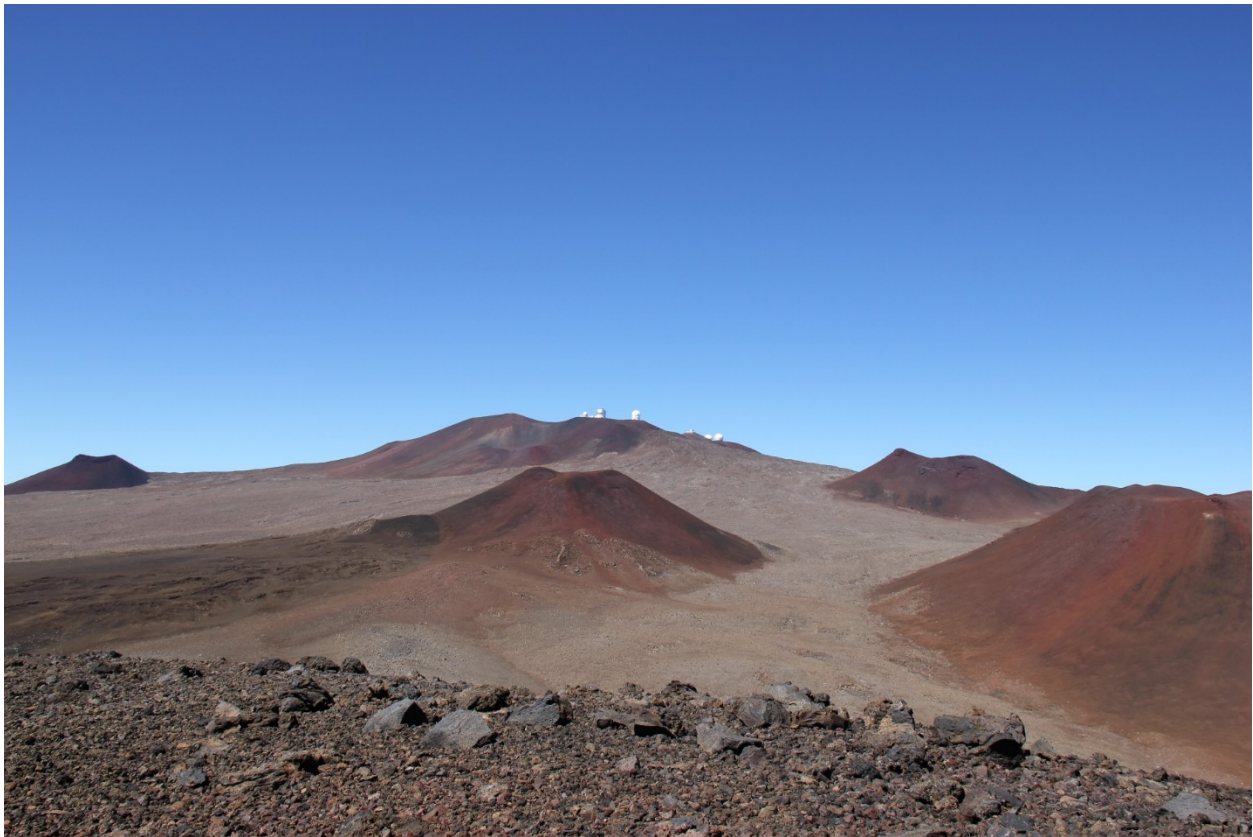

MAUNAKEA COMPREHENSIVE MANAGEMENT PLAN OUTCOME ANALYSIS REPORT

COMPREHENSIVE MANAGEMENT ACTION MEU-1



The summit region of Maunakea. Photo September 2013, J. Kirkpatrick, OMKM

AUGUST 2021

NOTE TO READERS

This report contains several hyperlinks that were created during the transition of management responsibility from the Office of Mauna Kea Management (OMKM) to the Center for Maunakea Stewardship (CMS). CMS is now in the process of updating the website where documents related to Maunakea management are kept. This will result in the OMKM hyperlinks used in this report becoming inactive once the files are migrated to the CMS website (see website note below).

The Office of Maunakea Management merged with Maunakea Support Services in August 2020, creating the [Center for Maunakea Stewardship](#), which is responsible for UH-managed Maunakea lands. Please visit [the center's website](#) for more information. The migration of OMKM information to the Center for Maunakea Stewardship site is expected to be completed by the start of 2022.

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LIST OF ACRONYMS

ACT	Activities and Uses
AMOC	Atlantic meridional overturning circulation
AR	Astronomical Resources, Activities, and Uses
BLNR	Board of Land and Natural Resources
BMP	Best Management Practices
BOR	UH Board of Regents
BTP	Burial Treatment Plan
C	Construction Guidelines
CDUA	Conservation District Use Application
CDUP	Conservation District Use Permits
CIP	Capital Improvement Program
CIO	Chlorine monoxide
CMP	Comprehensive Management Plan
CMS	Center for Maunakea Stewardship
CPR	Cardiopulmonary resuscitation
CR	Cultural Resources
CSO	Caltech Submillimeter Observatory
CUA	Core Use Area
DBEDT	Department of Business, Economic Development & Tourism
DLNR	Department of Land and Natural Resources
DOFAW	Division of Forestry and Wildlife
DOCARE	Division of Conservation and Resources Enforcement
DoD	Department of Defense
EA	Environmental Assessment
EEV	Emergency Evacuation Vehicle
EIS	Environmental Impact Statement
EISPN	EIS Preparation Notice
EMS	Emergency Medical Service
ENSO	El Niño-Southern Oscillation
EO	Education and Outreach
ESA	Endangered Species Act
FLU	Considering Future Land Use
FR	Foraging range
GIS	Geographic Information Systems
HAR	Hawai'i Administrative Rules
HISC	Hawai'i Invasive Species Council
HP	Halepōhaku
HRS	Hawai'i Revised Statutes
HVO	Hawai'i Volcanoes Observatory
IfA	Institute for Astronomy

IM	Infrastructure and Maintenance
ISMP	Invasive Species Management Plan
ISS	International Space Station
KKM	Kahu Kū Mauna
LEED	Leadership in Energy and Environmental Design
LiDAR	Light Detection and Ranging
MCP	Management Component Plans
MEU	Monitoring, Evaluation and Updates
MKFR	Mauna Kea Forest Reserve
MKMB	Mauna Kea Management Board
MKO	Maunakea Observatories
MKSR	Mauna Kea Science Reserve
MKSS	Mauna Kea Observatory Support Services
MLS	Microwave Limb Sounder
NAR	Natural Area Reserve
NARS	Natural Area Reserve System
NHO	Native Hawaiian Organizations
NOI	Notice of Intent
NR	Natural Resources
NRHP	National Register of Historic Places
NWR	National Wildlife Refuge
OAR	Outcome Analysis Report
OCCL	Office of Conservation and Coastal Lands, DLNR
OHA	Office of Hawaiian Affairs
OI	Operations and Implementation
O&M	Operations and Maintenance
OMKM	Office of Mauna Kea Management
OMMP	Operations, Monitoring and Maintenance Plan
P	Permitting and Enforcement
PCSI	Pacific Consulting Services, Inc.
PDO	Pacific Decadal Oscillation
PTA	Pōhakuloa Training Area, Army
RFI	Radio Frequency Interference
SHPD	State Historic Preservation Division, DLNR
SMILES	Superconducting Submillimeter-Wave Limb-Emission Sounder
SOP	Standard Operating Procedures
SPA	Site Plan Approvals
SR	Site Recycling, Decommissioning, Demolition, and Restoration
STEAM	Science Technology Engineering Art Math
STEM	Science Technology Engineering & Math
SUP	Special Use Permits
TCP	Traditional Cultural Property
TLS	Terrestrial Laser Scanning
TMT	Thirty Meter Telescope

UARS	Upper Atmosphere Research Satellite
UH	University of Hawai‘i
UH Hilo	University of Hawai‘i at Hilo
UNAVCO	University Navstar Consortium
USGS	United States Geological Survey
UST	Underground Storage Tank
VLBA	Very Long Base Array

EXECUTIVE SUMMARY

In 2009, the Board of Land and Natural Resources (BLNR) approved the *Mauna Kea Comprehensive Management Plan* (CMP). The CMP, which is the principal guide for the management of the University of Hawai‘i (UH) Management Areas, identifies 103 management actions related to the following four Management Component Plans (MCPs) and 12 “desired outcomes”:

- Understanding and protecting Maunakea’s resources (7.1)
 - Cultural resources (7.1.1; CR)
 - Natural resources (7.1.2; NR)
 - Education and outreach activities (7.1.3; EO)
 - Astronomical resources, activities, and uses (7.1.4; AR)
- Managing access, activities, and uses
 - Activities and uses (7.2.1; ACT)
 - Permitting and enforcement (7.2.1; P)
- Managing the built environment (7.3)
 - Infrastructure and maintenance (7.3.1; IM)
 - Construction guidelines (7.3.2; C)
 - Site recycling, decommissioning, demolition, and restoration (7.3.3; SR)
 - Considering future land use (7.3.4; FLU)
- Managing operations (7.4)
 - Operations and implementation (7.4.1; OI)
 - Monitoring, evaluation, and updates (7.4.2; MEU)

This *Outcome Analysis Report* (OAR), which is based on the most current available data, provides the information called for in CMP management actions MEU-1 and MEU-2. It describes the status of the resources in the plan area, summarizes the work that has been conducted regarding each of the management actions in the CMP, and outlines the progress made toward meeting the CMP’s stated goals (desired outcomes).

A draft of the OAR was circulated among stakeholders and agencies in order to: (i) inform them of the steps that UH has taken to date to implement the CMP’s 103 management actions; (ii) solicit their opinions as to the success and value of those measures; and (iii) obtain their suggestions regarding any adjustments (i.e., revisions, deletions, or additions) to management actions they believe should be made moving forward. In general, UH attempted to consult with all the government agencies having direct responsibility for regulating uses on Maunakea and organizations that have operations within or immediately adjacent to UH’s Maunakea lands. Because the focus was on parties having direct experience with management of activities on the mountain, the circulation was purposely kept narrower than the wide public distribution that is planned for the draft document outlining proposed updates to the CMP management actions which UH expects to issue in the fall of 2021.

All of the comments on the draft report that were received were reviewed and carefully evaluated, and revisions, where appropriate, are incorporated in this final report. CMS will use the information on program needs and recommended continuing and/or future management activities as UH finalizes its CMP progress report to DLNR and as the basis for adapting and/or adding CMP management actions in the years ahead.

This report is divided into the following chapters:

- Chapter 1 presents background information and outlines the intended purpose of the OAR.
- Chapter 2 presents detailed information concerning the present state of the cultural and natural resources within the UH Management Areas and the implementation of the CMP management actions associated with the desired outcomes related to those two resource categories (CR and NR).
- Chapter 3 contains detailed discussion of the many other measures that UH has implemented in accordance with the CMP. Those measures are related to the other ten desired outcomes.
- Chapter 4 summarizes the extent to which the UH's efforts have been successful in achieving the CMP's stated goals and objectives (desired outcomes) and identifies areas where additional effort and/or a correction in course, i.e., adaptive management, may be appropriate.
- Chapter 5 contains bibliographic references. This is followed by appendices which provide additional relevant information.

UH has made progress on nearly all the CMP's 103 management actions. Most importantly, in 2020 its efforts culminated in (i) the adoption of Hawai'i Administrative Rules (HAR) Chapter 20-26, *Public and Commercial Activities on Mauna Kea Lands* (the "UH Maunakea Rules" or "HAR Chapter 20-26"), and (ii) the recent creation of the Center for Maunakea Stewardship (CMS). As a result, UH is now in a better position to implement the CMP.

Overall, UH has made good progress toward achieving most of the CMP goals (desired outcomes) over the last ten years, including the governor's adoption of HAR Chapter 20-26, the Board of Regent's (BOR's) creation of CMS, and CMS's substantial progress in ongoing observatory decommissioning efforts. UH understands that some stakeholders believe that progress towards achieving management actions related to Native Hawaiian cultural resources and education and outreach are still inadequate, and the BOR, the President, and CMS are taking specific actions to address these issues.

As discussed in detail in this OAR and summarized in the table below, some management actions are complete after an express or implied action (e.g., preparation of a specific report) while other management actions (e.g., those requiring periodic and/or continuing action) are necessarily ongoing. UH has completed 15 of the CMP's management actions; no further action is needed for these.

Status of Management Actions by Category

Category	No. of Actions	Status			Discussion
		C	C/O	O	
Cultural Resources (CR)	14	8	1	5	2.1
Natural Resources (NR)	18	1	2	15	2.2
Education and Outreach (EO)	8	-	1	7	3.2.2
Astronomy Resource (AR)	2	-	-	2	3.3.2
Activities and Uses (ACT)	12	1	6	5	3.4.2
Permitting and Enforcement (P)	8	2	-	6	3.5.2
Infrastructure and Maintenance (IM)	14	-	3	11	3.6.2
Construction Guidelines (C)	9	-	-	9	3.7.2
Site Recycling, Decommissioning, Demolition and Restoration (SR)	3	-	-	3	3.8.2
Future Land Use (FLU)	7	1	-	6	3.9.2
Operations and Implementation (OI)	5	2	1	2	3.10.2
Monitoring, Evaluation, & Updates (MEU)	3	-	-	3	3.11.2
All Actions	103	15	14	74	
Key: "C" = Completed; "C/O" = Program framework completed; implementation is ongoing; "O" = ongoing					

As indicated in the "C/O" column of the table above, fourteen (14) of the management actions required UH to first establish an implementation framework and/or detailed procedures and then implement those procedures over the long term. The framework and procedures for all of these are now in place, i.e., the "establishment" part has been completed, and all are now being implemented (hence their "ongoing" nature).

All the remaining management actions (74) have from the outset involved ongoing implementation effort (see the "O" column in table above). The staff and facilities needed to accomplish this are generally in place, although some have been adversely affected by constraints related to the ongoing COVID-19 pandemic and/or the need for input from other agencies. UH will continue to implement these measures, adapting them as appropriate when it determines that the desired outcome that each one targets could be better achieved through a modified approach that is informed by its experience to-date.

1 INTRODUCTION

1.1 BACKGROUND AND PURPOSE OF THIS REPORT

1.1.1 BACKGROUND

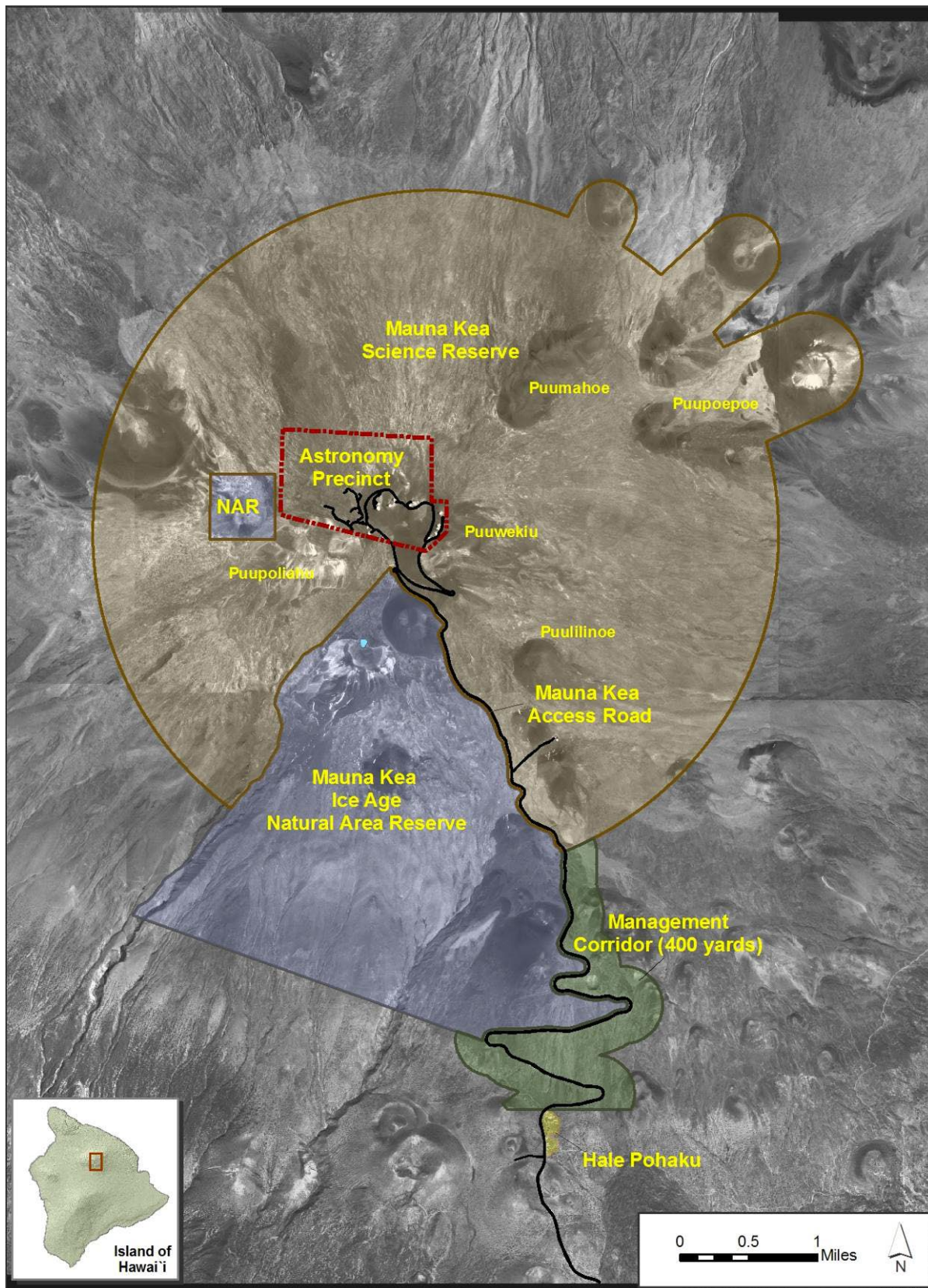
In April 2009, the Board of Land and Natural Resources (BLNR) approved, subject to conditions, the *Mauna Kea Comprehensive Management Plan* (CMP), an exhaustive and overarching plan guiding UH's administration of the "UH Management Areas." On March 25, 2010, the BLNR approved the four sub-plans (together, the "Sub-Plans") on which its approval of the CMP had been conditioned, thereby bringing the CMP into full effect. The CMP and Sub-Plans provide a framework for ensuring proper stewardship of the UH Management Areas. As used in this *Outcome Analysis Report* (OAR), "CMP" is inclusive of all five documents approved by the BLNR:

- The *Mauna Kea Comprehensive Management Plan, UH Management Areas* document dated April 2009.
- The *Natural Resources Management Plan for the UH Management Areas on Mauna Kea* document dated September 2009.
- The *A Cultural Resources Management Plan for the University of Hawaii Management Areas on Mauna Kea, Ka'ohe Ahupua'a, Hāmākua District, Hawai'i Island, State of Hawai'i* document dated October 2009.
- The *Public Access Plan for the UH Management Areas on Mauna Kea* document dated January 2010.
- The *Decommissioning Plan for the Mauna Kea Observatories* document dated January 2010.

The Office of Mauna Kea Management (OMKM) was the entity performing day-to-day implementation of the CMP during most of the period covered by this document, i.e., until the UH Board of Regents (BOR) approved the creation of the Center for Maunakea Stewardship (CMS) on August 20, 2020, at which time the transition from OMKM to CMS began. UH Management Areas during the period this document covers consisted of the following lands (see Figure 1-1):

- TMK 4-4-015:009, designated the Mauna Kea Science Reserve (MKSR) and leased to UH. The parcel is roughly 11,288 acres in size.
- TMK 4-4-015:012, known as Halepōhaku or the mid-level facilities and leased to UH. The parcel is roughly 19 acres.
- A portion of TMK 4-4-015:001, which is part of the Mauna Kea Forest Reserve, over which UH has a non-exclusive easement for the Mauna Kea Access Road. The easement encompasses roughly 71 acres.

Figure 1-1 UH Management Areas



Source: Figure 3-1, Maunakea Comprehensive Management Plan

- A 400-yard-wide corridor on either side of the Mauna Kea Access Road (except for portions of this corridor which fall within the Mauna Kea Ice Age Natural Area Reserve), which amounts to a roughly 670-acre portion of TMK 4-4-015:001 over which UH does not have any lease or easement. This corridor was originally included in the UH Management Areas in the Revised Management Plan for the UH Management Areas on Mauna Kea, dated March 10, 1995, and approved by the BLNR.

The CMP does not apply to areas not defined as UH Management Areas, although UH has actively sought coordination and consultation with neighboring landowners such as BLNR, DHHL, and others, since species and cultural resources, for example, know no boundaries.

1.1.2 PURPOSE OF THIS OAR

The CMP recommends management actions related to cultural resources; natural resources; education and outreach activities; astronomical resources, activities, and uses; permitting and enforcement; infrastructure and maintenance; construction guidelines; site recycling, decommissioning, demolition and restoration; future land use; operations and implementation; and monitoring, evaluation and updates. As stated on page 2-4 of the CMP, all the management actions were formulated in recognition that:

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).*

This OAR, which is based on the latest information available to its authors, provides the information called for in CMP management action MEU-1. It describes the status of the resources in the plan area, summarizes the work that has been conducted regarding each of the management actions in the CMP, and outlines the progress made toward meeting the CMP's stated goals (the "desired outcomes"). As required by the CMP, this OAR synthesizes information contained in the annual reports that the Office of Mauna Kea Management (OMKM), and in 2021 the Center for Maunakea Stewardship (CMS), has submitted to the BLNR each year since the CMP was adopted, with some additional information being included as appropriate.¹

CMS will use the information contained in this report to decide: (i) how best to adapt the measures it is presently implementing to better accomplish the desired outcomes of the CMP and (ii) to determine what, if any, additional actions it may be appropriate to implement.

¹ On August 20, 2020, the Board of Regents approved the creation of CMS which replaces OMKM. CMS is responsible for OMKM activities prescribed in governing plans and documents in addition to other responsibilities.

1.2 MANAGEMENT REPORTING

CMP management action MEU-1 calls for both annual reports and this periodic OAR (which the CMP also refers to as a “Progress Report” or a “Resource Status and Management Progress Report”). As summarized in Table 1.1, UH has submitted a total of eleven annual reports to the BLNR to date (see <http://www.malamamaunakea.org/management/comprehensive-management-plan>). Each annual report is cumulative, building on the previous year’s report. Thus, for example, the 2020 Annual Report, which is reproduced in Appendix A, discusses all the CMP management activities conducted between the time the CMP was approved and the end of the previous calendar year (i.e., December 31, 2019).

Table 1.1 Annual CMP Status Reports to BLNR

Report Title	Report Date
2010 Annual Report	April 8, 2011
2011 Annual Report	April 8, 2012
2012 Annual Report	April 9, 2013
2013 Annual Report	April 9, 2014
2014 Annual Report	April 9, 2015
2015 Annual Report	April 30, 2016
2016 Annual Report	September 2017
2017 Annual Report	August 2018
2018 Annual Report	August 2019
2019 Annual Report	June 2020
2020 Annual Report	February 2021
OAR (2021 Annual Report)	August 2021

This OAR was prepared in accordance with the following guidance contained in the portion of the CMP that describes the updating and revision process (see MEU-1 on page 7-65). This is the first OAR prepared and approved by the University; it builds on the cumulative annual reports listed above and serves as the 2021 Annual Report.

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.

As noted above, the CMP mandates that this progress report contain two specific sections. The first of these, which discusses the state of cultural and natural resources in the UH Management Areas, is presented in Chapter 2 of this OAR. The second, which describes the progress that has been made towards meeting the CMP's management goals, is addressed in Chapter 4 of this OAR. In addition to these two required sections, this OAR contains an additional chapter, Chapter 3, that summarizes UH programs and assesses UH's work on CMP management actions other than those related directly to cultural and natural resources. Chapter 5 contains bibliographic references.

Management action MEU-2 of the CMP details the update and revision process for the CMP. It calls for stakeholders to be given a copy of this OAR so that they are aware of the current status of the mountain's resources and of the successes, failures, and ongoing activities, of the CMP-related programs and activities. Comments received on program needs and recommended continuing and/or future management activities will then be addressed as UH continues to adaptively manage implementation of the CMP.

Finally, UH submits an annual report to the State Legislature on the Mauna Kea Lands, pursuant to HRS § 304A-1905. This annual legislative report addresses land activities, current and pending lease agreements and fees, the status of current and pending administrative rules, income and expenditures of the Mauna Kea Lands special fund established in HRS § 304A-2170, and other issues that may impact the activities on Maunakea. Content from these annual legislative reports is included in this OAR only where it is relevant to the CMP.

2 STATE OF RESOURCES

As part of the CMP review process, CMS has reviewed the results of the monitoring, research, and studies that OMKM and its contractors have conducted since the CMP was prepared so that it could consider any new information regarding the state of the resources that might warrant changes (e.g., adaptations and additions) in management approaches and activities. This chapter summarizes the results of that review. Each of the major sections is divided into the following three subsections that address MEU-1's requirements:

- New information obtained, via monitoring, research, restoration, and threat prevention and control activities, since the CMP was approved.
- Discernable trends and management impacts since related CMP management actions began.
- Future management actions related to the topic. Changes to the management approach and activities are touched on here but will be the subject of a separate document, which is the next step in the CMP update process.

The major subsections in this chapter are related to the resources (cultural, physical, biotic) and the management actions that specifically address them (i.e., the "CR-" and "NR-" coded actions in the CMP). Other management actions, including (but not limited to) those related to education and outreach (EO) and activities and uses (ACT), have the potential for wide-ranging secondary beneficial and adverse effects on these resources. For instance, education and outreach actions that inform people how to respect, protect, and conserve the resources should reduce adverse impacts to all resources discussed in this chapter. While there is limited pre-CMP data against which to compare the post-CMP situation, overall, it is believed that the totality of the management actions has benefitted and continues to benefit the resources discussed in this chapter.

Future management actions in non-CR and NR-coded categories, such as (but not limited to) future actions stemming from an update of the managed access policy (ACT-1), will also have secondary effects on the resources discussed in this chapter. Future non-CR and non-NR-coded management actions are addressed in other chapters of this report. UH will adjust, adapt, and potentially add management actions in coordination with stakeholders during the next step in the CMP update process.

2.1 NATIVE HAWAIIAN CULTURAL RESOURCES

The CMP summarizes cultural resources (historic properties and archaeological resources) that were known to be situated within the UH Management Areas at the time it was prepared. It then recommends 14 management actions related to cultural resources (CR-1 through CR-14). The remainder of this section describes new information related to native Hawaiian cultural resources that has emerged since the CMP was adopted (see sub-section 2.1.1), discusses discernible trends related to cultural resources (sub-section 2.1.2), and describes the status of the implementation of management measures related to native Hawaiian cultural resources (sub-section 2.1.3). As indicated in sub-section 2.1.4, while management actions related to cultural resources will continue to evolve in response to changing circumstances, no entirely new management actions are needed at this time.

2.1.1 NEW INFORMATION RELATED TO NATIVE HAWAIIAN CULTURAL RESOURCES

Archaeological surveys, monitoring reports, and other reports or publications dealing with historic resources that have become available since the CMP was adopted are listed in Table 2.1. A few of the most significant products are the *Long-Term Historic Property Monitoring Plan*, which DLNR's State Historic Preservation Division (SHPD) approved in 2014, and a *Burial Treatment Plan* (BTP), which SHPD approved on July 11, 2014.²

Table 2.1 Post-CMP Approval Archaeological and Historical Resource Reports

Report	Author	Year
<i>Archaeological Inventory Survey of the Astronomy Precinct in the Mauna Kea Science Reserve, Ka'ohē Ahupua'a, Hāmākua District, Island of Hawai'i.</i>	PCSI	2010
<i>Archaeological Inventory Survey of the Mauna Kea Access Road Management Corridor, Ka'ohē Ahupua'a, Hāmākua District, Island of Hawai'i.</i>	PCSI	2010
<i>Historic Resources Inventory of the Comfort Station (Stone Outhouse) at Halepōhaku, Site # 50-10-23-9076</i>	PCSI	2010
<i>Historic Resources Inventory of the Halepōhaku Rest Camp (Stone Cabins) at Halepōhaku, Site # 50-10-23-9074</i>	PCSI	2010
<i>Historic Resources Inventory of the Halepōhaku Rest Camp (Stone Cabins) at Halepōhaku, Site # 50-10-23-9075</i>	PCSI	2010
<i>Archaeological Inventory Survey of the Hale Pōhaku Rest Houses 1 and 2 and Comfort Station, Ka'ohē Ahupua'a, Hāmākua District, Hawai'i Island, Hawai'i.</i>	PCSI	2010
230Thorium Dating of Toolstone Procurement Strategies, Production Scale and Ritual Practices at the Mauna Kea Adze Quarry Complex, Hawai'i. <i>Journal of the Polynesian Society</i> , Vol 121 (4): 407-420. https://doi.org/10.15286/jps.121.4.407-420 .	McCoy, P.C., Nees, R., Weisler, M.I., Zhao, J.	2012
<i>2012 Assessment of Historic Properties Within Three University of Hawai'i Management Areas on Maunakea, Ka'ohē Ahupua'a, Hāmākua District, Hawai'i Island, State of Hawai'i.</i> Prepared for OMKM: Hilo, HI.	PCSI	2013
<i>Final Report Archaeological Inventory Survey of the Mauna Kea Ice Age Natural Area Reserve, Ka'ohē Ahupua'a, Hāmākua District, Island of Hawai'i, Vol. 1-4.</i> [(Not OMKM Sponsored, but funded using the Mauna Kea Lands Special Fund)]	PCSI	2013
<i>Revised Draft Report: 2012 Assessment of Historic Properties Within Three University of Hawai'i Management Areas on Maunakea, Ka'ohē Ahupua'a, Hāmākua District, Hawai'i Island, State of Hawai'i.</i> Prepared for OMKM: Hilo, HI.	PCSI	2013
<i>Long-Term Historic Property Monitoring Plan for the University of Hawai'i Management Areas on Mauna Kea, Ka'ohē Ahupua'a, Hāmākua District, Hawai'i Island, State of Hawai'i.</i>	PCSI	2014
<i>2013 Assessment of Historic Properties Within Three University of Hawai'i Management Areas on Maunakea, Ka'ohē Ahupua'a, Hāmākua District, Hawai'i Island, State of Hawai'i.</i> Prepared for OMKM: Hilo, HI. Yearly Monitoring Report #2 (2013)	PCSI	2014
<i>Burial Treatment Plan for Burial Sites in the Mauna Kea Science Reserve and the Mauna Kea Access Road Corridor, Ka'ohē Ahupua'a, Hāmākua District, Island of Hawai'i.</i>	PCSI	2014

² The BTP provides long-term preservation guidance on the 34 known, suspected, or potential burial sites found on the UH Management Areas. The plan also recommends 200-foot buffer zones and restoration guidelines should human remains become exposed and provides guidelines for the treatment of newly discovered burials or reburials sites to ensure consistency with state mandates and to addresses cultural concerns. Protocols identified in this OAR have been implemented on several occasions when human remains were uncovered through natural erosion processes.

Report	Author	Year
A Re-examination of Kenneth P. Emory's Theory of Necker Type Marae in the Summit Region of Mauna Kea, Hawaii: Many Marae or Shrines Later. <i>Hawaiian Archaeology</i> , 27-50.	P.C. McCoy, & R. Nees	2014
Geochemistry and Technology of Basaltic Glass Artifacts from an Embedded Source and Two High-altitude Base Camps in the Mauna Kea Adze Quarry Complex, Hawai'i. <i>Journal of Pacific Archaeology</i> , Vol. 6 (2): 1-20. http://pacificarchaeology.org/index.php/journal/article/view/153 .	McCoy, P.C., M.I. Weisler, E.J. St Pierre, R. Holhar, Y. Feng.	2015
2014 Assessment of Historic Properties Within Three University of Hawai'i Management Areas on Maunakea, Ka'ohē Ahupua'a, Hāmākua District, Hawai'i Island, State of Hawai'i. Prepared for OMKM: Hilo, HI.	PCSI	2015
2015 Assessment of Historic Properties Within Three University of Hawai'i Management Areas on Maunakea, Ka'ohē Ahupua'a, Hāmākua District, Hawai'i Island, State of Hawai'i. Prepared for OMKM: Hilo, HI.	PCSI	2016
2016 Assessment of Historic Properties Within Three University of Hawai'i Management Areas on Maunakea, Ka'ohē Ahupua'a, Hāmākua District, Hawai'i Island, State of Hawai'i. Prepared for OMKM: Hilo, HI.	PCSI	2017
Proceedings of a 2013 USGS workshop on combining traditional Hawaiian knowledge with scientific thought published. Focus is on Kīlauea volcano, although examples from Maunakea are included.	Kauahikaua and Babb (eds.)	2017
2017 Assessment of Historic Properties Within Three University of Hawai'i Management Areas on Maunakea, Ka'ohē Ahupua'a, Hāmākua District, Hawai'i Island, State of Hawai'i. Prepared for OMKM: Hilo, HI.	PCSI	2018
2018 Assessment of Historic Properties Within Three University of Hawai'i Management Areas on Maunakea, Ka'ohē Ahupua'a, Hāmākua District, Hawai'i Island, State of Hawai'i. Prepared for OMKM: Hilo, HI.	PCSI	2019
2019 Assessment of Historic Properties Within Three University of Hawai'i Management Areas on Maunakea, Ka'ohē Ahupua'a, Hāmākua District, Hawai'i Island, State of Hawai'i. Prepared for OMKM: Hilo, HI.	PCSI	2020
2020 Assessment of Historic Properties Within Three University of Hawai'i Management Areas on Maunakea, Ka'ohē Ahupua'a, Hāmākua District, Hawai'i Island, State of Hawai'i. Prepared for OMKM: Hilo, HI.	PCSI	2020
Source: Office of Maunakea Management		

Annual monitoring of historic properties, which began in 2012 and is ongoing, has documented the alteration to certain sites and recorded new find spots.³ The monitoring results are summarized in Table 2.2. Annual reports detailing these efforts have been submitted to SHPD after consultation with the Kahu Kū Mauna Council on management action recommendations.

In addition to the new information that has been gained through the monitoring summarized in the “Assessment” reports listed in Table 2.1, other new information related to archaeological resources has been gathered since the CMP was approved.⁴ For example, an archaeological inventory survey of the 400-yard wide easement along the Mauna Kea Access Road undertaken by PCSI for OMKM in 2009 (McCoy et al. 2010b) identified one previously recorded site (50-10-23-10314) and three new sites (see Table 2.3 below); forty-four (44) find spots were also recorded during the survey.

³ “Find spots” are defined as “anthropogenic features that are either obviously modern (e.g., camp sites with tin cans, pieces of glass and other modern material culture items), or features that cannot be classified with any level of confidence as historic sites because of their uncertain age and function (e.g., a pile of stones on a boulder)” (McCoy 1999).

⁴ This information is obtained from the items listed in Table 2.1.

About half of the find spots were on top of a cinder cone just above Halepōhaku, which is not surprising given the proximity of that area to locales frequented by the public.

Table 2.2. Changes Observed During Annual Monitoring of Historic Properties

Year	No. Sites Visited	No. Sites w/ Changes	Changes Observed	
			Human Impact	Natural Processes
2012	52	10	• 3 sites, features rearranged, all <0.3 mile from road (VLBA area)	• 5 sites, natural erosion, all at Pu‘umakanaka
2013	51	7	• 3 sites, features rearranged, all <0.3 mile from road (Park2/VLBA)	• 2 sites, lithics not found, <0.4 miles from road (VLBA)
2014	49	10	• 2 sites, features rearranged, all <0.3 mile from road (VLBA)	• 6 sites, 2 bldgs @ HP, 4 natural erosion – 1 @ HP, 3 @ VLBA
2015	199	5	• 3 sites, features rearranged, all <0.9 mile from road (VLBA and N. Plateau)	• 2 sites, 1 bldg @ HP, 1 natural erosion @ Pu‘umakanaka
2016	112	10	• 4 sites, features rearranged/ removed, all <0.3 mile from road (VLBA and Pu‘uwēkiu)	• 6 sites, 3 bldgs @ HP, 3 natural erosion @ Pu‘umakanaka
2017	61	12	• 4 sites, features rearranged/ added; all <0.3 miles from road (CSO, Park 2, VLBA)	• 8 sites, 3 bldgs @ HP, 5 natural erosion @ Pu‘umakanaka
2018	57	7	• 2 sites, features rearranged/ added, all <0.3 miles from road (CSO, VLBA)	• 5 sites, 3 bldgs @ HP, 2 natural erosion @ VLBA & Pu‘umakanaka
2019	16	2	• 2 sites, features rearranged/ offerings left, all <0.3 miles from road (TMT, Pu‘uwēkiu)	• 0 sites
2020	95	0	• 0 sites	• 0 sites

Note: Number of sites visited in 2019 reduced due to road blockages.
Source: Reports summarizing annual assessment of historic properties within the UH Management Areas by PCSI.

Table 2.3 Historic Properties Recorded in the Mauna Kea Access Road Corridor

Site No.	Site Type	Number of Features	Site Function
50-10-23-10314	Lithic scatter	1	Adze and octopus lure sinker workshop
50-10-23-27867	Mounds	4	Possible burial
50-10-23-27868	Mound	1	Possible burial
50-10-23-27869	Mounds	2	Possible burial

During the large-scale protests that took place on Maunakea in reaction to the start of the Thirty Meter Telescope (TMT) project construction, protesters erected many temporary ahu and other structures. Most of these were removed following the protest period in accordance with approved, CMP-identified guidelines and policies, and no formal documentation of them exists.

2.1.2 DISCERNABLE TRENDS RELATED TO CULTURAL RESOURCES⁵

2.1.2.1 General

The CMP recognizes that Maunakea is a living resource and that Native Hawaiians exercise customary and traditional practices within the UH Management Areas. It also identifies the valued

⁵ As used here, the term “cultural resources” has the same meaning as is laid out in the Chapter 5 of the CMP, which contains an extensive discussion of the term. It includes principles of Hawaiian Cultural Resource Management, cultural land use practices,

cultural, historical, and natural resources, including rights customarily and traditionally exercised for subsistence, cultural, and religious purposes within the UH Management Areas. The CMP describes the threats or impacts to these valued resources by uses and activities within the UH Management Areas and identifies the management actions to be taken by the stewards of the land to reasonably protect these valued resources.

Management of Maunakea has improved greatly since the Hawai‘i State Auditor’s 1998 *Audit of the Management of Mauna Kea and the Mauna Kea Science Reserve* (Report No. 98-6) as shown in follow-up audits by the State Auditor in 2005 (Report No. 05-13), 2014 (Report No. 14-07), 2017 (Report No. 17-06), and 2019 (Report No. 19-15). The adoption and implementation of the CMP and creating OMKM, MKMB, and KKM spurred many of these improvements. However, for many Native Hawaiians, Maunakea’s sacredness and perceived disrespect from past actions on Maunakea have grown. In addition, Maunakea has become a symbol for larger social movements aimed at restoring Native Hawaiian self-determination.

The activities conducted on Maunakea and perception of its relevance to larger social movements have changed in many ways since the CMP was adopted, which affects stewardship and management. For example:

- For many, Maunakea has become the focal point of longstanding historical injustice experienced by Native Hawaiians. Larger issues have entered the discourse, including social equity and the place of cultural ‘ike (knowledge) and practice in land use decisions and stewardship activities statewide that integrate the held value for sanctity of place. This has led to movements arguing the inequity and inappropriateness of specific projects. The most notable being the physical blockade of the Mauna Kea Access Road in protest against the TMT project in 2014, 2015, and again during 2019 and early 2020. Activities aimed at stopping the construction of TMT in 2019 included daily protocols at a blockade that stopped entry to UH Management Areas and frequent protocols within the UH Management Areas.
- This increased attention has led to a modest but measurable increase in cultural activities on Maunakea. It is not always clear that these activities are specifically customary and traditional practices. Still, it appears that the voices emphasizing the sanctity of place may be contributing to the exercise of spiritual practice within the UH Management Areas more generally.⁶
- Maunakea Rangers report that the number of Native Hawaiian individuals and groups accessing the summit area to participate in ceremonies and leave offerings is notably greater than it was at the time the CMP was adopted.

Providing further context to our ongoing and future planning regarding Maunakea stewardship is the Department of Land and Natural Resources’ report entitled, *Independent Evaluation of the Implementation of the Mauna Kea Comprehensive Management Plan*, dated December 2020. The report concludes that UH “has made progress in implementing most of the CMP MAs, and in many regards ... is effectively managing the activities and uses on Mauna Kea to better protect the natural

sources of information about cultural practices, and the “cultural landscape”. While the term defies a simple definition, it is clear that it encompasses all the interwoven physical, ecological, and spiritual factors that made Hawai‘i a distinctive place.

