMP and its acceptance by the local community.

2680 Woodlawn Drive, Honolulu, Hawai'i 96822

The Subaru Telescope is an outstanding facility in the prime of its scientific life. That being the case, we understand that this inquiry might seem premature and inappropriate. However, it is vitally important that the University of Hawaii and its partners on Mauna Kea address clearly the legitimate concerns raised by the community, and that we thereby demonstrate our commitment to careful long-term planning that is both environmentally and culturally sensitive.

Please be aware that the information you provide may be made public and included in the CMP. In order to keep the CMP process on schedule, we are asking for at least a preliminary response by August 22.

Thank you very much for your cooperation in responding to this request. Please do not hesitate to call me if you have questions about it.

Sincerely,

Rolf-Peter Kudritzki
Director

RPK:nll

UNIVERSITY OF HAWAI'I AT MĀNOA

Institute for Astronomy
Office of the Director

July 16, 2008

Dr. Douglas A. Simons
Director, Frederick C. Gillett Gemini Observatory
Northern Operations Center
670 N. A'ohoku Place
University Park
Hilo, HI 96720-2700

Dear Dr. Simons:

Subject: Mauna Kea Comprehensive Management Plan

As you know, the University of Hawaii (UH) is developing a Comprehensive Management Plan (CMP) for the lands on Mauna Kea managed by UH. A very important part of this effort is consultation and dialog with the local community. The CMP team, led by the consulting firm, Ku'iwalu, has undertaken a wide range of initiatives to reach all types of interested groups and individuals in every part of the community. A recurrent theme in these discussions is the question of what will happen with a telescope and its site after the sublease expires, or in the event that a facility closes before the sublease expiration for reasons such as a change in funding agency priorities. There is a concern that telescope structures could remain on the summit after a facility closes, because removal turns out to be technically too complicated and/or too expensive. There are, unfortunately, a number of examples in the history of the State of Hawaii (not related to astronomy), which make these worries understandable. The CMP team wishes to address this issue to the maximum extent possible under the circumstances. To that end, they have asked the Institute for Astronomy to approach each of the Mauna Kea Observatories with the following request for information.

The sublease between UH and the National Science Foundation (NSF) for the site of the Frederick C. Gillett Gemini North Telescope contains four options for the disposition of the facilities in the event of termination or expiration of the sublease:

1) removal of the facilities and restoration of the property at the expense of NSF,
2) sale to UH,
3) sale to a third party, contingent upon the execution of a new Sublease and Operating and Site Development Agreement between the third party and UH,
4) surrender in place.

Options 2, 3, and 4 require the approval of both UH and the Department of Land and Natural Resources. If none of these three alternatives is available, then option 1 (removal and restoration) must be completed within one year.

By this letter we are asking you to confirm that Gemini is aware of the technical and financial implications of option 1 and that it can guarantee its implementation, should the need arise at some point in the future. We are also asking for whatever information you can provide regarding the expected cost and source of funding for option 1. Both the confirmation of the awareness and the information about cost and anticipated funding are very important for the development of

2680 Woodlawn Drive, Honolulu, Hawai'i 96822

the CMP and its acceptance by the local community.

Gemini is an outstanding facility in the prime of its scientific life. That being the case, we understand that this inquiry might seem premature and inappropriate. However, it is vitally important that the University of Hawaii and its partners on Mauna Kea address clearly the legitimate concerns raised by the community, and that we thereby demonstrate our commitment to careful long-term planning that is both environmentally and culturally sensitive.

Please be aware that the information you provide may be made public and included in the CMP. In order to keep the CMP process on schedule, we are asking for at least a preliminary response by August 22.

Thank you very much for your cooperation in responding to this request. Please do not hesitate to call me if you have questions about it.