⁶ Note that in the case of *Matter of Conservation Dist. Use Application HA-3568*, 143 Hawai‘i 379, 396 n.16 (2018), the Hawai‘i Supreme Court opined that “recent construction of ahu to protest the TMT Project itself . . . was not found to be a reasonable exercise of cultural rights.”

and cultural resources.” However, the report also concludes that UH needs to improve consultation with the Native Hawaiian community “on cultural issues, including removal of family shrines, stacking of Pōhaku, and identification of cultural sites,” and on “education and outreach efforts, including decision-making process related to the management of Mauna Kea.” These conclusions are qualified by the report’s observation that individuals’ “assessment of how effectively UH has implemented the CMP has primarily varied depending on whether they are in favor or opposition of telescope development on Mauna Kea.”

In summary, despite the many positive steps that have been taken, disagreement about the appropriateness of the permitted astronomical uses on Maunakea remains strong. Moreover, some positions are polarized to the point where the hope of finding a middle ground for the sharing of Maunakea’s unique cultural, natural, and scientific resources is significantly challenged. Nonetheless, there is still common ground to work from.

2.1.2.2 Ranger Report Items

The Maunakea Rangers have kept records of the new cultural resource items that they have found in the UH Management Areas since 2004. Those finds are summarized in Table 2.4.⁷

Table 2.4 Cultural Resources Observed on UH Managed Land

Year	Rock pile/ stack	Offerings	Ashes	Mixed	Total
2004	0	0	1	0	1
2005	2	5	0	0	7
2006	4	1	0	0	5
2007	0	6	0	0	6
2008	1	0	0	0	1
2009	14	2	0	0	16
2010	8	3	0	4	15
2011	9	19	1	4	33
2012	3	11	2	2	18
2013	8	10	0	5	23
2014	15	28	0	6	49
2015	21	35	0	1	57
2016	34	54	2	4	94
2017	28	29	2	1	60
2018	25	23	7	2	57
2019	23	28	7	10	68
2020	13	21	0	1	35
Total	208	275	22	40	545

Notes: Meanings of column headings are as follows:
Rock pile/Stack: A gathering or setting of rocks that appears to be man-made; formations are of varied forms.
Offerings: Includes organic materials, such as whole or parts of plants (e.g., stalk, leaf, fruit, flower); and non-organic materials including glass, crystals, metals; which appear to have been placed/arranged by humans.
Ashes: Cremains, including hair, teeth, and bone fragments; dry substance may vary from powdery to coarser-grain; color appears to be beige/off-white/grey.
Mixed: A combination of apparently manipulated rocks, offerings and/or ashes appearing together in one locality.
Source: Center for Maunakea Stewardship, February 19, 2021.

⁷ The categorization used in the table is based on OMKM staff’s careful review of the entries in the Ranger reports. However, it is important to note that it has not been reviewed by the Kahu Ku Mauna, MKMB, or others. The categories also may not wholly reflect the original cultural resources - for instance, the observer filing the report might have seen and reported a lone ho‘okupu, but it could have been blown away from a larger, original feature.

A review of the data reveals several clear changes over time in the number and type of culturally related items being found. The following are among the more important:

- The average number of items reported each year from 2012 through 2020 was five times the average number counted each year from 2004 through 2011.
- More features (94) were reported during 2016 alone than had been reported in the first nine years of the monitoring (2004 through 2012). This peak coincides with the first wave of public protests that were conducted in opposition to the TMT project.
- Roughly half (261) of all the features reported were “offerings” and 40% (207) were rock piles or stacks.
- Whereas no ashes were reported from between 2004 and 2010, and only three sets of ashes were reported over the following five years (2011 to 2015), 16 sets of ashes were reported over the following four years (2016 to 2019).

2.1.2.3 Archaeological Monitoring Items

The archaeological monitoring results are summarized in Table 2.2. Taken together, they indicate that changes to historic properties by humans have been predictable based on such factors as accessibility (distance from known roads and trails) and visibility. The most common human-induced changes include the construction of new features as well as the re-positioning of upright stones at shrines. Natural changes, such as fallen uprights, have usually occurred at sites in vulnerable condition, while some low-visibility sites such as stone tool debitage scatters have been impacted by natural erosion. Finally, the monitoring results make it clear that most sites that are disturbed by human activity are within a short distance of the Mauna Kea Access Road.

2.1.3 STATUS OF MANAGEMENT ACTIONS RELATED TO CULTURAL RESOURCES

Table 7-1 in the CMP identifies 14 “management actions” to address the needs related to native Hawaiian cultural resources that it had identified. Those actions, and the extent to which they have been completed, are listed in Table 2.5 below. Additional information regarding the status of each measure is presented in subsections 2.1.3.1 through 2.1.3.14.

Table 2.5 Status of Measures Related to Native Hawaiian Cultural Resources

Measure	Description	Status	Discussion
CR-1	Kahu Kū Mauna (KKM) shall work with families with lineal and historical connections to Maunakea, cultural practitioners, and other Native Hawaiian groups, including the MKMB’s Hawaiian Culture Committee, toward the development of appropriate procedures and protocols regarding cultural issues.	Ongoing	2.1.3.1
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 <i>et seq.</i> in consultation with the larger community.	Ongoing (awaiting opportunity)	2.1.3.2
CR-3	Conduct educational efforts to generate public awareness about the importance of preserving the cultural landscape.	Ongoing	2.1.3.3
CR-4	Establish a process for ongoing collection of information on traditional, contemporary, and customary cultural practices.	Ongoing (process established)	2.1.3.4
CR-5	Develop and adopt guidelines for the culturally appropriate placement and removal of offerings.	Completed	2.1.3.5

Measure	Description	Status	Discussion
CR-6	Develop and adopt guidelines for the visitation and use of ancient shrines.	Completed	2.1.3.6
CR-7	Kahu Kū Mauna shall take the lead in determining the appropriateness of constructing new Hawaiian cultural features.	Completed	2.1.3.7
CR-8	Develop and adopt a management policy for the UH Mgt. Areas on the scattering of cremated human remains.	Completed	2.1.3.8
CR-9	A management policy for the cultural 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.	Completed	2.1.3.9
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.	Completed	2.1.3.10
CR-11	Complete an archaeological survey of the portions of the Mauna Kea Access Road corridor that are under UH management.	Completed	2.1.3.11
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.	Completed	2.1.3.12
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, recognized lineal or cultural descendants, and SHPD.	Completed	2.1.3.13
CR-14	Immediately report any disturbance of a shrine or burial site to the rangers, DOCARE, Kahu Kū Mauna Council, and SHPD.	Ongoing	2.1.3.14
Note: A status of “Completed/Ongoing” means that the needed procedures and systems have been completed and are being implemented on an ongoing basis.			
Source: Mauna Kea Comprehensive Management Plan, Table 7-1.			

2.1.3.1 *CR-1: Develop Appropriate Procedures and Protocols Regarding Cultural Issues*

Management action CR-1 calls on Kahu Kū Mauna to work with families with lineal and historical connections to Maunakea, cultural practitioners, and other Native Hawaiian groups, including the MKMB’s Hawaiian Culture Committee, toward the development of appropriate procedures and protocols regarding cultural issues. As discussed below, this has been ongoing.

In the Fall of 2013, the Hawai‘i Island Burial Council officially recognized several individuals as cultural descendants of Ka‘ohe Ahupua‘a. Identification of lineal and historical connections was part of the development and State Historic Preservation Division’s approval (2014) of the BTP (see CR-13). Solicitations were made through announcements in the daily newspapers and the Office of Hawaiian Affairs (OHA) newsletter. There were no responses to the solicitations but first OMKM and now CMS have continued to seek out individuals as part of its interaction and relationship-building with the community.

In October 2010 OMKM and Kahu Kū Mauna met with representatives of the Royal Order of Kamehameha regarding care taking of the summit lele. In October 2011 OMKM made a presentation to OHA trustees and staff visiting Maunakea regarding OMKM’s stewardship role and responsibilities, and Kahu Kū Mauna subsequently met with OHA representatives to discuss ahu-building and ahu-removal on Maunakea.

On May 21, 2016, Kahu Kū Mauna hosted a talk story session on matters related to CMP management actions that was attended by representatives from DLNR, DHHL, OHA, and members of the Native Hawaiian community. During late 2016 and the first half of 2017, OMKM placed ads over a period of several months in the *Hawaii Tribune Herald*, *West Hawaii Today*, *Honolulu Star Advertiser* and OHA's *Ka Wai Ola* inviting community members to participate in talk-story sessions.

The outcome of UH's work has been the formulation of several detailed policies (see <http://www.malamamaunakea.org/hawaiian-culture/policies>) that address the procedures and protocols that are to be followed in addressing cultural issues on Maunakea. As outreach to and consultation with the Native Hawaiian community continues, a need for additional procedures and protocols may arise.

2.1.3.2 CR-2: Support Application for Designation of Summit as TCP

According to National Register Bulletin 38 (Parker and King 1990), a traditional cultural property (TCP), is defined generally as one that is eligible for inclusion in the National Register of Historic Places (NRHP) because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history and (b) are important in maintaining the continuing cultural identity of the community. CR-2 calls for UH to support [emphasis added] a nomination for including the summit region of Maunakea as a TCP in the NRHP. If a nomination is submitted, UH will support it.

2.1.3.3 CR-3: Conduct Educational Efforts to Generate Public Awareness About the Importance of Preserving the Cultural Landscape

Section 5.1.5 of the CMP describes the "Hawaiian cultural landscape" relevant to Maunakea as "[w]ahi 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." CR-3 calls for educational efforts to generate public awareness about the importance of preserving the cultural landscape. UH has for many years undertaken significant efforts and devoted sizable resources towards this goal. For example, as outlined in its most recent progress reports:

- Rangers, which have been present on Maunakea since 2001, through their interactions with the visiting public help to educate and raise awareness about Maunakea.
- In 2014 UH developed an informational brochure on cultural and natural resources and has made periodic updates since then. A copy of the current version of the brochure may be found at <http://www.malamamaunakea.org/visitor-information/Resource-Brochure>.
- OMKM sent out eNewsletters informing the public about OMKM and its activities and Maunakea's resources for many years, and CMS has now assumed responsibility for this. As of April 2020, over 100 newsletters had been released, and many of them can be found at <http://www.malamamaunakea.org/about-us/news-archives>).
- Resource orientation of those who work on the mountain including astronomy personnel, Visitor Information Station (VIS) and MKSS staff, Rangers, commercial tour operators and

staff, and construction workers is required by the CMP.⁸ An online version of the orientation is available at [<http://www.malamamaunakea.org/about-us/maunakea-orientation>]. Those wishing to attend an orientation session in person are referred to the calendar at: <http://www.malamamaunakea.org/about-us/calendar>. Section 3.1.4 discusses the orientation in more detail and summarizes the number of people that have received it.

- In 2014 UH initiated the “Maunakea Speaker Series,” a regular, scholar-focused presentation offered as a partnership between the Office of Maunakea Management, 'Imiloa Astronomy Center, and the University of Hawai'i at Hilo Department of Physics & Astronomy. A venue for scholars to share their stories and learn from discussion, the series promotes understanding and collaboration across all sectors of the community, while addressing the goals of the University of Hawai'i at Hilo.

2.1.3.4 CR-4: Establish a Process of Ongoing Collection of Information on Traditional, Contemporary, and Customary Cultural Practices

CR-4 calls for the collection of information on traditional, customary, and contemporary cultural practices. Noting that there are several methods that could be used to establish a process for the ongoing collection of information on traditional and customary cultural practices and their significance, the CMP recommended establishing an oral history program that would memorialize the traditional and customary practices associated with Maunakea. It suggested that Native Hawaiian families or communities that have a connection to Maunakea be invited to collaborate with UH to identify traditional and customary practices associated with Maunakea and to ensure that those practices are appropriately protected and respected. Management action CR-4 in the CMP attempts to implement this measure by calling on UH to collect information on traditional and customary practices on Maunakea.

As reported in its 2020 Annual Report to the BLNR, UH has collected extensive archival and oral history and reported these in various reports and other documents (e.g., *Mauna Kea-Ka Piko Kaulana o Ka 'Āina*; *Cultural Resources Management Plan*; and various cultural analyses completed as part of environmental review requirements associated with HRS Chapter 343. Similar third-party materials, such as the USGS Open File Report 2017-1043 “Conversing with Pelehonuamea: A workshop combining 1,000+ years of traditional Hawaiian knowledge with 200 years of scientific thought on Kīlauea Volcanism” also incorporates knowledge on traditional and customary practices. The final EnVision Maunakea report (“Report of the Hui Ho‘olohe”) also draws together significant archival and oral histories of Maunakea. Finally, UH continues to seek additional information through other partnerships within the UH-system and other State-agencies.

2.1.3.5 CR-5: Develop and Adopt Guidelines for the Culturally Appropriate Placement and Removal of Offerings

CR-5 calls for the establishment of an official University policy for the placement and removal of offerings. In 2016, Kahu Kū Mauna reviewed the wording of draft policy guidelines for the

⁸ To receive credit for the Maunakea User Orientation with the Office of Maunakea Management (OMKM), individuals can: (1) Watch the video at <https://www.youtube.com/watch?v=k6hu2JFgA8> (last visited, April 7, 2021); (2) Complete the assessment quiz that is linked, answering at least 75% of the questions correctly; and (3) allow time for OMKM staff to score the quiz score and either issue a certificate or notify you if the assessment needs to be retaken.

culturally appropriate placement and removal of offerings.⁹ The MKMB advised that the policy be established and implemented early in 2018 after additional consultation by Kahu Kū Mauna. The policies may be found at http://www.malamamaunakea.org/uploads/culture/CulturalDocuments/CR-5_PlacementRemovalOfferings_2018.pdf.

2.1.3.6 CR-6: Develop and Adopt Guidelines for the Visitation and Use of Ancient Shrines

CR-6 calls for the creation of an official policy regarding the visitation and use of ancient shrines. In 2016, Kahu Kū Mauna drafted, MKMB reviewed, and OMKM began implementing such a policy, see http://www.malamamaunakea.org/uploads/culture/CulturalDocuments/CR-6_VisitationUseShrines_2016.pdf.

2.1.3.7 CR-7: Determining the Appropriateness of Constructing New Hawaiian Cultural Features

CR-7 calls for UH to adopt a formal policy regarding the construction of new Hawaiian features. In accordance with this, in 2012 OMKM prepared and Kahu Kū Mauna reviewed a draft of a process for determining the appropriateness of constructing new Hawaiian cultural features. OMKM reevaluated the policy in 2016 and held a consultation session that included representatives from the Office of Hawaiian Affairs. MKMB reviewed the process in early 2018 after additional consultation by Kahu Kū Mauna and advised OMKM that it be implemented. This guidance, which may be seen at http://www.malamamaunakea.org/uploads/culture/CulturalDocuments/CR-7_NewFeatures_2018.pdf, supplements but does not replace, other existing statutes and agency rules governing this type of activity.

2.1.3.8 CR-8: Develop and Adopt a Management Policy on the Scattering of Cremated Human Remains

The CMP notes that the scattering of the ashes of cremated human remains and the burial of urns in the summit area of Maunakea is an on-going cultural practice and that while these private affairs are not well-known or documented, they may impact historic properties. Accordingly, CR-8 calls for UH to establish a formal policy for dealing with such activities.

In 2012, Kahu Kū Mauna developed and reviewed a draft policy regarding the scattering of cremated human remains. It reevaluated the policy in 2016 and held a consultation session that included representatives from the Office of Hawaiian Affairs. MKMB reviewed the process in early 2018 after additional consultation by Kahu Kū Mauna and advised that OMKM implement it. The process may be seen at: http://www.malamamaunakea.org/uploads/culture/CulturalDocuments/CR-8_ScatteringRemains_2018.pdf.

⁹ CR-5 overlaps with CR-7 (constructing new Hawaiian cultural features) being that offerings are usually associated with the construction of new features.

The adopted policies are consistent with HAR § 20-26-40, which provides that “The scattering of cremated human remains is allowed within the UH Management Areas, consistent with this chapter and policies and procedures established by the president.”¹⁰

2.1.3.9 CR-9: Develop Management Policy for the Culturally Appropriateness of Building Ahu or Stacking of Rocks

The CMP reports that most of the “find spots” recorded in the 2005–2007 archaeological surveys were piled and stacked rocks. It notes that some of these features may have as their basis a traditional and customary cultural practice but that there is reason to believe that a large number of the single rock features and small concentrations of piled or stacked rocks on Maunakea are modern and that many were constructed by non-Hawaiian visitors in the last decade or so. Accordingly, it recommended that UH develop a policy related to the piling and stacking of rocks within the UH Management Areas.

As discussed in Section 2.1.3.7, in 2012 Kahu Kū Mauna reviewed a draft policy for the building of features such as ahu.¹¹ It reevaluated the policy in 2016 and held a consultation session that included representatives from the Office of Hawaiian Affairs. MKMB reviewed the process in early 2018 after additional consultation by Kahu Kū Mauna and advised OMKM to implement it (http://www.malamamaunakea.org/uploads/culture/CulturalDocuments/CR-7_NewFeatures_2018.pdf; note, ahu are new features and therefore addressed in the CR-7 policy statement).

2.1.3.10 CR-10: Develop and Implement Historic Property Monitoring Program

Following completion of the archaeological inventory survey of the MKSR and Mauna Kea Access Road, UH prepared and submitted to the SHPD its proposed *Long-Term Historic Property Monitoring Plan*. The plan provides for systematically monitoring the condition of the historic district and all historic properties, including cultural sites and burials. The State Historic Preservation Division reviewed the plan and approved it in 2014.

UH is continuing to implement the approved historic properties monitoring program. This includes an annual assessment of historic properties in the Astronomy Precinct and alongside the Mauna Kea Access Road and assessment of the more remote sites on a three- and five-year rotational basis. It continues to submit annual reports regarding the status of these efforts to SHPD after consultation with the Kahu Kū Mauna Council on management action recommendations.

2.1.3.11 CR-11: Complete an Archaeological Survey of the Access Road Corridor

An archaeological survey of the portions of the Mauna Kea Access Road corridor that are under UH management was completed in 2009, and the survey report was submitted to the SHPD that year. SHPD approved the survey report in February 2010.

¹⁰ OMKM, now CMS, operates under the Chancellor of the University of Hawai‘i at Hilo. The president delegated implementation of the HAR Chapter 20-26 to Chancellor of the University of Hawai‘i at Hilo, Executive Director of Maunakea Stewardship, and ‘Imiloa Astronomy Center, pursuant to University Executive Policy 10.104, available at <https://www.hawaii.edu/policy/index.php?action=viewPolicy&policySection=ep&policyChapter=10&policyNumber=104>.

¹¹ CR-7 was combined with CR-9 under the guidance of Kahu Kū Mauna who pointed out that the “stacking of rocks” may be a cultural feature.

2.1.3.12 CR-12: Establish Buffers Around Known Historic Sites

To protect historic sites within the Astronomy Precinct, the CMP recommends that a specified buffer be established around a site if development is proposed near it. It directed OMKM and Kahu Kū Mauna to work with DLNR, including SHPD and appropriate divisions, to establish protective buffers, where appropriate. The CMP emphasized that each buffer would vary in size based on the area of potential effect, and that to minimize potential visual impacts associated with buffers, their use will be limited to historic sites threatened by a specific activity.

In accordance with this recommendation, UH consulted with Kahu Kū Mauna and others about establishing buffers (preservation zones) around known historic sites in the Astronomy Precinct, to protect them from potential future development. In 2012 Kahu Kū Mauna determined that buffers should be reviewed on a case-by-case basis and identified criteria for when to consult for routine (minimal impact) project proposals and when, and how, to consult for more substantial future development. In 2016, Kahu Kū Mauna revised its policy. MKMB subsequently reviewed the process after additional consultation by Kahu Kū Mauna and advised that OMKM would implement it. The process may be seen at: http://www.malamamaunakea.org/uploads/culture/CulturalDocuments/CR-12_BufferZones_2016.pdf.

2.1.3.13 CR-13: Develop and Implement a Burial Treatment Plan for UH Management Areas

UH developed a BTP for the UH Management Areas in consultation with Kahu Kū Mauna Council, MKMB's Hawaiian Culture Committee, the Hawai'i Island Burial Council, recognized lineal or cultural descendants, and SHPD. It formally submitted the BTP to the SHPD in the Spring of 2014. After reviewing it, SHPD approved the Plan on July 11, 2014.

2.1.3.14 CR-14: Report any Disturbance of a Shrine or Burial Site

CR-14 calls on UH to immediately report any disturbance of a shrine or burial site to the Rangers, DOCARE, Kahu Kū Mauna Council, and SHPD. UH is fully implementing this measure. The Rangers monitor activities in the UH Management Areas daily. When all Ranger positions are filled, it is generally possible to schedule three Rangers for duty and ensure a minimum of two Rangers on duty should one Ranger be sick or on vacation. Because the Rangers are consistently present in all accessible areas of Maunakea, they are in a good position to monitor for/observe any disturbance of a shrine or burial site and/or to take reports from others who have seen such actions. The Rangers and OMKM/CMS immediately report their findings to DOCARE, Kahu Kū Mauna Council, and SHPD.

2.1.4 ADDITIONAL MANAGEMENT ACTIONS RELATED TO CULTURAL RESOURCES

Based on the information presented above, UH anticipates that the five CMP management actions related to Cultural Resources that are ongoing will continue to adapt, but it does not believe any entirely new measures are needed. The principal adaptations that CMS anticipates making are outlined below.

2.1.4.1 Adjustments in Historic Properties Monitoring Procedures

Based on ten years of intensive historic properties monitoring (and an additional 30 years of passive data collected during archaeological surveys), CMS believes that it is appropriate to adjust

the monitoring in a way that adapts stewardship of cultural resources while at the same time better utilizing the finite financial resources that are available for this purpose. It would do this by focusing the monitoring on the cultural resources that are demonstrably the most vulnerable, while limiting monitoring of the least vulnerable resources to ad-hoc surveillance. Specifically, the monitoring program will (with SHPD approval):

- Continue the current annual assessment program for sites on the 1-year list (including sites on Pu‘umākanaka [per the BTP] and all sites within the Astronomy Precinct in the summit area.
- Reduce the number of sites requiring visits during the 3-year and 5-year assessments (possibly excluding shrine sites with no upright/erect stones or surface lithic scatters).
- Propose conducting a full assessment once every ten years rather than once every five years (as is now the case).
- Propose a plan that links ad-hoc visits to cultural resources (not assessed annually) to work conducted as part of other projects or studies (e.g., biological and geological surveys).

2.1.4.2 Additional Data Recovery Efforts

Archaeological data recovery usually occurs as part of a mitigation effort during a construction project or other activity that will intentionally and irreversibly alter one or more historic properties and thus diminish their integrity and significance. The simple objective of such efforts is to collect data before they are irretrievably lost.

Within the framework of the CMS’ ongoing Long-Term Historic Properties Monitoring Program, there are no active construction projects requiring data recovery. However, there are several historic properties that, because of the effects of human impact and natural processes are losing integrity. Annual reports since 2012 have identified sites where some type of data recovery is appropriate to collect base-line information before the sites’ integrity diminishes to a point where they are no longer considered significant. The types of data recovery efforts considered appropriate vary from archaeological excavation to archaeological mapping. Specific recommendations from the archaeological reports include the following:

- Site 50-10-23-16204. In consultation with SHPD and Kahu Kū Mauna, develop a data recovery plan as a proactive response to collect baseline data before the likely loss of data due to continued alteration at the site. The plan should include: (i) a subsurface testing strategy for features with likely subsurface deposits (i.e., the enclosures and lithic scatters) and (ii) detailed mapping of the site (potentially using technologies such as LIDAR and 3-dimensional scanning) that not only records archaeological features, but non-feature-related rocks within the site complex.
- Site 50-10-23-25766. Develop a data recovery plan, in consultation with SHPD and Kahu Kū Mauna to determine whether a subsurface component to the site exists and whether that deposit retains any significance; and upon completion of the subsurface excavations, re-evaluate the significance of Site 25766.
- Sites 50-10-23-9074 and -9075. Consult with Architectural historian or engineer to determine the proper level of conservation for Sites 9074 and 9075.
- Site 50-10-23-25770. In consultation with SHPD and Kahu Kū Mauna, develop a plan to append site map for Site 25770 and track possible movement of surface artifacts.

- Site 50-10-23-10314. In consultation with SHPD and Kahu Kū Mauna, develop a data recovery plan to collect baseline data for Site 10314. The plan should include a research design, planned analyses, as well as a review of the site's known history of research; upon completion of the subsurface excavations, re-evaluate the significance of Site 10314.
- Sites 18683, 25768, 25769, 21214, 21452, 25807, and newly recorded lithic scatters. In consultation with SHPD and Kahu Kū Mauna, develop a plan to map sites and track possible movement of surface artifacts.

CMS will request the funds needed to implement these data recovery efforts in the 2022-2023 fiscal year.

2.2 NATURAL RESOURCES

Section 7.1.2 of the CMP contains information and management recommendations intended to ensure the protection, preservation, and enhancement of the natural resources of the UH Management Areas. The CMP is based on a comprehensive review of existing scientific studies, biological and physical resource inventories, and historical documentation. It addresses the protection and preservation of natural resources and also examines human uses of the area, with particular emphasis on their current and potential impacts on natural resources. It lists the following precepts as among its guiding concepts:

- The high-elevation areas of Maunakea represent a unique global resource that should be preserved for future generations.
- Management activities should be focused on limiting the impacts of human activities on natural resources.
- The planning and execution of natural resources management programs should involve input from the larger community, including scientists, educators, volunteers, and the public—as well as from natural resource managers.
- Long-term global environmental factors such as climate change must be considered when planning natural resource management activities.
- Natural resources management planning will use an ecosystem approach.
- Adaptive management techniques will be used.
- The biological and physical resources found in high elevation areas of Maunakea and the unique ecosystems that encompass them deserve further study by researchers and managers.

The “desired outcome” that the CMP seeks to achieve with respect to natural resources is as follows:

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.

In explaining the need for management of natural resources on Maunakea, the CMP notes that there are many unique geological features and biological communities within the UH Management

Areas. The summit region consists of an alpine stone desert with scattered pu‘u (cinder cones) that support a unique aeolian invertebrate community including the wēkiu bug. Below the stone desert lie the subalpine shrublands where the Maunakea silversword is found. Remnant subalpine māmane woodlands in the area of Halepōhaku could support the Palila and other native birds, as well as unique arthropod communities.

Section 6.3 of the CMP reviews resources found in the UH Management Areas. It concludes that at the time it was prepared the threats to natural resources considered to be of the highest priority for management action included habitat alteration, invasive species, population decline, and climate change. Observing that these threats are not all the same magnitude and that not all threats have been confirmed to be currently impacting resources on the mountain, the CMP acknowledges that this could change with time, and so, for completeness, it addresses all known potential threats. Table 7-2 in the CMP lists the resources, known threats, and sections in the CMP that address each threat.

The CMP goes on to note that natural resources are subject to actual and potential degradation and that without planned protections and a commitment to implement those plans, irreversible damage to Maunakea’s natural resources is likely to continue. It then presents guidelines for the long-term management of those natural resources and outlines a range of strategies and activities for their protection.

The CMP first cautions that 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. It then goes on to advise that such management requires establishment of programs that protect, preserve, and enhance Maunakea’s natural resources and lists five types of management actions as necessary to accomplish this goal: (i) preservation of sensitive habitats and unique high-elevation ecosystems in the UH Management Areas, including within the Astronomy Precinct¹²; (ii) enhancement of existing native communities and unique habitats; (iii) mitigation for planned damage to sensitive ecosystems; (iv) rehabilitation of damaged ecosystems; and (v) restoration of damaged ecosystems. Finally, the CMP states that natural resource management activities and policy development should be conducted to protect the rights of Native Hawaiian cultural practitioners and involve continuing consultation with Kahu Kū Mauna on cultural issues related to site access and permitted activities.

The CMP then identifies three management actions related to natural resources that the BLNR had previously identified and adopts those “where appropriate.” They are:

1. *The education of all persons involved with construction activities, about environmentally appropriate behavior while on the summit area for the protection for the natural resources.*
2. *The inspection/certification of all construction materials, equipment, crates, and containers carrying materials and equipment as being free of all flora and fauna that may potentially have an impact on the Maunakea summit ecosystem.*

¹² The CMP concludes that this objective has been largely met by limiting development to the Astronomy Precinct at the summit and at Halepōhaku.

3. *The presence of a trained entomologist, selected by OMKM and approved by DLNR whenever construction activities include earth movement or disturbance on site to monitor any impacts, real or potential, of construction activity on the wēkiu bug.*

The natural resource-related measures in the CMP (i.e., all the “NR”-coded management actions) are listed in Table 2.6. Because of the great breadth of the information regarding natural resources that was presented in the CMP, UH’s annual status reports have presented new information under individual topical areas (e.g., geology, hydrology, climate, etc.) and this OAR continues that practice. The work that has been done relating to each of the individual measures is discussed in Sections 2.2.1 through 2.2.10. The extent to which each measure has been fully implemented or is ongoing is noted in the right-hand column of the table and is summarized in Section 4.1.2.

Table 2.6 CMP Measures Related to Natural Resources

Measure	Description	Status
THREAT PREVENTION AND CONTROL		
NR-1	Limit threats to natural resources through management of permitted activities and uses.	Completed/ Ongoing
NR-2	Limit damage caused by invasive species through creation of an invasive species prevention and control program.	Completed/ Ongoing
NR-3	Maintain native plant and animal populations and biological diversity.	Ongoing
NR-4	Minimize barriers to species migration to help maintain populations and protect ecosystem processes and development.	Ongoing
NR-5	Manage ecosystems to allow for response to climate change.	Ongoing
NR-6	Reduce threats to natural resources by educating stakeholders and the public about Maunakea’s unique natural resources.	Ongoing
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 Halepōhaku and consider protection from development.	Ongoing
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).	Ongoing
NR-9	Increase native plant density and diversity through an outplanting program.	Ongoing
NR-10	Incorporate Mitigation Measures into Plans for New Development	Ongoing
NR-11	Conduct habitat rehabilitation projects following unplanned disturbances.	Ongoing
NR-12	Create restoration plans and conduct habitat restoration activities, as needed.	Ongoing
PROGRAM MANAGEMENT		
NR-13	Increase communication, networking, and collaborative opportunities, to support management and protection of natural resources.	Ongoing
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.	Ongoing
INVENTORY, MONITORING, AND RESEARCH		
NR-15	Conduct baseline inventories of high-priority resources, as outlined in an inventory, monitoring, and research plan.	Completed
NR-16	Conduct regular long-term monitoring, as outlined in an inventory, monitoring, and research plan.	Ongoing
NR-17	Conduct research to fill knowledge gaps that cannot be addressed through inventory and monitoring.	Ongoing

Measure	Description	Status
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.	Ongoing
Note: A status of "Completed/Ongoing" means that the needed procedures and systems have been completed and are being implemented on an ongoing basis. Source: Mauna Kea Comprehensive Management Plan, Table 7-3.		

2.2.1 GEOLOGY

None of the NR-coded CMP management actions are solely related to geologic resources. However, as discussed below, several of them, including NR-1, -6, -7, -17, and -18, have some relationship to geologic resources within the UH Management Areas.

2.2.1.1 New Information Regarding Geology

Reports documenting the results of the geological research and monitoring conducted since the CMP was adopted are listed in Table 2.7. A number of these were sponsored by OMKM. Those include: N. Schorghofer's permafrost research and monitoring work between 2012 and 2018 (which is also related to hydrology); R. Perroy Surficial Geomorphology and Erosion Monitoring between 2014 and 2018; and R. Perroy & N. Stephenson's High Resolution Habitat Suitability Modeling for a Narrow-Range Endemic Alpine Hawaiian Species conducted in 2015 and 2016 (which is also related to invertebrates).

Table 2.7 Reports Documenting the Ongoing Geological Research and Monitoring Conducted Since the CMP Was Adopted

Information Summary	Reference
The most recent update to the USGS Geological Survey National Volcanic Threat Assessment ranks Maunakea as 106 th (out of 161) based on an overall threat score of 30. In comparison, Kīlauea (with an overall threat score of 263) is ranked 1 st , Mauna Loa (with an overall threat score of 131) is ranked 16 th , and Hualālai (with an overall threat score of 45) is 23 rd . Haleakalā on Maui is 86 th . No new lava tubes or caves have been identified within the Management Areas.	Ewert, J.W., Diefenbach, A.K., and Ramsey, D.W., 2018. <i>U.S. Geological Survey Scientific Investigations Report 2018–5140</i> , 40 p., https://doi.org/10.3133/sir20185140
NASA's Jet Propulsion Laboratory, California Institute of Technology and the U.S. Geological Survey analyze high-resolution GPS data collected on the mountain, tracking tectonic plate movement and seismic events. The data indicate that seismic activity on Maunakea remains limited with no imminent signs of a potential eruption.	NASA, 2016 (GPS Time Series) USGS Earthquake Hazards Program
The Hawai'i Volcano Observatory (HVO) characterizes seismic activity beneath Maunakea has as "in frequent and sparse." However, elevated seismicity during October-December 2011 resulted in 30 felt earthquakes. Approximately 570 people reported the M 4.5 earthquake that occurred on 20 October 2011 and also ten of the aftershocks that followed. HVO reported that, these earthquakes were "most likely caused by structural adjustments within the Earth's crust due to the heavy load of Mauna Kea."	Global Volcanism Program, 2013. https://doi.org/10.5479/si.GVP.BG.VN201312-332030
A 2012 study on cinder cone morphometry highlighted the variability of volcanic cones due to cone material properties, eruption conditions, local setting, and method of cone height estimation.	Eff-Darwich et al., 2010 Kervyn, Matthieu & Ernst, G & Carracedo, Juan & Jacobs, Patric. (2012).

Information Summary	Reference
The overall topographical features of Maunakea have changed little since the CMP was written. However, small-scale topographical changes have been observed and have been studied in depth by Dr. Ryan Perroy (UH Hilo) in partnership with the University Navstar Consortium (UNAVCO). Dr. Perroy has monitored erosion and geomorphology using high resolution 3-D mapping and visualization methods. Dr. Perroy's graduate student, Nathan Stephenson, also produced high resolution mineral maps of the summit region, while studying wēkiu bug habitat suitability. Dr. Perroy's February 2021 report on surficial geomorphology and erosion in the Maunakea Summit area carefully documents the changes that have occurred over time and concludes that roadway improvements increased the potential for erosion but that this can be managed adequately so long as continued attention is paid to road maintenance and cinder replenishment efforts. The report notes that improvements to the roadways and surface runoff infrastructure that minimize and redirect flow accumulation pathways would help reduce new gully formation and starve existing gullies of the concentrated runoff that causes erosion.	UNAVCO, 2015 & 2017 (LiDAR data) Okal, 2014 Stephenson, 2016 Perroy, February 2021
A recent study on Maunakea deglaciation revealed that Maunakea glaciers re-advanced about 15,400 years ago after previous recessions. Paleontologists studied a helium isotope in glacial boulders and discovered that this glacial reemergence aligned with the major slowdown of the Atlantic meridional overturning circulation (AMOC). This AMOC slowdown allowed for colder conditions and increased precipitation from frequent cyclonic storms.	Anslow et al., 2010
Permafrost research results show that certain cinder cones crater temperatures can drop to temperatures of -20°C, which facilitates permafrost persistence. These low temperatures are due in part to crater topography and its influence on shadows, cold air pools, and temperature. A 2016 study determined the subsurface architecture of Pu'u wai'au and Pu'upōhaku did not suggest permafrost presence, but rather impermeable sediment layers that result in the perched water bodies. Researcher Dr. Norbert Schorghofer will continue monitoring of permafrost bodies on Maunakea as a part of his long-term research to understand environmental factors responsible for permafrost health or deterioration. His project also supports research in astrobiology, planetary exploration, and climate change.	Schorghofer et al., 2013 Leopold et al., 2016 Yoshikawa, 2013 Schorghofer et al., 2017 Schorghofer et al., 2018
A 2014 study highlighted pu'u influence on wind speeds and direction, which leads to moisture and nutrient (aeolian debris, e.g. bugs) collection within pu'u. This study also provided topographical influenced snowdrift models, which can be used to detect areas of high moisture and potential food sources, which supports wēkiu bug research.	Eaton & Businger, 2014
The Global Mountain Biodiversity Assessment inventories mountainous terrain across the globe and provides a framework for understanding biodiversity and conducting regional and larger scale (bio)diversity assessments.	Körner et al., 2017 http://www.gmba.unibe.ch
The U.S. Geological Survey released updated 1:24,000-scale topographic maps for the State of Hawai'i, including for Maunakea. These maps are part of the U.S. Topo map series, use the familiar 7.5-minute grid, were published in September 2017, and can be downloaded from The National Map download client.	https://viewer.nationalmap.gov/basic/ https://nationalmap.gov/ustopo/quicksstart.pdf
Source: OMKM records	

2.2.1.2 Discernable Trends and Management Impacts Regarding Geological Resources

Daily monitoring by the Rangers and staff has documented various small-scale human-related changes to the mountain's landscape, including development of social trails, construction of new features (piling and stacking rocks), and vandalism. It is unknown whether the incidence of these undesirable events has decreased since the CMP management actions were initiated. Records also

reveal occasional natural events that have impacted geological resources, e.g., heavy rains that have damaged roadways. Additional information and discussion related to this topic may be found in the discussion of surface features and soils that is presented in Section 2.2.2 of this OAR.

Recent permafrost research suggests that two ice bodies of permafrost still exist in the summit area of Maunakea. However, one has shrunk considerably since 1973 when its boundaries were first estimated and is expected to disappear soon due to the ongoing and gradual climate warming trend. A permafrost monitoring plan is underway and UH will monitor permafrost bodies to better understand this natural process.

In summary, the additional information that has been assembled since the CMP was prepared indicates that there are some impacts to geological resources resulting from natural processes and human activity both globally and on the mountain. Ongoing monitoring will help to better understand these processes and will inform adjustments to management actions aimed at preserving geological resources.

2.2.1.3 Future Management Actions Related to Geological Resources

OMKM largely completed the work called for in NR-7 (delineating areas requiring specific protections), but CMS expects to conduct some additional research related to this as funding permits. Similarly, because scientists regularly identify new issues and collect additional data, NR-17 (conducting research needed to fill data gaps) and NR-18 (developing a geospatial database of known natural resources) are necessarily ongoing. CMS will continue to implement NR-1 (limiting threats by managing permitted activities and uses) and NR-6 (educating stakeholders and the public about Maunakea's unique natural resources).

2.2.2 SURFACE FEATURES & SOILS

None of the CMP management actions are related solely to surface features and soil resources. However, several, including NR-1, -6, -17, and -18, apply to these resources within the UH Management Areas.

2.2.2.1 New Information Regarding Surface Features & Soils

Reports documenting the ongoing research and monitoring related to this topic that have been conducted since the CMP was adopted are listed in Table 2.8. The results of these studies, as well as some of the work related to permafrost that is described in Section 2.2.1, provide some additional details regarding specific aspects of a few surface features. While the work done to date suggests that there has been little change in the surface features or soils since the CMP was prepared, it is possible that this could change in the future. The stability is consistent with the fact that the low rates of precipitation and generally cool temperatures characteristic of the summit region mean that rock weathering is slow and is predominately mechanical in nature.

OMKM's 2013 placement of signs asking hikers to stay away from Pu'u uwēkiu has helped reduce the number of people on the pu'u and, therefore, the amount of physical disturbance that the foot-traffic formerly caused.

Table 2.8 Reports Documenting the Ongoing Surface Features/Soil Research and Monitoring Conducted Since the CMP Was Adopted

Information Summary	Reference
Data collected at the summit weather stations from 2008 through 2010 were used in SnowModel to assess snowfall and summit aeolian debris accumulation across the summit of Maunakea in order to better understand the weather of the summit area and its relationship to the distribution and population health of the wēkiu bug.	Eaton & Businger, 2014 http://www.bioone.org/doi/abs/10.1657/1938-4246-46.4.719
Dr. Ryan Perroy (UH Hilo) used high resolution topographic, spatial imagery, and soils field data to map and quantify topographic changes over time relating to natural and anthropogenic disturbance and erosion events (establishing baseline erosion rate). Sub- objectives were to identify locations of greatest concern for erosion and disturbance, determine how erosion rates in disturbed areas compare to erosion rates on undisturbed cones, and determine how these rates compare to other cinder cones globally.	UNAVCO, 2015 and 2017 (LiDAR data) Perroy, Ryan L, February 8, 2021
In 2016, Nathan Stephenson, a graduate student studying under Perroy completed his study on high-resolution habitat suitability modeling for the endemic alpine wēkiu bug. As a part of his research he was able to create high-resolution surface minerology and wēkiu bug habitat suitability maps.	Stephenson, 2016 Stephenson et al., 2017
Source: OMKM records	

2.2.2.2 Discernable Trends and Management Action Impacts Related to Surface Features & Soils

The additional information that has been assembled since the CMP was prepared, particularly Dr. Perroy’s 2021 work, shows that the topographic changes that have been made in the summit area have created an increased (relative to natural) potential for erosion and emphasizes the importance of continuing active road maintenance activities in order to maintain stable conditions. While the need for continuing maintenance was understood at the time the CMP was completed, subsequent studies have better-quantified the required effort and the magnitude of the material that must be handled in order to maintain the stability of the access road and the terrain through which it passes. That, in turn, points to the importance of continuing to adequately fund road and drainage facility maintenance.