Sincerely,

Rolf-Peter Kudritzki

Rolf-Peter Kudritzki
Director

RPK:nll

UNIVERSITY OF HAWAI'I AT MĀNOA

Institute for Astronomy
Office of the Director

July 16, 2008

Dr. Raymond Blundell
Director, Submillimeter Array
Smithsonian Astrophysical Observatory
60 Garden Street
Cambridge, MA 02138

Dear Dr. Blundell:

Subject: Mauna Kea Comprehensive Management Plan

As you know, the University of Hawaii (UH) is developing a Comprehensive Management Plan (CMP) for the lands on Mauna Kea managed by UH. A very important part of this effort is consultation and dialog with the local community. The CMP team, led by the consulting firm, Ku'iwalu, has undertaken a wide range of initiatives to reach all types of interested groups and individuals in every part of the community. A recurrent theme in these discussions is the question of what will happen with a telescope and its site after the sublease expires, or in the event that a facility closes before the sublease expiration for reasons such as a change in funding agency priorities. There is a concern that telescope structures could remain on the summit after a facility closes, because removal turns out to be technically too complicated and/or too expensive. There are, unfortunately, a number of examples in the history of the State of Hawaii (not related to astronomy), which make these worries understandable. The CMP team wishes to address this issue to the maximum extent possible under the circumstances. To that end, they have asked the Institute for Astronomy to approach each of the Mauna Kea Observatories with the following request for information.

The sublease between UH and the Smithsonian Institution (Smithsonian) for the site of the Submillimeter Array (SMA) contains four options for the disposition of the facilities in the event of termination or expiration of the sublease:

1) removal of the facilities and restoration of the property at the expense of Smithsonian,
2) sale to UH,
3) sale to a third party, contingent upon the execution of a new Sublease and Operating and Site Development Agreement between the third party and UH,
4) surrender in place.

Options 2, 3, and 4 require the approval of both UH and the Department of Land and Natural Resources. If none of these three alternatives is available, then option 1 (removal and restoration) must be completed within one year.

By this letter we are asking you to confirm that the SMA is aware of the technical and financial implications of option 1 and that it can guarantee its implementation, should the need arise at some point in the future. We are also asking for whatever information you can provide regarding the expected cost and source of funding for option 1. Both the confirmation of the awareness and the information about cost and anticipated funding are very important for the development of the CMP and its acceptance by the local community.

2680 Woodlawn Drive, Honolulu, Hawai'i 96822

The SMA is an outstanding facility in the prime of its scientific life. That being the case, we understand that this inquiry might seem premature and inappropriate. However, it is vitally important that the University of Hawaii and its partners on Mauna Kea address clearly the legitimate concerns raised by the community, and that we thereby demonstrate our commitment to careful long-term planning that is both environmentally and culturally sensitive.

Please be aware that the information you provide may be made public and included in the CMP. In order to keep the CMP process on schedule, we are asking for at least a preliminary response by August 22.

Thank you very much for your cooperation in responding to this request. Please do not hesitate to call me if you have questions about it.

Sincerely,

Rolf-Peter Kudritzki

Rolf-Peter Kudritzki
Director

RPK:nll

Joint Astronomy Centre

660 N. A'ohōkū Place, University Park
Hilo, Hawaii 96720-2700, USA

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Professor Gary R. Davis *BSc MSc DPhil*
Director, Joint Astronomy Centre
James Clerk Maxwell Telescope
United Kingdom Infrared Telescope

Tel: +1 808 969 6504 (Direct)
Email: g.davis@jach.hawaii.edu

Ms. Dawn S. Chang,
Principal Ku'iwalu,
by email.

27 July 2008

Dear Ms Chang,

Revised IfA Plan for Future Development

I am writing to amplify slightly on the letter sent to you by Professor Kudritzki on 15th July. It was stated in that letter that, should UKIRT cease operations before the expiration of the general lease in 2033, the IfA would not seek to re-use the site for astronomy. That decision is entirely the University's prerogative as holder of the general lease.

I want to emphasize that, whilst it is possible that UKIRT will cease operations before 2033, there is no fixed timeline for this. UKIRT is owned by a scientific research body in the United Kingdom, and the future of the facility is one element of that organization's forward strategic planning. I can confirm that UKIRT is not scheduled for closure within the organization's current planning horizon; indeed, as its Director, I believe it has the potential to continue operating for many years at the forefront of infrared astronomy.