In addition to the meso-scale changes discussed in the preceding paragraph, daily monitoring by the Rangers and staff have documented various small-scale impacts on the mountain’s landscape, including development of social trails, construction of features, and vandalism. It is thought that these conditions have decreased since the management actions were implemented (primarily the non-NR coded actions); however, there is no pre-CMP data against which to compare the current situation and the ongoing observational data are not standardized sufficiently to allow trend analysis. Overall, it is believed that the management actions have and continue to benefit surface features and soils.

2.2.2.3 Future Management Actions Related to Surface Features and Soils

OMKM made progress towards the surface feature and soils-related work called for in NR-17 (conducting research needed to fill data gaps) and NR-18 (developing a geospatial database of known natural resources). CMS is continuing to implement two management actions related to this topic. They are NR-1 (limiting threats by managing permitted activities and uses) and NR-6 (educating stakeholders and the public about Maunakea’s unique natural resources).

2.2.3 HYDROLOGY

None of the CMP management actions are related solely to hydrology resources, but several, including NR-1, -6, -17, and -18, apply to hydrology within the UH Management Areas.

2.2.3.1 New Information Regarding Hydrology

Reports documenting the ongoing research and monitoring related to this topic that have been conducted since the CMP was adopted are listed in Table 2.9. The results of these studies provide additional details regarding specific aspects of a few features, they show that there has been little change in the water resources of the area since the CMP was prepared.

Table 2.9 Reports Documenting Hydrologic Research and Monitoring Conducted Since the CMP Was Adopted

Information Summary	Author, Reference
While acquiring baseline hydrologic data along Saddle Road between Kaūmana wells and Pōhakuloa Training Area, the authors of this report conducted a series of geophysical surveys that suggested the depth to saturated rock in places are 400 to 600 meters (1,300 to 2,000 feet) above mean sea level beneath the surveyed region. Therefore, at the Saddle Road-Mauna Kea Access Road intersection, saturated rock would be roughly 4,000 feet below the ground based on this survey. The results of these studies did not change what had previously been reported regarding conditions beneath the UH Management Areas.	Pierce, H.A., and Thomas, D.M., 2009, https://pubs.er.usgs.gov/publication/ofr20091135 .
In 2011 the U.S. Geological Survey completed a water budget model and estimates for groundwater recharge rates on the island of Hawai‘i. The report concluded that most aquifer systems have higher baseline mean annual recharge than recharge estimates used in the 2008 State of Hawai‘i Water Resource Protection Plan, but that recharge in several Maunakea aquifer sectors (including Waimea, Honoka‘a, and Pa‘auilo) was lower. It also concluded that changes in rainfall associated with climate change suggest annual recharge in the late 21st century will be higher than baseline estimates for every aquifer system, except ‘Anaeho‘omalu.	Engott, 2011 https://pubs.usgs.gov/sir/2011/5078/
This USGS report describes the hydrogeologic framework, groundwater budgets (inflows and outflows), conceptual models of groundwater occurrence and movement, and the factors limiting groundwater availability for Kaua‘i, O‘ahu, Maui, and Hawai‘i Island. It confirms that groundwater recharge on the UH Management Areas is naturally low.	Izuka et al., 2018 https://pubs.er.usgs.gov/publication/sir20155164
This paper reports that an ongoing drilling project in the Humu‘ula area along the Saddle road has uncovered groundwater at depths of 500’, 700’, and 1,800’. These findings indicate that groundwater is present at much higher elevations (i.e., closer to the ground surface) than had previously been thought.	Thomas & Haskins, 2013
In 2015, the U.S. Geological Survey documented the major changes in Lake Wai‘au from 2010-13. They report that the lake’s typical surface area of 5,000-7,000 m ² shrunk to just over 100 m ² . This is thought to be a potentially unprecedented shrinkage in the level of Lake Wai‘au and it corresponds to drought conditions as lake levels began to rise again after later winter snowstorms in 2013-2014. OMKM Rangers continue to conduct monthly photo-monitoring efforts of Lake Wai‘au.	Delparte et al., 2014; Patrick & Delparte, 2014; Patrick & Kauahikaua, 2015; OMKM, 2016 (Lake Wai‘au time series)

Information Summary	Author, Reference
Concern over declining water levels in Lake Wai'au led researchers to explore the most accurate and cost-effective combination of new approaches to enable long-term monitoring with minimal disturbance to the lake and its environs. As detailed in this report, three strategies were used to construct 3D models of the lake: soft-copy stereo photogrammetry from aerial photography, image-based 3D reconstruction from overlapping photographs (Structure from Motion), and terrestrial laser scanning (TLS). To supplement these detection methods, side scan sonar was used to collect bathymetric data. The results were three high-resolution 3D models that were used to calculate volumetric and areal changes over time using Geographic Information Systems (GIS) to analyze and visualize the lake body.	Delparte et al., 2014 www.bioone.org/doi/pdf/10.1657/1938-4246-46.4.709
This report documents the results of the first ever geophysical survey of the area around Lake Wai'au and establishes the existence of a second body of standing water in a nearby cinder cone, Pu'upōhaku (~4000m above sea level), which has a sporadic pond of water. Together, the available information now indicates that perched groundwater resides both in Pu'uwaiau (Lake Wai'au) and in Pu'upōhaku crater. The researchers conclude that ground temperatures are too high and specific electric resistivity values are too low to be consistent with either ice-rich permafrost or massive rock. They conclude that the presence of fine-grained material such as ash and its clay-rich weathering products are likely responsible. At Pu'uwaiau, a significant groundwater reservoir may be present outside of the lake and further be responsible for perching the water toward the lake.	Leopold et al., 2016 https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1002/2016JF003853
Source: OMKM Records	

2.2.3.2 *Discernable Trends Related to Hydrology*

The additional information that has been assembled since the CMP was prepared has not revealed any discernable trends related to hydrology.

2.2.3.3 *Future Management Actions Related to Hydrology*

OMKM made considerable progress regarding the hydrology-related work called for in NR-17 (conducting research needed to fill data gaps) and NR-18 (developing a geospatial database of known natural resources). CMS will continue the and update the database as appropriate. It will also continue to implement two other management actions related to this topic. They are NR-1 (limiting threats by managing permitted activities and uses) and NR-6 (educating stakeholders and the public about Maunakea's unique natural resources).

2.2.4 CLIMATE

None of the CMP management actions are related solely to climate, but CMS believes that most of the NR-coded measures can help ecosystems within the UH Management Areas be more resilient to climate change.

2.2.4.1 *New Information Regarding Climate*

Reports documenting the ongoing research and monitoring related to this topic that have been conducted since the CMP was adopted are listed in Table 2.10. The results of these studies provide additional details regarding specific aspects of a few factors but indicate that most of these do not fundamentally alter any of the information on which the CMP was based. An ongoing climate project by Dr. Thomas Giambelluca (UH Mānoa) involves the development of *MaunakeaNet*, which is being designed as a climate monitoring network that will aid research in mountain

climatology, extreme weather occurrences, ecological climate influences, and public safety. More information concerning that is presented below in Section 2.2.4.3.

Table 2.10 Reports Documenting Climate Research and Monitoring Conducted Since the CMP Was Adopted

Information Summary	Reference
This master's thesis describes climatological observations at the summit of Maunakea from 1982 through 2010. The author concludes that altitude and topography of the summit of Maunakea are major climate influences and that Maunakea can also be characterized by its low monthly temperature means, a large dew point depression, a weak wind speed diurnal cycle, infrequent rainfall, and large wind speed extremes. The report observes that during El Niño, winters are typically warmer, relative humidity is lower, rainfall is decreased, and the wind is weaker.	Da Silva, 2012
In their article entitled "Climatic Changes in Mountain Regions of the American Cordillera and the Tropics: Historical Changes and Future Outlook", the authors conclude that observed changes in the climate of Hawai'i are generally consistent with expectations from the Intergovernmental Panel on Climate Change (IPCC) projections. They state that results from these studies indicate a significant warming trend over the past 80 years, but they also point to an amplification of the warming signal at higher elevations. They also find that indicators of enhanced upper elevation warming include a reduction in the frequency of freezing temperatures on the upper slopes of Maunakea.	Diaz et al., 2014
This report documents changes in surface air temperature between 1916 and 2006 that show a long-term increase for Hawai'i and enhanced warming in the more recent decades (1975–2015), particularly at high elevations. The results indicate that mean air temperature has a statistically significant ($p=0.01$) upward trend of $0.042^{\circ}\text{C}/\text{decade}$ over the past 100 years, with 2015 as the warmest year on record, 0.794°C above the 100-year average. The warming is largely attributed to increases in nighttime mean minimum temperature ($T_{\min}$) rather than increased mean maximum temperature ($T_{\max}$), which remained stable. Positive correlations were found between Hawai'i Temperature Index (HTI) and the Pacific Decadal Oscillation (PDO) and the Multivariate ENSO (El Niño-Southern Oscillation) Index (MEI) suggesting that natural climate variability has a significant impact on temperature variability in Hawai'i. High elevation temperature trends in Hawai'i were similar to those on another tropical island in the Atlantic.	McKenzie, 2016
The <i>Rainfall Atlas of Hawaii</i> shows that the summit region receives less than 10" of rain annually, while the subalpine environment receives less than 35" of rain annually. This corroborates the low evapotranspiration rate on Maunakea, which is also due to limited biomass. The average annual evapotranspiration on the summit is less than 300 mm and subalpine levels are less than 450 mm a year. The UH Management Areas contain some of the lowest average numbers of heavy rainfall events in the State, with 0-5 days annually.	Chu et al., 2009; Giambelluca et al., 2013; Giambelluca et al., 2014; MKWC, 2017 (Archive)
There appears to be a decreasing trend in snow events on Maunakea, both in intensity and frequency as noted anecdotally from historical reports and literary use. Researchers concluded the summit did not have a perpetual mantle of snow in recent history. Scientific evidence of snowfall, snowpack, and ice formation cannot confirm historical accounts as there is little to no data before 1972.	Mayer, 2012; Schorghofer et al., 2014
Snow precipitation predictions by The Asian-Pacific Data-Research Center, using the Hawaii Regional Climate Model simulation, show that by the late 21st century significant snow cover on the Hawai'i island mountains may disappear.	Zhang et al., 2012; Zhang et al., 2017
Climate modelling research led by Dr. Steven Businger using nested downscaled climate models focusing on Hawai'i, Hawai'i Island, and Maunakea provides detail forecasts regarding climate change including changes in the trade wind inversion altitude and potential for increasing moisture (relative humidity) at higher altitudes while simultaneously increasing the potential for drought. This work builds on Lauer et al. and Zhang et al. which identified the likelihood of increasing frequency in trade wind inversion and fewer days with the possibility of deep convection (related to rainfall) over the island of Hawai'i, including at high elevations.	Pattantyus, in review Downscaled Data archive; Lauer et al., 2013; Zhang et al., 2016a; Zhang et al., 2016b

Information Summary	Reference
Research on unique microclimates in the alpine stone deserts of Maunaloa and Maunakea documented a new temperature extreme for Hawai‘i (-20°C).	Schorghofer et al, 2018
Source: OMKM records	

2.2.4.2 *Discernable Trends Related to Climate*

The additional information that has been assembled since the CMP was prepared is too limited to allow precise forecasts to be made about climate changes within the UH Management Area. However, when considered together with information from measurements made elsewhere, they support the notion that the microclimate in the UH Management Areas is tending towards more temperature extremes and increasing moisture (humidity) combined with more frequent droughts. While there is a very limited amount that UH can do to alter the course of these changes, CMS believes that the continued implementation of natural resource actions can help to increase the ecosystem’s resilience to the adverse effects of climate change. It also believes that the University’s system-wide effort to reduce its own greenhouse gas emissions and to motivate its staff and students to do their best to reduce their individual emissions is important and will be beneficial in this regard.

2.2.4.3 *Future Management Actions Related to Climate*

Climate Monitoring. Experience to-date points to the value of continuing to make University resources available to entities wishing to collect climate-related data from within UH’s Management Area, and CMS will continue to be supportive of such endeavors. Specifically, CMS will continue to encourage the further implementation of climate monitoring and modeling that has been initiated under the auspices of *MaunakeaNet*. As presently conceived, that program includes a master climatological monitoring station at the summit and satellite stations at lower elevations and the fostering of user communities willing to help contribute in effort or time. The instrumentation would continuously monitor the climate of the upper elevations of Maunakea with possible transects from Windward–Leeward and North–South that would provide data relevant to the trade wind inversion (~2,000 m), an intermediate elevation to the summit (~3,000 m), and the summit (~4,000 m). Both the master station at the summit and satellite stations at lower elevations would include solar radiation, radiation balance, temperature, humidity, wind speed and direction, turbulent fluxes of heat, moisture and momentum, precipitation including snow and soil moisture and temperature. Satellite stations would be analogous to HaleNet (Maui), with a standard suite of sensors and likely solar powered. Installation and operation of most of these facilities is subject to review and approval of the University, the issuance of one or more CDUPs, and compliance with the environmental impact evaluation requirements of Chapter 343, HRS.

Climate-Related Actions. NR actions 1 through 12 and NR actions 15 through 18 are all important in regard to climate change (NR actions 13 and 14 are indirect actions, but are still useful to guide climate change resilience). Examples of the kinds of actions that UH intends to take include, but are not limited to the following:

- Limiting the further incursion of/removing existing invasive species so that native species are able to adapt to climate change without added pressures from competition, predation, etc.
- Increasing native plant density by outplanting and conducting habitat restoration in order to enhance native ecosystems and help maintain ecosystem interactions.

- Collecting seeds from various individuals to increase genetic diversity, thereby helping ecosystems adapt to climate change.
- Continuing to implement regular long-term monitoring as called for in NR-16, including the monitoring of certain climatic parameters (e.g., temperature, precipitation, wind, etc.).

CMS anticipates that carefully observing and evaluating the results of the management actions will allow it to adapt those measures in ways that enhance ecosystems and make them more resilient to climate change.

2.2.5 AIR QUALITY & SONIC ENVIRONMENT

None of the CMP management actions pertain solely to air quality or the sonic environment, but certain ones, including NR-16 and -17, relate to these topics within the UH Management Areas.

2.2.5.1 New Information Regarding Air Quality & Sonic Environment

Air pollutants have continued to be emitted in the region from eruptive activity and from anthropogenic sources such as electrical power generation and internal combustion engine-powered vehicular traffic. However, nearly all of that occurs in areas that are both distant from and at much lower elevations than the UH Management Areas, which is above the trade-wind inversion.

No new astronomy-related noise sources have been established since the CMP was adopted. Vehicular traffic volumes have changed over time as the number of astronomy personnel working at the summit has decreased and visitor numbers have increased. Overall, these changes have increased vehicular traffic and had a small effect on ambient sound levels adjacent to the Mauna Kea Access Road. However, the effect on sound levels is localized both spatially and temporally and is a function of ongoing public access. No new information is available that is relevant to the management of noise levels.

Reports documenting the ongoing research and monitoring related to air quality and sound levels that have been conducted since the CMP was adopted are listed in Table 2.11. The results of these studies do not fundamentally alter any of the science on which the CMP was based.

Table 2.11 Reports Documenting Air Quality and Noise Research and Monitoring Conducted Since the CMP Was Adopted¹³

Summary	Sources
Chlorine monoxide (ClO), a catalyst in the destruction of the ozone layer, has been measured with a ground-based millimeter wave instrument on the summit of Maunakea since 1982. This article, titled “Ground-based measurements of ClO from Maunakea and intercomparisons with Aura and UARS MLS” compares measurements of upper stratospheric ClO, made with a ground-based millimeter wave instrument at Maunakea with Upper Atmosphere Research Satellite MLS ClO measurements. It concludes that the measurements by the two are comparable and that both instruments show similar seasonal variations over Maunakea.	Nedoluha et al., 2011

¹³ In 2015 the ClO instrumentation was relocated to Maunaloa to test the site given anticipated CSO decommissioning. Because subsequent experience showed that the Maunaloa site was not viable, the instrumentation was returned to Maunakea in 2018.

Summary	Sources
Other data analysis related to chlorine monoxide (ClO) measurements on Maunakea has been undertaken. The authors of this article entitled “Comparison of SMILES ClO profiles with satellite, balloon-borne and ground-based measurements” evaluated the quality of ClO profiles derived from the Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES) on the International Space Station (ISS) relative to other data sources, including the ground-based radiometer at Maunakea. They conclude that the SMILES data is as accurate as that from other available sources.	Sagawa, et al., 2013
In an article entitled “Re-analysis of ground-based microwave ClO measurements from Maunakea, 1992 to early 2012”, the authors present a re-analysis of upper stratospheric ClO measurements from the ground-based millimeter-wave instrument from January 1992 to February 2012. They used daytime and nighttime measurements together to form a day–night spectrum, from which they determined difference in the day and night profiles and then compared to the day–night difference profiles from the Upper Atmosphere Research Satellite (UARS) and Aura Microwave Limb Sounder (MLS) instruments. The authors concluded that the reanalyzed data set has less short-term variability and exhibits a more constant long-term trend that is more consistent with other observations and that the data from 1995 to 2012 indicate a linear decline of mid-stratospheric ClO.	Connor et al., 25 July 2013
Source: OMKM records	

2.2.5.2 Discernable Trends Related to Air Quality and Noise

The increase in vehicular traffic that has occurred since the CMP was prepared is likely to have caused a very small, temporal increase in ambient sound levels and in the concentrations of certain air pollutants adjacent to the Mauna Kea Access Road. While the extent of the change has not been quantified, it is undoubtedly small as traffic volume above Halepōhaku remains light.

Observatories have not reported any noticeable changes to air quality in the summit area, something that is of great concern to them as excellent air quality is a favorable condition for astronomical observations. Neither have they reported any noise-related issues that affect their work. The current management actions and review processes appears to be effective for managing air quality and the sonic environment.

2.2.5.3 Future Management Actions Related to Air Quality and Noise

Although no new data gaps related to air quality and noise have been identified, CMS will consider additional work on these topics as the need arises. UH will continue to require activities that are conducted within the UH Management Areas to use the best available control technologies related to emissions. That, together with the measures it is considering that will reduce the number of vehicles accessing the mountain are expected to reduce air pollutant and noise emissions over the long term. In addition, since the passage of HAR Chapter 20-26, additional tools are available for managing vehicular traffic.

2.2.6 VISUAL ENVIRONMENT

None of the “NR”-coded measures in the CMP directly address the visual environment, but some of the elements that are covered do affect the appearance of the landscape within the UH Management Areas.

2.2.6.1 *New Information Regarding the Visual Environment*

The visual environment of Maunakea has changed very little since the CMP was completed as no major structures have been constructed. The TMT project complied with FLU-4 by providing visual renderings of the future facility from several viewpoints. Decommissioning projects have been announced, but none have as yet been implemented.

2.2.6.2 *Discernable Trends and Management Impacts Related to the Visual Environment*

There has been no substantial change in the visual environment since the CMP was completed.

2.2.6.3 *Future Management Actions Related to the Visual Environment*

CMS will continue to require project-specific visual renderings of both pre- and post-project settings to facilitate analysis of potential impacts to view planes.

2.2.7 BOTANICAL RESOURCES

Several of the NR-coded CMP management actions specifically address botanical resources and others apply generally to botanical resources. Those that specifically address the resource include:

- 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-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 out-planting program.

2.2.7.1 *New Information Regarding Botanical Resources*

Reports documenting the ongoing research and monitoring related to botanical resources that have been conducted since the CMP was adopted are listed in Table 2.12. The results of these studies do not fundamentally alter any of the science on which the CMP was based.

Table 2.12 Reports Documenting Botanical Research and Monitoring Conducted Since the CMP Was Adopted

Summary	Sources
This article examined variation in life history in an invading temperate weed, <i>Verbascum thapsus</i> , across an elevation gradient (5,540 - 8,920 feet; 1,690 - 2,720 m) along the montane and subalpine slopes of Maunakea. While the study area barely reached the elevation of the lowest land covered by the CMP, it does contain some information that may be relevant to management of the area around Halepōhaku. It concluded that compared to plants at lower elevations, those at higher elevation sites (>6,500 feet; >2,000 m) had lower early seedling survival, higher established rosette survival, higher vegetative growth rates, higher threshold sizes for flowering, and commonly lived more than 3 years before flowering. The authors found that the abundance of competing vegetation generally decreased with elevation and speculate that this may drive variation in <i>V. thapsus</i> survival and growth.	Ansari and Daehler, 2010

Summary	Sources
This article, entitled “High-resolution carbon mapping on the million-hectare Island of Hawai‘i” discusses the way in which field measurements, airborne light detection and ranging (LiDAR)-based observations, and satellite-based imagery, were used to develop a 30-meter-resolution map of aboveground carbon (C) density spanning 40 vegetation types found on Hawai‘i Island. It concludes that the approach reveals fundamental ecological controls over C storage, including climate, introduced species, and land-use change, and provides a fourfold decrease in regional costs of C measurement over field sampling alone. The results of the mapping confirm that the vegetative density in the area covered by the CMP is low.	Asner et al., 2011
This baseline botanical survey documents specific plant species and distributions within the area covered by the CMP. The study also provides recommendations for invasive species control, habitat restoration, and vegetative impact mitigation. It documents the way in which the vegetation composition has been altered due to long-term human use. It reports that roadside surveys show that native shrubs and trees are more frequent along the roadway than they are in similar areas farther from the right-of-way, while native herbaceous species were less frequent, most likely due to dust particulates resulting from vehicular traffic. Importantly, it identifies 3 ecosystems on UH managed lands instead of the 4 that had been identified by Daehler previously. The authors’ study of substrate-plant relationships indicates that plants within the alpine ecosystems prefer lava flow, while subalpine plants prefer cinder or disturbed substrates. It documents the presence of the endangered Maunakea silversword (<i>Argyroxiphium sandwicense sandwicense</i>) but no other endangered species were observed. No candidate species under the Endangered Species Act were observed. The survey found State Species of Concern, Douglas’ bladderfern (<i>Cystopteris douglasii</i>) and the Maunakea dubautia (<i>Dubautia arborea</i>).	Gerrish, 2013 (Data)
In an article entitled “Overview of Habitat History in Subtropical Oceanic Island Summit Ecosystems”, the authors review the geological and climatic processes that explain the spatial and temporal dynamics of mountain summit ecosystems in (sub)tropical islands and explore how these dynamics may influence species diversity and affect the balance between speciation and extinction in this unique biota.	Fernandez et al, 2014
The University’s <i>Maunakea Invasive Species Management Plan (ISMP)</i> identifies invasive species, potential pathways in which invasive species can become introduced, and assesses their impacts to Maunakea resources. The <i>ISMP</i> outlines efforts to prevent, detect, monitor, control, and rapidly respond to invasive plant species; it also includes standard operating procedures (SOPs) for specific invasive species implementation. OMKM has completed 9 SOP’s which include invasive species inspection and cleaning requirements and procedures, identification guides for plants, vertebrates, and invertebrates and procedures for monitoring	Vanderwoude et al., 2015 ISMP SOPs D, -01, -02, -03, & -12
The authors’ OMKM-sponsored <i>2013 Invasive Species & Native Arthropod Monitoring Report</i> documents all management monitoring activities regarding invasive and native species. The expansion of invasive weed populations have been documented within the UH Management Areas. It concludes that aside from road-related influences, the spread seems most closely linked to wind patterns that can transport seeds to higher elevations even with efforts from the Rangers that remove weeds alongside roads and facilities in the MKSR. . It also reports that fireweed and mullein species (<i>Verbascum thapsus</i> & <i>virgatum</i>) are prevalent within the Halepōhaku parcel, but volunteer weed removal events and future native out-planting events are expected to facilitate mechanical control of these invasive populations. As part of the annual monitoring of historic properties, OMKM staff conduct botanical surveys in and around historic properties.	Kirkpatrick & Klasner, 2015
DLNR prepared a <i>Wildfire Management Plan</i> for Maunakea in 2011. As the UH Management Areas are sparsely vegetated and wildland fire is likely to only be sustainable, in part, in the vicinity of Halepōhaku, the University role emphasizes supporting DLNR actions.	Beavers, 2011
Camp et al. (2018) discuss the potential impacts of climate change on Maunaloa’s subalpine and alpine vegetation, with similar implications for Maunakea.	Camp et al., 2018
Source: OMKM records	

The quantitative botanical survey information gap has been filled for both native and invasive species with the 2013 Gerrish botanical survey for Halepōhaku, the MKSR, and the Mauna Kea Access Road. Additional invasive plant species analyses were incorporated in the 2015 *Invasive*

Species Management Plan (ISMP) (Vanderwoude et al., 2015). Ongoing management programs such as volunteer weed-pull events and invasive weed removal by Rangers have been implemented to monitor and control invasive plants. The 2013 Gerrish botanical survey also filled the protected-species information gap, resulting in maps of native species including *Argyroxiphium sandwicense sandwicense*, *Cystopteris douglasii*, and *Dubautia arborea*.

In addition to the reports detailed above, OMKM/CMS has continued its regular efforts to remove invasive weeds such as fireweed (*Senecio madagascariensis*) and protect native plants within the UH Management Areas. Maunakea Rangers are constantly on the lookout for and remove non-native species that they observe as part of their regular duties. Information regarding this is logged in their daily reports. In the spring of 2012, OMKM-initiated volunteer weed-pulls in the vicinity of Halepōhaku. Since that time, it has hosted nearly five-dozen Mālama Maunakea Volunteer Weed Pulls and been responsible for planting approximately 300 native plants.

Finally, OMKM conducted ongoing efforts to monitor for invasive and native flora from 2007 through 2019, and CMS is continuing that work. Since 2012, first OMKM and now CMS have also conducted invasive species inspections for deliveries and equipment for all Maunakea users that hold a CDUP. Data resulting from these efforts is maintained in CMS' files, and CMS is continuing this monitoring and inspection work.

2.2.7.2 Discernable Trends Related to Botanical Resources

Gerrish's baseline botanical survey report noted that ecosystems are dynamically changing rather than at static equilibrium and that because of this modern conservation management does not have the goal of static preservation of a rigidly defined community or ecosystem. Instead, the achievable conservation goal is to see that the changes are driven primarily by natural factors rather than predominantly human interventions.¹⁴

The baseline botanical survey report identified three "trends" within what it referred to as the Natural/Cultural Preservation Area (which generally included most of the summit area above an elevation of 11,500 feet). However, the observations related more to patterns than to changes in those patterns which could constitute a trend. The report identified a general pattern of: (i) higher frequency and species diversity on lava flows than on unconsolidated materials and (ii) the ancient Hāmākua lava flows possibly being more conducive to diverse plant life than are the more recent Laupāhoehoe flows. The additional botanical information that has been assembled since the CMP was prepared has not yielded any discernable trends.

The efforts that UH has made to control and prevent invasive plant species appears to be working as new invasive plants have not become established in the UH management area. Invasive weed removal has helped to reduce habitat for invasive ants, prevented or slowed the spread of other unwanted invasive species, and preserved the potential for future native plant restoration projects. These are all considered beneficial impacts of the invasive species management actions conducted to date.

¹⁴The report recommended that managers of Mauna Kea consider defining their conservation goal to match that which was adopted for Hawai'i Volcanoes National Park, i.e., maintaining or restoring the ecosystem that existed before western contact, accepting any influence of the indigenous people as a "natural" part of this ecosystem.

2.2.7.3 *Future Management Actions Related to Botanical Resources*

OMKM completed much of the botanical resources-related work called for in the CMP. Specifically, OMKM:

- Limited damage by establishing an invasive species prevention and control program (NR-2).
- Delineated areas of high native diversity and unique communities within the Astronomy Precinct and at Halepōhaku and protected them from development (NR-7).
- Constructed a greenhouse within Halepōhaku for use as a nursery for native plants. The plant propagation work is ongoing and the plants are being used on Maunakea (NR-9).
- Completed baseline inventories of high-priority resources, as outlined in its inventory, monitoring, and research plan (NR-15).
- Completed research that has filled knowledge gaps (NR-17).
- Developed a 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 (NR-18). New information is added to the database as it becomes available.

In addition to the work that OMKM completed, CMS is continuing to implement the following management actions related to this topic:

- Continue to provide support to DLNR for its implementation of its 2011 *Wildfire Management Plan for Maunakea*. As the UH Management Areas are sparsely vegetated and wildland fire is likely to only be containable, in part, in the vicinity of Halepōhaku, the UH role emphasizes supporting DLNR actions.
- Do what it can to maintain native plant and animal populations and biological diversity (NR-3). This includes training Rangers and staff to recognize new introduced plants and remove known invasive plants visible near observatories, roads, or other facilities, and in pavement cracks and retaining walls along the Mauna Kea Access Road.
- Fence areas of high native biodiversity or populations of endangered species to exclude feral ungulates (NR-8) should any be found.
- Continue to incorporate mitigation plans into project planning and ensure that mitigation measures are implemented as necessary following new development (NR-10).
- Formulate and implement habitat restoration plans if there are unplanned disturbances or it becomes evident that they are needed (NR-11 and NR-12).
- Continue regular long-term botanical monitoring and studies (NR-16 and NR-17).

2.2.8 INVERTEBRATES

Several of the NR-coded CMP management actions specifically address invertebrates and others apply generally to them. The following management actions of the CMP address invertebrate resources specifically, particularly those related to the wēkiu bug:

- 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-7: Delineate areas of high native diversity, unique communities, or unique geological features within the Astronomy Precinct and at Halepōhaku and consider protection from development.
- NR-12: Create restoration plans and conduct habitat restoration activities, as needed.

2.2.8.1 New Information Regarding Invertebrate Resources

Reports documenting the ongoing research and monitoring related to invertebrate resources that have been conducted since the CMP was adopted are listed in Table 2.13. Data from the vehicle, construction materials, equipment, and supplies inspections that have been conducted since 2013 are summarized in Table 2.14.¹⁵ The results of these studies increase understanding of the ecological interrelationships within the summit area and they, together with the data from the inspections, provide insights into the best means of managing the area and conducting site restoration during the decommissioning process. They do not fundamentally alter the science on which the CMP was based.

Table 2.13 Reports Documenting Invertebrate Research and Monitoring Conducted Since the CMP Was Adopted

Summary	Reference
This publication documents the complete life history of the Wekiu bug (<i>Nysius wekiuicola</i> , Lygaeidae), an alpine carnivore endemic to Maunakea that is one of only two obligate carnivore scavengers of the family. The results demonstrate the importance of behavior, rather than pure physiological adaption, in an insect's persistence in a harsh environment. The Wekiu bug's shift to carnivory from a suite of herbivorous congeners is a remarkable adaptive shift in an aeolian system bereft of vascular plants.	Eiben, J and D. Rubinoff, 2010
To determine which insects are at risk, how insect populations fluctuate in natural areas, and which management actions are most beneficial to Hawaiian ecosystems, this publication proposes that insects be monitored whenever possible. Insect monitoring should be broad, generating community-based metrics such as species richness, rather than focusing on individual species. Resultant data should be entered into a stable, central database. The authors emphasize that measures of insect diversity can provide an assessment of restoration efforts and serve as a metric for prioritizing areas for conservation.	Medeiros et al., 2013
This PhD dissertation investigated the wēkiu bugs life history, genetic analyses of mtDNA haplotype diversity, and the evolution of the wekiu bug within the <i>Nysius</i> lineage. The study found that wēkiu bugs have a low reproductive output in captivity, develop most quickly at 30-42°C, and require 622 degree-days for one generation; this development requirement is only achieved for a maximum of 8.5 hours of solar heating on Mauna Kea. The wekiu bugs closest relatives are seed feeding <i>Nysius</i> on Maui and Hawai'i Island.	Eiben, 2012
This publication investigated growth parameters and environmental models for wekiu bug phenology and demographic change. Experiments were made in the laboratory by manipulating rearing temperatures of lab colonies. Wekiu bugs developed optimally from 26 to 30°C, confirming a physiological reason why the wekiu bug is only found on cinder cones. These results can help guide population monitoring and inform habitat restoration and conservation. The developmental parameters quantified in this study were used to determine the species would not be listed as endangered or threatened.	Eiben and Rubinoff, 2014

¹⁵ The bump in the number of inspections in 2017 and 2019 noted in the table is the result of construction work that took place in those years at Halepōhaku and in the summit area.

Summary	Reference
These OMKM produced reports describe all invasive species management activities conducted for the year and include native species monitoring. Species lists and data analyses are provided from the various management activities.	Kirkpatrick & Klasner, 2015; Kirkpatrick et al. 2019
OMKM initiated an Arthropod Biodiversity Study in 2012. The investigations expand on information in Eiben & Rubinoff's baseline study of arthropods within the UH Management Areas emphasizing community assemblages in subalpine and alpine ecosystems. The final report is still in progress.	2011 – 2017. J. Eiben
Annual invasive species and wēkiu bug monitoring reports continue to be generated by OMKM staff with the same general procedures established by the Hawaii Biological Survey in 2007-2008. General trends within the reports show wide variability in summit arthropod populations for both native and non-native species. Annual surveys continue to function as native species monitoring and early detection of any new threats.	Englund et al., 2009, 2010, and 2012; Preston et al., 2012 and 2013; Kirkpatrick & Klasner, 2015
This master's thesis assesses the efficacy of OMKM's Invasive Species Management plan procedures and evaluates the potential pathways through which species can arrive at UH managed lands. The study documents the occurrence of non-native arthropod threat species associated with regulated human activities and assesses the ability to detect non-native species threats, evaluates the risks posed by these species, and tests the recommendations to mitigate risks posed by non-native arthropods to alpine and subalpine habitats on Maunakea. It includes an evaluation of practices to prevent transport of species between lower and upper elevation sites. The results identify that regular vehicle washing as required by the Maunakea Invasive Species Management Plan is more effective than other alternatives, and also suggest that further study and refinement of invasive arthropod monitoring protocols is needed.	Zarders, 2018
Determining potentially suitable habitat is critical for effective species conservation and management but can be challenging in remote or sensitive areas. This publication describes an approach using two habitat suitability models for the endemic wēkiu bug that combines non-intrusive spatial data collection techniques and supporting field data that can lead to a better understanding of landscape-scale species distributions. The modeling results show that elevation and surficial mineralogy were the strongest predictors of suitable habitat, with lesser contributions from aspect and slope. They indicate that the wēkiu bug has a high degree of habitat specificity and represents a classically rare species.	Stephenson et al., 2017
This master's thesis evaluated wēkiu bug populations and habitat use over time on two cinder cones (high elevation and low elevation cinder cone) to inform habitat restoration efforts and conservation management decisions. Results indicate that wēkiu bugs had a highly aggregated distribution on cinder cones and the density of bugs changed within and between cinder cones throughout the year. A generalized linear mixed model indicated that sample month, topographic aspect, and elevation on a cinder cone influences wēkiu bug distributions and abundance; bug abundance increase with elevation within a cinder cone; highest captures are predicted to be on the northeast aspects of the higher elevation cinder cone year-round. Thermal conditions on cinder cones were also investigated and showed that multiple microclimates exist throughout cinder cone habitats at any given time, and the ash layer could provide an important habitat refuge for the wēkiu bug, as this layer rarely freezes. Preserving contiguous cinder cone habitats and monitoring populations in a random sample design was recommended. This information can be used to recreate habitat that is most favorable for the bugs, help estimate population densities, and measure the success of restored populations.	Kirkpatrick, 2018
Several new non-native arthropod species were reported within the Mauna Kea Forest Reserve (MKFR), which is lower in elevation than the UH Management Areas, except for Halepōhaku which shares the same elevation as the highest boundaries of the MKFR. New threat species within the Orders Araneae, Coleoptera, and Hymenoptera will be monitored for movement upslope during annual surveys.	Krushelnycky et al., 2014

Summary	Reference
The Native Hawaiian Insect Microbiome Initiative is an effort intended to develop a framework for informing evolutionary and biological studies in Hawaii. The bacterial microbes of thirteen species representing iconic, endemic Hawaiian insect groups were sequenced. The wēkiu bug exhibit unique ecological transitions that are correlated with shifts in their microbiomes (transitions from carrion feeding from plant-feeding <i>Nysius</i>).	Poff et al., 2017
The Maunakea Invasive Species Management Plan (ISMP) identifies invasive invertebrate taxa and their impacts on natural resources. The ISMP outlines efforts to prevent, detect, monitor, control, and rapidly respond to non-native and invasive arthropod and plant species. The ISMP also includes various Standard Operating Procedures (SOPs) that provide methods for invasive species management activities. Nine SOPs have been completed across all areas of the ISMP and represent the continued need for invasive species management on Maunakea. For example, invasive species inspections of large equipment, vehicles and construction materials are identified in SOP02, and quarterly invasive species monitoring and monthly monitoring of Halepōhaku facilities are identified in SOP10. All SOPs are implemented and are ongoing.	Vanderwoude et al., 2015; SOP's C, -01, -02, -03, -10, -11, 12, 20, and -31.
This master's thesis and peer-review journal article describes the ecology of the wēkiu bug's environment with particular attention paid to potential food distribution for the wēkiu bug derived from wind and snow deposition. It uses data from 12 weather stations on the summit ridges and various cinder cones. The results of the research provide a better understanding of the areas on the summit of Maunakea that are affected by deposition and erosion of snowpack, food deposits, and how the wind's direction and velocities are influenced by the variable terrain. It indicated that snow-fall and bug fall accumulations are fairly well collocated with previous Wēkiu Bug trapping sites.	Eaton, 2011; Eaton & Businger 2014.
This master's thesis describes the results of a climatological investigation of observations taken at the Mauna Loa Observatory from 1958 through 2010 and observations taken at the summit of Maunakea from 1982 through 2010. In addition to diurnal and annual cycles, and the inter-annual variability associated with ENSO, the extremes in temperatures and wind are also presented. The information was, among other things, designed to improve understanding of how some animal life, including the Wēkiu Bug, are sustained.	Da Silva, 2012
This master's thesis conducted a baseline inventory of the arthropod diversity associated with three endemic Hawaiian plants in Maunakea's subalpine region; 'Āweoweo, Hinahina, and Māmane. Over 13,000 arthropods were collected within the University of Hawai'i Management Areas and Mauna Kea Forest Reserve between July and November 2015. The community composition between plant species and various arthropod sampling techniques were also identified. The results of this study increase knowledge and awareness of Hawaiian arthropods and their ecological interactions and help OMKM and other land management entities minimize the cost and effort required to conserve native arthropods on Maunakea.	Stever, 2016
This master thesis completed a habitat suitability map. MaxEnt habitat suitability models were generated from fifteen years of species occurrence data and a variety of spatial datasets, including high resolution digital elevation models, surface mineralogy based on hyperspectral remote sensing, and climate variables. A trapping experiment based on surface mineralogy and geomorphic position affirmed that both elevation and surface mineralogy play significant roles in the spatial patterns of wēkiu bugs, but observed presence upslope on a cinder cone and absence downslope, even within the same predominant surface mineral, suggests that other habitat variables may be at play such as competition or predation. The methods developed in his research can also be applied to habitat suitability modelling for other species of interest on Maunakea such as the endemic summit wolf spider (<i>Lycosa hawaiiensis</i>) and native Noctuid moths.	Stephenson, 2016
This study described two new endemic Hawaiian <i>Agrotis</i> (Noctuidae) moth species: <i>A. helela</i> and <i>A. kuamauna</i> . Both species are day-flying and occur at high elevations on Hawai'i Island. Observations of adult and larval morphology and biology are described, and illustrations of adult moths and genitalia for both sexes are included. This information helps land managers put a name to these moth species that have been captured and observed on Maunakea and Maunaloa since the early 1980's.	Medeiros et al. 2019
Source: OMKM records	

Table 2.14 Vehicle, Construction Materials, Equipment, & Supplies Inspections

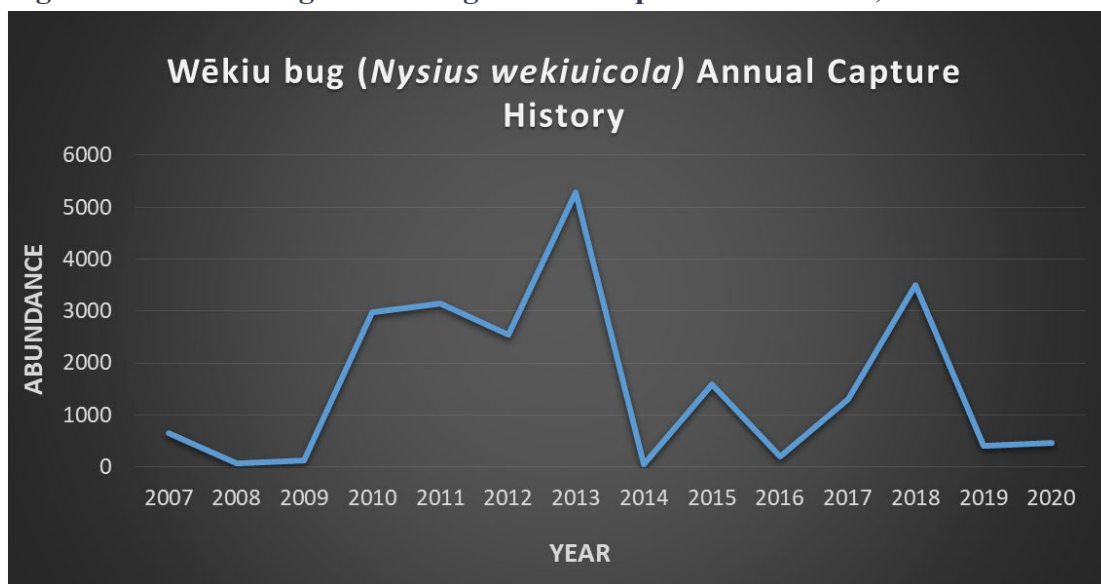
Facility	2013	2014	2015	2016	2017	2018	2019	2020
Keck	2	0	14	11	15	21	51	28
Subaru	3	8	17	11	30	16	10	10
JCMT	0	0	0	0	0	0	1	0
UKIRT	0	0	0	0	0	2	5	0
UH88	0	0	1	1	57	2	8	9
IRTF	2	0	0	1	1	9	2	9
CFHT	11	0	3	0	4	10	0	6
SMA	0	0	0	10	19	16	21	14
CSO	0	0	4	0	0	0	0	0
UH24	0	0	0	0	0	3	0	0
VLBA	0	0	4	0	0	2	1	0
Gemini	4	12	9	13	12	10	6	0
TMT*	0	14	18	0	0	0	75	0
MKSS/VIS	6	11	5	4	8	3	150	3
<i>All Inspection</i>	<i>28</i>	<i>45</i>	<i>75</i>	<i>51</i>	<i>146</i>	<i>94</i>	<i>330</i>	<i>79</i>
Remediation	4	12	20	7	15	10	58	14
No Remediation	24	33	55	44	131	84	272	65
Approved	28	43	72	51	145	90	316	74
Rejected	0	2	3	0	1	0	11	1
Non-compliance	0	0	0	0	0	4	3	4
Notes: * The majority of invasive species inspections for the TMT were conducted by the Big Island Invasive Species Committee. "Rush/ No Rush": Not recorded until 2019. Rush inspections = those not requested four days prior to the scheduled delivery. "Remediation/ No remediation": Remediation occurred when there was a cleanliness or invasive species concern with the load or vehicle. Most remediation actions entailed pressure-washing or vacuuming. "Approved/ Rejected/ Non-compliance": Vehicles and loads that were clean and free of invasive species were approved. Vehicles and loads that could not be remediated quickly with pressure washing or vacuuming were rejected, and re-inspected after the concern was addressed. Non-compliance was documented when vehicles or loads did not request for an invasive species inspection and traversed the UH Management Areas without approval.								
Source: OMKM Records.								

2.2.8.2 Discernable Resource Trends Related to Invertebrates

Threats to native invertebrates include habitat alteration, invasive species, human use impacts, and climate change. Habitat alteration remains minimal due to no major construction or removal of structures within the UH Management Areas since the CMP was adopted in 2009. Invasive species threats continue to be monitored, managed, and controlled through OMKM/CMS's preventative invasive species protocol. Through these actions, OMKM/CMS has, to the best of its knowledge, been able to prevent the establishment of new alien invertebrate species within the management area.

Regarding wēkiu bugs, OMKM annual monitoring data (see Figure 2-1) shows that wēkiu bug abundance varies greatly from year to year. During the 14 years covered by the dataset, the lowest count was in 2008, when only 70 were observed, and the highest was in 2013, when 5,290 were counted. There is no clear long-term trend in abundance. Most importantly, OMKM surveyors find all life stages on all cinder cones in wēkiu bug habitat which suggests that they are growing and reproducing.

Figure 2-1 Wēkiu Bug Monitoring Annual Capture Abundance, 2007 to 2020



Source: OMKM

Although not a trend in the natural resources, Table 2.14 indicates that the number of inspections conducted has fluctuated, and reached its maximum in 2019. The number of inspections is proportional to the number of maintenance and construction projects occurring in the UH management areas. The number of inspections in 2019 was elevated because UH was implementing the ingress/egress project at Halepōhaku. Importantly, Table 2.14 also shows that in 2019 the proportion of remediation to no remediation outcomes remained within historic ranges.

2.2.8.3 Future Management Actions Related to Invertebrates

OMKM/CMS has completed much of the invertebrate resources-related work called for in the CMP. Specifically, it has:

- Created an invasive species prevention and control program designed to limit damage caused by invasive species (NR-2).
- Worked to maintain native plant and animal populations and biological diversity (NR-3).
- Delineated areas of high native diversity, unique communities, or unique geological features within the Astronomy Precinct and at Halepōhaku and protected them from development (NR-7).
- Created restoration plans and conducted habitat restoration activities, as needed (NR-12).
- Prepared baseline inventories of high-priority resources, as outlined in its inventory, monitoring, and research plan (NR-15).
- Conducted research to fill knowledge gaps that cannot be addressed through inventory and monitoring (NR-17).
- Developed a geo-spatial database of all known invertebrate resources and their locations in the UH Management Areas that can serve as baseline documentation against change and provide information essential for decision-making (NR-18). New information is added to the database as it becomes available.

Because successful management of the invertebrate resources requires an ongoing effort many of the existing efforts will be continued, and others will be initiated as existing facilities are decommissioned and/or sites redeveloped. Specifically, UH will:

- Continue to implement the invasive species prevention and control program that it has established (NR-2).
- Continue efforts to maintain native plant and animal populations and biological diversity (NR-3).
- Conduct habitat restoration activities called for in decommissioning/redevelopment plans and as the need arises (NR-12).
- Continue to conduct regular long-term monitoring, as outlined in an inventory, monitoring, and research plan (NR-16).
- Continue funding research to fill knowledge gaps that cannot be addressed through inventory and monitoring. Much of this effort is directed towards knowledge that will be useful in site restoration.

2.2.9 BIRDS

As documented in the CMP, most of the birds that inhabit the higher slopes of Maunakea thrive in māmane woodlands. This forest type, which is generally found at elevations from 6,000 to 9,500 feet above sea level, has been degraded by non-native ungulate grazing for over 100 years. In recent history, the palila (*Loxioides bailleui*), ‘amakihi (*Hemignathus virens*), ‘apapane (*Himatione sanguinea*), and ‘i‘iwi (*Vestiaria coccinea*) are the only forest birds that have been observed at Halepōhaku; none of these Hawaiian forest birds have been observed within the MKSR, because there is no native forest habitat within it. Non-native game birds and non-native passerines are common throughout Halepōhaku and occasionally seen in the MKSR.

Several bird species that the CMP identified as being present, or potentially present, on Maunakea are listed under the State and Federal Endangered Species Act (ESA) as endangered or threatened. These include: Nēnē (*Branta sandvicensis*, endangered), ‘Io or Hawaiian Hawk (*Buteo solitarius*, endangered), Pueo or Hawaiian Owl (*Asio flammeus sandwichensis*, State endangered [O‘ahu only]), Palila (*Loxioides bailleui*, endangered), ‘Ua‘u (*Pterodroma sandwichensis*, endangered), and ‘I‘iwi (*Drepanis coccinea*, threatened). While Palila are rarely detected within the UH Management Areas, the area around Halepōhaku is within the area that has been designated as critical habitat for Palila, and CMS is supporting ongoing restoration efforts through such things as cat-trapping and Māmane tree planting.

There are no NR-coded CMP management actions that specifically address birds; however, several of the 18 NR management actions have some relevance to birds.

2.2.9.1 New Information Regarding Birds

Reports documenting the ongoing research and monitoring related to birds that have been conducted since the CMP was adopted are listed in Table 2.15. Ongoing CMS-sponsored research and program activities in this topical area includes work intended to expand the existing inventory of seabirds, forest birds, and bats in the region. If additional threatened and endangered wildlife

resources are found in the MKSR, appropriate measures (e.g., predator control, predator-proof fencing, etc. will be implemented per the adaptive management provisions of the CMP.

Table 2.15 Reports Documenting Avian Research and Monitoring Conducted Since the CMP Was Adopted

Summary	Sources
This report uses information obtained from surveys conducted in 2012 to update population estimates for the Palila (<i>Loxioides bailleui</i>). The report concludes that Palila numbers fluctuated widely between 1998 and 2003, peaked in in 2003, then declined steadily through 2011, increasing only slightly in 2012. The average rate of decline from 2003 to 2012 was 519 birds per year for a 66% decline over ten years. The paper estimated that there were approximately 2,100 Palila present within the survey area on Maunakea 2012.	Camp, Richard and Paul Banko, October 2012
This report summarizes results of Palila Restoration Project research from December 1996 to December 2012 to assist government agencies mitigate the effects of realigning Saddle Road. The document synthesizes the existing body of ecological knowledge concerning the Palila and provides guidance regarding the species' demography and breeding ecology, habitat use and food ecology, vegetation ecology, and predator ecology and management. The results of the research inform efforts to reintroduce the Palila to a portion of its former range.	Banko, Paul, and Chris Farmer (eds.), 2014
This report summarizes the results of annual surveys of the Palila population during 1998–2014. In 2013 the population was estimated at 1,492–2,132 birds (point estimate: 1,799) and the 2014 population was estimated at 1,697–2,508 (point estimate: 2,070). No Palila were detected at Halepōhaku or other areas outside the core survey area in 2013 or 2014, suggesting that most if not all Palila inhabited the western slope (the core survey area) during the survey period. Since 2003, the size of the area containing all Palila detections has not indicated a significant change among years, suggesting that the range of the species has remained stable; although this area represents only about 5% of its historical extent. After peaking in 2003, population estimates declined steadily through 2011; since 2010, estimates have fluctuated moderately above the 2011 minimum (CV = 0.18). Over the 16-year monitoring period, the estimated rate of change equated to a 68% decline in the population.	Camp, R. et al, May 2014
This report summarizes the results of annual surveys of the Palila population during 1998–2016. These surveys were designed to determine abundance, population trend, and spatial distribution of the species on Maunakea. In the latest surveys, the 2015 population was estimated at 852–1,406 birds (point estimate: 1,116) and the 2016 population was estimated at 1,494–2,385 (point estimate: 1,934). Five Palila were detected on supplemental survey stations in the Ka'ōhe restoration area, outside the core survey area but still within Palila Critical Habitat (one in 2015 and four in 2016), suggesting that Palila are present in habitat that is recovering from cattle grazing on the southwest slope. The average rate of decline during 1998–2016 was 150 birds per year. Over the 18-year monitoring period, the estimated rate of change equated to a 58% decline in the population.	Camp, Richard, et al., May 29, 2016
This report describes the habitat and food preferences of the Palila on Maunakea. It emphasizes the extent to which the species is behaviorally adapted to consume māmane seeds, a degree of single-species dependency rare among birds. It concludes that protecting and restoring māmane in woodlands adjacent to the current range of Palila will benefit their recovery, allowing them to exploit increased food availability in areas of their former range.	Hess, Steven, et al., 2014

Summary	Sources
This article presents the results of tracking the Hawaiian goose (Nēnē) in five areas on Hawai‘i Island, including Maunakea, during migrations in 2010–2012. The results indicated that breeding areas were at Hakalau Forest NWR and Big Island Country Club golf course; non-breeding areas included Kīpuka ‘Ainahou Nēnē Sanctuary (Kīpuka ‘Ainahou), Kūlani Correctional Facility, and the Kahuku unit of Hawai‘i Volcanoes National Park. Migration corridors that were mapped based on Brownian bridge utilization distributions indicate that the species overfly the saddle area between Mauna Loa and Maunakea but do not appear to be present in significant numbers at the elevations within the U.H. Management Area.	Leopold, Christina R. and Steven C. Hess, January 2014
The objectives of this research were to identify habitats preferred by two subpopulations of the Hawaiian goose (Nēnē) and determine how preferences shift seasonally at both meso- and fine scales. Data were collected from ten ganders outfitted with satellite transmitters with GPS capability. The authors then used binary logistic regression to compare habitat use versus availability and an information-theoretic approach for model selection. Meso-scale habitat modeling revealed that preferred exotic grass and human-modified landscapes during the breeding and molting seasons and native subalpine shrubland during the nonbreeding season. Fine-scale habitat modeling further indicated preference for exotic grass, bunch grass, and absence of trees. The results showed that Nēnē make pronounced seasonal movements between existing reserves and use distinct habitat types; understanding annual patterns has implications for the protection and restoration of important seasonal habitats.	Leopold, Christina R. and Steven C. Hess, 2013
Bird monitoring on Maunakea still consists of qualitative records of both native and non-native species. Reports typically include game bird species in the Halepōhaku area and occasional sightings in the summit region. Rangers also occasionally report dead native and non-native birds on the summit. An identification, collection and processing guide was developed by OMKM for easier field detection and to provide proper collection and reporting techniques if dead birds are found.	SOP-B Vertebrate Threat Identification, Collection, and Processing Guide
Source: OMKM records	

In addition, in May 2019 the University of Hawai‘i Hilo (UH Hilo) bio-acoustics researchers announced that, thanks to research funded by OMKM, scientists working for the UH Hilo Listening Observatory for Hawaiian Ecosystems Bioacoustics Laboratory had heard calls of the ‘Ua‘u or Hawaiian Petrel (*Pterodroma sandwichensis*) on Maunakea at many locations near Pu‘ukanakaleonui (approximately 9,000 feet above sea level) for the first time in over 50 years. The first documented ‘Ua‘u call was in 2018 and since that time a dead ‘Ua‘u was found in the forest reserve on the eastern slope of Red Hill indicating the species likely continues to use some areas on the mountain for breeding.

All the areas where Hawaiian Petrel have been detected are outside the UH Management Areas. The results of the studies that have been conducted since the CMP was completed do not fundamentally alter any of the science on which the CMP was based.

2.2.9.2 Discernable Trends Related to Birds

Anecdotal information indicates that the Palila populations in some areas close to the UH Management Areas may have stabilized, possibly as a result of efforts to reverse the decline of the Māmane forest, but the data are insufficient to establish a definitive trend. There are no well-documented changes in the abundance of Nēnē in the region. University of Hawai‘i at Hilo researchers located a Hawaiian Petrel (‘ua‘u) nesting site in 2021 on DHHL-managed Maunakea lands planned for māmane forest restoration. Hawaiian Petrel nesting has not been identified within the UH Management Areas and data are insufficient to identify any trends on Maunakea.

Management actions performed by OMKM/CMS, including its invasive species program and management of human activities, are believed to be beneficial to native birds. While few native birds visit the UH Management Areas, the management actions help to maintain the environment in a condition that potentially supports bird range expansion into the area.

2.2.9.3 *Future Management Actions Related to Avian Resources*

OMKM completed much of the bird resources related work called for in the CMP. Specifically, it has:

- Worked to maintain native plant and animal populations and biological diversity (NR-3).
- Delineated areas of high native diversity, unique communities, or unique geological features within the Astronomy Precinct and at Halepōhaku and protected them from development (NR-7).
- Developed a geo-spatial database of all known invertebrate resources and their locations in the UH Management Areas that can serve as baseline documentation against change and provide information essential for decision-making (NR-18). New information is added to the database as it becomes available.

Because successful management of the avian resources requires an ongoing effort many of the existing efforts will be continued, and others will be initiated as existing facilities are decommissioned and/or sites redeveloped. Specifically, UH will:

- Continue efforts to maintain native plant and animal populations and biological diversity (NR-3).
- Conduct habitat restoration activities called for in decommissioning/redevelopment plans and as the need arises (NR-12).
- Continue to conduct regular long-term monitoring, as outlined in an inventory, monitoring, and research plan (NR-16).
- Conducted research to fill knowledge gaps that cannot be addressed through inventory and monitoring (NR-17). Examples includes:
 - Seabird, forest bird, and bat surveys by Dr. Patrick Hart.
 - Acoustical monitoring by the UH Hilo Listening Observatory for Hawaiian Ecosystems Bioacoustics Lab that detected the sound of the Hawaiian petrel at many locations near Maunakea's Pu'ukanakaleonui, an indication that the species likely continues to use the mountain as a nesting site.
- Continue funding research to fill knowledge gaps that cannot be addressed through inventory and monitoring. Much of this effort is directed towards knowledge that will be useful in site restoration.

2.2.10 MAMMALS

As detailed in the CMP, the only native land mammal is the endangered ōpe'ape'a or Hawaiian hoary bat (*Lasiurus cinereus semotus*). At the same time, non-native mammals (e.g., ungulates, cats, dogs, and rodents) and other animals (i.e., arthropods) have negatively impacted native biota, including the hoary bat, and the CMP note that such invasive mammals must be carefully

monitored and controlled to ensure species and ecosystem protection within the UH Management Areas.

None of the 18 NR-coded CMP management actions specifically address mammals. However, because of the negative effects that introduced mammals can have on native flora and fauna, several actions have some relevance to them.

2.2.10.1 New Information Regarding Mammals

Reports documenting the ongoing research and monitoring related to mammals that have been conducted since the CMP was adopted are listed in Table 2.16. The numbers of mammals that have been observed and/or trapped in and immediately around the UH Management Areas from 2012 to 2019 are shown in Table 2.17. It is important to note that because the data summarized in Table 2.17 consists of “observations” that were not made according to a well-established protocol that was followed by all those reporting, they cannot be used to establish trends in vertebrate abundance over time. CMS is using the experience gained to begin to develop additional guidance that will lead to greater standardization of observations and reporting in the future.

Table 2.16 Reports Documenting Mammalian Research and Monitoring Since the CMP Was Adopted

Summary	Sources
This report documented the nightly movements of 28 radio-tagged Hawaiian hoary bats on the island of Hawai‘i. It found that the mean foraging range (FR) was 230.7 hectares and the core use area (CUA) was 25.5 ha. The CUAs of 4 adult males neighboring each other had almost no overlap when tracked simultaneously or within a 90-day window of each other. CUAs of subadults partially overlapped with multiple adult males or with one other subadult. The concentration of feeding activity, low values of individual overlap, and agonistic chasing behavior within CUAs all demonstrate a structured use of individual space by the bats.	Bonaccorso et al., 2016
The authors used acoustic recordings of the vocalizations of the endangered Hawaiian hoary bat (<i>Lasiurus cinereus semotus</i>) collected over a five-year period (2007–2011) from 25 survey areas across Hawai‘i Island to model the relationship between habitat attributes and bat occurrence. Their data support the conclusion that bats concentrate in the coastal lowlands of Hawai‘i during the breeding season, May through October, and migrate to interior highlands during the winter non-breeding season. Occupancy peaked on September 15th, which is during the fledging season, across the five-year average. Although the Hawaiian hoary bat is a habitat generalist species and occurs from sea level to as high as 10,000 feet above sea level, they are most abundant in areas where there is mature forest cover. Trends in occupancy identified in this study were stable to slightly increasing during the breeding season over the five years of our surveys. The report did not include any monitoring stations within the UH Management Areas.	Gorresen et al., 2013
Source: OMKM records.	

Table 2.17 2012-2020 Vertebrate Observations on UH Managed Lands

Name	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coqui frogs	1	3	1	0	1	0	1	0	0
Mouflon & Sheep	4	0	0	0	3 +2 skel.	0	4 & bones	Bones	23
Cats sighted (trapped)	2 (1)	3(3)	1(1)	2(2)	5(3)	2, 1 skel.	0	(5)	1(2)
Dogs	0	0	0	2	1	2	2	0	1
Mongoose	0	0	1	0	0	0	0	0	0
Mice & Rats	0	0	7	1	2	1	5	1	134

Name	2012	2013	2014	2015	2016	2017	2018	2019	2020
Red-billed leothrix	0	unk	0	3	1	0	0	0	3
Mynah bird	0	0	0	1 dead	0	0	0	0	0
Chukars	0	0	3	6	17	1 egg	11+1 egg	19	52
Erkel Francolin	0	0	0	0	0	1	2	1	3
Kalij pheasant	0	0	1	1	0	0	0	0	0
I'iwi	0	0	1		0	0	1	0	0
‘Apapane	0	0	0	3+1 dead	0	0	1	0	10
‘Amakihi	0	0	0	0	0	0	1	0	0
‘Iwa bird	0	0	0	0	0	0	1	0	0
Native Pueo	0	0	0	0	0	0	0	1	0
Anole lizards	0	0	1	0	0	0	0	0	0
Madagascar gecko	0	0	0	1	2	1	1	0	1
Feral Pig	0	0	1	1 dead	0	0	0	0	0
Note: The numbers reported in the table are reflective of the amount of observational effort and other factors and do not necessarily reflect the abundance of the species. Hence, for example, the relatively high numbers of mice & rats reported in 2020 reflects the increased trapping efforts by MKSS and VIS staff and improved record-keeping. Similarly, the increase in chukar observations is probably a function of increased Ranger presence at the Halepōhaku soft gate near the VIS where they are in a position to see more chukars than they did before COVID when they were more often patrolling the summit road. The increase in sheep observations could be a function of a few things, including: (i) decreased human activity leading them to come closer to facilities than they otherwise would) (ii) DLNR’s aerial shootings driving some sheep closer to Halepōhaku; and (iii) greater Ranger presence at the Halepōhaku “soft gate” increasing the observational time/effort there. Source: OMKM Records updated Jan 2021.									

Ongoing CMS research and program activities in this topical area continue to provide additional information on the following topics:

- Anecdotal reports documented by on-mountain staff and visitors in an activity log, and reported to DLNR’s Division of Forestry and Wildlife (DOFAW). This allows for limited examination of trends of observed mammalian wildlife, but does not provide a quantitative inventory of mammal populations present in or around the Management Area.
- Traps are set for mice and rats within facilities such as those at Halepōhaku and the observatories in the summit region, while occasionally traps for dogs, cats, and mongoose are set outside when these non-native mammals are observed.
- There are no control procedures for observed ungulates other than notification to DLNR as CMS does not have authority to manage game animal populations.

2.2.10.2 Discernable Trends and Management Impacts Related to Mammals

The new information that is available indicates that while Hoary bat distribution and use of Maunakea has not been precisely established, their known habitat preferences strongly suggests that their numbers are quite low even near Halepōhaku and are probably absent from the summit area. The additional information that has been assembled since the CMP was prepared has not yielded any discernable trends related to mammals.

Management actions performed by OMKM/CMS, including its Invasive Species Management Program and management of human activities, are believed to help control non-native mammals and be beneficial to native bats. While few native bats likely visit the UH Management Areas, management actions in the CMP that are designed to help restore the native forest will tend to promote bat range expansion into the Halepōhaku area.

Although not believed to indicate a trend in vertebrate activity, there was a substantial increase in the number of vertebrates identified during 2020 (Table 2.17). The reason more vertebrates were identified in 2020 is because CMS personnel were regularly present at Halepōhaku making observations as they performed out-plantings and other activities associated with the ingress egress project.

2.2.10.3 *Future Management Actions Related to Mammals*

There are no NR-coded CMP management actions that specifically address mammals; however, two of the 18 NR management actions that have some relevance to them have been completed. Specifically, UH has:

- Delineated areas of high native diversity, unique communities within the Astronomy Precinct and at Halepōhaku and prohibited development within them (NR-7).
- Developed a geo-spatial database that includes 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 (NR-18). New information is added to the database as it becomes available.

Because successful management/control of non-native mammals and management for bats requires an ongoing effort, many of the existing efforts will be continued and others will be initiated as existing facilities are decommissioned and/or sites redeveloped. Specifically, UH will:

- Continue to implement its Invasive Species Management Program, specifically, SOP-B.
- Conduct habitat restoration activities called for in decommissioning/redevelopment plans and as the need arises (NR-12).
- Continue to conduct regular long-term monitoring, as outlined in an inventory, monitoring, and research plan (NR-16).

Conduct research to fill knowledge gaps that cannot be addressed through inventory and monitoring (NR-17) that will be helpful in developing management programs for the bat. The bird and bat study will fulfill the quantitative and protected bat species information gaps and provide direction for additional management efforts if those are called for.

Under HAR § 20-26-21(2), “[i]ntroducing any form of plant or animal life, except dogs when permitted by the hunting rules of the department of land and natural resources and legally authorized service animals when accompanying their handlers,” is prohibited.

3 MANAGEMENT & OUTREACH ACTIVITIES

Many of the goals and objectives of the CMP have to do with the way the UH Management Areas are administered and managed. This chapter begins (Section 3.1) with an overview of its outreach and education efforts. That is followed by a topic-by-topic discussion of the extent to which its efforts have resulted in UH meeting the CMP's goals and objectives for each category. Specifically:

- Education and outreach (“EO”-coded measures) are discussed in Section 3.2.
- Astronomical resources (“AR”-coded measures) are covered in Section 3.3.
- Activities and uses (“ACT”-coded measures) are covered in Section 3.4.
- Permitting and enforcement (“P”-coded measures) are addressed in Section 3.5.
- Infrastructure and maintenance (“IM”-coded measures) are described in Section 3.6.
- Construction guidelines in the CMP (“C”-coded measures) are covered in Section 3.7.
- Site recycling, decommissioning, demolition, & restoration (“SR”-coded measures) are discussed in Section 3.8.
- Future land use considerations (“FLU”-coded measures) are addressed in Section 3.9.
- Operations and maintenance (“OI”-coded measures) are discussed in Section 3.10.
- Monitoring, evaluation, and plan updates (“MEU”-coded measures) are addressed in Section 3.11.

3.1 OVERVIEW OF OUTREACH AND EDUCATION ACTIVITIES

3.1.1 COMMUNITY ADVISORY GROUPS

OMKM has been, and CMS is now, supported and assisted by the community, including its volunteer advisory board (MKMB), Kahu Kū Mauna Council, and committees (e.g., Environmental Committee). The makeup and responsibilities of these organizations are explained in the *Mauna Kea Science Reserve Master Plan* (2000 Master Plan), adopted by the BOR on June 16, 2000, and summarized below.

Mauna Kea Management Board. The MKMB provides the community with a sustained direct voice for the management of the Maunakea. It is comprised of seven members from the community who are nominated by the UH Hilo Chancellor and approved by the BOR. The MKMB has advised OMKM and now advises CMS and the UH Hilo Chancellor on matters relating to management of Maunakea. It provides input on proposed projects, management policies, and other matters. Meetings are open to the public and well-publicized in advance.

Kahu Kū Mauna Council. The Kahu Kū Mauna Council is composed of seven members from the Hawai‘i Island native Hawaiian community who serve in a volunteer capacity. The Council advises the UH Hilo Chancellor, MKMB, and CMS on Maunakea cultural matters. CMS also consults with the Council on project proposals and draft policies. Kahu Kū Mauna submits names of prospective new Council candidates to the MKMB; after reviewing the recommendations, the

MKMB either endorses the nominees or returns the recommendation to the Council for further consideration.

Environment Committee (EC). The EC was one of several special advisory committees created by the MKMB at its meeting on October 10, 2000. The MKMB appoints volunteers to the EC. Members have included persons with environmental expertise from state and federal agencies, staff and faculty within UH, past and current MKMB and Kahu Kū Mauna Council members, and other persons from the community with subject area expertise. The EC provides its recommendations to the MKMB regarding environmental impacts of proposed uses on UH Management Areas and has taken the lead on issues related to environmental issues as assigned by MKMB. The EC meets as needed.

3.1.2 DATA REPOSITORIES

UH recognizes that documentation and record keeping of day-to-day operational activities as well as long-term oversight are required as part of sound stewardship and management. Moreover, recognizing that it is a prerequisite for sound management and is the basis for community engagement, UH also places a high priority on proactive public dissemination of educational information on Maunakea's resources, community values, and management activities. Accordingly, it has established and maintains the following data repositories that are relevant to the ongoing management of Maunakea.

CMS Library. Since 2003, the OMKM (now CMS) Library has collected and maintains more than 2,000 publications about or pertinent to Maunakea, which include monographs, journal articles, and theses on: (i) the effects that high altitude has on the human body and its functions; (ii) archaeological findings; (iii) flora and fauna; (iv) ecology; (v) geology and hydrology; (vi) Hawaiian culture, including legends and cultural practices; (vii) Pōhakuloa Training Area and Hakalau Forest National Wildlife Refuge; (viii) weather and climate changes; and (ix) historical accounts, recreation, and controversial issues related to Maunakea. The library also contains environmental assessments, environmental impact statements, planning documents, and legal documents related to Maunakea. In addition, the library hosts the Akiyama Archival Collection which consists of nine volumes (about 1,000 items) of correspondence, newspaper clippings, photographs, invitations, copies of programs, and other materials related to the early development of astronomy on Maunakea. The Library Catalog is available on-line via CMS's website at <http://www.malamamaunakea.org/library/>.

CDUA/CDUP Database. CMS maintains a database of Maunakea projects and their Conservation District Use Applications (CDUA), CDUP, Site Plan Approvals (SPA), Department of Land and Natural Resources (DLNR) staff reports, correspondence, maps, drawings, project descriptions, etc.

Electronic Database of Media Articles. UH maintains an electronic media database to document Maunakea-related news; including natural resources, astronomy news (non-research papers), management, community concerns, and events or incidents (including issues of concern for immediately adjacent area). Sources include newspapers, various newsletters, blogs, and other online websites. Over 7,000 media entries are presently included in the database that extends back to the 1800s. This tool allows managers and researchers to readily access historic and public

articles about management, community concerns, events and incidents related to Maunakea. Access to the database is available to CMS-designated individuals and entities.

Photo Database. UH maintains a searchable, georeferenced, photo database that illustrates conditions, resources, activities, and issues or topics of concern on the UH Management Areas. Photos originate from OMKM/CMS staff, MKSS staff, observatories, independent researchers, private citizens, commercial sources, historic sources, etc. As of October 2020, the database contained approximately 6,500 photos, and is constantly growing as new staff submissions are received, reviewed, and added on a daily basis. Access to the photo database is available to CMS-designated individuals and entities.

Maunakea Ranger Database. The Rangers maintain a comprehensive internal computerized database containing information related to their activities. It includes daily Ranger reports that log vehicle and visitor counts, as well as public, commercial and astronomy activities on the mountain. The first Ranger report was initiated on June 10, 2001, and the format and content of the reports have evolved over time. Today the types of information gathered include: (i) number of permitted as well as unpermitted commercial tour operators; (ii) number of visitor vehicles by four-wheel-drive (4WD), two-wheel-drive (2WD) and motorcycles; (iii) number of hikers; (iv) number of visitors under the age of 16; (v) parking, road and weather conditions; (vi) special requests; (vii) the number of emergency and search and rescue responses made; (viii) astronomy project activity; (ix) debris removal; and (x) astronomy facility inspections for CDUP compliance.

Resources Database. OMKM staff created and maintained an electronic database of all resources including datasets of all monitoring efforts and provided many of these datasets to DLNR annually. CMS is continuing this practice.

Other Information Sources. In addition to the sources listed above, data is also available in the UH Library digital collection repository and commercial equivalents. Relations have been established with UHM and UHH for this purpose. Thesis and data are in the UH Library system repositories, as are third-party products. The OMKM library has copies of most, but not all, of this material.

3.1.3 COMMUNITY ENGAGEMENT

Community engagement has and continues to inform OMKM/CMS on good stewardship and is a major focus of UH management. Appendix F of OMKM's 2020 Annual Report to DLNR (see Appendix A) contains a detailed listing of the education, training, and outreach events that OMKM has participated in. Examples of the kinds of community activities that OMKM and CMS have engaged in since the CMP was adopted are provided below.

Community Outreach and School Visits. OMKM (and now CMS) has maintained relationships, shared information about the work being done on Maunakea, and addressed concerns face-to-face through community engagement with island schools, UH Hilo, civic organizations, businesses, and through its volunteer program begun in 2012. OMKM booths have typically included hands-on activities and displays (e.g., insect display box); educational and age-appropriate take-home items; and informational literature. Community engagement is also formalized through public attendance of MKMB meetings. Recent events include:

- Kealakehe Elementary School - 2015, 2016, 2017, 2018, and 2019.

- Keaukaha Elementary School – 2016, 2018, and 2019 for Science Technology Engineering Art Math (STEAM) night.
- Mountain View Elementary School – 2019.
- Volcano School of Arts and Science – 2018.
- Hilo Intermediate School – 2015.
- Hawaii Academy of Arts & Sciences Public Charter School – 2017.
- Nā Kilo: PUEO – 2017.
- UH Hilo Earth Day – 2015, 2016, 2017.
- Aunty Mimi' Astro Bash – 2017.
- Kona-Kohala CC Business Expo – 2016, 2017, and 2019.
- Waimea Community Association Presentation regarding ongoing stewardship – 2018.
- Hawai'i Island Chamber of Commerce general membership meeting – 2018.
- Hawai'i Leeward Planning Conference– 2018.
- Japanese Chamber of Commerce & Industry of Hawai'i, Kona Lions Club, Kiwanis Club Kona, Rotary Club of Hilo, West Hawai'i Community Forum, Rotary Club of Hilo Bay – 2018.
- Waikoloa Lions Club, Hawaiian Affairs Caucus of the Democratic Party, Kona-Kohala Chamber of Commerce, Hawai'i Island Portuguese Chamber of Commerce, Pōhakuloa Advisory Council, Rotary Club of Kona Mauna, Rotary Club of North Hawai'i – 2019.

Brochures & Educational Outreach. OMKM has communicated with the public in a variety of formats suited to the task. Examples of the brochures and educational outreach materials that UH has prepared and distributed to help inform visitors about Maunakea's unique and significant landscape, history and resources are shown in Table 3.1. The brochures and materials are also available from the OMKM/CMS website (<http://www.malamamaunakea.org/visitor-information>). With the reorganization that has recently occurred, Imiloa has assumed responsibility for much of this type of work.

Table 3.1 Examples Brochures and Educational Outreach Materials

Topic	Number Produced
What is OMKM?	5,000 prints
Cultural Brochure	80,100 prints
Hazards Flyer (English, Chinese & Japanese)	44,500 prints
Visiting Safely Brochure	224,000 prints
Heritage & Natural Resources Guide	23,600 prints
Coloring Sheets	200 prints
‘Āhinahina Postcards	1,100 prints
Trading Cards (5)	7,380 prints
Resource Poster	1,000 prints
Temporary Tattoos	4,000 prints
Source: OMKM records. Numbers reflect those who attended and received completion certificates.	

Volunteer Events. The OMKM/CMS volunteer program provides community members an opportunity to participate in management, learn about Maunakea, provide direct feedback to

managers, and experience the resources first hand. Since the program's inception in Spring 2012, OMKM/CMS has held 58 events, filled over 2,400 bags of weeds by nearly 1,500 volunteers putting in over 10,400 hours. Volunteers have included individuals from local schools, UH Hilo student groups, Rotary Clubs, Chambers of Commerce, observatories, and the general public. Among other accomplishments, these efforts have prepared areas at Halepōhaku for outplanting with native biota, including māmane seedlings. The long-term goal is to repopulate the Halepōhaku area with native plants. OMKM/CMS is propagating native plants for future restoration efforts in the Halepōhaku area.

Maunakea Speakers Series. The Maunakea Speakers Series provides opportunities for UH to share with the community the results of science and scholarship involving Maunakea. The series emphasis is on place, it focuses on knowledge, and it is not about taking positions for or against astronomy. Monthly talks are free, are recorded for on-demand viewing, originate in Hilo, and are presented as a collaboration between UHH Physics & Astronomy, 'Imiloa Astronomy Center, and OMKM/CMS. They are available on YouTube. Topics to date have included tropical mountain permafrost, the history of snow & ice on Hawai'i's summits, Hawai'i's birds, rapid 'ō'hia death, Maunakea geology and groundwater, Lake Waiau, adze quarrying and the movement of Hawaiian adzes through the islands, high school student research projects, climate change on Maunakea, Lake Wai'au, lunar eclipse observing, Maunakea arthropod biodiversity, Maunakea weather forecasting services, Maunakea erosion, and sea-level rise.

Student Mentorship/Career Development. OMKM has worked with staff, faculty, graduate students, and undergraduate students to mentor students and prepare them for careers, and CMS is continuing these initiatives. For example, between 2012 and 2019 OMKM sponsored 17 undergraduate internships to work on resource management, research, inventory, and monitoring projects. Three of these interns continued as regular employees at OMKM for several years before returning to graduate school to work on conservation-related research projects in Hawai'i. Additional interns and students have partnered with UH faculty or OMKM on topics ranging from basic office support to collaborative research. CMS is continuing this initiative.

Graduate students or post-docs sponsored in-whole or in-part by OMKM have worked directly on CMP-identified resource management concerns such as climate-change modelling and monitoring, erosion, wēkiu bug habitat restoration, wēkiu bug food deposition, arthropod biodiversity, and DNA analysis of arthropods. Many of these same students, faculty, and staff work with local middle and high schools to serve as science fair judges, science project mentors, and career role models. Recent examples include participating in school career days, serving as science fair judges, and science fair projects on Maunakea's ants and spiders. Student mentorship directly contributes to numerous CMP action items such as resource protection; provides solid science to OMKM/CMS and other resource managers; boosts UH's educational and training mandate; and gives students knowledge, skills, and networking experience; all of which ensures efficient use of resources while maximizing positive societal benefits.

Community Engagement with Management Plans, Rulemaking, and Other Relevant Plans. Community Open Houses have provided an opportunity for community members to interact directly with OMKM/CMS staff while learning about management, resources, and other issues. These interactions have informed OMKM's drafting plans and policies and educated the public regarding the need for and the content of the plans and policies. Examples of the meetings are shown in Table 3.2. CMS is continuing these activities.

Table 3.2 Public Meetings Regarding Management Activities, Products, and Processes

Subject of Engagement	Date	Location
Comprehensive Management Plan	2008 Nov. 14, 17, 18	Kona, Waimea, Hilo
Cultural Resources Management Plan & Natural Resources Management Plan	2009 Sept. 1, 2, 3	Waimea, Kona, Hilo
Public Access Plan & Decommissioning Plan	2009 Dec. 1, 2, 3	Hilo, Waimea, Kona
Resource open house	2015 May 28	Halepōhaku
Suggested administrative rules	2015 June 23, 24, 25	Kona, Hilo, Waimea
Land Authorization EISPN scoping mtgs	2015	Waimea, Hilo, Honolulu
Land Authorization EISPN scoping mtgs	2018 March 12, 13, 14	Waimea, Hilo, Honolulu
Proposed administrative rules	2018 Sept. 24, 25, 26, 28	O‘ahu, Hawai‘i, and Maui
Draft administrative rules	2019 June 3, 4, 5, 7	O‘ahu, Hawai‘i, and Maui
Source: OMKM records.		

Awards. UH has received several awards for its Maunakea planning and outreach. Examples are listed in Table 3.3.

Table 3.3 Awards and Recognition for Maunakea Planning

Year	Award Description
2013	Hawai‘i Invasive Species Council (HISC) Community Hero Award to Mary Begier and the Hawai‘i Island Chamber of Commerce for helping establish a volunteer program to facilitate invasive species management on Maunakea.
2016	Kona-Kohala Chamber of Commerce, Pūalu Awards: <i>Environmental Awareness</i>
2017	Kona-Kohala Chamber of Commerce, Pūalu Awards: <i>Culture & Heritage</i>
2017	Historic Hawaii Foundation Preservation Honor Awards, Preservation Commendation: <i>The Long-Term Historic Property Monitoring Plan for UH Managed Land on Maunakea</i>
Source: OMKM records.	

3.1.4 ORIENTATION

Persons Working on Maunakea. Orientation of all persons working on Maunakea above Halepōhaku (i.e., astronomy personnel, mountain staff, contractors, etc.) is required under the CMP. The purpose of this requirement is to: maintain the integrity of the environment, communicate cultural significance and appropriate behavior, and ensure staff and public safety on Maunakea. Beginning in August 2013, prior to working on or in support of activities in the UH Managed Areas, OMKM required all astronomy staff, tour operators, support staff, contractors, vendors, Rangers, etc. that travel to Halepōhaku or above to attend an orientation session (or, beginning in 2017, view a training video) and receive certification that must be periodically renewed. Topics covered in the 45-minute orientation include the scope of UH/OMKM/CMS management on Maunakea, cultural resources, natural resources, and best practices and safety. The number of program participants is shown by year in Table 3.4. Responsibility for the orientation was transferred to Imiloa in the Fall of 2020, and that organization is now conducting the orientation using the system it inherited from OMKM while working to improve the orientation as directed by BOR Resolution.

Table 3.4 Maunakea Worker Orientation Statistics

Year	# Sessions	No. In-Person	No. Online
2013	18	543	N/A
2014	21	362	N/A
2015	28	480	N/A
2016	28	458	N/A
2017	15	275	263
2018	13	258	114
2019	12	85	630
2020	10	93	245
Source: OMKM records. Numbers reflect those who attended and received completion certificates.			

General Public. In collaboration with CMS, the ‘Imiloa Astronomy Center has been tasked with developing a suite of educational programs regarding Maunakea. These include, but are not limited to programs dealing with Native Hawaiian culture, history, environmental, and biological considerations and are designed for tour guides and drivers, employees, contractors, recreational users, scientists, observatory workers, and visitors, as required by the CMP and Executive Policy EP10.104. The target date for completing program development is September 30, 2021, with implementation targeted to commence no later than December 31, 2021.

3.1.5 PERMITTING & COMPLIANCE

OMKM/CMS oversees activities in the UH Management Areas to ensure that appropriate permits are obtained, permit and lease conditions are complied with, and relevant reporting is completed. All permits, from project proposals to film permits, are reviewed for general appropriateness as well as fulfillment of permit-specific criteria and requirements. Visitors are informed that Maunakea is a sensitive place and visitors must conduct themselves responsibly and be respectful at all times and reminded that all Federal, State, and County laws apply. Additional information about each type of oversight is provided below.