I trust this helps to clarify the situation. Should you require any further information pertaining to these issues, please do not hesitate to ask.

Kindest regards,

Professor Gary Davis,
Director JAC.

cc: Prof. Kudritzki, IfA
Ms S. Nagata, OMKM
Mr B. Taniguchi, MKMB

UNIVERSITY OF HAWAI'I AT MĀNOA

Institute for Astronomy
Office of the Director

August 28, 2008

Ms. Dawn N. S. Chang
Principal Ku'iwalu
1003 Bishop Street
Pauahi Tower, 27th Floor
Honolulu, Hawaii 96813

Dear Ms. Chang:

Enclosed for your information are copies of the eight responses we have received to my July 16 letter asking the observatories about their plans for eventual removal and site restoration. We have heard from all of the observatories except for VLBA. Note that the letter from Professor Davis addresses both UKIRT and JCMT.

Sincerely yours,

Rolf-Peter Kudritzki
Director

RPK:nll
encl.

Canada - France - Hawaii Telescope Corporation
65-1238 Mamalahoa Highway, Kamuela, Hawaii 96743 USA

CFH

Société du Télescope Canada - France - Hawaii
Telephone (808) 885-7944 Fax (808) 885-7288

6 August 2008

Dr. Rolf-Peter Kudritzki
Director
Institute for Astronomy
University of Hawai'i at Manoa
2680 Woodlawn Drive
Honolulu, HI 96822

Dear Dr. Kudritzki,

Subject: Mauna Kea Comprehensive Management Plan

In response to your letter dated July 16, 2008 inquiring about CFHT's potential obligation to remove its facilities on Mauna Kea and restoring the property at its expense, I am pleased to let you know that this issue is well known to the CFHT Corporation.

Very early on in my directorship, I looked thoroughly at all the options for the future of CFHT, including the one I liked the least, i.e. the closure of the telescope. I asked for a quote from a demolition company located on 'Oahu, Island Demo Inc. (http://www.islanddemo.com/) which looked at the drawings of the summit facility and pictures of the construction, and visited the site on Mauna Kea. The quote came to approximately $6M, with a strong warning on possible substantial additional cost for cleaning soil contamination that could be found once the facility is removed (a problem often encountered at industrial sites). This quote was issued back in 2004, and corresponded at the time to a one-year operating budget of the Corporation.

I asked at that time to present the observatory at an MKMB meeting, as a first courtesy visit. I outlined not only the current and planned activities of CFHT, but also the various scenarios for the future, including the closure and restoration of the site.

Since then, I have kept in mind that the demolition cost would be the equivalent of one year of operation of the facility. So, the owners of the Corporation should think of the cleaning cost as one year of funding once the observatory is closed.

This cost also happens to be the value of CFHT's property in Waimea, which is a nice piece of land for business use in town. For CFHT, the sale of the Corporation's assets could therefore pay for the cleanup of its Mauna Kea site.

I hope that this information is helpful. Please do not hesitate to come back to me, should you need more information.

Aloha,

CV/ms
File: 1920.02/1116.05

Christian Veillet
Executive Director

XC: RF
Bright

National Aeronautics and Space Administration
Headquarters
Washington, DC 20546-0001

AUG 14 2008

Reply to Attn of: Planetary Division

AUG 15 2008
DIRECTOR
INSTITUTE FOR ASTRONOMY

Professor Rolf-Peter Kudritzki
Institute for Astronomy
2680 Woodlawn Ave.
Honolulu, Hawaii 96822

Dear Professor Kudritski:

Through the IRTF Director, Alan Tokunaga, NASA has received your letter date July 16, 2008, and related recent email communications from Alan Tokunaga of your staff at UH. NASA has also reviewed the November, 1974 Sublease agreement between the University of Hawaii and the agency regarding the NASA Infrared Telescope Facility (IRTF), and has taken into consideration the needs you have expressed regarding information for the Mauna Kea Comprehensive Management Plan.