On-Site Astronomy Facility Project Monitoring. Believing that regular, consistent communications and teamwork are key to successful completion of projects, Rangers and construction monitors keep watchful eyes on all phases of exterior building repairs and renovations, ground disturbance, and road work requested on UH Management Areas. Monitoring is performed by the Rangers and designated construction project monitors. The purpose for monitoring is to ensure that proper documentation, including permits and required construction best management practices, are in place and their provisions adhered to. The presence of monitors also helps construction workers keep in mind the cultural importance of the area, know how to conduct themselves in a respectful manner, refrain from littering, remain mindful of others while on the job, and encourages the orderly cleanup of all construction debris at the completion of the project. Examples of the projects that have been monitored are listed in Table 3.5.

Table 3.5 Examples of Projects Monitored

Year	Projects Monitored
2013:	TMT – Geo-technical surveys, core sampling, geologist surveys.
2014:	TMT – access road and ground breaking site preparations.
	CFHT – Nexus Steel, replacement of 2 dome vents.
	Keck – mirror polishing repairs.
2015	Gemini – Shutter door replacement.

Year	Projects Monitored
	CSO – Decommissioning planning site inspection.
	SMA – overhead crane repair.
2016	Gemini – Gear box replacement.
	CFHT – Vent gear drive replacement.
	IRTF – Chiller replacement.
2017	CSO – Decommissioning planning.
	IRTF – Re insulation / re-foiling (painting) of dome.
	UH 2.2m – Modernization project. Major upgrade to telescope.
	Hōkū Ke‘a – Decommissioning planning cost estimates inspection.
2018	IRTF – Re-foiling (painting) of dome continues.
	Gemini – Equipment upgrade.
2019	Keck – Photovoltaic system installation
	MKSS – VIS Ingress/Egress improvements
2020	UH IfA – Long-term permafrost monitoring
Source: OMKM records as of December 31, 2020.	

Film Permits. OMKM/CMS has worked cooperatively with the State of Hawai‘i Film Office on permits for filming on Maunakea. Neither has promoted Maunakea as a visitor destination and the vast majority of film permits granted (generally about 30 per year) are for films that are educational in nature. News/media are allowed for current events coverage. Projects have included documentary and educational films, music videos, travel logs, TV episodes, and TV commercials.

Oversight of Commercial Tours. UH accepted the responsibility for oversight of commercial tour operators in the UH Management Areas from DLNR in 2005. The eight current permittees are each limited to two, 14-passenger vans daily during the sunset and stargazing period. The number of permitted tour vehicles and passengers that have visited the summit since 2010 are shown in Table 3.6. The data show that after peaking in 2012 and 2013, the number of commercial tour vehicles and passengers over the years prior to the road blockages and the pandemic were generally between 60 and 80 percent of the daily maximum allowed by the permits.

Table 3.6 Number of Permitted Commercial Tour Vehicles & Passengers: 2010 to 2020

Year	Vehicles	Passengers
2010	5,576	63,142
2011	5,880	62,532
2012	6,470	70,281
2013	6,690	70,615
2014	6,364	67,106
2015	5,753	56,380
2016	5,793	60,069
2017	6,098	64,983
2018	5,305	52,887
2019	2,936	27,833
2020	823	7,658
Source: OMKM records through December 31, 2020.		

During the 2015-2019 period, Rangers reported seeing an increasing number of unpermitted tour operators (those with no UH permit) in the summit area.¹⁶ When they did, the Rangers made contact with suspected unpermitted tours and OMKM issued cease and desist notifications. Rangers worked with DOCARE to address the violations, and DLNR acted on DOCARE-issued citations on adjacent DLNR lands. In addition to collaborating with DOCARE and law enforcement, HAR § 20-26-73 allows an authorized agent, law enforcement officer, or the UH president to issue civil fines on unpermitted commercial tour operators and to exclude them from the UH Management Area.

Astronomy/MKSS/Research/Management Project Proposal Permits. Each year UH receives a number of requests involving “land uses” as that term is defined under HAR Chapter 13-5, which requires approval from DLNR’s Office of Conservation and Coastal Lands (OCCL). Under the project review process established by OMKM based on the 2000 Master Plan, OMKM coordinated review by advisory bodies (e.g., KKM, MKMB, EC), University approvals, and community input, before an application was submitted to OCCL for consideration and issuance of Conservation District use permits and approvals by OCCL, DLNR, or BLNR. CMS has now been assigned responsibility for processing such applications.

Examples of astronomy projects are listed above in Table 3.5. MKSS Projects have included such things as continued maintenance and repairs to the summit road, installation of septic tanks at Halepōhaku, minor renovations to the Visitor Information Station, installing fiber optic cables at Halepōhaku, installation of guardrails around culverts on the Mauna Kea Access Road, installation of a remote road surface condition sensor, and installing a photovoltaic system at Halepōhaku.

Research/experiment projects that have requested and received approvals include: (i) spectral mineral mapping of the summit cinder cones; (ii) history of the ice ages as recorded on Maunakea; (iii) measuring of atmospheric pressure, temperature and humidity; (iv) acute mountain sickness surveys; (v) climate change; (vi) study of basaltic rocks under glaciers and ice sheets; (vii) astro-geology survey of hydrological outflow features around the base of Pu‘upōliahu; (viii) testing of a star tracker; (ix) use of a portable cosmic-ray muon detector to take cosmic ray data; (x) study of arthropod diversity assessment and develop species descriptions on Maunakea; (xi) permafrost monitoring; (xii) baseline study on surficial geomorphology and erosion monitoring; and (xiii) surveys of the distribution of native Hawaiian birds and bats within sub-alpine and alpine habitats on Maunakea. The types of permits that have been issued each year from 2009 through 2020 are shown in Table 3.7.

¹⁶ These increased from 154 in 2014 to 360 in 2016 before dropping back to 244 in 2017. The COVID-19 pandemic reduced the number to near zero during 2020. Rangers estimated that unpermitted tour operators carried an average of 5 passengers on each of these trips.

Table 3.7 Requests for Project Approvals by Type: 2009 to 2020

Year	Astronomy	MKSS	Research/Exp.	Mgmt.	Annual Total
2009	4	-	1	1	6
2010	4	1	-	-	5
2011	5	1	2	-	8
2012	6	2	1	-	9
2013	2	2	5	-	9
2014	5	4	1	-	10
2015	7	2	-	1	10
2016	7	2	4	-	13
2017	5	1	4	2	12
2018	3	2	1	-	6
2019	5	2	3	1	11
2020	3	4	3	1	11
Totals	56	23	25	6	110

Source: OMKM records through December 31, 2020.

Special Requests. UH's Special Request policy was developed to address increasing visitation levels and is consistent with DLNR Special Use Permitting required for groups comprised of ten or more individuals seeking access to their lands. OMKM has reviewed special requests on a case-by-case basis and approved them only if they were for appropriate purposes and the proponents were able to meet transportation, insurance and other requirements. Most of the Special Requests approved have been for activities that are educational in nature (elementary through college), for traditional cultural practice, and/or consist of astronomy guests including scientific review boards and visiting dignitaries. Depending on the participants' ages, time of visit, and stated itinerary, the group may have been required to arrange for a Ranger escort, similar to a film permit.

Table 3.8 Outcome of Special Requests Received by OMKM/CMS: 2014-2020

Year	Approved	Not Approved	Withdrawn	Total
2014	162	13	40	215
2015	113	16	32	161
2016	106	12	25	143
2017	84	13	17	114
2018	102	11	29	142
2019	51	22	6	79
2020	4	6	3	13

Source: OMKM records.

In January 2020, promulgation of the UH Maunakea Rules replaced the Special Request policy for public and commercial groups with a requirement for "Special Use Permits" (SUPs). HAR § 20-26-63 describes SUPs as required for activities otherwise prohibited under HAR Chapter 20-26 and for activities other than research, commercial tour activities, and commercial film and recordings, which have separate permitting. It calls for SUPs to be evaluated for: (i) compatibility with the functions and purpose of the UH Management Areas; (ii) consistency with existing approved management plans; (iii) potential effect on the surrounding resources, existing facilities, and the public's use of the UH Management Areas; (iv) compatibility with existing approved uses; (v) compatibility with scheduled or ongoing construction, repairs, or maintenance activities; and (vi) the applicant's prior record of compliance with conditions of previous permit (if any). It is important to note that the UH Maunakea Rules apply to activities not "land uses," which are still reviewed, processed, and approved by OCCL, DLNR, or BLNR.

3.1.6 STAFF TRAINING EFFORTS

A training plan (see Section 3.10.2.2) that went into effect in 2016 addresses general staff training (all OMKM/CMS and MKSS employees & staff), volunteer training, field-personnel training, Visitor Information Staff training, Ranger training, etc. The focus of staff training is to ensure that all those who work on Maunakea have an in-depth grasp of the resources, cultural considerations, and management to enable them to better respond to public questions and be ambassadors for UH and Maunakea.¹⁷ This training is in addition to the User Resource Orientation and training sessions have covered such things as the CMP, invasive species, historic property preservation, and Hālau ‘Ōhi‘a - cultural principles of resource management.

3.1.7 RANGER PROGRAM / PUBLIC SAFETY

The Maunakea Ranger program was established in 2001. There are currently eight full time and three part-time Rangers. Ranger presence is 365 days a year from 7:15 am to 10:00 pm daily, with at least two Rangers on-duty at all times within those hours. Rangers also sleep at Halepōhaku to be better prepared to respond to after-hours emergencies. Their duties and responsibilities include:

- Patrolling and monitoring activities in the UH Management Areas.¹⁸
- Serving as ambassadors on the mountain by interacting with visitors and sharing information about: (i) visitor safety; (ii) the natural, historical, cultural, and scientific resources; and (iii) management policies on Maunakea.
- Coordinating and managing visitor movements during peak visitation periods, especially on days following heavy snowfall.¹⁹
- Providing first-responder first aid.
- Coordinating with County of Hawai‘i and Pōhakuoloa Training Area emergency personnel with medical emergencies and search and rescue operations.
- Assisting visitors with vehicle break-downs or stalls.
- Inspecting the Mauna Kea Access Road for snow and ice, closing it when necessary for safety reasons.
- Conducting biannual inspections of astronomy facilities for DLNR permit compliance.
- Maintaining orderly traffic flow.
- Removing invasive plants in the upper elevations as time permits.

¹⁷ The monthly staff trainings have been on hold since Fall 2018. The suspension stems from changes in operations associated first with the protests and then with the COVID-19 pandemic.

¹⁸ In coordination with VIS staff, Rangers help to maintain orderly traffic and parking, cone off hazardous areas including accidents, provide updated notification to all users of road conditions, and provide emergency transport.

¹⁹ A snow event on Maunakea in 2017 coincided with Christmas and favorable weather that reopened the road to the public. Highs approaching 1,200 private vehicles were recorded on the RFID traffic monitor December 25-26, 2017, during which one Ranger estimated 300-400 vehicles on the summit at any one time (Ranger Report, 12/23/2017). Higher visitation was still observed through the first week of January 2018, with about 250-450 total vehicles per day. On normal days, visitor traffic varies between approximately 125-250 vehicles. The majority of summit traffic occurs around sunset. In contrast, between December 2017-January 2018, the maximum daily RFID total for observatory and commercial vehicles was 55 vehicles.

- Picking-up and properly disposing of trash found in the upper elevations on a daily basis.
- Shadowing film crews to ensure compliance with the conditions of their permits.
- Photo-documenting their daily observations and adding these to the OMKM/CMS database.
- Hiking to Lake Wai‘au, which is not in the UH Management Areas, bimonthly to photo-document the lake level and pick up trash.
- Hiking into the adze quarry, which is not in the UH Management Areas, to monitor activity.
- Assisting foreign visitors having conversational difficulty by communicating with rental car companies, tow services, locksmiths, police, and others.

The Rangers have played a prominent role in documenting the level of vehicular and pedestrian activity within the UH Management Areas that is referenced elsewhere in this OAR. Rangers conduct point-in-time counts of vehicles while on patrol, and a vehicle monitoring system was installed with full-year data available from 2015 onward (see Table 3.9). The data that they have collected show that: (i) the problems most frequently encountered by motorists include vehicle stalls/breakdowns, overheating, and flat tires and (ii) major and fatal vehicular accidents are often related to brake failure, poor visibility, and/or loss of vehicle control.

Table 3.9 Ranger Vehicle Counts: 2011-2020

Vehicle Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
2WD and 4WD	17,027	20,244	20,967	20,595	18,278	22,115	24,536	21,350	13,769	10,287
Permitted Tours	5,891	6,458	6,680	6,322	5,720	5,783	6,072	5,305	2,936	823
Astronomy	10,049	9,485	9,184	8,631	7,821	7,613	8,182	7,888	6,894	7,562

Source: OMKM records.

Maunakea Ranger reports provide the best available indication of the level of use of the foot paths and trails on Maunakea. Hikers are asked to register at the VIS and to sign-out once done, and Rangers record hiker-numbers based on visual observation of persons on a specific trail/route, currently the best method to estimate hiker presence on Maunakea. Rangers also proactively check on hikers by inquiring about the hiker’s wellbeing, general level of preparation including knowledge of planned route and supplies, and whether the hiker registered.

Yearly totals shown represent activity on the five major hiking routes: Humu‘ula Trail, Lake Wai‘au Trail, Pu‘upoliahu, Pu‘uwēkiu, and the Mauna Kea Access Road. Data for the years since the CMP was adopted are shown in Table 3.10.

Table 3.10 No of Hikers on the UH Management Areas on Maunakea: 2010 to 2020

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
7,958	9,134	13,778	10,240	7,489	4,326	6,126	6,652	8,197	5,112	3,781

Note: Roadside sign asking visitors to stay off of Pu‘uwēkiu was installed August 2014.

Source: OMKM records.

3.2 EDUCATION AND OUTREACH

3.2.1 EDUCATION AND OUTREACH PROVISIONS OF THE CMP

Section 7.1.3 of the CMP provides information and management recommendations intended to improve upon education and outreach efforts related to the UH Management Areas. 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 Maunakea through community consultation, through community involvement in resource management activities, and through volunteer-based programs.

The “desired outcome” that the CMP seeks to achieve with respect to education and outreach is as follows:

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.

Education Needs. After summarizing the various educational and outreach efforts that were ongoing at the time it was prepared, the CMP identifies a number of educational and outreach needs that its authors concluded were not then being fully met. These include the following:

- Inadequate education of persons accessing the mountain on a range of issues, such as (i) sensitivity to cultural resources; (ii) the status and condition of natural resources; (iii) threats to resources; (iv) the ban on off-road vehicle use; (v) the proper way to deal with the health and safety concerns that accrue to visitors to the high-altitude environment; (vi) the rules and regulations in effect within the UH Management Areas; and (vii) Rangers as a resource.
- The desirability of having visitors undergo a mandatory educational program before traveling above Halepōhaku. At a minimum, the education would consist of viewing an orientation video or program before accessing Maunakea to educate visitors about its cultural, historical and natural resources, along with critical safety information.

Noting that many people visiting and/or working on Maunakea were unaware of the current status of its natural and cultural resources and why certain management activities may be necessary, the CMP directed that the education efforts be aimed at raising awareness and appreciation of the area, for both those who visit and for those who work at Maunakea. It expressed the strong belief that most damage to historic properties and natural resources is done inadvertently or in ignorance, it postulates that public outreach and education that addresses community concerns and needs, while highlighting measures developed to protect Maunakea’s resources, would increase support for management activities.

The CMP also stresses the importance of educating those visiting and/or working on Maunakea regarding personal safety and the potential hazards of visiting the mountain. It notes that 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 Needs. The CMP concluded that additional outreach activities that focus on involving the community in the management decision-making process were needed and recommended that this consist of two major components: (i) community consultation and (ii) community involvement. Specifically, it highlights the following needs related to each.

- Community Consultation. It recommended that UH increase its effort at community consultation to address concerns that the decision-making process is not transparent and that community members have not been adequately involved. The desired consultation was for a range of activities, including management planning, rule-making, development of cultural protocols, historic preservation, and environmental analyses for new projects. It specifically recommended that the Native Hawaiian community be involved through direct consultation, in addition to their representation in the entities that advise on management, such as Kahu Kū Mauna.
- Community Involvement. The CMP concludes that there is a need to encourage and coordinate community participation in the stewardship of Maunakea through protection and conservation of its cultural and natural resources and that doing this will require educating and informing the public about activities there, including management programs and providing ways for the community to become involved. It also recommends that IfA and the astronomy community become more involved in the greater Hawaiian community in which they operate and live and that it do this, in part, by supporting education and outreach programs focused on astronomy (such as astronomy scholarships and school field trips to ‘Imiloa).

The CMP goes on to outline ideas regarding the nature of the education and outreach program. It recommends that the first step be to outline and prioritize education and outreach activities that would build awareness about Maunakea and involve the community in education, volunteer projects, and research aimed at protecting cultural and natural resources. It emphasizes that an orientation program for visitors and workers addressing cultural, environmental, and safety concerns would be a major aspect of the program.

Table 7-4 in the CMP identifies eight “management actions” to address the needs related to education and outreach that it had identified. Those actions, and the extent to which they have been completed, are listed in Table 3.11. Their status is discussed in detail in Section 3.2.2.

Table 3.11 Status of Measures Related to Education and Outreach

Measure	Description	Status	Discussion
PROGRAM DEVELOPMENT			
EO-1	Develop and implement education and outreach program.	Ongoing	3.2.2.1
EDUCATION			
EO-2	Require orientation of users, with periodic updates and a certificate of completion, including but not limited to visitors, employees, astronomy staff, contractors, and commercial and recreational users.	Ongoing	3.2.2.2
EO-3	Continue to develop, update, and distribute materials explaining important aspects of Maunakea.	Ongoing	3.2.2.3
EO-4	Develop and implement a signage plan to improve signage throughout the UH Management Areas (interpretive, safety, rules and regulations).	Completed/ Ongoing	3.2.2.4
EO-5	Develop interpretive features such as self-guided cultural walks and volunteer-maintained native plant gardens.	Ongoing	3.2.2.5
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.	Ongoing	3.2.2.6

Measure	Description	Status	Discussion
OUTREACH			
EO-7	Continue and increase opportunities for community members to provide input to cultural and natural resources management activities on Maunakea, 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.	Ongoing	3.2.2.7
EO-8	Provide opportunities for community members to participate in stewardship activities.	Ongoing	3.2.2.8
Note: A status of “Completed/Ongoing” means that the needed procedures and systems have been completed and are being implemented on an ongoing basis. Source: Table 7-4, CMP.			

3.2.2 STATUS OF MEASURES RELATED TO EDUCATION AND OUTREACH

3.2.2.1 EO-1: Develop Education and Outreach Program

This element of the CMP calls on UH to develop an Education & Outreach Plan that would: (i) guide development of programs which generate visitor and user awareness about Maunakea’s cultural, natural, and scientific resources; (ii) promote health and safety awareness on visiting high altitudes; and (iii) inform the public about the Office of Maunakea stewardship efforts. OMKM, in collaboration with representatives of the Maunakea Observatories, and the Visitor Information Station, completed the “*Maunakea Education and Outreach Plan*”, which addresses the entirety of EO-1²⁰ and portions of CMP management actions EO-3, 5, 6, 7, and 8, and submitted it to MKMB late in 2019 for consideration. Following MKMB input, OMKM finalized the plan in July 2020 and began working to implement it as fully as possible given the constraints that COVID-19 placed upon its resources. The *Maunakea Education and Outreach Plan* is presently being further reviewed and revised in accord with Executive Policy 10.104 which delegated authority to administer HAR § 20-26-5 regarding required orientation to the executive director of the ‘Imiloa Astronomy Center.

The stated purposes of the *Maunakea Education and Outreach Plan* are to:

- Contribute to the protection and conservation of State of Hawai‘i owned lands on Maunakea, including cultural, natural, and scientific resources.
- Significantly increase the knowledge of University-supported interpretive opportunities – on-site, within the community, and through partners – regarding the heritage, resources, and stewardship of Maunakea.
- Increase public support and strengthen the constituency for University management of State lands on Maunakea in general, and more specifically the management of the MKSR.
- Guide the development and implementation of education and outreach programs.

²⁰ The CMP calls for the education and outreach plan to “...outline the process and discuss a venue for mandatory visitor orientation, and community consultations.” The program that was formally adopted makes the program “mandatory” only for “users,” which Section 1.1.1 of the plan defines as “...individuals working under the auspices of a land-use permit on Maunakea.” Examples of users include observatory employees, observatory vendors, University support staff, and other public agency employees. However, mandatory visitor orientation is addressed further in EO-2.

The *Maunakea Education and Outreach Plan* identifies the collective vision, core values, and visitor experience goals that represent an array of interpretive services, media, programs, and outreach activities to communicate UH's mission in accepting stewardship of lands on Maunakea. It also recommends specific actions that should be taken over the next decade.

3.2.2.2 EO-2: Mandatory Visitor Orientation

HAR § 20-26-5 of the UH Maunakea Rules provides that as set forth in the CMP, all persons accessing the UH Management Areas must complete an orientation regarding cultural and natural resources, safety matters, and other relevant information before entering the UH Management Areas. While UH has developed a substantial amount of material that it uses to inform visitors of the nature and sensitivity of the cultural and natural resources that are present, it has tasked 'Imiloa to develop a brief (less than 15 minute) visitor orientation for the general public. The video will be on-line and shared at the VIS as circumstances permit and once infrastructure is available.

3.2.2.3 EO-3: Develop, Update, & Distribute Materials Explaining Important Aspects of Maunakea

The CMP calls on UH to develop and distribute educational materials in a variety of formats covering important aspects of Maunakea. As described in detail in its reports, UH has prepared a variety of printed materials (brochures, maps, newsletters, etc.) covering topics such as safety, cultural resources, natural resources, and recreational activities. It distributes these free of charge from various outlets (e.g., VIS, Halepōhaku, IfA/OMKM/CMS office in Hilo, 'Imiloa, commercial tour operators, etc.). It is also developing more interactive web-based products that it believes reach a broader audience.

CMS has increasingly used its [website](#) to make available information on the natural and cultural resources found at Maunakea, and on visiting the mountain safely and responsibly. The website contains versions of brochures available at the VIS and user entrance requirements and rules and regulations. It is also used to distribute up-to-date information, such as documents, meeting agenda and minutes, results of scientific studies, etc.) that help keep the public informed. Many, but not all of, the potential topics mentioned in the CMP are already being addressed, and the range of topics covered is constantly being expanded. UH is working towards having all of the orientation and educational materials available in the Hawaiian language as well as English, but considerably more remains to be done in this regard.

3.2.2.4 EO-4: Develop Signage Plan

OMKM staff completed an inventory of the signs present on Maunakea in 2012. OMKM developed an internal draft signage plan for Maunakea in 2016 that was subsequently reviewed by the MKMB, and a draft of the plan was released to the public on February 6, 2017. It describes the underlying legal and policy requirements, presents a sign policy, describes the different types of signs that are allowed, provides guidance on sign design, installation, and maintenance, and presents a review and approval process for signage. The Signage Plan was formally adopted by the MKMB on February 14, 2017, and it has guided the design, installation, and maintenance of all official signage on the mountain since that time.

3.2.2.5 EO-5: Develop Interpretive Features and Activities

This element of the CMP calls for UH to develop interpretive features such as self-guided cultural walks and volunteer-maintained native plant gardens. This work is intended to make information about and interaction/experience with cultural and natural resources more available to those visiting the upper slopes of Maunakea.

UH has progressed farthest with respect to the natural resources part of this measure. It has worked with DLNR to improve the fence around the Silversword enclosure at the VIS and to establish an area of native vegetation as part of the recently completed expansion of the parking immediately below the VIS. Some of the restoration and even more of the maintenance of these re-vegetated areas has been done with the help of volunteers. Interpretive signage has been installed to call out the particular value of the restored areas. Finally, UH has committed to fencing other high-value vegetation within the UH Management Areas if resource managers determine that this is needed.

UH has also progressed on the cultural aspects of this management action and plans to implement additional measures in the near future. For example, UH has led or contributed to programs that provide guided experiences on Maunakea, such as the Kama‘āina Observatory Experience, that included a cultural component. ‘Imiloa has started planning new and improved displays that focus on cultural resources; some have already been installed at the VIS and others will be installed as they become available. Furthermore, this management action includes efforts to keep people away from vulnerable resources or sensitive cultural practices that are unsuitable for public visitation or can be adversely affected by the general public. CMS has coordinated with cultural practitioners to identify areas where access should be restricted and facilitate privacy for sensitive cultural practices.

Based on input from advisory groups, concerns related to health and safety, and the imperative to conserve the resources, UH has not yet implemented other possibilities for interpretive features mentioned in the CMP, e.g., (i) a self-guided tour (using brochures or podcasts) of geological resources at the summit; (ii) development of one or more small pull-out gardens along the Mauna Kea Access Road, from Halepōhaku to the Summit, planted with representative vegetation and accompanying interpretive signage, to illustrate change of vegetation communities with an increase in elevation; or (iii) designate historic properties suitable for public visitation.

3.2.2.6 EO-6: Engage in Outreach and Partnerships

As documented elsewhere in this OAR (e.g., Section 3.1.3) and in Appendix D of its 2020 Annual CMP status report to DLNR (see Appendix A), UH has engaged in extensive public outreach. It has also entered into partnerships with many schools by collaborating with local experts, teachers, and university researchers, and by working with the ‘Imiloa Astronomy Center, which is a part of UH Hilo.

Partnership efforts have included, but are not limited to a June 2014 West Hawai‘i Science Technology Engineering & Math (STEM) camp presentation on maps and drones to primary school students at summer camp done in partnership with STEM Works and Kealakehe Robotics and a June 2017 partnership with the American Association for the Advancement of Science Pacific Division in an OMKM sponsored session called “Student Science Conference” for middle and High School student science projects. In addition, while it has not formally joined as a

member, staff from OMKM has regularly participated in meetings of the Maunakea Watershed Alliance and, where possible, has supported its initiatives. CMS is committed to continuing that effort.

3.2.2.7 EO-7: Create Opportunities for Community Input on Resource Management

This element of the CMP calls on UH to continue and expand opportunities for community members to: (i) provide input to cultural and natural resources management activities on Maunakea and (ii) 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. It recommends that outreach efforts include such things as contacting local civic and environmental groups, local experts in natural and cultural resources, families with lineal and historic connections to Maunakea, kūpuna, cultural practitioners, the Office of Hawaiian Affairs and other Native Hawaiian groups. The CMP further notes that input should be gathered during both public meetings and more informal private consultations with community members. It advises OMKM/CMS to maintain a list of interested individuals, families, and organizations who should be notified and consulted when individual development projects requiring regulatory review (e.g., outreach and consultation required by state and federal historic preservation and environmental laws) are proposed or when other issues arise that may be of public interest. Finally, it cautions that while web sites and email list-serves can and should be used to distribute information pertinent to the community and to keep the public informed, other mechanisms (e.g., telephone, regular mail, meetings, a web-based forum, and a comment box at the VIS) may be required to reach all interested parties.

As documented in its annual reports to the BLNR and in this OAR, UH has created the opportunities for input that are called for in the CMP. Specifically, OMKM/CMS through the MKMB, Kahu Kū Mauna, and special committees such as the EC have provided an ongoing opportunity for members of the community and other organizations to contribute their ideas on how best to manage activities of the mountain. These meetings, as well as opportunities to participate in bi-monthly volunteer activities provide an opportunity for the community to participate in work that helps maintain and restore the mountain and to share their extensive knowledge about it.

A specific example involved the recent review, approval, and adoption of the UH Maunakea Rules. For that effort, UH held several rounds of public meetings at various locations seeking input on iterative drafts of the UH Maunakea Rules. The opportunities for comments that these created resulted in the receipt of hundreds of oral and written comments that were considered by UH and the BOR, and the rules that were ultimately adopted incorporate many of the items that commentors suggested. Outreach was wide-ranging and included open houses and small meetings with groups and persons representing specific interests, such as native Hawaiian cultural practitioners, relevant agencies including OHA and DLNR, observatories, and commercial tour operators.

3.2.2.8 EO-8: Provide Community Opportunities to Participate in Stewardship Activities

Measure EO-8 in the CMP calls on UH to provide opportunities for community members to participate in stewardship activities. Examples of these include public meetings, workshops,

meetings with citizen advisory and “friends” groups, volunteer opportunities and school-related programs that will help involve children. Additionally, the CMP recommends:

- The consideration of establishing a docent program to provide guided tours highlighting cultural and natural resources.
- Developing service projects that fulfill stewardship objectives while also providing education and enjoyment to volunteers.²¹

It recommends that OMKM cooperate and collaborate with other state and federal agencies that run volunteer-based projects to increase the volunteer pool and conduct larger-scale projects than would be possible with only its own dedicated resources.

As documented in its annual reports to the BLNR and in this OAR, OMKM has created many of the opportunities for participation that are called for in the CMP. These include such things as:

- Arranging bi-monthly volunteer activities that provide an opportunity for the community to participate in conservation efforts and to share their knowledge with University staff and other volunteers.
- Conducting regular meetings of the MKMB, Kahu Kū Mauna, and special committees like the EC that provide opportunities for members of the community to discuss and participate in the management of the mountain.
- Providing guided tours, such as the Kama‘āina Observatory Experience, that highlight cultural and natural resources.
- Stationing a CMS natural resources representative at Halepōhaku to inform people about the out-planting efforts, species, and success.
- Supporting student projects and providing mentoring opportunities (science fair, legacy, etc.) that allow for one- on-one interaction and more in-depth efforts.

3.2.3 ADDITIONAL MEASURES RELATED TO EDUCATION AND OUTREACH

Based on the information presented above, UH anticipates that the CMP management actions related to Education and Outreach that are ongoing will continue to adapt and evolve, but it does not believe any entirely new measures are needed.

²¹ The CMP gives the following as examples of the kinds of efforts it deems appropriate for different types of projects. Projects related to natural resources: (i) basic maintenance (trash pick-up and inspection for damage to facilities or signs); (ii) care of the botanical enclosure (weeding, watering, and inspecting the enclosure); (iii) enhancing native plant communities (weeding, outplanting, and care of native species around VIS and dormitories); (iv) trail maintenance and development; and (v) restoration projects for native plant communities. For projects related to cultural resources, it mentions training of archaeology students in field methods during the monitoring of historic properties.

3.3 ASTRONOMICAL RESOURCES

3.3.1 PROVISIONS OF THE CMP REGARDING ASTRONOMICAL RESOURCES

Section 7.1.4 of the CMP provides information and management recommendations intended to preserve the conditions that make Maunakea so well-suited for astronomy research. The “desired outcome” that the CMP seeks to achieve with respect to astronomy resources is as follows:

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.

The CMP lists the two management actions shown in Table 3.12 that are needed to achieve the desired level of protection of astronomical resources. As indicated in that table and in the discussion in Section 3.3.2, UH has established and is implementing procedures that are protective of the astronomical resources.

Table 3.12 Status of Measures Related to Protection of Astronomy Resources

Measure	Description	Status	Discussion
AR-1	Operate the UH Management Areas to prohibit activities resulting in negative impacts to astronomical resources.	Ongoing	Sec. 3.3.2.1
AR-2	Prevent light pollution, radio frequency interference (RFI) and dust.	Ongoing	Sec. 3.3.2.2

Source: Table 7-5, CMP.

3.3.2 STATUS OF MEASURES RELATED TO ASTRONOMY RESOURCES

3.3.2.1 AR-1: Prohibit Activities That Negatively Impact Astronomical Resources

In addition to the clauses that are in the sub-leases that UH has granted to various observatories, UH has included provisions in the UH Maunakea Rules that provide the protection called for in the CMP.²² Specifically, HAR § 20-26-23 preserves scientific and educational resources by prohibiting activities within the UH Management Areas north of Halepōhaku, as follows:

1. *Using any radio transmitter, including but not limited to two-way radios, Wi-Fi and Bluetooth devices, and cellular telephones; provided that, cellular telephones may be used for emergency purposes or when radio transmission is suspended, for example by using airplane mode.*
2. *Directing artificial illumination, for example, lasers and flashlights, at or near observatories.*
3. *Conducting any other activity that materially interferes with the scientific and educational operations of the astronomical facilities or research equipment or with the protection of scientific resources.*

²² The subleases provide that the land be used by the Lessee as a scientific complex, including without limitation thereof an observatory, and as a scientific reserve being more specifically a buffer zone to prevent the intrusion of activities inimical to said scientific complex. Activities inimical to said scientific complex shall include light and dust interference to observatory operation and certain types of electric or electronic installation on the demised lands, but shall not necessarily be limited to the foregoing.

These provisions, together with the restrictions on vehicular travel on the mountain contained in HAR § 20-26-38, will ensure that the Maunakea's astronomical resources are preserved.

3.3.2.2 AR-2: Prevent Light Pollution, Radio Frequency Interference (RFI) and Dust

UH has included provisions in its UH Maunakea Rules that specifically prohibit using radio transmitters except for emergency purposes (e.g., HAR § 20-26-23(1)). Similarly, HAR § 20-26-23(2) prohibits artificial illumination (including lasers and flashlights) at or near the observatories. Finally, HAR § 20-26-23(3) broadly prohibits all activities (including those that would generate dust) that might materially interfere with the educational and scientific operations of the astronomical facilities or research equipment that is situated there. Taken together, these provisions provide the degree of protection called for in AR-2.

3.3.3 ADDITIONAL MEASURES RELATED TO ASTRONOMICAL RESOURCES

No need for additional measures to protect astronomical resources has been identified.

3.4 ACTIVITIES AND USES

3.4.1 PROVISIONS OF THE CMP REGARDING ACTIVITIES AND USES

Section 7.2.1 of the CMP contains information and management recommendations related to the management of scientific research work, cultural and religious activities, and recreation activities and uses within the UH Management Areas. While recognizing that the best known and most prominent activity there is astronomical research, it also references other types of ongoing scientific research, including that related to geology, meteorology, biology, and archaeology. It also refers to the cultural and religious practices associated with the mountain, including prayer, burial, and other rituals and the construction of small shrines. Finally, it acknowledges the value of the recreational activities that occur in the UH Management Areas, including sightseeing, stargazing, skiing and snow-play, hiking, biking, hunting, and the attraction to visitors wishing to see the natural beauty and scenic vistas.

The “desired outcome” that the CMP seeks to achieve with respect to activities and uses is as follows:

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 Maunakea.

The CMP observes that public use of Maunakea has increased immensely since the State constructed the Mauna Kea Access Road. It concludes that a managed access policy would help protect resources, enhance visitor safety, and maintain the unique qualities of the mountain. It also emphasizes that one of the best methods of minimizing damage to resources is through education such as that discussed under other headings in this OAR. The rules that are contained in HAR Chapter 20-26 provide the framework within which managed access can be fully implemented.

Table 7.6 in the CMP lists what it refers to as “Permitted General Uses,” Table 7-7 in the CMP lists what it refers to as “Permitted Public Uses,” and Table 7-8 in the CMP lists what it refers to

as “Permitted Commercial Uses.” Many of those are the same as those that are included in HAR Chapter 20-26, which is consistent with the provisions of the CMP and has replaced it as the governing document.

Table 7-9 in the CMP identifies 12 additional “management actions” to address the needs related to activities and uses that it had identified. Those actions, and the extent to which they have been completed, are shown in Table 3.13. Their status is discussed in detail in Section 3.4.2.

Table 3.13 Status of Management Actions Related to Activities and Uses

Measure	Description	Status	Discussion
GENERAL MANAGEMENT			
ACT-1	Continue and update managed access policy of 1995 Management Plan.	Completed/ Ongoing	3.4.2.1
ACT-2	Develop parking and visitor traffic plan.	Completed/ Ongoing	3.4.2.2
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.	Completed/ Ongoing	3.4.2.3
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.	Ongoing	3.4.2.4
RECREATIONAL			
ACT-5	Implement policies to reduce impacts of recreational hiking.	Completed/ Ongoing	3.4.2.5
ACT-6	Define and maintain areas where snow-related activities can occur and confine activities to slopes that have a protective layer of snow.	Ongoing	3.4.2.6
ACT-7	Confine University or other sponsored tours and star-gazing activities to previously disturbed ground surfaces and established parking areas.	Ongoing	3.4.2.7
ACT-8	Coordinate with DLNR in the development of a policy regarding hunting in the UH Management Areas.	Completed/ Ongoing	3.4.2.8
COMMERCIAL			
ACT-9	Maintain commercial tour permitting process; evaluate and issue permits annually.	Ongoing	3.4.2.9
ACT-10	Ensure OMKM input on permits for filming activities.	Completed/ Ongoing	3.4.2.10
ACT-11	Seek statutory authority for the University to regulate commercial activities in the UH Management Areas.	Completed	3.4.2.11
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.	Ongoing	3.4.2.12
Note: A status of “Completed/Ongoing” means that the needed procedures and systems have been completed and are being implemented on an ongoing basis. Source: Table 7-9, CMP.			

3.4.2 STATUS OF MEASURES RELATED TO ACTIVITIES AND USES

3.4.2.1 ACT-1: Update and Implement Managed Access Policy

This measure calls for UH to adopt administrative rules that would allow it to better manage access and protect resources. HAR § 20-26-38 provides UH the authority and mandate to:

- Install a gate or other control structure (with the approval of the BLNR) to manage vehicular access to the UH Management Areas.
- Close or limit access to all or portions of the UH Management Areas, when needed for protection from hazardous conditions, including but not limited to inclement weather conditions, construction or maintenance activities on or near the roadway or at astronomy sites, transportation of wide, heavy, or otherwise hazardous loads, or roadway congestion.
- Limit access by private vehicles for public safety and welfare, for the protection of resources, and to reduce congestion. Restrictions may include, but are not limited to, setting a maximum number of private vehicles allowed within the UH Management Areas at a time, restricting the areas in which private vehicles may operate, or utilizing shuttle vehicles in lieu of private vehicles.
- Limit public access hours for the UH Management Areas, provided that hunting be allowed pursuant to hunting rules.

The CMP notes that a key component of a managed access program will be visitor registration and orientation to ensure that all who work at or visit Maunakea are taught about its unique, sensitive landscape, potential impacts of activities, health and safety issues, and rules and regulations. Accordingly, it calls for UH to develop and implement an “entrance control protocol” to manage the Mauna Kea Access Road and the number of visitors at the summit. It envisions managing access to the summit region using a control point, with registration required for travel beyond Halepōhaku.

The CMP does not attempt to define the logistics of implementing the access control process, but it does note that it would include establishment of an entrance kiosk at Halepōhaku and states that signage stating hours of operation and access policies shall be displayed prominently, including at the entrance kiosk. It goes on to state that information and warnings regarding such things as: (i) personal safety, (ii) protection of historic properties; (iii) invasive species; (iv) off-road vehicular use; (v) hiking off trail; (vi) exposure to high winds, and leave-no-trace practices should be distributed to all those desiring to proceed above Halepōhaku and call for an orientation program that would ensure visitors are educated on safety and resources issues as well as on prohibited uses. Finally, the CMP explicitly states that entrance fees may be charged at the discretion of UH under its rule-making authority.

3.4.2.2 ACT-2: Develop Parking and Visitor Traffic Plan

As documented in its annual reports to the BLNR, UH has used capital improvement funds to implement various ingress/egress upgrades and area improvements to address concerns of traffic flow and pedestrian safety. These include such things as: (i) the construction of a new paved parking lot and an ingress access lane at the VIS (see CMP IM-9) and (ii) evaluation of Mauna Kea Access Road repair and improvements. The work in the vicinity of the VIS has improved vehicle and pedestrian flow and safety. In addition, the automated vehicle-counter that OMKM has installed on the Mauna Kea Access Road provides accurate information concerning the number of vehicles that drive above Halepōhaku. Finally, the Rangers provide important field support for the management of vehicles that aggregate at and around the VIS. That assistance helps maintain order, allows the facility to function efficiently and accommodate the greatest number of vehicles possible during peak periods, and improves the safety of visitors to the VIS.

Now that HAR Chapter 20-26 has been promulgated, UH is in a position to enforce those CMP management actions that have parallel provisions in it. If fully implemented, those measures (including the possible institution of a shuttle system) have the potential to significantly reduce visitor-related vehicular traffic on the Mauna Kea Access Road, with the greatest reduction felt on the particularly sensitive stretch above Halepōhaku.

3.4.2.3 ACT-3: Interpretive and Enforcement Personnel

This management action calls on UH to maintain a presence of interpretive and enforcement personnel on the mountain at all times to educate users, deter violations of the applicable rules, and encourage adherence to restrictions. UH's establishment of, and on-going support for, the Ranger program and its implementation of the provisions of HAR Chapter 20-26 fully implement this measure.

As described in Section 3.1.7, the Rangers are present year-round from 7:15 am to 10:00 pm daily, monitor activities, help educate people about Maunakea, pick up trash, address public safety and provide first aid, assist in the coordination with County of Hawai'i emergency responders in search and rescue efforts,²³ and perform other tasks. Twice annually the Rangers conduct inspections of the summit and Halepōhaku facilities for compliance with their Conservation District use permits.