Your letter of 16 July references the sublease agreement with respect to two (2) options "for the disposition of the facilities in the event of termination or expiration of the sublease:

1) surrender to UH subject to the approval of UH and the Chairman of the Board of Land and Natural Resources
2) removal of the facilities and restoration of the property at the expense of NASA"

Your letter also seeks that NASA "confirm that the IRTF is aware of the technical and financial implications of Option 2 and that it can guarantee its implementation," and also seeks "whatever information [NASA] can provide regarding the expected cost and source of funding" for "option 2." You letter also indicates that "information [provided by NASA] may be made public and included in the CMP."

In review of the 1974 sublease agreement, it is clear subparts "VII SURRENDER," and "XII TITLE TO FACILITIES, ALTERATIONS, [etc]" are applicable to the potential termination or abandonment by NASA of the Mauna Kea/IRFT site.

Since at this time NASA has no plans for termination or abandonment of the IRFT and no studies have been done related to such action, NASA is not in a position to provide any information about the potential costs in the event of termination because such costs have not been quantified. NASA also points out that, consistent with language in subpart XII of the

sublease, financial obligations associated with the IRFT are "subject to the availability of appropriated funding," in other words, congressional approval for the expenditure of taxpayer dollars.

Nonetheless, NASA does represent that it will honor the terms of the sublease in the event of termination or abandonment of the site.

Sincerely,

James L. Green, Director
Planetary Division

cc: Alan Tokunaga, Philippe Crane, Richard McCarthy

Joint Astronomy Centre

660 N. A'ohōkū Place, University Park
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Professor Gary R. Davis *BSc MSc DPhil*
Director, Joint Astronomy Centre
James Clerk Maxwell Telescope
United Kingdom Infrared Telescope

Tel: +1 808 969 6504 (Direct)
Email: g.davis@jach.hawaii.edu

Dr R-P Kudtrizki, Director,
Institute for Astronomy,
by email.

22 July 2008

Dear Professor Kudritzki,

Mauna Kea Comprehensive Management Plan

Thank you for your letters dated 16th July, pertaining to the eventual dispositions of JCMT and UKIRT. I appreciate fully the CMP team's need for visibility of these arrangements and it is my pleasure to provide you with the following information.

Both telescopes are managed by the Science and Technology Facilities Council (STFC) of the United Kingdom. I hereby confirm that STFC is fully cognisant of its obligation, should none of the other options specified in the sub-lease prove possible, to remove the facilities and restore the properties. Although neither of the facilities is scheduled for closure within the current planning horizon, STFC has nevertheless made advance provision for these decommissioning costs. I can state unequivocally that STFC will, consistent with the requirements of the sub-lease, meet the full cost of removing the observatories and restoring the sites.

The amount of this provision is based on a quotation which was provided to us in 2006 by a private contractor following a tender exercise. I am regrettably unable to provide you with public details of the expected cost since this quotation was provided to us on a commercial-in-confidence basis. I can nevertheless offer you my complete assurance that STFC has made provision for the costs of decommissioning based on a sound engineering assessment of the requirements.

I trust this information will satisfy your requirements. Please do not hesitate to contact me should you require anything further.

Kindest regards,

Professor Gary Davis,
Director JAC.

CALIFORNIA INSTITUTE OF TECHNOLOGY
GEORGE W. DOWNS LABORATORY OF PHYSICS 320-47
PASADENA, CALIFORNIA 91125-4700

August 21, 2008

Rolf-Peter Kudritzki, Director
Institute for Astronomy University of Hawaii at Manoa
2680 Woodlawn Drive
Honolulu, HI 96822

Dear Dr. Kudritzki:

This letter is in response to your letter dated July 16, 2008 regarding the Mauna Kea Comprehensive Management Plan. You requested that we provide you with certain information regarding the removal of the facilities and restoration of the property at the termination or expiration of the Sublease between University of Hawaii and Caltech.