Various provisions of the UH Maunakea Rules are particularly germane to the enforcement aspects of this CMP recommendation. For example, HAR § 20-26-73(a) provides that "[a]n authorized agent, law enforcement officer, or the president shall impose...sanctions for violations of these rules or permits issued pursuant to these rules." Likewise, HAR § 20-26-74 provides that "[a]n authorized agent or law enforcement officer has the power(s) to issue a citation for any violation of the provisions of this chapter."²⁴

3.4.2.4 ACT-4: Establish/Enforce Policy and Regulations Prohibiting Off-Road Vehicle Use

The CMP calls attention to the fact that off-road vehicle use has the potential to irreversibly damage cultural and natural resources and calls for their prohibition except on roads or trails and in parking areas specifically designated for their use. Recognizing that successful implementation of this prohibition will require a significant educational effort, it calls for the off-road vehicle policy for the UH Management Areas to be advertised widely and for UH to coordinate closely with DLNR to ensure that all off-road vehicle users of the adjacent land areas (Natural Area Reserve and Forest Reserve) are informed of the policy.

In full alignment with this provision of the CMP, HAR § 20-26-28 generally prohibits driving, operating, or using any motorized or non-motorized vehicles in areas not specifically designated for that purpose. This prohibition is explicitly called out on all permits and other authorizations that UH issues for travel on its managed lands above Halepōhaku. It is also displayed prominently in printed material distributed at the VIS and on the CMS website.

²³ DOCARE officers and Hawai'i County Police are called for assistance on an as-needed basis.

²⁴ The UH Maunakea Rules define "Authorized agent" as a person, persons, or entity authorized by the president, to act on the president's behalf under this chapter.

CMS' educational efforts, the presence of the Maunakea Rangers, and the authority that the adoption of HAR Chapter 20-26 gives UH to enforce the prohibition on unauthorized off-road vehicle use has greatly reduced the incidence of off-road vehicle use. Failure to comply with the UH Maunakea Rules may result in penalties, as provided for in HAR § 20-26-73 and § 20-26-74.

3.4.2.5 ACT-5: Implement Policies to Reduce Impacts of Recreational Hiking

The CMP calls on UH to keep a well-maintained trail network as a means of minimizing the development of new, unwanted trails by individuals and groups. It recommends that any proposal for the creation of a new, formalized trail or substantial alteration of an existing route be subject to review by SHPD.²⁵ The CMP also calls for UH to delineate the trail network on maps that it makes available to the public, to mark the trails with signs, and to assign members of the Rangers to patrol them. It recommends that hikers be asked to self-register at the VIS, be provided with maps, and informed that hiking off trail is prohibited and about safety concerns, including that hiking alone at high elevations is dangerous and discouraged. Finally, the CMP calls for all unwanted trails to be removed and the terrain restored insofar as is practical.

UH has taken a number of actions to fully implement this measure. HAR § 20-26-21(10) specifically prohibits hiking, conducting nature study, or conducting any activity on pu'u unless on designated trails or roads, except by written permit. HAR § 20-26-28(2) prohibits "[d]riving, operating, or using any motorized or non-motorized vehicle in areas and on roads or trails unless designated for that use." In addition, UH:

- Always consults with the SHPD when considering the possible creation of a new, formalized trail or substantial alteration of an existing route.
- Has prepared a map delineating trails within the UH Management Areas and makes it available at no charge to the public both at the VIS and on-line.
- Has marked trailheads with informational and warning signs.
- Assigns Rangers to patrol trails on an as-needed basis.
- Encourages hikers to self-register at the VIS, provides them with maps, and distributes materials informing hikers that hiking off trail is prohibited and about safety concerns, including that hiking alone at high elevations is dangerous and discouraged. Table 3.10 summarizes the number of hikers observed by the Rangers.

While UH has posted signs discouraging use of some existing trails (e.g., trails to the summit of Poli'ahu and to Kūkahau'ula the highest point on Maunakea), it has not removed those trails and they continue to be used.

3.4.2.6 ACT-6: Regulate Snow Play

The CMP recognizes the public's desire for limited public access to the summit for "snow play" (which it defines as skiing, sledding, snowboarding or other recreational activities involving snow). The CMP recommends that areas suitable for snow-play be designated on maps, using temporary signs, or through directions given by Rangers. It further calls for the monitoring of

²⁵Actions of this sort are also subject to Chapter 343, HRS and the implementing environmental regulations (HAR 11-200).

areas that are used for snow play for adverse effects once the snow is gone. Finally, the CMP calls for snow-play activities to be confined to areas with a layer of snow deep enough to provide protection to resources.

The Rangers maintain a constant presence on the summit region during periods when snow may attract the public and the Mauna Kea Access Road is open. They generally perform several functions to improve safety, including:

- Warning persons who appear likely to engage in activities that will be dangerous to themselves, others, or to the mountain's cultural or natural resources when they believe such a warning is appropriate.
- Directing people to areas where snow is deepest.
- Establishing one-way traffic flow on the summit loop road so that vehicles are able to move safely when the designated parking areas are full and many cars are parked along the sides of the roadway.
- Cleaning up the trash and garbage that is invariably left behind.

CMS is working on additional measures to address this management action, including temporary signage.

With the adoption of the UH Maunakea Rules, UH is in a position to better manage this activity. Specifically, HAR § 20-26-39 provides UH authority to restrict and/or prohibit skiing, snowboarding, sledding and other similar winter or snow sports to maintain public safety and welfare, to prevent damage to resources, and to minimize conflicts among visitors. It also prohibits formally or informally organized contests, meets, or competitions, snow play tours, or other similar events for skiing, snowboarding, sledding or other forms of snow recreation or snow activities and the operation of snowmobiles, all-terrain vehicles, or other motorized vehicle used for snow recreation. Citations may also be issued for vehicles not parked in designated areas under HAR § 20-26-28(4).

3.4.2.7 ACT-7: Confine Commercial Activities to Limited Areas

The CMP calls on UH to confine tours and stargazing activities to previously disturbed ground surfaces and established parking areas. As discussed below, UH has complied and continues to comply fully with this management action.

HAR Chapter 20-26 contains regulations governing all aspects of commercial tour activities on UH Management Areas.²⁶ HAR § 20-26-61(3) authorizes the issuance of permits for commercial tour activity. HAR § 20-26-64 authorizes UH to issue permits allowing entities to conduct commercial tours or transport passengers for hire within the UH Management Areas. HAR § 20-26-64(c) requires that each commercial tour permit application be evaluated for its: (i) compatibility with the functions and purpose of UH Management Areas; (ii) consistency with existing approved management plans; (iii) potential effect on the surrounding resources, the

²⁶ The regulations state: "Commercial tours" means the transport of people for compensation for the purpose of engaging in public activities within the UH Management Areas, including but not limited to transport by cars, sport utility vehicles, trucks, taxis, vans or buses.

existing facilities and infrastructure, and the public's use of the UH Management Areas; (iv) compatibility with existing approved uses; (v) compatibility with scheduled or ongoing construction, repairs, or maintenance activities; (vi) the applicant's prior record of non-compliance with permit conditions, or of violations; and (vii) the quality of the educational aspects of the activity, the comprehensiveness of planned staff training, the inclusion of safety protocols, and the extent to which additional practices are incorporated to ensure customer and public safety and welfare and to protect the resources of the UH Management Areas.

HAR § 20-26-64 gives UH considerable flexibility in the way that it manages commercial tour activities. Specifically, it provides that this may be done through issuance of one or more concession agreements in lieu of, or in addition to, commercial tour activity permits. It also allows for UH to enter into an agreement with another public agency to manage commercial tour activities and transportation of passengers for hire within the UH Management Areas. Such agreements may be in lieu of, or in addition to, written permits or concession agreements for such purposes. Finally, it allows fees to be charged and for the imposition of whatever terms and conditions are necessary or appropriate to reduce congestion, protect the resources of the UH Management Areas, and protect safety and welfare.

UH limits commercial star gazing activities to: (i) designated parking areas along the Mauna Kea Access Road above Halepōhaku and (ii) previously disturbed areas within Halepōhaku that are suitable to star-gazing.

3.4.2.8 ACT-8: Coordinate with DLNR Regarding Hunting Policy

This measure in the CMP requires UH to work with DLNR to establish a clear policy regarding recreational hunting within the UH Management Areas. As outlined below, UH has, through its UH Maunakea Rules, codified the hunting policy on the UH Management Areas and ensured that hunting rights are preserved there.

HAR § 20-26-3, which addresses the general applicability of UH's rules, states (in subsection (c)):

“Where overlapping jurisdictions within UH management areas are present, including but not limited to department of land and natural resources administrative rules pertaining to conservation districts, forest reserves, historic preservation, hunting [emphasis added], and natural area reserves, those rules shall govern.”

Subsection (d) further states that the rules will be implemented in such a way as to allow hunting in accordance with DLNR's hunting rules. Complementary assurances regarding hunting are provided elsewhere in the regulations [see, for example, HAR § 20-26-4; HAR § 20-26-21(8); HAR § 20-26-27; HAR § 20-26-32; and HAR § 20-26-38(c)].

3.4.2.9 ACT-9: Oversee Commercial Tour Permitting Process

The CMP calls on UH to review the commercial tour permitting process at regular intervals to determine any changes that should be made in view of relevant information relating to permit violations or impacts to cultural and natural resources. It also recommends that commercial tour permits include a requirement for an orientation and for University review and approval of brochures and/or maps distributed by commercial operators. Finally, it recommends that

commercial permit funds collected continue to be deposited into a revolving fund²⁷ used to support management of the mountain.

As discussed elsewhere in this OAR (e.g., Section 3.4.2.7), UH maintains close oversight and control of the commercial tour permitting process. Specific requirements are spelled out in HAR § 20-26-64, entitled “Commercial tour activity permits.” Accordingly, UH is continuing to comply fully with this measure.

In collaboration with UH Mānoa’s School of Travel Industry Management, in 2019 UH initiated a study intended to assess the capacity for commercial tour operations and public visitation on the UH Management Areas and assess reasonable fees. Unfortunately, data collection efforts have been hampered by road blockades associated with demonstrations against the TMT project and imposed travel limitations in response to the COVID-19 pandemic. Because of this, no results or information are yet available. However, UH expects data on future conditions will provide valuable insights to guide changes, if any, to the commercial tour permitting process to address impacts.

3.4.2.10 *ACT-10: Advise Regarding Film Permits*

The CMP stipulates that UH be provided an opportunity to review all applications for film permits on Maunakea that are initiated through the State of Hawai‘i Film Office. As discussed below, UH has established and is continuing to implement procedures that are consistent with this mandate.

As provided for in HAR § 20-26-65, commercial video, digital, film, still photography, or any other visual and audio recordings may not be taken within the UH Management Areas without a written permit issued by the State Department of Business, Economic Development and Tourism Hawai‘i Film Office. All film permits must be reviewed by UH before they are issued, and UH is authorized to recommend approval or denial of each permit application,²⁸ may require specific conditions, and may request fees, insurance, performance bonds, or deposits to cover administrative and personnel expenses or potential damages to resources associated with the proposed activity. However, ultimate authority remains at DBEDT’s Hawai‘i Film Office.

3.4.2.11 *ACT-11: Seek Statutory Authority to Regulate Commercial Activities*

At the time the CMP was adopted, UH had no express statutory or regulatory authority to issue permits for commercial activities, and the CMP’s authors observed that statutory amendments allowing UH to control these activities in a manner consistent with this CMP would be beneficial. The CMP notes that a wide variety of commercial activities had been proposed over the years, including concessions, resource extraction, and special events. It recommended that special one-time or yearly events (e.g., conferences, cultural festivals or other permitted organized gatherings) be required to obtain a permit limiting the number of participants, fees, and other conditions imposed on daily commercial operators such as insurance requirements. It also concluded that fees generated from commercial projects, such as one-time events, be deposited into the fund used

²⁷ The CMP uses the term “revolving fund.” The funds are deposited into the Mauna Kea lands management special fund established in HRS § 304A-2170.

²⁸ Film permit applications are submitted to the State of Hawai‘i Film Office. That office informs the University of all requests to film within the UH Management Areas. The University makes its recommendations to the Film Office, and then that office makes its determination.

to support management of the mountain and recommended that requests for commercial activities permits be subject to review and approval by UH and DLNR. Other CMP recommendations were that: (i) commercial events expected to draw a large number of visitors or that would be ongoing be subject to community input; (ii) cultural- and eco-tours be subject to the same conditions as required for commercial tours; and (iii) cultural tour operators be required to consult with Kahu Kū Mauna and SHPD to determine which sites are appropriate for visitation. Finally, the CMP recommends that Commercial permits not be granted for snow-play tours, ski meets, or any snow-play events.

Some of these recommendations may be allowed under HAR § 20-26-63, entitled “Special use permits.” SUPs may be issued to allow activities otherwise prohibited by the UH Maunakea Rules. Such activities may be allowed if they are compatible with the functions and purpose of the UH Management Areas and consistent with approved management plans. UH is required to evaluate each special use permit application for such things as: (i) compatibility with the functions and purpose of the UH Management Areas; (ii) consistency with existing approved management plans; (iii) potential effect on the surrounding resources, the existing facilities, and the public's use of the UH Management Areas; (iv) compatibility with existing approved uses; (v) for compatibility with scheduled or ongoing construction, repairs, or maintenance activities; and (vi) the applicant's prior record of non-compliance with permit conditions, or of violations. Issuance of a permit requires the payment of fees that are set in accordance with HAR § 20-26-6 and compliance with additional terms and conditions UH deems necessary to protect the resources of the UH Management Areas and to protect safety and welfare.

3.4.2.12 ACT-12: Oversee Research Permits

Section 7.2.1 of the CMP states the following regarding 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 OMKM's 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.

In accordance with this guidance, OMKM has sought and CMS is continuing to seek input from all relevant parties on all requests for scientific research permits within the UH Management Areas. They have also worked to ensure that: SHPD and Kahu Kū Mauna are consulted, as appropriate, whenever research is proposed near known historical or cultural sites. OMKM has typically recommended project-specific conditions it believes should be included in those research project permits that are issued, and CMS presently anticipates continuing that practice.

In general, research permit conditions are intended to help ensure that activities are properly regulated and monitored for any type of disturbance and incidental take or damage. They also provide a means of ensuring that all permits relating to the study of cultural, archaeological or natural resources contain a condition requiring that the results be reported to UH for inclusion in its database and/or to establish/update existing condition/baseline information. In deciding whether to approve research requests, UH considers the extent to which the results will contribute to improved management decisions, address existing data gaps, and further the objective of protecting natural and cultural resources. It also considers the extent to which the proposed activity is in accord with the CMP and the Conservation District rules.

In its decision-making regarding requests for research permits, UH attempts to ensure that the research is conducted in such a way as to have minimal impact on cultural and natural resources, avoiding insofar as practical: (i) inadvertent alteration of shrines, other archaeological sites, or burial sites; (ii) alteration of the landscape by installing permanent equipment or instruments; (iii) visual intrusion by installed equipment or instruments in the historic district; (iv) habitat disturbance through access and sampling; and (v) the potential for introduction or spread of invasive species. It insists that researchers use best practices to minimize negative effects on cultural, archaeological and natural resources, and it seeks to protect astronomical research by requiring those who are granted permits to control dust and light emissions near the summit. Finally, UH does not allow the use of equipment or instruments that emit radio or sound waves unless special permission is granted after consultation with IfA and the observatories.

The UH Maunakea Rules fully implements the kinds of oversight over research that the CMP calls for. Specifically, HAR § 20-26-62, entitled “Research permits,” allows UH to issue research permits to parties wishing to engage in scientific, educational, or management purposes. It requires that applications for research permits adequately describe the planned research activity (including but not limited to the scope, duration, and location of the research) and be submitted at least 120 calendar days in advance of the date the permit is to be in effect. Applications for research permits are evaluated to confirm that: (i) they do not duplicate existing or previously approved research; (ii) they are compatible with the functions and purpose of the UH Management Areas and consistent with existing approved management plans; (iii) do not have undue adverse effect on the

surrounding resources, existing facilities, and/or the public's use of the UH Management Areas; and (iv) are compatible with existing approved uses.

Where appropriate, researchers are required to seek the advice of the MKMB and the Kahu Ku Mauna. As required for any activity conducted under the UH Maunakea Rules, research permittees are prohibited from abridging Native Hawaiian traditional and customary rights as recognized and protected under article XII, section 7, of the Hawai'i State Constitution.

3.4.3 ADDITIONAL MEASURES RELATED TO ACTIVITIES AND USES

No need for additional measures related to activities and uses has been identified.

3.5 PERMITTING AND ENFORCEMENT

3.5.1 PROVISIONS OF THE CMP REGARDING PERMITTING AND ENFORCEMENT

Section 7.2.2 of the CMP addresses the permitting and enforcement that is needed to be proper stewards of Maunakea. Noting that successful stewardship will come, in part, from balancing development and public access with the enforcement of rules, it highlights the importance of UH establishing rule-making authority. The UH Maunakea Rules were adopted by the BOR on November 6, 2019, and approved by the governor on January 13, 2020.

The “desired outcome” that the CMP seeks to achieve with respect to permitting and enforcement is as follows:

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.

The CMP observes that the UH Management Areas are designated part of the Resource Subzone of the State Conservation District. As such, “land use” as that term is defined under HAR Chapter 13-5 is regulated DLNR. Consequently, any land uses in the Conservation District requires a permit or approval from OCCL, DLNR, or BLNR. In certain cases, a management plan is required as well as part of the permit approval process.

UH is responsible for monitoring activities and uses within the UH Management Areas under terms of its Master Lease, conditions imposed by several CDUPs issued to UH as applicant for land uses in the area, and the implementation mechanisms of the UH Maunakea Rules. The astronomy facility operators are responsible to UH for compliance with their respective sublease agreements and operating agreements, compliance with the terms of applicable CDUPs, and compliance with UH Maunakea Rules when engaged in public or commercial activities outside of its subleased area. UH monitors the activities of its sublessees for compliance.²⁹ DLNR has ultimate authority over the Conservation District and is responsible for enforcing Conservation District Use regulations and CDUP terms on Maunakea. Monitoring of historic sites during construction or maintenance may be required as determined by DLNR.

²⁹ On behalf of the University, OMKM, now CMS, has been designated the entity responsible for monitoring holders of CDUPs, and twice a year, Rangers inspect each observatory for compliance with its CDUP.

State and County personnel are alerted to potential violations by on-mountain personnel, principally the Rangers. As discussed elsewhere in this OAR, the Rangers monitor activity in the summit region, inform visitors of rules and appropriate behavior, and assist with visitor safety. Although the Rangers do not have law enforcement authority, they do have authority to issue citations and impose other non-criminal civil remedies under the UH Maunakea Rules. Their presence and their firm but positive behavior deters vandalism and promotes adherence to rules.

BLNR, DLNR's Natural Area Reserve System (DOFAW-NARS), and UH have entered into a cooperative agreement for the Rangers to provide certain assistance with respect to the Maunakea Ice Age Natural Area Reserve which is located outside UH Management Areas and is not subject to the UH Maunakea Rules and the CMP. Under the agreement, DOFAW-NARS is primarily responsible for land management within the NAR and the Rangers provide an on-site presence at the summit, disseminate information about the NAR to visitors, and report illegal activities. The agreement also addresses cooperative research and management of natural and cultural resources.

UH issues permits for a variety of activities as provided for in HAR Chapter 20-26. These include research activities, special uses, commercial tour activity, and commercial film and recordings. The details of this are discussed elsewhere in this OAR. As provided in § 20-26-74, Rangers have the power to issue citations for violations under the UH Maunakea Rules. The UH Maunakea Rules provide for civil penalties and other sanctions and an appeal process.

In discussing the need for additional measures related to Permitting and Enforcement, the CMP stressed the need for UH to adopt its own rules and regulations. As noted above, the formal BOR adoption and governor's approval of HAR Chapter 20-26 fully implements that recommendation.

Table 7-10 in the CMP identifies eight "management actions" to address the needs related to permitting and enforcement. Those actions, and the extent to which they have been completed, are listed in Table 3.14. Their status is described in detail in Section 3.5.2.

Table 3.14 Status of Management Actions Related to Permitting and Enforcement

Measure	LAWS AND REGULATIONS	Status	Discussion
P-1	Comply with all applicable federal, state, and local laws, regulations, and permit conditions related to activities in the UH Management Areas.	Ongoing	3.5.2.1
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.	Ongoing	3.5.2.2
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.	Complete	3.5.2.3
P-4	Educate management staff and users of the mountain about all applicable rules and permit requirements.	Ongoing	3.5.2.4
ENFORCEMENT			
P-5	Continue coordinating with other agencies on enforcement needs.	Ongoing	3.5.2.5
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.	Complete	3.5.2.6
P-7	Develop and implement protocol for oversight and compliance with Conservation District Use Permits.	Ongoing	3.5.2.7
P-8	Enforce conditions contained in commercial and Special Use permits.	Ongoing	3.5.2.8

Source: Table 7-10, CMP.

3.5.2 STATUS OF MEASURES RELATED TO PERMITTING AND ENFORCEMENT

3.5.2.1 P-1: Comply with Applicable Laws, Regulations, and Permit Conditions

Compliance with applicable statutes and regulations is the responsibility of everyone who comes to Maunakea. Like anywhere in the state, various statutes and regulations may apply to a person or entity depending on the acts conducted by that person or entity. Examples include the following (primary enforcement entities indicated in parentheses):

- HAR Chapter 20-26, “Public and Commercial Activities on Mauna Kea Lands” (University of Hawai‘i).
- HAR Chapter 13-5, “Conservation District Rules” (DOCARE).
- HRS § 701-100, et seq., “Hawai‘i Penal Code” (law enforcement officers).
- HRS Chapter 6E, “Historic Preservation” (DOCARE).

When an agency issues permits under its administrative rules, those permits often include conditions of approval. Failure to comply with those conditions can result in penalties and/or permit revocation.

BLNR or DLNR has issued numerous Conservation District Use Permits or approvals for specific land uses on Maunakea. To ensure compliance with the conditions of these permits, OMKM has historically conducted biannual inspections of all facilities within the UH Management Areas, and CMS has now assumed responsibility for that task. CMS maintains files of facility inspection reports and respective follow-up letters. OMKM was (and now CMS is) in regular contact with DLNR regarding compliance matters. CMS consults with DLNR regarding land uses that may require permits or other approvals since all the UH Management Areas are within the Conservation District.

Coordination also occurs with local law enforcement officers such as the Hawai‘i County Police Department, DOCARE, and the State Sheriff’s Office when assistance is required for matters that appear to fall within their respective jurisdictions. For example, OMKM works with DOCARE when unpermitted commercial activities are observed on adjacent lands under the jurisdiction of DLNR. Also, Rangers coordinate with the Hawai‘i County Police Department when criminal activities such as theft are observed or suspected.

3.5.2.2 P-2: Encourage DLNR to Require Compliance with CMP be a CDUP Condition

UH has, and is continuing, to implement this provision of the CMP. Specifically:

- CMS requires project proposals to include a summary and/or plan of how the proposer would comply with CMP action items relevant to the proposal.
- Since the CMP was adopted, several CDUPs have been issued to UH for projects proposed by UH and by other entities. In all cases OMKM advocated that compliance with the CMP be made a condition of approval.

3.5.2.3 P-3: Obtain Rule-Making Authority

The 2009 State Legislature granted UH authority to promulgate administrative rules governing the Maunakea Management Areas when it adopted Act 132. UH exercised this authority when it formally adopted HAR Chapter 20-26, which was approved by the Governor on January 13, 2020, and became effective on January 23, 2020.

3.5.2.4 P-4: Promote User-Awareness Regarding Applicable Rules & Permit Requirements

All University personnel with the authority to make significant decisions concerning activities on Maunakea are informed of the rules and permit requirements applicable to their areas of responsibility. Similarly, UH provides an overview and detailed information regarding Maunakea-specific rules, including HAR Chapter 20-26, to sub-lessees and other personnel at every new-project start-up meetings.

3.5.2.5 P-5: Coordinate Enforcement Efforts with Other Agencies

As specified in this measure, UH actively coordinates with other agencies regarding enforcement of the rules and regulations that are applicable within the UH Management Areas and on immediately adjacent lands. It is continuing to work with them to achieve coordinated and consistent policies for access and use. Importantly, this coordination includes entering into a cooperative agreement with DOFAW relating to the Mauna Kea Ice Age NAR.

UH coordinates its enforcement activities and shares Ranger reports with other entities (e.g., NAR, DOFAW, DOCARE, U.S. Army Installation Management Command/Pōhakuloa Training Area, and the U.S. Fish & Wildlife Service) as it deems appropriate.

3.5.2.6 P-6: Establish Law Enforcement Presence

Noting that effective enforcement is an essential component in obtaining compliance and compliance is needed to protect resources and manage public activity and safety, this measure calls upon UH to obtain legislative authority for establishing administrative rules and then establishing a law enforcement presence on the mountain that can enforce the rules that are adopted.³⁰ The adoption of Act 132 in 2009 provided the prerequisite legal authority for UH to adopt and enforce administrative rules within the UH Management Areas. UH subsequently adopted HAR Chapter 20-26, entitled “Public and Commercial Activities on Mauna Kea Lands,” on November 6, 2019, which the governor approved on January 13, 2020. UH enforces these rules through its president and her/his designees within the UH system. The president may also seek the assistance of authorized agents or law enforcement officers for enforcing the rules.

Act 132 required the rules to establish violations, penalties, costs, administrative fines, and sanctions, which are enumerated under HAR § 20-26-73 and Exhibit A attached to the rules. Here is a brief summary of those provisions:

³⁰ Under the Hawaii Penal Code, “law enforcement officer” is defined as “any public servant, whether employed by the State or county or by the United States, vested by law with a duty to maintain public order or, to make arrests for offenses or to enforce the criminal laws, whether that duty extends to all offenses or is limited to a specific class of offenses.” See HRS § 701-118. Rangers do not have “law enforcement” authority; however, they do have authority to enforce the UH Maunakea Rules through citations that impose civil violations, penalties, costs, administrative fines, and sanctions.

- HAR § 20-26-71 governs UH's practices and procedures relating to civil violations of the rules and the assessment of administrative sanctions for such violations.
- HAR § 20-26-72 provides that civil penalties imposed under the UH Administrative Rules are separate from civil or criminal penalties imposed under other laws by other agencies or governmental entities.
- HAR § 20-26-73 lists penalties, costs, administrative fines, and sanctions that may be imposed under the rules. These include: (i) immediate expulsion from the UH Management Areas; (ii) exclusion from the UH Management Areas until the violation has been corrected; (iii) an administrative fine; (iv) a monetary assessment to recover costs of mitigation or restoration required as a result of the violation and to recover the costs of enforcement proceedings; (v) revocation or suspension of a permit; and (vi) imposition of additional permit conditions.
- HAR § 20-26-74 describes the nature of the citations that may be issued for violation of the rules.

The rules also provide for an appeals process under HAR § 20-26-75.

3.5.2.7 P-7: Oversee Compliance with Conservation District Use Permit Conditions

This measure recommends that UH establish and enforce a permit and sublease monitoring system to promote responsible stewardship, prevent damage to Maunakea, and report infractions to DLNR. In accordance with this provision of the CMP, UH has developed a protocol for the Rangers to conduct biennial inspections of all of the facilities within the UH Management Areas for which CDUPs have been issued. The purpose of the inspections is to confirm that all permit conditions are being met. It has, and will continue, to submit the results of these inspections to the DLNR as part of its annual reporting. Hence, it is fully implementing this measure.

3.5.2.8 P-8: Enforce Commercial and Special Permit Conditions

The Rangers monitor activities on the UH Management Areas on a daily basis. They record pertinent data regarding the number and behavior of commercial tour operators and their clients and provide real-time feedback to operators when they observe activity that appears to be inappropriate. In addition, as discussed in the preceding section of this OAR, twice annually the Rangers inspect facilities at the summit and Halepōhaku that have a Conservation District Use Permit and prepare reports regarding their findings regarding the status of compliance with the permit conditions.

3.5.3 ADDITIONAL MEASURES RELATED TO PERMITTING AND ENFORCEMENT

No need for additional measures related to permitting and enforcement have been identified.

3.6 INFRASTRUCTURE AND MAINTENANCE

3.6.1 PROVISIONS OF THE CMP REGARDING INFRASTRUCTURE AND MAINTENANCE

Section 7.3.1 of the CMP provides management recommendations concerning the maintenance needs of the existing infrastructure and other components of the built environment.³¹ Activities to maintain infrastructure are on-going, so minimizing the impact to resources from maintenance activities is essential.

The “desired outcome” that the CMP seeks to achieve with respect to managing the built environment is as follows:

*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.*³²

The maintenance actions that were the focus of the CMP recommendations range from basic tasks (e.g., painting buildings) to more complex and involved tasks (e.g., installing, operating, and maintaining septic tanks and keeping the roadways in serviceable condition).

In discussing the need to minimize the impacts of maintenance actions required to keep facilities operating and in compliance with their permits, the CMP noted the importance of UH working closely with the observatories to identify strategies and protocols that reduce impacts to resources associated with infrastructure and maintenance practices. It emphasized that educational efforts targeted at maintenance staff and astronomy 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. Finally, the CMP made it clear that while the observatories themselves are legally required to comply with terms of their permits, OMKM/CMS has a shared responsibility for helping ensure that: (i) CDUP conditions are met (see Section 7.2.2); (ii) operational and maintenance activities are compliant with applicable historic preservation review requirements set forth by SHPD; and (iii) facilities comply with all applicable regulations pertaining to wastewater disposal and management of hazardous materials.

Table 7-11 in the CMP identifies 14 “management actions” to address the infrastructure and maintenance needs that it had identified. Those actions, and the extent to which they have been completed, are listed in Table 3.15. Their status is described in detail in Section 3.6.2.

Table 3.15 Status of Management Actions Related to Infrastructure and Maintenance

Measure	Description	Status	Discussion
ROUTINE MAINTENANCE			
IM-1	Develop and implement an OMMP.	Complete/ Ongoing	3.6.2.1

³¹ The infrastructure of the UH Management Areas includes observatories, support facilities, and associated support elements (e.g., roadways, electric power supply, communications network).

³² 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.

Measure	Description	Status	Discussion
IM-2	Reduce impacts from operations and maintenance activities by educating personnel about Maunakea's unique resources.	Ongoing	3.6.2.2
IM-3	Conduct historic preservation review for maintenance activities that will have an adverse effect on historic properties.	Ongoing	3.6.2.3
IM-4	Evaluate need for and feasibility of a vehicle wash station near Halepōhaku, and requiring that vehicles be cleaned.	Complete/ Ongoing	3.6.2.4
IM-5	Develop and implement a Debris Removal, Monitoring and Prevention Plan.	Ongoing	3.6.2.5
IM-6	Develop and implement an erosion inventory and assessment plan.	Ongoing	3.6.2.6
IM-7	Prepare a plan, in collaboration with the Department of Defense, to remove military wreckage from an area of the UH Management Areas, while ensuring protection of natural and cultural resources.	Ongoing	3.6.2.7
INFRASTRUCTURE			
IM-8	Assess feasibility of paving the Mauna Kea Access Road.	Complete/ Ongoing	3.6.2.8
IM-9	Evaluate need for additional parking lots and vehicle pullouts and install if necessary.	Ongoing	3.6.2.9
IM-10	Evaluate need for additional public restroom facilities in the summit region and at Halepōhaku, and install close-contained zero waste systems if necessary.	Ongoing	3.6.2.10
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.	Ongoing	3.6.2.11
IM-12	Conduct energy audits to identify energy use and system inefficiencies, and develop solutions to reduce energy usage.	Ongoing	3.6.2.12
IM-13	Conduct feasibility assessment, in consultation with Hawaii Electric Light Company, on developing locally-based alternative energy sources.	Ongoing	3.6.2.13
IM-14	Encourage observatories to investigate options to reduce the use of hazardous materials in astronomy operations.	Ongoing	3.6.2.14
Note: A status of "Completed/Ongoing" means that the needed procedures and systems have been completed and are being implemented on an ongoing basis. Source: Table 7-11, CMP.			

3.6.2 STATUS OF MEASURES RELATED TO INFRASTRUCTURE AND MAINTENANCE

3.6.2.1 IM-1: Develop and Implement an OMMP

As envisioned in the CMP, the purpose of an "Operations Monitoring and Maintenance Plan" (OMMP) is to identify maintenance needs, strategies, and protocols that minimize impacts to the resources, and ensure that permittees comply with the provisions of their CDUP, subleases, and other State of Hawai'i and Federal regulations including Conservation District Rules. The OMMP also serves as a reporting mechanism documenting implementation of CMP management actions.

UH completed its OMMP for Maunakea in 2017 and has implemented it since that time. Consistent with the adopted OMMP and in accordance with its provisions, each astronomy facility and MKSS annually submit descriptions of projects and activities they anticipate undertaking over the coming five years. These "5-year outlook" submittals describe all activities that involve: (i) the alteration or modification of the exterior of a facility; (ii) interior projects with exterior impacts;

(iii) the outdoor storage of materials for more than 30 days; or (iv) the use of heavy equipment.³³ The level of review that operations and maintenance projects receive depends upon how they are classified (i.e., as either “Minimal Impact or Routine Activities” or “In-Depth Consultation”).

Monitoring is accomplished through CMS’s project approval and tracking, daily Ranger Activity Reporting, State permitting, and comparison of detailed project proposals with existing 5-year outlooks. Examples of the kinds of review and mitigation considerations that are being applied to proposals are presented in Table 3.16.

Table 3.16 Review and Mitigation Considerations

Minimal Impact/Routine Activities	
Environmental	Mitigation Considerations
Security Cameras	OMKM and the astronomy facility shall work with the MKSS Oversight Committee to ensure installed cameras are necessary, eliminate potential redundancy, comply w/policy, prior to submitting to MKMB.
Cloud/Sky Cameras	Same as security cameras
Weather masts, sensors & other environmental monitoring	Typically, sensors are only useful for astronomy observations and weather forecasting (but not suited for long-term climate monitoring). OMKM will work with observatories to maximize utility to the potential user community.
Facility Maintenance & Safety	Mitigation Considerations
Safety	Generally inconspicuous hardware or signs outside of buildings for fall protection, de-icing, alarms, etc.
Painting	Repainting with same color. Color change could entail in-depth consultation.
Dome Hardware	Repair or replace with like-to-like materials.
Renovations & Infrastructure	Mitigation Considerations
Resurface Concrete pads	Minimize color change to the extent possible.
Equipment movement & Mirror maintenance	No permanent land use.
Photovoltaic Systems	Reduce energy use.
Dome Vents	No substantive change in visible profile.
HVAC repair and renovations	No change in facility footprint.
Fiber Optic Conduit	No change in facility footprint.
Projects Requiring “In-Depth” Consultation	
Includes all “Upgrades”	Mitigation Considerations
CFHT renovation, including soils testing and UST removal	Major scientific upgrades and potential for visibility impacts, along with ground disturbance.
UH 2.2m renovation	Major maintenance and interior upgrades. Include laser astronomy and environmental instruments in consultation.
VIS & HP renovations	Improve public facilities, more clearly define limits for Astronomy Support and road maintenance purposes. Ground disturbance.
Consolidate storage at HP	Includes (potential for) ground disturbance.
VIS ingress/egress	Public access.
Slope Stabilization of Mauna Kea Access Road	Ground disturbance on pu‘u near the summit.
New or replaced pavement	Includes (potential for) ground disturbance.
Moving or Backfilling cinder	Includes ground disturbance.

³³ These plans do not cover work that is limited to the existing interior of a facility, or routine maintenance and replacement in-kind of outdoor items that otherwise would not require OMKM, State, or MKMB approval.

Projects Requiring “In-Depth” Consultation (cont’d)	
Septic or other Underground Tanks	Includes ground disturbance. Evaluate closed-system for liquid waste if updating septic system.
Electrical transformer relocation	Includes (potential for) ground disturbance.
Trail or parking delineation	Includes (potential for) ground disturbance.
New sign posts, gates, etc.	Includes (potential for) ground disturbance.
Decommissioning	Includes (potential for) ground disturbance.
Source: 2017 Operations, Monitoring, and Maintenance Plan	

3.6.2.2 IM-2: Reduce O&M Impacts by Educating Personnel about Unique Resources

As discussed in Section 3.2.2.1 and elsewhere in this OAR, UH has developed and requires all persons who are going to work in the UH Management Areas to complete an educational orientation. The program informs them of the unique nature of the resources and the kinds of behavior that they need to engage in to protect them. As a result of these efforts, operation and maintenance activities have not caused any known adverse effects on unique resources.

3.6.2.3 IM-3: Conduct Historic Preservation Review for O&M Activities

The CMP, which was approved by the State Historic Preservation Officer, notes that most daily activities and routine maintenance operations that take place within the UH Management Areas will not affect historic properties and need not be subject to historic preservation review. At the same time, it concludes that certain maintenance activities may require additional historic preservation review. Accordingly, it calls upon UH to develop, in consultation with DLNR, a list that distinguishes between maintenance actions that require no further historic review and those that do require historic review.

In fulfillment of this, UH and DLNR reached agreement on such a list, and UH has followed the appropriate review and consultation procedures for all of its O&M activities. CMS is using this list as guidance when it reviews activities by its sublessees and other entities that conduct operations within the UH Management Area. However, because sublessees generally conduct work only within areas that have already been disturbed, most such activities do not entail detailed review or consideration. This is discussed further in Section 3.6.2.1.

3.6.2.4 IM-4: Provide for Cleaning of Vehicles Proceeding above Halepōhaku

This measure calls for UH to evaluate the need for/feasibility of establishing a vehicle wash-station near Halepōhaku to prevent the transport of invasive plants and animals to higher elevations on the mountain where they do not presently exist. Such a wash station would allow UH to reduce the potential for inadvertent introductions as a result of activities within the UH Management Areas.

In accordance with this measure, in 2015 UH initiated a study to evaluate measures to prevent the introduction of invasive species, in particular the inspections of vehicles and equipment. This included an analysis of the feasibility of a vehicle washing facility as a means of helping to prevent the introduction of invasive species. This study concluded in early 2018 and provides management-specific recommendations as part of a MS thesis (Zarders, 2018).

As part of its Invasive Species control efforts, UH developed a set of standard operating procedures (SOPs) regarding the cleaning of vehicles and personal belongings (Version 1.3, 2/4/2016, Jessica

Kirkpatrick, Fritz Klasner, & Darcy Yogi) [http://www.malamamaunakea.org/uploads/environment/MKISMP/SOP01_CleaningofVehiclesPersonalBelongings.pdf] that apply to the passengers, vehicle operators, immediate personal possessions, and any vehicle operating under a permit within the UH Management Areas. The SOP requires that all vehicles entering the UH Management Areas must be cleaned and inspected by the operator, prior to arrival at the Saddle Road/Mauna Kea Access Road junction to ensure they are free of plant, animal, and earthen materials. It further requires that vehicles with three or more axles, vehicles kept in lots with irregular grounds-keeping, and equipment (i.e., motor vehicles without a highway license plate) be inspected by a DLNR-approved biologist. The objective of the cleaning/inspection is to remove any plant, animal, or earthen material (i.e., ants, soil, mud and food scraps), that might harbor invasive animals or plant seeds. If invasive species are found, the operator is required to stop, confine the invasive species, and immediately leave the UH Management Areas.

3.6.2.5 IM-5: Develop & Implement Debris Removal, Monitoring, and Prevention Plan

This measure recommends preparation of a *Debris Removal, Monitoring and Prevention Plan* to address fugitive trash, which could impact cultural resources directly, through impact, and indirectly, through clean-up activities. It calls for the plan to assign responsibilities for: regular trash maintenance (e.g., observatories: dumpsters, MKSS: trash receptacles, Rangers: fugitive trash); provide for the installation and operation of adequate, secured receptacles, including temporary receptacles during high-use periods; conduct of 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).

In accordance with this recommendation, OMKM/CMS has developed a draft *Debris Removal, Monitoring and Prevention Plan* that contains numerous procedures aimed at maintaining the UH Management Areas in a clean and orderly condition for resource protection. The expressed goals of the plan include: (i) identifying actions which would prevent the introduction of litter and debris; (ii) establishing standards for documenting and reporting efforts to monitor presence of litter and debris; (iii) articulating plans for removing debris when appropriate; (iv) educating staff and visitors about ways to prevent the introduction of litter and debris; and (v) minimizing impacts to historic properties, cultural sites, and native biota.

Some of the relevant Best Management Practices (BMP) measures in that plan that are designed to prevent litter and debris include: the use of secured receptacles; regular pickup of trash from dumpsters and trash receptacles; placement of extra receptacles during high-use periods; and post-snow inspection and pickup of trash and debris left behind after snow-melt. Consistent with the provisions of that plan, MKSS and/or contractors remove waste from the HP facilities and VIS on a daily basis. Each astronomy facility operator collects and stores solid waste generated by its activities and stores it on-site in containers that are protected from the elements. The stored material is collected as needed, generally every few days, and transported off-site to an approved disposal facility.

Rangers routinely look for and pick up the small amounts of trash and debris found along the roadside and in frequently used parking areas while on their daily patrols. Rangers also pick up

and map the location of trash found at the parking lot near the Lake Waiau trail head. They report that the amount of human waste and soiled paper they find decreased following the installation of a portable toilet.

3.6.2.6 IM-6: Develop and Implement Erosion Control Plan

OMKM partnered with the UH Hilo Geography Department to study surficial geology and cinder cone erosion issues. As indicated in its 2020 Annual Report to the BLNR, the targeted completion date for the study is 2021. Implementation of the erosion control will depend upon the findings outlined in the report and UH's ability to obtain funds needed to take recommended actions.

3.6.2.7 IM-7: Prepare Plan to Remove Military Wreckage

This component of the CMP calls for UH to prepare a plan, in collaboration with the U.S. Department of Defense (DoD), to remove military wreckage from the UH Management Areas, while ensuring protection of natural and cultural resources. As indicated in UH's 2020 status report to the BLNR, UH completed an inventory of all known military aircraft wreckage within the UH Management Areas and submitted it to the DoD. In collaboration with DoD, OMKM/CMS has prepared a Draft *Military Wreckage Removal Plan*. In addition to providing a detailed description of the wreckage that has been found, the plan identifies potential impacts to resources if wreckage is removed or remains. CMS anticipates finalizing the plan in consultation with DoD over the next year, subject to DoD priorities and resources. Once finalized, the plan will be submitted to the SHPD for review and approval before any action is taken.³⁴

3.6.2.8 IM-8: Paving Mauna Kea Access Road

The CMP notes the drawbacks that are associated with the fact that portions of the Mauna Kea Access Road remain unpaved. Accordingly, it recommends that the feasibility of paving it be evaluated based on known considerations related to: (i) safety; (ii) road maintenance costs (including direct costs, as well as indirect costs such as wear and tear on State vehicles); (iii) potential adverse environmental impacts from dust, cinder movement, and erosion; and (iv) the potential impacts from paving on natural and cultural resources.

The road paving issues discussed in the CMP are largely facility issues that are being considered in UH's new Maunakea Master Plan. UH has consulted with engineers, archaeologists, and other professionals and determined that it will not pursue paving the entire unpaved portion of the Mauna Kea Access Road at this time. Nevertheless, after carefully considering safety and road maintenance issues, UH continues to consider paving certain portion (e.g., the last/upper half mile) of the unpaved access road.

3.6.2.9 IM-9: Parking and Pullouts

Management measure IM-9 calls for an evaluation of the need for additional parking areas and pullouts and for the construction of such facilities that are found to be needed both at Halepōhaku and in the summit region. This recommendation resulted in a study of the need for additional

³⁴ Based on the information in the draft *Military Wreckage Removal Plan*, it is possible that SHPD may decide that some or all of the wreckage should remain in place.

visitor and employee parking at the VIS and the 2018-2019 construction of roadway and parking improvements in that area that have improved both the safety and maintainability of these facilities. No further study of the need for additional road pullouts has yet been conducted.

While recognizing that parking does become challenging in the summit region on high-use snow days, the authors of the CMP did not recommend the addition of formal visitor parking lots there. Instead, they suggested continuing the practice of establishing a one-way loop system to keep cars flowing during periods of high traffic, including high-use snow days. Finally, the CMP recommended that parking areas be designated by unobtrusive signs, temporary signs when needed, and on maps distributed to public users. Furthermore, identifying designated parking areas, roads, and trails for motorized or non-motorized vehicles is required to enforce HAR § 20-26-28.

The parking and pullout issues discussed in the CMP are largely facility issues that are being considered in UH's new Maunakea Master Plan. Relevant considerations covered in the CMP are being addressed as part of that planning process and subsequent project-specific planning.

3.6.2.10 IM-10: Evaluate Need for Restroom Facilities/Install as Needed

Recognizing the potential for pollution if substantial numbers of people congregate in areas with inadequate restroom facilities, management action IM-10 calls on UH to evaluate the need for additional public restroom facilities in the summit region and at Halepōhaku and to install close-contained zero waste systems in those locations if necessary. Because this is primarily a facility issue, it is being considered in the Master Plan and will be informed by access management facilities and procedures implemented, if any.

3.6.2.11 IM-11: Encourage Sustainable Technologies and Adherence to LEED Standards

This measure calls on UH to do its best to encourage existing and new facilities within the UH Management Areas to maximize their use of sustainable technologies, energy-efficient technologies, and LEED standards.

Few projects have been proposed within the UH Management Areas since the CMP was approved that involve the development of new land uses that could achieve a LEED certification. Nevertheless, through the design review process, OMKM encouraged existing and new facilities to maximize sustainability and energy efficiency. For example, the TMT project incorporated energy audits, waste minimization, zero-waste discharge, and other sustainable elements into its design and operation plan; Keck Observatory and Gemini Observatory installed photo-voltaic panels on the roofs of their support buildings; and UH installed photo-voltaic panels and water-saving fixtures at Halepōhaku.

In addition, since the adoption of the CMP, the UH System has adopted several policies that reinforce its commitment to sustainability in all its functions. These include BOR Policy RP 4.208 entitled "Sustainability Policy," effective as of May 21, 2015, and Executive Policy EP 4.202 entitled "System Sustainability."

3.6.2.12 IM-12: Conduct Energy Audits/Implement Changes to Reduce Energy Use

UH has conducted energy audits of all the facilities that it operates on Maunakea. As documented in the Office of the State Auditor July 2017 report entitled “*Follow-Up on Recommendations from Report No. 14-07, Follow-Up Audit of the Management of Mauna Kea and the Mauna Kea Science Reserve* (Report No. 17-06), UH has completed energy audits to identify energy use and system inefficiencies. It has used the information obtained through the audits to develop measures that reduce energy usage at its facilities on Maunakea. A prime example of this is the way that energy audits have been used as part of the photovoltaic system design process at Halepōhaku.

Many of the entities whose facilities are situated on astronomy sites (e.g., Gemini, Keck, and others) have also completed energy audits and have installed, or are in the process of installing, photovoltaic systems that provide self-generated electricity and modernizing equipment to reduce the amount of electrical energy needed to operate the facilities. In addition, the move by many to largely off-site control of operations means that far less energy is consumed transporting workers to and from their job sites.

3.6.2.13 IM-13: Assess Feasibility of Developing Alternative Energy Sources

After investigating the opportunities for developing alternate energy sources on Maunakea, MKSS installed a photovoltaic system at Halepōhaku. Additional energy conservation and sustainable generation possibilities are discussed by UHH, MKSS, and Observatories as opportunities arise. Astronomy facilities continue to add renewable energy sources (e.g., PV panels, solar hot water systems, etc.) as the opportunities arise.

3.6.2.14 IM-14: Encourage Observatories to Reduce Use of Hazardous Materials

The University encourage the managers of all astronomy facilities to minimize the use and presence of hazardous materials. For new facilities this begins with the concept of removing from the UH Management Areas all material (hazardous and otherwise) that they bring onto the mountain and disposing of it in a proper manner. As evidenced by the spill prevention and response plans that all of the facilities have prepared and are implementing, multiple safety measures and protocols are in place that: (i) reduce the potential for accidental spills of hazardous materials; (ii) maximize the speed with which leaks or spills that do occur can be detected (e.g., built-in leak detection systems, mandated daily inspections of equipment that handles hazardous materials), and (iii) require rigorous training of all personnel responsible for implementing each facility’s detailed Spill Prevention and Response Plan.

3.6.3 ADDITIONAL MEASURES RELATED TO INFRASTRUCTURE AND MAINTENANCE

No need for additional measures related to infrastructure and maintenance have been identified.

3.7 CONSTRUCTION GUIDELINES

3.7.1 PROVISIONS OF THE CMP REGARDING CONSTRUCTION GUIDELINES

Section 7.3.2 of the CMP provides information and management recommendations focused on minimizing the direct and indirect impacts that construction activities can have on resources. It

notes that such planning guidance and protocols are especially important since construction workers are often temporary, may be unfamiliar with the high-altitude alpine habitat that is present, are likely to be unfamiliar with the site, and have to conduct their activities over short durations, often under difficult conditions.

The “desired outcome” that the CMP seeks to achieve with respect to construction is as follows:

Minimize adverse impacts to resources during all phases of construction through use of innovative best management practices.

Whereas minor routine construction activities are addressed under the discussion of infrastructure and maintenance, this section focuses on construction activities associated with large projects, including new buildings, site recycling, demolition, and site restoration. The guidelines contained in this section of the CMP are intended to supplement and complement, not replace, guidelines and mandates in other governing approvals and requirements so that these issues are considered early in the planning and development process.³⁵

The CMP concluded that there was 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. It emphasized the importance of carefully observing the effects of activities undertaken during the construction phase of projects so that managers could gather information that would allow them to differentiate between processes and procedures that are working and those that are not.³⁶ It also called for this sort of information to be passed on to UH for inclusion in an ever-growing database on: (i) the status and condition of resources; (ii) the type and level of construction activities; and (iii) potential effects of these activities on cultural and natural resources. Finally, the CMP called for an independent monitor to report to UH on major construction projects to allow UH to be assured that construction activities are in full compliance with all of the conditions that have been imposed during the various approval processes.

Table 7-12 in the CMP identifies nine “management actions” related to construction guidelines. Those actions, and the extent to which they have been completed, are listed below in Table 3.17. The nature of the work that has been done for these measures is discussed below in Section 3.7.2.

Table 3.17 Status of Management Actions Related to Construction Guidelines

Measure	Description	Status	Discussion
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.	Ongoing	3.7.2.1
BEST MANAGEMENT PRACTICES			
C-2	Require use of Best Management Practices Plan for Construction Practices.	Ongoing	3.7.2.2

³⁵ For example, construction guidelines for activities permitted under a CDUP are promulgated by DLNR and may require an approved BMP plan or identify safeguards to protect resources prior to authorizing construction activities. Similarly, SHPD may require protection of cultural resources through a site-specific archaeological monitoring plan as required by SHPD. Similar guidelines and procedures may arise out of the University’s design review process.

³⁶ As an example, the CMP noted that ensuring that construction contractors transmit relevant information such as recorded data and field notes arising from their activities (e.g., soil boring log sheets with data on subsurface composition), is a low-cost method for data acquisition.

Measure	Description	Status	Discussion
C-3	Develop, prior to construction, a rock movement plan.	Ongoing	3.7.2.3
C-4	Require contractors to provide information from construction activities to OMKM for input into OMKM information databases.	Ongoing	3.7.2.4
C-5	Require on-site monitors (e.g., archaeologist, cultural resources specialist, entomologist) during construction, as determined by the appropriate agency.	Ongoing	3.7.2.5
C-6	Conduct required archaeological monitoring during construction projects per SHPD approved plan.	Ongoing	3.7.2.6
C-7	Education regarding historical and cultural significance.	Ongoing	3.7.2.7
C-8	Education regarding environment, ecology and natural resources.	Ongoing	3.7.2.8
C-9	Inspection of construction materials.	Ongoing	3.7.2.9

Source: Table 7-12, CMP.

3.7.2 STATUS OF MEASURES RELATED TO CONSTRUCTION GUIDELINES

3.7.2.1 C-1: Require Independent Construction Monitor

This measure requires that there be an independent on-site construction monitor (funded by the project) during all periods of construction (including, but not limited to, the delivery of construction materials to the site or to staging areas) whose duty is to oversee 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 UH.

Several CDUPs have been issued since the CMP was adopted, most for relatively small projects. However, two involved larger undertakings. One was for the improvements made to the VIS and other facilities at Halepōhaku; the other was for the TMT project. The Management Plans on which both those approvals, and others that involved ground disturbance, were predicated provide for an on-site construction monitor (selected by UH with the concurrence of DLNR) who has the authority to order that any or all construction activity cease if/when she/he believes that: (i) there has been a violation of the terms or conditions of the CDUP that warrants cessation of construction activities or (ii) continued construction activity will unduly harm natural or cultural resources.³⁷

3.7.2.2 C-2: Best Management Practices Plan for Construction Practices

This measure requires that each project have a “Best Management Practices Plan for Construction Practices” that covers a range of topics and incorporates sustainable practices. It also requires that the project proponent bear all costs of implementing the BMPs.³⁸

UH has required a Best Management Practices Plan for all construction projects that have been granted a CDUP since the CMP was adopted. It has also prepared a template for the required plan that can be used for future projects, whether initiated by UH or by others. The template incorporates all the protocols and other items referenced in the CMP.

³⁷ Persons designated as construction monitors must have experience and be knowledgeable in construction management and have completed the educational and training programs as provided in C-7 and C-8.

³⁸ The CMP calls on the BMPs to target such things as minimizing: (i) construction time; (ii) water use; (iii) traffic; (iv) use and transport of toxic materials; (v) disturbance to ground surface and dust generation; (vi) noise; and (vii) transport of invasive species. It recommends that as part of an adaptive management approach, the University should study past projects to learn which BMPs were most successful and to recommend that those measures and/or ones shown to have equal or greater effectiveness, to be used for future projects.

3.7.2.3 C-3: Rock Management Plan

Management action C-3 requires all new construction in the summit region, including new development or site demolition and restoration, that requires a CDUP and involves the movement of rock material to prepare a “rock management plan.” It further requires that excess excavated cinder be placed within the UH Management Areas after consultation with the SHPD and with the prior approval of the OMKM and the DLNR. Management action C-3 also stipulates that:

- Construction staging or storage areas within the UH Management Areas be confined to areas that have already developed, improved, or previously disturbed and that such use be coordinated with and be approved by UH and DLNR.
- The rock management plan: (i) identify the location and type of the source material; (ii) provide estimates of the volume of material to be moved; (iii) present a detailed description of the extraction and movement process (employing appropriate construction BMPs); and (iv) identify storage or disposal locations.
- Rock management plans for the summit area are to be based, in part, on a consideration of the following factors: (i) the source of material used for site restoration or, for potential new construction; (ii) the logistics of storing extracted material for future use; (iii) the cultural sensitivity of the rock material (e.g., use of non-summit material on the summit); (iv) the visual impacts of the extraction site, the stored material, and any restored site using rock material; (v) preventing the side-casting of cinder and other materials into wēkiu bug habitat; and (vi) the potential for transport of invasive species if rock material is moved to the summit from lower elevations.

UH is fully implementing this measure as it develops its own plans and reviews proposals from sublessees that involve the movement of rock material. It has ensured that DLNR is consulted to determine whether trained biologists and/or archaeologists need to be on site to monitor any impacts, real or potential, of construction activity on the wēkiu bug habitat or on archaeological or historical resources. All monitoring has been paid for by the individual project proponents.

3.7.2.4 C-4: Information/Documentation

This component of the CMP requires contractors to provide information from construction activities to UH for input into the informational database that UH maintains for its UH Management Areas. Required submittals include field logs, laboratory analyses, and other construction documents that contain information on the biotic and abiotic environmental variables encountered.

UH has been requiring contractors who perform work within the UH Management Areas to submit the required information, and it has maintained hard copy and/or electronic versions of that information in its files. UH has already digitized some of the hard copy information and is in the process of scanning additional documents. These will be made available via the CMS Library.

3.7.2.5 C-5: On-Site Monitoring During Construction

Measure C-5 of the CMP calls for the need for on-site construction monitors to be determined by the appropriate agency (e.g., SHPD, DLNR, etc.). As discussed elsewhere in this chapter, this monitoring is focused primarily on those activities involving earth movement or disturbance.

Experts (e.g., archaeologist, cultural resource specialist, entomologists, etc.) approved by the appropriate agency have been on-site to monitor construction impacts on resources in accordance with the applicable permit conditions of their approval.

3.7.2.6 C-6: Archaeological Monitoring Plan

This management action calls for project proponents, in consultation with UH, to consult with SHPD about whether archaeological monitoring is required during a construction project. In all cases where SHPD determines that archaeological monitoring is needed, an acceptable archaeological monitoring plan must be approved by SHPD prior to the start of any ground-disturbing work, and monitoring must be conducted according to the approved plan. SHPD has jurisdiction over inadvertently discovered human remains, and in the event of an inadvertent discovery of any human burial during construction, work in the immediate area of the burial must be halted and may not be resumed until it is authorized by SHPD and UH.

Archaeological monitoring has been conducted in accordance with this provision for all projects that have been initiated since the CMP was adopted.

3.7.2.7 C-7: Education Regarding Historical and Cultural Significance

This measure calls for all persons involved with the construction and installation of any future facilities and all persons involved in the operation and maintenance of astronomy facilities (including scientists and support staff) to be educated about the historical and cultural significance of the Maunakea summit area, and to be made aware of what constitutes respectful and sensitive behavior while there. As discussed in Section 3.2.2.1, OMKM has completed a detailed plan for complying with this condition (including the content of training, the procedures for implementation, and the means for certifying completion) and CMS is now implementing it. It is now implementing this plan.³⁹

The OMKM launched the Maunakea Orientation program in 2012. The program covers many topics and includes an extensive module relating to the historical and cultural significance of the mountain. All astronomy facility staff (both office and on-mountain), vendors, construction workers, Halepōhaku support and VIS staff, UH employees, and commercial tour drivers must complete the orientation program. As documented in Table 3.4, more than 3,800 individuals had successfully completed the training since 2013. As of February 1, 2021, approximately 1,500 individuals held a current orientation certificate. While the program was originally available only “in-person,” UH subsequently developed an online version with an assessment quiz as a more efficient means of delivery and an alternative to in-person sessions. With this capability, regular workers needing to maintain their certification have been able to do so conveniently despite COVID-19 restrictions on business and interpersonal contact. The Orientation is also available free to interested persons in the general public.

³⁹ As called for in the CMP, the compliance plan was developed by 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.

3.7.2.8 C-8: Education Regarding Environment, Ecology, and Natural Resources

This measure, which parallels that regarding historical and cultural significance discussed in the preceding section of this OAR, calls for all persons involved with the construction and installation of any future facilities and all persons involved in the operation and maintenance of astronomy facilities (including scientists and support staff) to be educated about the environment, ecology and natural resources of the summit area, and to be given training as to what constitutes appropriate behavior while there for the protection of the natural resources. The work that UH has done to comply with this condition parallels and is comparable to that related to historic and cultural resources as discussed in Section 3.7.2.7.

3.7.2.9 C-9: Inspection of Construction Materials

This part of the CMP requires that all construction materials, equipment, crates, and containers carrying materials and equipment be inspected by a trained biologist approved by the DLNR before it is allowed to enter the summit area. Before being allowed to proceed higher, the biologist must certify that they are free of any flora and fauna that may potentially have an impact on the Maunakea summit ecosystem. As discussed in Section 3.6.2.4, UH is fully implementing inspections and controls called for in this measure.

3.7.3 ADDITIONAL MEASURES RELATED TO CONSTRUCTION GUIDELINES

No need for additional measures related to construction guidelines have been identified.

3.8 SITE RECYCLING, DECOMMISSIONING, DEMOLITION, & RESTORATION

3.8.1 CMP PROVISIONS RELATED TO SITE RECYCLING, DEMOLITION, & RESTORATION

Section 7.3.3 of the CMP provides general guidance on site recycling, decommissioning, demolition and restoration for facilities in the UH Management Areas. It notes that while these apply primarily to astronomy facilities, they are also relevant to the Mauna Kea Access Road as well as the support facilities at Halepōhaku as infrastructure needs in that area change.

The “desired outcome” that the CMP seeks to achieve with respect to site recycling, decommissioning, demolition and restoration is as follows:

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.

In discussing the then-current status regarding these topics, the CMP notes that although the observatories are aware that they will need to comply with the decommissioning, demolition, and restoration terms specified in their agreements with UH, there were then no specific plans for restoration in terms of what might physically happen at any particular site. It then goes on to note that each astronomy facility will need to identify what course of action it will pursue when it is taken out of service and that the decision-making regarding that needs to be a collaborative effort between OMKM, DLNR, UH, and the observatories.

Table 7-13 in the CMP identifies three “management actions” related to site recycling, decommissioning, demolition and restoration. Those actions, and the extent to which they have been completed, are listed in Table 3.18. The nature of the work that has been done for these measures, all of which are ongoing, is discussed below in Section 3.8.2.

Table 3.18 Status of Management Actions Related to Site Recycling, Decommissioning, Demolition and Restoration

Measure	Description	Status	Discussion
SR-1	Require observatories to develop plans to recycle or demolish facilities once their useful as ended, in accordance with their sublease requirements, identifying all proposed actions.	Ongoing	3.8.2.1
SR-2	Require observatories to develop a restoration plan in association with decommissioning, to include an environmental cost-benefit analysis and a cultural assessment.	Ongoing	3.8.2.1
SR-3	Require any future observatories to consider site restoration during project planning and include provisions in subleases for funding of full restoration.	Ongoing	3.8.2.2

Source: Table 7-13, CMP.

3.8.2 STATUS CMP PROVISIONS RELATED TO SITE RECYCLING, DEMOLITION, & RESTORATION

3.8.2.1 SR-1 and SR-2: Required Site Recycling, Decommissioning, Demolition, & Restoration

UH has established a robust site recycling, decommissioning, and restoration process as called for in the CMP. In accordance with that process, the operators of two of the observatories decided to decommission their facilities and have submitted official notices announcing their intent.

- On September 16, 2015, UH Hilo, on behalf of its Department of Physics and Astronomy, submitted to OMKM its Notice of Intent (NOI) to decommission its Hōkū Kea telescope and observatory structure.
- On November 18, 2015, the California Institute of Technology (Caltech) submitted its NOI to Decommission its Caltech Submillimeter Observatory (CSO).

Caltech subsequently completed a Phase I Environmental Site Assessment and is moving ahead with subsequent steps in the decommissioning process, such as preparing its Site Decommissioning Plan, CDUA, and Environmental Assessment (EA). The announced goal is to begin removal before the end of 2023.

The Hōkū Kea decommissioning process is less advanced than that for CSO, but is following the same general path. UH believes it is likely that it will lag only slightly behind that of CSO.

Because UH administration has also confirmed that there will be no more than nine operational astronomical facilities in the MKSR by the end of 2033 even if UH is able to obtain a new lease, at least three additional observatories must be decommissioned by that time. Given the complexity and duration of the decommissioning process and the fact that a good part of the timing depends upon choices that are presently up to the discretion of the sublessees, it expects that it may not be in a position to report a decision as to which additional facilities will be decommissioned before the end of 2025.

3.8.2.2 SR-3: Potential Future Observatories, Restoration

This element of the CMP calls on UH to require observatories being established, reconstructed, or replaced (i.e., subject to site recycling) following adoption of the CMP to consider site restoration during project planning and for UH to include provisions for funding of site restoration in all new subleases. Depending upon the exact circumstances on each site, as indicated in the Decommissioning Plan, the following levels of restoration are to be considered.

- *Minimal restoration* is the removal of all man-made materials and grading of the site, leaving the area in safe condition.
- *Moderate restoration* goes beyond minimal to include enhancing the physical habitat structure to benefit the native arthropod community.
- *Full restoration* would return the site to its original pre-construction topography, as well as restoring arthropod habitat.

The only new sublease that UH has issued since the CMP was adopted was for the TMT project. Item 10 in the “Sublease and Non-Exclusive Easement Agreement” between TMT International Observatory LLC and UH deals specifically with what must be done as part of the decommissioning of that facility in accordance with the provisions of an approved Decommissioning Plan. It specifies that upon termination the sublessee must (at UH’s sole option and at sublessee’s sole cost and expense) either: (i) surrender the subleased area with all improvements existing or constructed thereon or (ii) decommission and remove the facilities and restore the land in accordance with the CMP and the Decommissioning Plan. The aforementioned sublease provision is fully consistent with this component of the CMP.

3.8.3 ADDITIONAL MEASURES RELATED TO SITE RECYCLING, DECOMMISSIONING, DEMOLITION AND RESTORATION

No need for additional measures related to site recycling, decommissioning, demolition and restoration has yet been identified.

3.9 CONSIDERING FUTURE LAND USE

3.9.1 PROVISIONS OF THE CMP CONCERNING FUTURE LAND USE

Section 7.3.4 of the CMP addresses issues related to new land uses or activities and their potential impacts on the resources. It notes that “future land use” is not confined to astronomy development but could include roadway upgrades, improvements to Halepōhaku, or a cultural facility such as a *hale* for Hawaiian navigation or astronomy. The discussion makes it clear that the CMP does not address development plan issues related to future observatories, including whether new observatories should be located on Maunakea to support the astronomy program or if observatories should have their leases extended or be decommissioned. Instead, it defers to UH’s Maunakea Master Plan on that subject.

The most relevant CMP passage specifically states:

“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 “desired outcome” that the CMP seeks to achieve with respect to future land use is as follows:

To protect cultural and natural resources in the assessment of future projects.

The CMP contains a lengthy discussion of design and siting issues that existed at the time the CMP was prepared in view of the provisions of the *2000 Master Plan*. The design and siting issues are being addressed through the ongoing process to prepare a new Master Plan.

Table 7-14 in the CMP identifies seven “management actions” (all of which are characterized as “Facility Planning Guidelines”) related to future land use. Those actions, all of which are ongoing, are listed in Table 3.17. The nature of the work that has been done for these measures is discussed below in Section 3.9.2.

Table 3.19 Status of Management Actions Related to Future Land Use

Measure	Description	Status	Discussion
FLU-1	Follow design guidelines presented in the 2000 Master Plan.	Ongoing	3.9.2.1
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.	Completed	3.9.2.2
FLU-3	Require cataloguing of initial site conditions for use when conducting site restoration.	Ongoing	3.9.2.3
FLU-4	Require project-specific visual rendering of both pre- and post-project settings to facilitate analysis of potential impacts to view planes.	Ongoing	3.9.2.4
FLU-5	Require an airflow analysis on the design of proposed structures to assess potential impacts to aeolian ecosystems.	Ongoing	3.9.2.5
FLU-6	Incorporate habitat mitigation plans into project planning process.	Ongoing	3.9.2.6
FLU-7	Require use of close-contained zero-discharge waste systems for any future development in the summit region, from portable toilets to astronomy facility restrooms, if feasible.	Ongoing	3.9.2.7

Source: Table 7-14, CMP.

3.9.2 CMP PROVISIONS RELATED TO FUTURE LAND USE

3.9.2.1 FLU-1: Master Plan Design Guidelines

UH has followed the Design Review Process it established in accordance with the recommendations of the 2000 Master Plan in reviewing project proposals that it has received. This includes the very detailed review that was given to the TMT project. It anticipates that the process will evolve, as will the CMP, through iterative planning and review as required under MEU-3.

3.9.2.2 FLU-2: Map Land Use Zones

This management action called for UH to more precisely delineate areas where future observatories could be sited, essentially refining the areas indicated in the 2000 Master Plan based on updated cultural and natural resource information. Since the time the CMP was approved, the situation has changed, and UH is no longer considering siting additional observatories in areas within the MKSR where they do not presently exist. Instead, UH has committed to reducing the

number of operational astronomy facilities within it to nine and it has stipulated that all of these will be on astronomy sites that BLNR has already approved for that use, i.e., there will be no new observatories established on sites where they do not presently exist. In view of these decisions, there is no need for a map that delineates where future observatories could be sited. Hence, further action related to this measure is unnecessary and it is therefore considered “completed”.

3.9.2.3 *FLU-3: Cataloging Initial Site Conditions*

This management action calls on UH to catalog and retain baseline information so that it can be used to inform the future restoration of each site. Such information includes topography, substrate composition, and presence/absence and density of species. Accordingly, UH maintains copies of reports, permit applications, permit approvals, construction plans, and other documents related to the facilities that have been constructed within the UH Management Areas. Those constitute the best information available for use in establishing the original site conditions and providing a baseline for use during site restoration as called for in the site decommissioning process. As scientific and data recording techniques and methodologies have improved over the decades since the first astronomical facilities were constructed on Maunakea, pre-development site conditions are better known for the most recently developed sites than for the ones that were developed long ago. In the case of the TMT project, which is the only astronomy facility permitted after the CMP was approved, its owner conducted high-resolution surface and aerial photography to document conditions prior to development.

3.9.2.4 *FLU-4: Require Visual Rendering*

Through its project review and approval process, UH requires visual renderings to be prepared for all major new development projects that have the potential to substantially affect view planes or other aesthetics. It uses this information in consulting with stakeholders and in making project-related decisions.

3.9.2.5 *FLU-5: Require Airflow Analysis*

Recognizing that wind direction and speed across the summit area play a large role in the aeolian environment on Maunakea, bringing small debris (including food such as insects and other small arthropods) from lower elevations up to the summit area, this provision of the CMP calls on UH to require an airflow analysis on the design of proposed structures to assess impacts to aeolian ecosystems. UH has required such an analysis for all major projects that have been proposed since the CMP was adopted and will continue to require similar studies for any new major projects that may be proposed in the future.

3.9.2.6 *FLU-6: Incorporate Habitat Mitigation Plans into Project Planning Process*

UH has incorporated a requirement for habitat conservation into its project planning process. That, together with the decision to limit future astronomical land uses in the MKSR to a subset of already approved sites means that this measure is being fully implemented.

3.9.2.7 FLU-7: Expand Use of Zero-Discharge Waste Treatment Systems

UH is requiring the use of zero-discharge treatment systems for all new and replacement facilities within the summit area and is encouraging operators of facilities that do not already have such systems to incorporate them at the earliest possible date.

3.9.3 ADDITIONAL MEASURES RELATED TO FUTURE LAND USE

No need for additional measures related to siting future land uses have been identified.

3.10 OPERATIONS AND IMPLEMENTATION

3.10.1 CMP PROVISIONS RELATED TO OPERATIONS AND IMPLEMENTATION

Section 7.4.1 of the CMP provides recommendations relating to operations and implementation of the CMP and to emergency procedures. While it recognizes that the CMP does not apply to other state lands on Maunakea, it notes that coordination with other entities will be required to implement the full range of management actions that it calls for.

The “desired outcome” that the CMP seeks to achieve with respect to operations and implementation is as follows:

Conduct effective operations to support management that is focused on resource protection, education, and public safety.

The CMP identifies numerous operations-related items that it concludes deserve attention, including a stronger foundation (e.g., sufficient funding, staffing, and facilities) to support the achievement of management goals. In particular, the CMP calls attention to the importance of having a greater staff presence in the summit region to work as enforcers and resource managers. Hand-in-hand with that was a call for improved staff training in safety, emergency response, visitor orientation, and cultural and natural resource protection.

Accordingly, the CMP calls for UH to work with various stakeholders, including IfA, MKSS, and with federal and state agencies and local landowners in the region, to define policies and procedures relating to the CMP and to coordinate management planning and implementation measures. It makes specific reference to the importance of gathering input from the community, federal and state agencies, and other stakeholders on an ongoing basis. It specifically references doing this via such things as: (i) the periodic CMP review process of which this OAR is a part (especially the stakeholder comments on the OAR); (ii) through interagency meetings conducted annually; and (iii) through a grievance procedure to address problems and issues as they arise, so that community concerns can be addressed in the periods between CMP updates. Finally, the CMP identifies a need to update emergency response procedures so that UH can work with neighboring landowners and other agencies to plan for coordinated response to range of emergency situations.

Table 7-15 in the CMP identifies five “management actions” related to operations and implementation. Those actions, and the extent to which they have been completed, are listed in Table 3.20 and discussed in Section 3.10.2.

Table 3.20 Status of Management Actions Related to Operations and Implementation

Measure	Description	Status	Discussion
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.	Completed	3.10.2.1
OI-2	Develop training plan for staff and volunteers.	Completed	3.10.2.2
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.	Ongoing	3.10.2.3
OI-4	Establish grievance procedures for OMKM, to address issues as they arise.	Completed/ Ongoing	3.10.2.4
OI-5	Update and implement emergency response plan.	Ongoing	3.10.2.5
Note: A status of “Completed/Ongoing” means that the needed procedures and systems have been completed and are being implemented on an ongoing basis. Source: Table 7-14, CMP.			

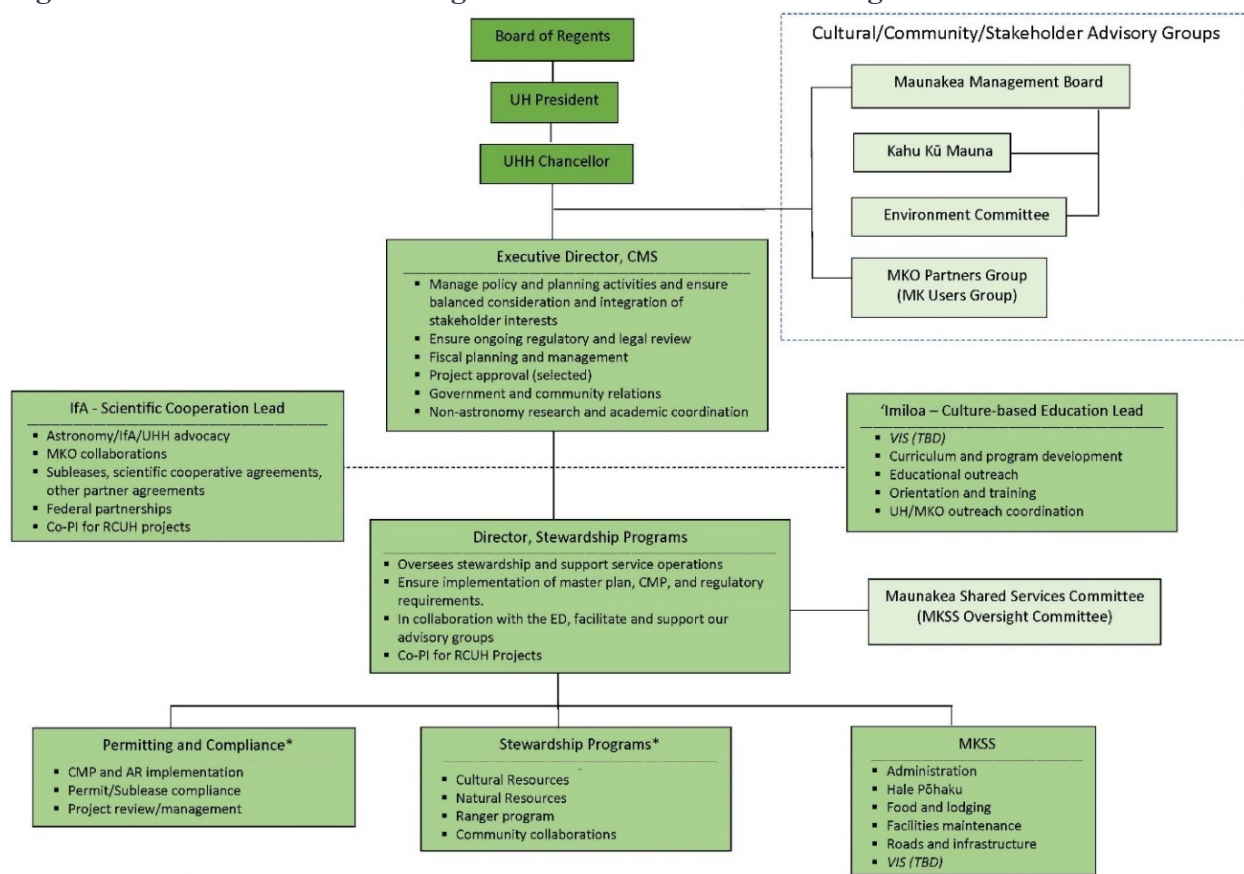
3.10.2 STATUS OF MEASURES RELATED TO OPERATIONS AND IMPLEMENTATION

3.10.2.1 OI-1: Local Management of the UH Management Areas

Per this management action, for many years OMKM, MKMB, Kahu Kū Mauna, and MKSS provided local management, advice, expertise, and guidance as they were in existence when the CMP was approved. In August 2020, the structure of the local management was modified in a manner that brought the MKSS function and personnel and the OMKM function and personnel together under a centralized operations and management entity, named CMS. As illustrated in the CMS organization chart (Figure 3-1), MKMB, Kahu Kū Mauna Council, and the EC continue to advise CMS. Those advisory groups continue to provide local advice and input to the management entity.

The management restructuring has the following six primary objectives: (i) improve lines of management accountability and financial transparency; (ii) organize UH functions around mission-critical activities.; (iii) clarify UH’s regulatory, stewardship, and advocacy roles by separating those functions in its organization; (iv) leverage and optimize existing networks and partnerships; (v) broaden, diversify, and elevate stakeholder input into decision-making; and (vi) maintain governance continuity and minimize disruption as much as possible. The updated organization, which was approved by the BOR in August 2020, provides greater local control and opportunity for community input into decision-making related to Maunakea.

Figure 3-1 UH Maunakea Management Structure Effective August 2020.



*Shown here for descriptive purposes. Organization of these functions to be finalized by Director of Stewardship Programs.
Source: Center for Maunakea Stewardship

3.10.2.2 OI-2: Develop Training Plan for Staff and Volunteers

General. UH prepared a formal training plan, MKMB provided input, and OMKM has been implementing it since 2016. The approved plan conforms with all the requirements stated in the CMP.⁴⁰ As discussed in Section 3.2.2, CMS requires all staff and volunteers to attend a Maunakea orientation program that conforms with the provisions of its official training plan and pass a certification test.

Volunteers. Volunteers are primarily involved in weed-pulls or native plantings. Volunteers are provided preliminary information prior to the day's work; once on-site, in-person training is provided to ensure safe and respectful conduct by all participants. Similar to staff trainings, the volunteer training covers the same major themes of natural and cultural resources awareness,

⁴⁰ This means, for example, that it addresses such things as: (i) specialized Ranger training, field-personnel training, volunteer training and general staff training; (ii) applicable laws and regulations; (iii) basic cultural and natural resources orientation, and standard procedures for documenting potential violations (for non-enforcement personnel); (iv) general safety training, 4-wheel drive vehicle operation, orientation to working at high elevations, emergency response, CPR/first aid, Global Positioning System (GPS) operation, and recognition of culturally significant areas and items and protected flora and fauna for all personnel involved in field-based management activities; (v) safety orientation and basic cultural and natural resources training for all staff who access the mountain should receive. Rangers should receive high-level training in emergency response, including CPR and first aid as well as in-depth cultural and natural resources training, to enable them to better understand and protect the resources.

current management activities, and mountain safety. The volunteer program has been on hold since 2019 due to access issues and the ongoing COVID-19 pandemic.

Maunakea Rangers. UH has established particularly stringent qualification requirements for persons being considered for being hired as Rangers.⁴¹ The primary qualifications include a Bachelor's Degree from an accredited four (4) year college or university or a combination of college course work, formal training, and experience that are equivalent to a Bachelor's Degree in a related field. To be considered for a Ranger position, applicants must have at least two years' experience in a general public health and safety capacity related to some/all of job duties including rule enforcement experience. They must also demonstrate that they have: (i) knowledge of practices and techniques in public health and safety; (ii) knowledge of the cultural, environmental, geological and scientific importance of Maunakea; (iii) a Certification in First Aid/CPR (or be able to obtain certification within 12 months of hire); (iv) experience in enforcing rules of conduct; (v) experience using good teamwork skills; (vi) excellent writing and verbal communication skills; (vii) the ability to establish and implement crowd control and traffic management procedures; (viii) a valid driver's license, clean driver's abstract, and ability to drive a 4-wheel drive vehicle on ice or snow covered unpaved or paved roads; (ix) passed instructional courses in First Responder/First Aid certification training and other safety related disciplines; (x) passed a post-offer criminal background check including a substance abuse test; (xi) the ability to work and hike long distances over rugged terrain at 14,000 feet elevation under inclement weather conditions to assist injured victims.

3.10.2.3 *OI-3: Coordinated Management*

Noting that effective ecosystem management requires that UH work closely with neighboring landowners, the CMP commits UH to coordinate its actions within the UH Management Areas with adjacent property owners and users. Accordingly, it has worked diligently with the managers of the Mauna Kea Ice Age NAR, the State Division of Forestry and Wildlife, and other agencies responsible for the management of resources that also depend upon continuing use of the UH Management Areas. It has formalized an agreement with DOFAW-NARS, coordinated closely with the Department of Hawaiian Home Lands, attempted to make its trail management efforts supportive of the Na Ala Hele Trail system's goals and objectives, and coordinated with the Mauna Kea Watershed Alliance, whose members include the major adjacent landowners. Rangers report unusual or suspicious behavior observed on DLNR lands to DLNR including DOCARE so that those agencies can take appropriate follow-up action.

⁴¹The formal Ranger job description lists the following duties: (i) directly monitoring all activities including rules/laws compliance within the UH Maunakea Rules; (ii) supporting public, observatory and commercial activities; (iii) liaison and coordinate with other safety and law enforcement agencies; (iv) coordinating with the various departments at Halepōhaku; (v) providing crowd control and vehicle management including parking and traffic; (vi) conducting external inspections of observatory sites within the Science Reserve; (vii) providing interpretive services for visitors and other users on Mauna Kea; (viii) explaining environmental, archeological, geological, cultural and scientific features of Mauna Kea to workers and visitors; (ix) informing visitors of the hazards encountered on Mauna Kea and explaining how to safely deal with them; (x) interacting with and educating visitors to the Mauna Kea summit region, including cultural practitioners, film crews, observatories' staff; natural and cultural resource managers and research staff, recreational visitors such as hunters and skiers, commercial tour operators including guides and customers; (xi) acting as First Responder and following established safety procedures in emergency situations; and (xii) inspecting road conditions during inclement weather and performing crowd management duties during road closures.

3.10.2.4 *OI-4: Grievance Procedures*

The public has the opportunity to inform UH of grievances at the MKMB publicly held meetings. The Director of CMS is present at all such meetings and the grievance procedure consists of the following:

- If the grievance concerns management issues or items within CMS' jurisdiction, the Director researches the issue, consults with staff and advisory groups, and coordinates with the individual or group to bring the grievance to a resolution. If the grievance cannot be resolved within a month, updates are provided at subsequent MKMB meetings and input from MKMB sought until it is resolved.
- If the issues represent broad planning or policy questions beyond the management authority of CMS, the Director refers the questions or questioner to specific contacts at the appropriate agencies, usually DLNR, the UH Hilo Chancellor, the President, or the BOR as appropriate. The Director follows the progress of the grievance and assist in its resolution where able.