As you correctly point out, Caltech has a sublease with the University of Hawaii for the site of the Caltech Submillimeter Observatory, and that sublease contains provisions regarding the disposition of the facilities in the event of termination or expiration of the Sublease. Caltech also signed an operating agreement with the University of Hawaii in which the parties agree that the facilities are to be disposed of according to the provisions of the sublease. One option in the event of termination or expiration of the sublease is the removal of the facilities and restoration of the property.

We confirm that we are aware of the technical and financial implications of the removal/restoration option in the event of termination or expiration of the sublease. Consistent with Caltech's legal obligations set forth in the sublease and the operating agreement, if the removal/restoration option becomes necessary, we are able to guarantee its implementation. Caltech will be the source of funding for the removal of the facilities and restoration of the property.

Sincerely,

T. G. Phillips
Director, Caltech Submillimeter Observatory

TGP:smc
xc: D. Currie, Vice President for Business & Finance
B. T. Soifer, Director, Spitzer Science Center
K. Dolan, Office of the General Counsel

W. M. KECK OBSERVATORY
On the summit of Mauna Kea, Island of Hawai'i

August 22, 2008

Dr. Rolf-Peter Kudritzki
Director, Institute for Astronomy
University of Hawaii
2680 Woodlawn
Honolulu, Hawaii 96822

Dear Rolf,

This letter is in response to your letter dated July 16, 2008 regarding the Mauna Kea Comprehensive Management Plan. You requested that we provide you with certain information regarding the sublease between University of Hawaii and the California Institute of Technology (Caltech).

As you correctly point out in your letter, Caltech has a sublease with the University of Hawaii for the site of the W. M. Keck Observatory, and that sublease contains provisions regarding the disposition of the facilities in the event of termination or expiration of the Sublease. One option in the event of termination or expiration of the sublease is the removal of the facilities and restoration of the property within one year from the termination or expiration of the Sublease. Caltech and the University of California (UC) also signed operating agreements with the University of Hawaii in which the parties agree that the facilities are to be disposed of according to the terms of the sublease.

We confirm that we are aware of the technical and financial implications of the removal/restoration option in the event of termination or expiration of the sublease. Consistent with Caltech and UC's legal obligations set forth in the sublease and operating agreements, if the removal/restoration option becomes necessary, we are able to guarantee its implementation. Caltech and University of California will be the source of funding for removal of the facilities and restoration of the property.

Sincerely,

Taft Armandroff

Taft Armandroff
Director, W. M. Keck Observatory

cc:
Edward Stone, Chair, California Association for Research in Astronomy
George Blumenthal, Vice Chair, California Association for Research in Astronomy

Tel: 808.885.7887 ● Fax: 808.885.4464
Headquarters: 65-1120 Mamalahoa Highway, Kamuela, HI 96743 www.keckobservatory.org

Subaru Telescope
National Astronomical Observatory of Japan
650 North A'ohoku Place, Hilo, Hawaii 96720, U.S.A.

August 18, 2008

Dr. Rolf-Peter Kudritzki
Director
Institute for Astronomy
University of Hawaii
2680 Woodlawn Drive
Honolulu, HI 96822-1839

Dear Dr. Kudritzki:

This is a reply to your letter regarding the "Mauna Kea Comprehensive Management Plan" dated July 16, 2008. You asked us to confirm that Subaru Telescope is aware of technical and financial implications in the event of termination or expiration of the sublease and that the National Astronomical Observatory of Japan (NAOJ) must remove the facilities and restore the property at its own expense within one year.

I have confirmed with the NAOJ administration that it is fully aware of its responsibility and it guarantees the removal of the facilities and restoration of the property, should the need arise at some point in the future.

Regarding the expected cost and source of funding, NAOJ will provide the funds for the necessary cost, which is expected to be more than US$10M. Since this is a significant amount, we need to ask you to give us ample time for securing the funds prior to the implementation.

It is our pleasure that the Subaru telescope is producing world frontier scientific results and no one doubts that Mauna Kea is essential for our successful achievements. We would like to express, at this time, our sincere appreciation to the University of Hawaii and to the local community on the Big Island for making this happen.

Sincerely yours,

Masahiko Hayashi
Director, Subaru Telescope
National Astronomical Observatory of Japan

CC: Shoken M. Miyama, Director-General

Administration Office Tel (808) 934-7788 Fax (808) 934-5099 Director's Office Tel (808) 934-5904 Fax (808) 934-5984

GEMINI OBSERVATORY

Office of the Director
Gemini Observatory: Teaching Humanity about the Universe

Northern Operations Center
670 N. A'ohoku Place
Hilo, Hawai'i 96720

Phone: (808) 974-2514
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Email:dsimons@gemini.edu

To: Rolf-Peter Kudritzki, Director, UH Institute for Astronomy
From: Doug Simons, Director, Gemini Observatory
Date: 12 August 2008
Subj: Reply to your letter regarding the CMP

Dear Rolf –

I am writing in response to your letter to me dated 16 July 2008 regarding the CMP process and long-term plans for Gemini in the context of the expiration of our sublease on the summit of Mauna Kea. For reference, you noted 4 options in your letter including –

1) Removal of the facilities and restoration of the property at the expense of the NSF
2) Sale to UH
3) Sale to a third party, contingent upon the execution of a new Sublease and OSDA between that third party and UH
4) Surrender in place

It is important to emphasize that the agreement authorizing Gemini's use of a portion of the Mauna Kea science reserve for the Gemini-N telescope is formalized by our OSDA, which is an agreement between UH and our executive agency, the NSF. Upon receiving your letter I therefore contacted the NSF about your query and asked Gemini's engineering team for a rough estimate of the cost (2008 dollars) of deconstructing Gemini-N. Regarding the latter, we estimate a cost of USD9,000,000 to remove the entire facility from the summit and restore the original grade on the site. Of the options listed above, the NSF represented to me that option 4 is certainly the least desirable, given their sensitivities to Hawaiian interests and broader concern for the environment on Mauna Kea. Options 2 and 3 are somewhat speculative and certainly have not been explored in the relatively young lifetime of Gemini-N, which only entered science operations in 2000. Option 1 (removal of the facilities) would require consideration of all the Gemini Partner agencies, which are all stakeholders in the Gemini-N facility under our International Agreement. Any decision to execute option 1 would therefore be contingent upon those discussions and the availability of funds to conduct the deconstruction of Gemini-N. An absolute "guarantee" to execute option 1 is therefore not possible at this point as it would, at a minimum, require funding commitments that to date have not been sought from our funding agencies. Nonetheless I have confidence the NSF would work diligently on behalf of the Gemini partnership to find a mutually agreed solution, in the context of the current OSDA, in the event our sublease is terminated or expires.

Aloha,

Douglas A. Simons
Director, Gemini Observatory

Cc: Wayne van Citters, Craig Foltz

Date: Fri, 15 Aug 2008 14:16:51 -0400
From: Ray Blundell <rblundell@cfa.harvard.edu>
To: Rolf Peter Kudritzki <kud@ifa.hawaii.edu>
Cc: Dr. Ray Blundell <rblundell@cfa.harvard.edu>,
Dr. George Nystrom <gnystrom@cfa.harvard.edu>
Subject: Eventual clearing of the SMA site

Dear Rolf,

I discussed your request with Charles Alcock (SAO Director) and with Paul Ho (ASIAA Director) and subsequently asked George Nystrom to take a look at how we might remove the SMA from Mauna Kea should the need arise following eventual closure of the observatory. Below please find a draft summary of his findings. With regards to a source of funding for eventual removal of the SMA, Charles has contacted SI Washington for advice. However, we believe that SI (and ASIAA) will take any responsibilities they have in this regard very seriously. We are close to finalizing a cost estimate for complete removal

Sincerely,

Ray

Below we outline a number of possible options for property disposition of the Smithsonian Institution's Submillimeter Array in the event of eventual closure of the observatory. We are currently making cost estimates for we are currently costing all the options, starting with complete removal. We would appreciate guidance as to what other options might prove acceptable.

Antennas:

We have 8 antennas which will be dis-assembled one at a time and transported down to a holding area at sea level. The procedure will be the reverse of their construction and deployment.

Antenna Transporter Forklifts etc:

The transporter will be dis-assembled and transported down to a holding area at sea level. The forklifts and other heavy equipment will also be transported down to a holding area at sea level and would likely be

placed on the government surplus property list.

Antenna pads:

Complete removal:

The Antenna Pad removal will require excavation, demolition and transport of debris to a refuse site. There are 24 pads all of which have up to 20-30 tons of subsurface concrete. The removal all this material will cause a significant environmental impact and the need to bring new material to back fill and restore the pad area along with its access road.

Optional approach:

The Pads have an approximate above ground projection of about one foot, over a diameter of about nine feet. As an alternative to complete removal, we recommend demolishing the above ground projection to a subsurface level of 2 feet. Removing all the debris and filling and grading the pad area to the natural terrain.

Pad cable runs:

Each Pad location has an underground conduit and a subsurface power cable. The conduit is used for sensitive fiber optic cables and other electrical lines. The power cables are copper wire with protective shields for sub-surface burial. The conduit is buried 3-4 meters below grade and has several junction boxes to allow distribution to several locations. The junction boxes are above ground. The power cables have been buried in a simple trench system.

Complete removal:

Complete removal will require extracting the conduit and demolishing the junction boxes and back filling and grading to the natural terrain. This is true also for the power cables.

Alternative option:

Leave the subsurface conduit and power lines in place and remove only

the junction boxes. This option will have significantly less environmental impact on the summit.

Control building and high bay:

Complete Removal:

This would include removal of all contents, demolishing the structures, foundations and pavement.

Alternative Option:

A property transfer to a federal or state agency. The building contents could be discussed with the recipient and their proper transfer or disposal could be arranged. The high bay building is ideal for storing HP summit equipment (road grader, snow equipment and safety vehicle). The control building could be used as a Ranger station and emergency response area.

Appendix A10. Association of Hawaiian Civic Clubs Resolutions

ASSOCIATION OF HAWAIIAN CIVIC CLUBS

A RESOLUTION

08-47

URGING THE STATE OF HAWAI`I, BOARD OF LAND AND NATURAL RESOURCES, TO APPROVE THE COMPREHENSIVE MANAGEMENT PLAN COVERING THE LANDS LEASED TO THE UNIVERSITY OF HAWAI`I ON MAUNAKEA MOUNTAIN

WHEREAS, the State of Hawai`i laws defines a management plan as a comprehensive plan for carrying out multiple land uses; and Maunakea has multiple land use issues that are in need of a comprehensive land use management plan; and

WHEREAS, the lands leased to the University of Hawai`i on Maunakea mountain have been leased to the University of Hawai`i until 2033; and

WHEREAS, the Institute for Astronomy, under the University of Hawai`i, Manoa, was tasked with the responsibility for the "management" of the area covered by the lease agreement; and

WHEREAS, those management activities had caused concern amongst the Hawaiian communities of Hawai`i Island, which resulted in a "Master Plan" being approved in 2000 by the University of Hawai`i Board of Regents; and

WHEREAS, the Office of Mauna Kea Management, an entity of the University of Hawai`i, Hilo was created, and has been functioning since 2000 without adequate authority of a "Comprehensive Management Plan", but the Office of Mauna Kea Management has formulated a comprehensive management plan; and

WHEREAS, the Office of Mauna Kea Management's Comprehensive Management Plan builds on the previous management and master plans to update the management strategies for the diverse range of activities and uses such as astronomy, cultural and religious activities, recreational and commercial activities, scientific research, and includes comprehensive components to manage the Cultural Resources, Historical Resources, and the Natural Resources on Maunakea mountain; and

WHEREAS, the Cultural, Historical, and Natural resources are not being adequately preserved and protected, primarily because of the absence of properly written, and enforced rules and regulations, to cover the lands on Maunakea mountain leased to the University of Hawai`i;

NOW, THEREFORE, BE IT RESOLVED by the Association of Hawaiian Civic Clubs at its 49th Annual Convention at Nukoli`i, Kaua`i, Hawai`i, this 24th day of October 2008, that it

Kaua`i-2008 0101

strongly urges the State of Hawai`i, Board of Land and Natural Resources, approve a Comprehensive Management Plan covering the lands leased to the University of Hawai`i on Maunakea Mountain; and

BE IT FURTHER RESOLVED, that a certified copy of this Resolution be transmitted to the Governor of the State of Hawai`i, the Chairperson and members of the Board of Land and Natural Resources, and to the President of the Senate and the Speaker of the House of Representatives of the Legislature of the State of Hawai`i.

The undersigned hereby certifies that the foregoing Resolution was duly adopted on the 24th day of October 2008, at the 49th Annual Convention of the Association of Hawaiian Civic Clubs at Nukoli`i, Kaua`i, Hawai`i

Ramona Hau

President

ASSOCIATION OF HAWAIIAN CIVIC CLUBS

A RESOLUTION

08-48

URGING THE LEGISLATURE OF THE STATE OF HAWAI`I, TO AUTHORIZE THE OFFICE OF MAUNA KEA MANAGEMENT, AN ENTITY OF THE UNIVERSITY OF HAWAI`I, HILO, TO DEVELOP ADMINISTRATIVE RULES COVERING THE LANDS LEASED TO THE UNIVERSITY OF HAWAI`I ON MAUNAKEA MOUNTAIN

WHEREAS, a portion of the lands on Maunakea mountain have been leased to the University of Hawai`i until 2033; and

WHEREAS, the Institute for Astronomy, under the University of Hawai`i, Manoa, was tasked with the responsibility for the "management" of the area covered by the lease agreement; and

WHEREAS, those management activities had caused concern amongst the Hawaiian communities of Hawai`i Island, which resulted in a "Master Plan" being approved in 2000 by the University of Hawai`i Board of Regents; and

WHEREAS, the Office of Mauna Kea Management, an entity of the University of Hawai`i, Hilo, was created, and has been functioning since 2000 without adequate authority of Administrative Rules and Regulations; and

WHEREAS, the Cultural, Historical, and Natural resources are not being adequately preserved and protected, primarily because of the absence of properly written, and enforced rules and regulations, to cover the lands leased to the University of Hawai`i on Maunakea mountain; and

WHEREAS, the Office of Mauna Kea Management has undertaken the development of a Comprehensive Management plan for those leased lands atop Maunakea, which includes components for the comprehensive management of Cultural, Historical, and Natural resources as well;

NOW, THEREFORE, BE IT RESOLVED by the Association of Hawaiian Civic Clubs at its 49th Annual Convention at Nukoli`i, Kaua`i, Hawai`i, this 24th day of October 2008, that it strongly urges the Legislature of the State of Hawai`i, to authorize the Office of Mauna Kea Management, an entity of the University of Hawai`i, Hilo, to develop Administrative Rules covering the lands leased to the University of Hawai`i on Maunakea Mountain; and

Kaua`i -2008 0103

BE IT FURTHER RESOLVED, that a certified copy of this Resolution be transmitted to the Governor of the State of Hawai`i, the President of the Senate and the Speaker of the House of Representatives of the Legislature of the State of Hawai`i, and the Mayor of the County of Hawai`i.

The undersigned hereby certifies that the foregoing Resolution was duly adopted on the 24th day of October 2008, at the 49th Annual Convention of the Association of Hawaiian Civic Clubs at Nukoli`i, Kaua`i, Hawai`i

Ayimoni Khan

President

Appendix B. References

Appendix B. References

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