CMS' goal is to handle all grievances in a sensitive and timely manner.

3.10.2.5 *OI-5: Emergency Response Plan*

This CMP management action was to generate and implement an Emergency Response Plan. In cooperation with the various organizations that have facilities within the UH Management Areas, the Institute for Astronomy, and County, State, and Federal agencies, UH has established a comprehensive set of emergency response procedures for Maunakea, which are outlined in the *Maunakea Emergency Procedures* (July 2019) document. Noting that Maunakea is an isolated work location situated many miles from the nearest professional Emergency Medical Service (EMS), the procedures outline how to access the various services available, describes the limitations of these services on Maunakea, and emphasizes that the most critical thing is to do all that can be done to minimize the incidence of accidents in the first place. It stresses that the primary source of first aid assistance must be the work location itself and calls for each facility to have staff trained in first aid and CPR and to maintain a stock of emergency first aid supplies and equipment. It also recommends that each facility establish a regular schedule for first aid drills, testing of emergency and safety equipment, including the EEV (Emergency Evacuation Vehicle) and the equipment it contains. The document explains the role of the Rangers, who have emergency medical responder training and carry oxygen, backboards, AED, splints, and assorted first aid supplies in their vehicles. At the same time, it makes it clear that while the Rangers are available for assistance in an emergency, 911 should still be called immediately and before contacting Rangers for any serious emergency.

The emergency procedures document outlines the many logistical considerations in responding to emergencies on the mountain. These include appropriate communications links, the EMS (ambulance) response that is available from the Hawai'i County Fire Department and Pōhakuloa Training Area (PTA), helicopters (civilian, and Army National Guard). It also provides specific advice and guidance for dealing with a variety of emergency situations, including: (i) altitude sickness; (ii) deficient oxygen; (iii) fire; (iv) weather hazards; (v) earthquakes; (vi) hazardous material spills; (vii) missing-person/lost hiker; and (ix) other human and/or cultural issues. In addition to maps showing the locations of facilities and places where help may be available, it also contains a comprehensive list of telephone numbers.

3.10.3 ADDITIONAL MEASURES RELATED TO OPERATIONS AND IMPLEMENTATION

No need for additional measures related to operations and implementation have been identified.

3.11 MONITORING, EVALUATION, AND UPDATES

3.11.1 CMP PROVISIONS RELATED TO MONITORING, EVALUATION, AND UPDATES

Section 7.4.2 of the CMP outlines the process for monitoring, evaluating, and updating the CMP. The “desired outcome” that the CMP seeks to achieve with respect to monitoring, evaluation, and updates is as follows:

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.

The CMP notes that it was based on the state of knowledge as of December 2008 regarding the status of the resources, activity levels, and most appropriate management actions. Recognizing that new information would become available and that environmental conditions would likely evolve over time, it calls for the application of adaptive management principles that would allow resource managers to improve strategies and plans as new information becomes available. It also requires that management plans undergo regular review, to reduce uncertainty, incorporate lessons learned, and take advantage of new data and information from monitoring, ecosystem science, surveys, and traditional knowledge.

The CMP concludes that comprehensive evaluation to develop or refine management actions requires collection of specific data, performance evaluation measures to be identified, and data collected that can be used to assess the effectiveness of these performance measures. It concluded that the CMP needs to be reviewed and revised as new, pertinent information becomes available about the resources being managed and the extent to which the management actions being implemented are achieving the management objectives.

Finally, the CMP calls for monitoring and evaluation of its effectiveness to be conducted annually and for the results to be summarized in an annual progress report. It also recommends that a major review and revision of the CMP be undertaken every five years, using information contained in the annual reports, and that this evaluation and revision 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 report also calls for the CMP to be updated as needed to comply with any requirements or conditions imposed by the BLNR on the CMP upon acceptance of the plan. Taken as a whole, the CMP provisions relating to updates, which focus on adaptive management, indicate that the authors of the plan believed that most plan revisions could be made without going through the very lengthy process that had been used to develop the original (2009) plan.

Table 7-16 in the CMP identifies three “management actions” related to monitoring, evaluation, and updates. Those actions, and the extent to which they have been completed, are listed in Table 3.21. All the work that has been completed for these measures is discussed below in Section 3.10.2.

Table 3.21 Status of Management Actions Related to Monitoring, Evaluation, & Updates

Measure	Description	Status	Discussion
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.	Ongoing	3.11.2.1
MEU -2	Conduct regular updates of the CMP that reflect outcomes of the evaluation process, and that incorporate new information about resources.	Ongoing	3.11.2.1
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 Maunakea and reflect stewardship matters resolved with DLNR.	Ongoing	3.11.2.2

Source: Table 7-16, CMP.

3.11.2 STATUS OF PROVISIONS RELATED TO MONITORING, EVALUATION, AND UPDATES

3.11.2.1 MEU-1 and MEU-2: CMP Reporting and Update/Revision Process

UH has established and is implementing a comprehensive reporting system that provides the information needed to internally track and report to others the status of its efforts to fully implement the measures called for in the CMP. Specifically, it has operationalized the reporting system called for in the CMP and, in accordance with the approved system, it has:

- Prepared and submitted annual status reports to the BLNR every year since 2012. Additionally, UH submits reports to other agencies in compliance with the requirements of the various permits that are held in its name and provides copies of the reports to interested parties at public meetings that it participates in, including presentations to the MKMB.
- Prepared this OAR – using information contained in the annual progress reports and multiple other sources – which: (i) discusses the state of the cultural and natural resources; (ii) summarizes new information; (iii) analyzes trends and impacts; (iv) lists future management actions; and (v) summarizes the progress made towards meeting CMP goals and objectives.

UH will submit this OAR to stakeholders and agencies participating in the review process for their review and comment. UH will carefully consider all the comments it receives in finalizing its CMP progress report. Then, it will use the information contained in the CMP progress report as the basis for determining when management actions have been completed and for adapting or adding CMP management actions.

3.11.2.2 MEU-3: Revising and Updating Planning Documents

This measure calls for UH to endeavor to keep the planning documents that govern land use within the UH Management Areas consistent with the goals and objectives of the CMP, thereby promoting the responsible stewardship and use of the UH Management Areas on Maunakea. As evidenced by the following examples, UH has implemented this measure:

- Provisions of the CMP are a key element in formulating a new Maunakea Master Plan and in negotiating terms of all subleases. UH expects to release the public review draft of the Master Plan later this year (2021). Once finalized and adopted, the updated Master Plan will guide the use of those lands through 2040.

- The information that is in this OAR and the feedback on it that is received from reviewers will inform adaptation and refinement of ongoing CMP management actions and possibly the formulation of additional measures.
- Because UH and its partner observatories wish to continue astronomical activities on Maunakea beyond the end date of its current master lease, on August 22, 2013, the BOR informed the BLNR that it intended to seek a new land authorization.
- In February 2018, UH issued an Environmental Impact Statement Preparation Notice (EISPN) for a new land authorization. Preparation of the EIS will include additional information received after 2018, including the UH Maunakea Rules, the new Maunakea Master Plan, and the updated CMP.

3.11.3 ADDITIONAL MEASURES RELATED TO OPERATIONS AND IMPLEMENTATION

No need for additional measures related to operations and implementation have been identified.

4 MANAGEMENT PROGRAMS STATUS

4.1 PROGRESS TOWARD GOALS AND OBJECTIVES

Chapter 7 of the CMP contains an explicit discussion of the plan's goals and objectives, which are referred to as "desired outcomes." Those desired outcomes are as follows:

- Increase understanding and appreciation of Native Hawaiian history and cultural practices related to Maunakea 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. [CMP Section 7.1.1, Native Hawaiian Cultural 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. [CMP Section 7.1.2, Natural Resources]
- Build and maintain a constituency to engage in active and meaningful stewardship of Maunakea, through education and involvement of the public, to support, enhance conservation, and sustain the natural, cultural, and astronomical resources of Maunakea. [CMP Section 7.1.3, Education and Outreach]
- Protect astronomical resources. UH's lease of the summit area provides that the MKSR shall be operated as a buffer zone to prevent the intrusion of activities incompatible with the use of the land as a scientific complex for astronomy. The lease specifically recognizes light and dust interference as well as certain types of electronic interference as incompatible with such protection. [CMP Section 7.1.4, Astronomy Resources]
- 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 Maunakea. [CMP Section 7.2.1, Activities and Uses]
- Achieve compliance with existing and any new policies and regulations designed to manage and minimize human impacts, to preserve and protect Maunakea's resources. [CMP Section 7.2.2, Permitting and Enforcement]
- Manage the built environment by implementing an 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. [CMP Section 7.3.1, Infrastructure and Maintenance]
- Minimize adverse impacts to resources during all phases of construction through use of innovative best management practices. [CMP Section 7.3.2, Construction Guidelines]
- 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. [CMP Section 7.3.3, Site Recycling, Decommissioning, Demolition, and Restoration]

- Protect cultural and natural resources in the assessment and consideration of future projects. [Section 7.3.4, Considering Future Land Uses]
- Conduct effective operations to support management that is focused on resource protection, education, and public safety. [CMP Section 7.4.1, Operations and Implementation]
- 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. [CMP Section 7.4.2, Monitoring, Evaluation, and Updates]

The extent to which these goals and objectives (desired outcomes) have been achieved is discussed below.

4.1.1 ACHIEVEMENT OF GOALS AND OBJECTIVES RELATED TO NATIVE HAWAIIAN CULTURAL RESOURCES

UH has taken numerous steps to achieve the objective of increasing understanding and appreciation of Native Hawaiian history and cultural practices that occur on and are related to Maunakea. It has identified and protected cultural resources and historic properties in the UH Management Areas. It has also worked diligently and successfully to ensure that cultural practices are able to continue and are respected.

OMKM together with Kahu Kū Mauna developed, and MKMB considered, policies for the construction of new cultural features, including the stacking of rocks, the scattering of human remains, placement of offerings, buffers around historic properties, and visitation and use of ancient shrines. Extensive community consultation was held over a period of several years before policies regarding this were adopted and subsequently implemented in 2018.

Over the course of several years OMKM established formal education and training programs designed to educate and train management staff, stakeholders, and the general public about many aspects of Maunakea, including its cultural significance to native Hawaiians. Information concerning cultural resources is also provided to all astronomy facility staff (both office and on-mountain), vendors, construction workers, Halepōhaku support and VIS staff, UH employees, and commercial tour drivers. Over 400 people attended the orientation in 2018 and since the orientations began in 2013, over 2,500 people have attended. An online version with an assessment quiz is available as a more efficient means of delivery and an alternative to in-person sessions. Since 2020, HAR § 20-26-5 has reinforced this by stipulating that all persons accessing the UH Management Areas must complete an orientation regarding cultural and natural resources, safety matters, and other relevant information prior to entering the UH Management Areas. CMS is working diligently to ensure that the orientation procedures are fully operationalized.

The Rangers monitor activities on the UH Management Areas and through their individual interactions with those present help to educate people about all aspects of Maunakea, including its cultural significance. The UH Maunakea Rules provides the Rangers with tools to manage activities that impact cultural resources by those who visit UH Management Areas. After significant consultation and outreach on the development of the rules, as discussed in this OAR, the drafters of the rules and the BOR removed provisions that might indirectly impact cultural practitioners, such as requiring group permits. In addition, based on community input and consistent with similar administrative rules governing DLNR lands, UH added the following

statement to HAR §20-26-3(f), “Native Hawaiian traditional and customary rights as recognized and protected under article XII, section 7, of the Hawai‘i State Constitution shall not be abridged.”

Ku‘iwalu’s independent CMP evaluation report to DLNR (Ku‘iwalu, December 2020) states (in Table 1) that OMKM reported nine of the 14 measures in this category as completed and five as “ongoing.” Ku‘iwalu’s judgment, as reported in that table, was that “some progress” had been made in achieving the desired outcomes. Ku‘iwalu gave OMKM this middle grade because not all of the work was timely, and it was unclear to some consulted persons whether the materials and training programs that OMKM had put in place are sufficient to increase understanding of Native Hawaiian history and practices related to Maunakea. Accordingly, its report recommends that: (i) Native Hawaiian Organizations (NHOs) be more directly involved in developing and reviewing the materials and providing suggestions, and (ii) there be greater clarity of the role that Kahu Kū Mauna plays in engaging and coordinating with NHOs on cultural issues and protocols.

In summary, as discussed in Section 2.1 and presented in tabular form in Section 4.2 (Table 4.1, Table 4.2, and Table 4.3) of this OAR, this objective is largely being met; however, refinement of the CMP and how it is implemented based on community input is an overarching and crucial objective of the CMP framework. UH will continue to reach out to and invite input from cultural practitioners on the best way to achieve the goals and objectives related to native Hawaiian cultural resources under the CMP.

4.1.2 ACHIEVEMENT OF GOALS AND OBJECTIVES RELATED TO NATURAL RESOURCES

The work that UH has conducted and/or sponsored since the CMP was adopted has further enhanced scientists’ understanding of the status of Maunakea’s biological and physical resources. The studies and research that have been completed have clearly identified the major threats to those resources and recommended management actions that should be undertaken to protect against those where feasible. As discussed in Section 2.2 of this OAR, the contents of OMKM’s annual reports show that while the implementation status of the majority of the CMP’s 18 natural resource management actions are necessarily “ongoing” because they have open-ended implementation phases, UH has been generally successful in implementing measures that will better protect and preserve unique geological features, ecosystem functions, subalpine and alpine habitats, and biological communities through adaptive management of stressors and threats. With the formal promulgation of HAR Chapter 20-26 in 2020, UH has an even stronger set of tools to use to protect the mountain’s natural resources, and it is seeking funding to carry out those management duties through legislative appropriations and other channels.

Ku‘iwalu’s independent CMP evaluation report to DLNR supports OMKM/CMS’s reporting and assessment of UH’s performance on natural resource measures. It states that both the public comments it received and its evaluation indicated that OMKM had done a good job of managing natural resources by, for example, identifying threats, managing invasive species, protecting wekiu bug habitat, and conducting biological studies. It also concluded that OMKM can improve upon its outcomes reporting to the public. Accordingly, Ku‘iwalu recommended that the many studies be made more readily available to the public by ensuring that all are available for download from the Internet. It also suggested that communications of the status of natural resources might be enhanced if the CMS developed a “Natural Resources Dashboard” that tracked the status of certain aspects of the natural environment (e.g., the number of invasive species identified and removed).

In summary, for reasons discussed in Section 2.2 and presented in tabular form in Section 4.2 (Table 4.4, Table 4.5, Table 4.6, and Table 4.7) of this OAR, the natural resource goals and objectives are largely being met, but there is room for improvement in the way the information is made available to the public.

4.1.3 ACHIEVEMENT OF GOALS AND OBJECTIVES RELATED TO EDUCATION & OUTREACH

As discussed in detail in various parts of Chapter 3 of this OAR and presented in tabular form in Section 4.2 (Table 4.8, Table 4.9, and Table 4.10), UH has worked to expand its contribution to the meaningful stewardship of Maunakea. Its outreach programs and public involvement and education programs have fostered much greater public awareness and conservation of the natural, cultural, and astronomical resources of the mountain. Its Ranger program provides individualized contact with visitors to the mountain that has been largely successful in promoting behavior that is respectful of Maunakea's natural and cultural value. Hence, OMKM's July 2020 CMP status report to the BLNR concluded that it was on track with respect to the Education and Outreach component of the CMP. As evidenced by information in the following paragraph, not all Maunakea's stakeholders shared OMKM's views. Despite its efforts, some members of the Hawai'i Island community have continued to feel as though they lack an effective voice in decision-making regarding activities within the UH Management Areas.

Ku'iwalu's independent CMP evaluation states that a substantial portion of the general public believes that OMKM has engaged in too little community engagement and outreach and that it needs to do more to develop strong positive relationships with the broader community (i.e., not just its supporters). However, it is important to note that Ku'iwalu's evaluation did not include a scientific poll and its list of consulted parties was not a sample of the "general public." Still, the comments are useful and UH is taking those comments seriously. UH also agrees that seeking diverse opinions about implementing the CMP, not only supporters, is critical.

Public comments summarized in the Ku'iwalu report suggest various education and outreach deficiencies, including: (i) the orientation video's lack of a Native Hawaiian cultural perspective and cultural sensitivity; (ii) an imbalance between protecting cultural resources and pursuing astronomy development; (iii) insufficient consultation with NHOs in decision-making for management of Maunakea; and (iv) a need for more thorough orientation of visitors before they are allowed to travel to the summit. Ku'iwalu's assessment was that OMKM had not clearly demonstrated that its actions had achieved the desired outcome of building a larger and/or stronger constituency to steward Maunakea. Accordingly, Ku'iwalu recommended that OMKM develop improved reporting metrics regarding the effectiveness of its measures, that it utilize the 'Imiloa Astronomy Center to develop culturally based materials to educate and raise awareness of cultural resources on Maunakea, and that it increase its efforts in presenting that information to the broader community.

As discussed in Section 3.10.2.1 of this OAR, UH has, with the establishment of the CMS, made administrative changes that will lead to enhanced community input from a more diverse set of parties, thereby improving management decision-making. The new management structure is helping UH administer the UH Management Areas in a way that is better-aligned with the desires of direct stakeholders and the broader community. Similarly, the formal promulgation of HAR Chapter 20-26 in 2020, has given UH the ability to make the successful completion of a cultural education program a prerequisite for visiting the summit area. Assuming CMS obtains the required

funding, it is committed to the public education and outreach program improvements that have been identified. Also, as noted previously, Executive Policy EP 10.104, specifically delegates authority to administer HAR § 20-26-5 regarding required orientation to the Executive Director of the ‘Imiloa Astronomy Center.

4.1.4 ACHIEVEMENT OF GOALS AND OBJECTIVES RELATED TO ASTRONOMY RESOURCES

As discussed in Section 3.3.2 and summarized in tabular form in Section 4.2 (Table 4.11), CMS believes that UH’s management of Maunakea has protected the summit’s value as a place for world-class astronomical research. Its control of activities within the summit area, together with the underlying Conservation District regulations, have prevented the intrusion of activities incompatible with the use of the land as a scientific complex for astronomy. Activities that emit light or cause the avoidable release of dust into the atmosphere are prohibited as are activities that could produce electronic emissions that are incompatible with astronomical research. UH’s commitment that no additional sites will be used for astronomy facilities and that the number of operating astronomy facilities will be reduced to no more than nine by the end of 2033 will not keep Maunakea from continuing to be supremely attractive to the world’s astronomical community and is consistent with achievement of UH’s and the Maunakea Observatories’ (MKO) astronomy goals.

Ku‘iwalu’s report to DLNR supports OMKM’s assessment. It states that astronomy stakeholders believe that OMKM had done a good job of protecting the quality of the summit area for astronomical purposes, though some operators felt that the situation would be even better if OMKM had initiated more regular, ongoing communications with them rather than waiting until big issues arose.

4.1.5 ACHIEVEMENT OF GOALS AND OBJECTIVES RELATED TO ACTIVITIES AND USES

The actions that UH has taken since the CMP was adopted have allowed important recreational and cultural activities on Maunakea to continue alongside the numerous astronomical uses that have been approved. The recent adoption of the UH Maunakea Rules enhances UH’s ability to regulate public and commercial activities, while continuing to support scientific studies, maintain adequate protection of resources, educate users regarding resource sensitivity, and ensure the health and safety of those visiting or working at Maunakea.⁴²

The roadway and parking improvements that UH made in the vicinity of the VIS during 2019 significantly improved circulation and safety in that location. OMKM installed and CMS is continuing to operate an automated counter that records the number of vehicles proceeding above Halepōhaku, differentiating between astronomy vehicles, commercial tour vehicles, service vehicles, and others. The authority that was granted to UH when HAR Chapter 20-26 was adopted in January 2020 provides enforcement measures that support access management already called for in the CMP. These enforcement measures further support access management measures being considered as part of the ongoing new Master Plan process.

⁴² None of the restrictions limit hunting activities. As provided for in HAR § 20-26-3(c), where overlapping jurisdictions are present, DLNR’s administrative rules continue to govern.

The Rangers, who are present from 7:15 am to 10:00 pm daily, maintain a presence of interpretive and enforcement personnel on the mountain at all times to educate, encourage people to conform to the rules, and generally promote positive behavior. While they have some enforcement authority, the Rangers' most effective tool is the way in which they model and teach appropriate behavior and help keep visitors safe while they are on the mountain. DOCARE officers and Hawai'i County Police are called for assistance only on an as-needed basis.

UH has taken several steps designed to minimize the adverse effects that recreational activities have on natural and cultural resources. These include encouraging hikers to use established trails and snow play enthusiasts to remain in areas that have a sufficient depth of snow-covering to prevent damage to underlying biological, physical, and cultural resources. Several provisions of the recently adopted UH Maunakea Rules provide UH with additional authority to implement the CMP management actions related to activities so that it can better steward the UH Management Areas.

Ku'iwalu's report to DLNR found that the public's perception of the effectiveness of UH's management of activities and uses is generally positive. It notes that the Rangers receive many compliments on their knowledge of the mountain's various resources and on the guidance that they provide to visitors. There was also public praise for the cultural orientation that some of the commercial tour operators provide and general support for reducing the number of vehicles accessing the summit, possibly through implementation of a shuttle service. Ku'iwalu's conclusion was that UH had made good progress towards achieving the activities and uses outcomes that the CMP "activities and uses" management actions targeted. Moving forward, the report suggested that this element might benefit from periodic surveys designed to measure the extent to which visitors, tour operators, and others felt OMKM's management was effective in preserving the environment and providing a good experience.

4.1.6 ACHIEVEMENT OF GOALS AND OBJECTIVES RELATED TO PERMITTING & ENFORCEMENT

UH believes it is achieving all its objectives related to permitting and enforcement. Specifically, it has complied with the terms and conditions of all the permits for Maunakea that are held in its name and has made sure that sublessees report regularly on their compliance with the terms and conditions of approvals that have been granted. In the few instances where violations have been reported, UH has used its best efforts to ensure that immediate steps are taken to resolve the problems.

While it does not have authority to direct sublessees' activities, UH is the permit-holder for all CDUPs on Maunakea and is, therefore, ultimately responsible for sublessees' compliance with the terms of the CDUPs. Accordingly, UH has used its best efforts to ensure that all the activities that it and others undertake on its property are in compliance with applicable regulations.

As a result of the efforts that UH and its sublessees have made, CMS believes that the policies and regulations that are now in place are adequate to minimize human impacts that might otherwise harm Maunakea's resources. As discussed in Section 3.5.2 and presented in tabular form in Section 4.2 (Table 4.16 and Table 4.17), the information presented in its July 2020 annual CMP status report to the BLNR indicates that UH is achieving its goals and objectives related to permitting and enforcement.

Ku‘iwalu’s report to DLNR found that the public’s perception of the effectiveness of UH’s implementation of the CMP’s permitting and enforcement measures is generally positive, with the bulk of the credit being given to the performance of the Rangers. Some members of the public were of the opinion that there is room for improvement in the management of the commercial tour operators and a need to use higher fees from them to better manage resources. Complaints that visitors were allowed unlimited access while cultural practitioners were restricted were also noted. UH is not aware of instances where cultural practitioners and others were treated differently and such an event would be counter to the CMP management actions and employee training. Others had a feeling that there was inadequate coordination and clarity between County enforcement personnel and DOCARE staff with respect to jurisdiction on the Mauna Kea Access Road. In its report, Ku‘iwalu’s overall assessment was that UH was making good progress towards the permitting and enforcement objectives.

4.1.7 ACHIEVEMENT OF GOALS AND OBJECTIVES RELATED TO INFRASTRUCTURE & MAINTENANCE

OMKM developed and began implementing an OMMP that prescribes specific maintenance strategies and protocols designed to ensure that its operations cause minimal disruptions to other activities and uses, minimize impacts to natural and cultural resources, and ensure that permittees remain compliant with their CDUP requirements. The OMMP is formulated in a way that minimizes impacts from operations and maintenance activities by using the best available procedures and equipment and by educating all personnel working on Maunakea about its unique resources, and CMS is continuing to implement it.

Maintenance efforts that have the potential to affect historic and cultural resources are not undertaken without first having undergone thorough historic preservation review. OMKM funded a study to evaluate the efficacy measures to prevent the introduction of invasive species, including vehicle and equipment wash practices, and has implemented appropriate inspection measures. Trash from the HP facilities and VIS are removed daily, and each astronomy facility removes trash from its facilities on a regular basis. Rangers routinely check for and pick up trash and debris from public areas while on their daily patrols.

As discussed in Section 3.6.2 and summarized in Section 4.2 (Table 4.18, Table 4.19, and Table 4.20), OMKM’s July 2020 Annual Report concludes that it has made very good progress with respect to implementation of infrastructure and maintenance measures and concludes that it is, therefore, achieving its goals and objectives related to infrastructure and maintenance.

Ku‘iwalu’s report to DLNR found that the public’s perception of the effectiveness of UH’s implementation of the CMP’s infrastructure and maintenance measures was good, and this matched its own assessment of UH’s accomplishments regarding these elements of the CMP. Ku‘iwalu expressed the belief that it would be even better if future reporting included more details, copies of the reports that had been prepared, and an explanation of the ways in which the information they contained would be used to guide UH’s ongoing infrastructure and maintenance efforts.

4.1.8 ACHIEVEMENT OF GOALS AND OBJECTIVES RELATED TO CONSTRUCTION GUIDELINES

Following adoption of the CMP, UH established stricter controls over and construction BMPs for construction within its managed areas. It believes the measures that it has put in place are allowing it to achieve the goal of avoiding or minimizing adverse construction impacts. For example, all contractors are required to adopt BMPs and to have an independent construction monitor who has oversight and authority to ensure that all aspects of ground-based work comply with agreed-upon protocols and permit requirements. The guidance that OMKM has adopted requires that the BMPs: (i) be developed prior to work beginning; (ii) include a rock movement plan, if appropriate; (iii) provide for on-site monitors (e.g., archaeologist, cultural resources specialist, entomologist) during construction, as determined to be warranted by the appropriate agency; (iv) require that archaeological monitoring be conducted during construction per an SHPD approved plan; (v) mandate thorough inspection of all materials brought onto the mountain to minimize the potential introduction of invasive species; and (vi) require contractors to educate their employees and sub-contractors regarding historical and cultural significance and about particularly sensitive aspects of the ecology and natural resources.

In summary, as discussed in Section 3.7.2 and presented in tabular form in Section 4.2 (Table 4.21 and Table 4.22), UH believes it is achieving its goals and objectives related to construction guidelines.

Ku‘iwalu’s CMP evaluation report to DLNR indicates that the public had not yet formed an opinion as to how successful the construction guidelines are at protecting Maunakea’s resources. Its own judgment was that good progress had been made with respect to achieving the outcome that these measures were intended to produce.

4.1.9 ACHIEVEMENT OF GOALS AND OBJECTIVES RELATED TO SITE RECYCLING, DECOMMISSIONING, DEMOLITION, AND RESTORATION

By adhering strictly to its construction guidelines and by limiting development to only those areas specifically called out in the 2000 Master Plan and approved through the Conservation District Use process as discussed in Section 3.8.2 and presented in tabular form in Section 4.2 (Table 4.23), UH believes it is making reasonable progress towards achieving its goals and objectives related to this topic, though the processes are proceeding slightly slower than it had hoped.

As demonstrated by the decommissioning efforts that two existing astronomy facility have initiated, the responsible parties are working to restore sites as deemed appropriate through the established processes. It is conceivable that as additional decommissioning proposals are received, they may include (at UH’s request) provisions for the continuation or establishment of minor non-astronomy uses (e.g., restrooms, parking, space for cultural practitioners, etc.). UH may consider accommodating this through the adoption of internal guidelines or adaptations of the management actions.

Ku‘iwalu’s report to DLNR included a summary of comments that it had received from the public regarding progress on these CMP measures. In general, those comments indicated a strong desire for more timely decommissioning in accordance with statements by the Governor and UH representatives and for site restoration in accordance with the provisions of the Decommissioning Plan. Ku‘iwalu’s assessment noted that clear decommissioning requirements had been included

in the *TMT Management Plan*, the first agreement concluded following adoption of the CMP, but it noted that substantial decommissioning efforts had not been initiated until 2019. As a result, it concluded that only “some progress” had been made towards achieving the desired outcome of these management actions.

4.1.10 ACHIEVEMENT OF GOALS AND OBJECTIVES RELATED TO FUTURE LAND USES

There have been several minor new land uses and only a few major new land uses proposed and/or approved since the CMP was approved in 2009. The minor land uses include data collection efforts (including several of the research efforts discussed in Chapter 2 of this OAR). The major uses are the TMT project and the parking lot and related roadway improvements at Halepōhaku. All projects followed the appropriate CMP-required review process (different processes for minor and major projects). The projects considered their potential impacts to cultural and natural resources and incorporated avoidance, minimization, and mitigation into their designs as deemed appropriate to protect resources. Based on these outcomes, and as discussed in Section 3.9.2 and presented in tabular form in Section 4.2 (Table 4.24), the objectives related to future land uses have been met.

Ku‘iwalu’s report to DLNR included a summary of comments that it had received from the public regarding progress on these CMP measures. In general, those comments focused on the TMT project, with people being both for and against its construction. It was stated that TMT was proposed for a location that the 2000 Master Plan had indicated would not be developed. However, the site where the TMT project is permitted was identified as “Area E” in the 2000 Master Plan and specifically identified as an appropriate area for a “Next Generation Large Telescope,” such as the TMT project. Ku‘iwalu’s assessment reach a similar conclusion as UH’s and indicated “good progress” had been made towards achieving the desired outcome of these management actions.

4.1.11 ACHIEVEMENT OF GOALS AND OBJECTIVES RELATED TO OPERATIONS & IMPLEMENTATION

UH has made strides in implementing the CMP measures related to operations and implementation. As discussed in Section 3.10.2 and presented in tabular form in Section 4.2 (Table 4.25), it is on track with respect to implementing the operations and implementation measures in the CMP.

Perhaps the most important change that has occurred is the reconfiguration of the management entity from OMKM to CMS. That restructuring, which was approved by the BOR in August 2020, enhances local control, clarifies lines of responsibility, and makes the decision-making more open and responsive to community input. However, prior to and in addition to the restructuring, UH has also developed and is implementing stringent training programs for staff and volunteers, coordinating its management activities with the owners of adjacent lands, and implementing the emergency response plan procedures called for in the CMP.

Ku‘iwalu’s report to DLNR indicates that the public had mixed opinions as to how successful UH has been regarding the management of operations and implementation. Many felt UH was doing a “really good job,” but members of the Native Hawaiian community felt that despite Kahu Kū Mauna and MKMB there had been no community involvement on resource management.

Ku‘iwalu’s own judgment was that good progress had been made with respect to achieving the desired outcome.

4.1.12 ACHIEVEMENT OF GOALS AND OBJECTIVES RELATED TO MONITORING, EVALUATION, AND UPDATES

Although UH has been preparing annual reports and adapting its management since the CMP was adopted, this OAR is the first effort by UH to document its evaluation of its progress and systematically and comprehensively update the management strategies in writing as called for in the CMP. As discussed in Sections 1.1.2 and 3.11.2, has consistently prepared annual report and submitted them to DLNR; those reports are cumulative and provided opportunities for the CMP-approving agency, DLNR, to provide input on UH’s implementation of the plan. UH believes that because of those efforts it is now making reasonable progress towards achieving its goals and objectives related to this topic, though the CMP update process is proceeding slower than it had hoped. However, only after CMS has received feedback on this OAR and determined what adjustments it will make to its management actions will the update process as envisioned in the CMP be complete.

Ku‘iwalu’s report to DLNR indicated that the public felt that little progress on this goal had been made because they had not been involved in the annual reporting and OMKM had not completed a CMP update as the CMP calls for. Ku‘iwalu’s assessment was that minimal progress had been made toward this goal because the CMP had not been reviewed and updated in a timely manner.

4.2 IMPLEMENTATION STATUS OF MAUNAKEA CMP MANAGEMENT ACTIONS

The following tables summarize the implementation status of each of the management actions identified in the CMP. They are drawn from OMKM’s 2020 Annual Report to the DLNR, which covers actions through the end of 2019.

Table 4.1 Implementation Status of Items Related to Native Hawaiian Cultural Resources: Management

ID No.	Description	Status	Comments/Discussion
CR-1	Kahu Kū Mauna shall work with families with lineal and historical connections to Maunakea, cultural practitioners, and other Native Hawaiian groups, including the MKMB's Hawaiian Culture Committee, toward the development of appropriate procedures and protocols regarding cultural issues.	Ongoing	Identification of lineal and historical connections was part of the development and State Historic Preservation division approval (2014) of the Burial Treatment Plan (see CR-13). Solicitations were made through announcements in the daily newspapers and the OHA newsletter. There were no responses to the solicitations but OMKM continues to seek out individuals as part of its interaction and relationship building with the community. Fall 2013 the Hawaii Island Burial Council officially recognized several individuals as cultural descendants of Ka'ōhe Ahupua'a. OMKM placed ads over a period of several months in <i>Hawaii Tribune Herald</i>, <i>West Hawaii Today</i>, <i>Honolulu Star Advertiser</i> and OHA's <i>Ka Wai Ola</i> inviting community to participate in talk story sessions. Kahu Kū Mauna. May 21, 2016, Kahu Kū Mauna hosts a talk story session on matters related to CMP management actions, representatives from DLNR DHHL OHA and members of the Native Hawaiian community attended.
CR-2	Support application for designation of the summit region of Maunakea 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.	Ongoing	An application for the designation of the summit region of Maunakea as a Traditional Cultural Property (TCP) has not yet been submitted to the National Register of Historic Places. UH will support an application should one be submitted.
CR-3	Conduct educational efforts to generate public awareness about the importance of preserving the cultural landscape.	Ongoing	Rangers through their interactions with the visiting public help to educate and raise awareness about Mauna Kea. An informational brochure on cultural and natural resources was developed in 2014, revised in 2016, with periodic updates since then. OMKM sends out eNewsletters informing the public about OMKM and its activities. Resource orientation of those who work on the mountain including observatory personnel, VIS and MKSS staff, rangers, commercial tour operators and staff, and construction workers commenced in 2013. An online orientation is also available. A brief public / visitor orientation is complete and provided for scheduled group visits.
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.2 Implementation Status of Items Related to Native Hawaiian Cultural Resources: Cultural Practices

ID No.	Description	Status	Comments/Discussion
CR-4	Establish a process for ongoing collection of information on traditional, contemporary, and customary cultural practices.	Ongoing	Archival and oral history (Mauna Kea-Ka Piko Kaulana o Ka 'Āina); Cultural Resources Management Plan; various cultural analyses completed as part of Chapter 343 mandates; Maunakea topics included by related agencies such as USGS subject matter reviews; and other studies.
CR-5	Develop and adopt guidelines for the culturally appropriate placement and removal of offerings.	Completed	In 2016, Kahu Kū Mauna reviewed and approved the wording of draft policy guidelines. Approval by MKMB occurred in early 2018 after additional consultation by Kahu Kū Mauna. Administrative rules for the UH Management Areas, effective beginning January 2020, incorporate policies approved by the University President while ensuring protections afforded to Native Hawaiian traditional and customary practices. Note: CR-5 overlaps with CR-7 (constructing new Hawaiian cultural features) being that offerings are usually associated with the construction of new features.
CR-6	Develop and adopt guidelines for the visitation and use of ancient shrines.	Completed	In 2016 Kahu Kū Mauna drafted and the MKMB approved the policy. Administrative rules for the UH Management Areas, effective beginning January 2020, incorporate policies approved by the University President while ensuring protections afforded to Native Hawaiian traditional and customary practices.
CR-7	Kahu Kū Mauna shall take the lead in determining the appropriateness of constructing new Hawaiian cultural features.	Completed	In 2012, Kahu Kū Mauna reviewed a draft of a process. In 2016 Kahu Kū Mauna re-evaluated the policy and held a consultation session that included OHA. Approval by MKMB occurred in early 2018 after additional consultation by Kahu Kū Mauna. It is noted that the proposed policy acknowledges there are existing statutes and other agency rules governing this type of activity.
CR-8	Develop and adopt a management policy for the UH Mgt. Areas on the scattering of cremated human remains.	Completed	In 2012 Kahu Kū Mauna developed and approved a draft policy. In 2016 Kahu Kū Mauna re-evaluated the policy and held a consultation session that included OHA. Approval by MKMB occurred in early 2018 after additional consultation by Kahu Kū Mauna. Administrative rules for the UH Management Areas, effective beginning January 2020, incorporate policies approved by the University President while ensuring protections afforded to Native Hawaiian traditional and customary practices.
CR-9	A management policy for the cultural 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.	Completed	In 2012 Kahu Kū Mauna approved a draft policy. In 2016 Kahu Kū Mauna re-evaluated the policy and held a consultation session that included OHA. Approval by MKMB occurred in early 2018 after additional consultation by Kahu Kū Mauna. CR-7 was combined with CR-9 under the guidance of Kahu Kū Mauna who pointed out that the “stacking of rocks” may be a cultural feature.
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.3 Implementation Status of Items Related to Cultural Resources: Historic Properties

ID No.	Description	Status	Comments/Discussion
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.	Completed/ Ongoing	SHPD approved OMKM's long term historic properties monitoring plan; monitoring is ongoing according to the plan's schedule.
CR-11	Complete an archaeological survey of the portions of the Mauna Kea Access Road corridor that are under UH management.	Completed	An archaeological survey of the MKSR and Mauna Kea Access Road was completed in 2009.
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.	Completed	In 2012 Kahu Kū Mauna determined that this should be reviewed on a case-by-case basis. They identified criteria for when to consult for routine (minimal impact) project proposals, as well as with future development. In 2016, Kahu Kū Mauna revised their policy. MKMB approved their policy.
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, recognized lineal or cultural descendants, and SHPD.	Completed	SHPD reviewed and approved the Burial Treatment Plan for Mauna Kea in 2014.
CR-14	Immediately report any disturbance of a shrine or burial site to the Rangers, DOCARE, Kahu Kū Mauna Council, and SHPD.	Ongoing	Rangers report disturbance to OMKM and OMKM in turn notifies other parties.
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.4 Implementation Status of Items Related to Natural Resource: Threat Protection and Control

ID No.	Description	Status	Comments/Discussion
NR-1	Limit threats to natural resources through management of permitted activities and uses.	Completed/ Ongoing	OMKM consulted with agencies on a draft of administrative rules governing public and commercial activities. Public hearings seeking public comments on a proposed draft were held in 2018. Administrative rules, effective beginning January 2020, for the UH Management Areas incorporate policies approved by the University President while ensuring protections afforded to Native Hawaiian traditional and customary practices. An Operations, Monitoring and Maintenance Plan (OMMP) relating to the coordination of maintenance plans, activities and schedules was developed and approved by the MKMB, and is being implemented.
NR-2	Limit damage caused by invasive species through creation of an invasive species prevention and control program.	Completed/ Ongoing	The Maunakea Invasive Species Management Plan is approved and is being implemented. Additional topics are addressed as situations arise, and procedures are developed based on scientific, management board, and community feedback. A volunteer program was established to pull invasive weeds on the UH Management Areas with emphasis in the Halepōhaku area. Beginning in 2007 OMKM conducted annual surveys of invasive arthropod species on the UH Management Areas. This program was expanded to include monthly monitoring of the 9,200 ft mid-level facilities and quarterly monitoring of the summit facilities. Rapid response strategies were drafted as part of the Invasive Species Management Plan. Inspections of heavy equipment, construction material, and other items too large to be carried by an individual occur prior to coming on to the UH Management Areas. Specific requirements are part of the Invasive Species Management Plan. A MS Student evaluated program efficacy as part of his 2018 thesis, with management recommendations incorporated into OMKM policies and procedures. Beginning in 2013 to July 2020, a total 808 large vehicles and loads were inspected. 782 passed initial inspection or following quick remediation and were approved; 17 were rejected and required re-inspection; and 9 were non-compliant, that is, no requests for inspections were made prior to proceeding to the mountain.
NR-3	Maintain native plant and animal populations and biological diversity.	Ongoing	Non-native plants and arthropods are monitored. The Division of Forestry and Wildlife is completing a circum-Maunakea fence and ungulate removal from Palila critical habitat. OMKM staff investigated māmane leaf curl frequency at Halepōhaku (plant disease response) in coordination with UHH scientists. Arthropod food webs and parasites are being investigated.
NR-4	Minimize barriers to species migration to help maintain populations and protect ecosystem processes and development.	Ongoing	OMKM coordinates with Forest Reserve, Natural Area Reserve, and Department of Land and Natural Resources technical staff to identify issues, craft appropriate responses, and investigate concerns regarding ecosystems and flora and fauna populations.
NR-5	Manage ecosystems to allow for response to climate change.	Ongoing	OMKM coordinates with Forest Reserve and Natural Area Reserve staff to ensure management activities do not inadvertently impede natural ecosystem response. Research into climate change forecast downscaling and climate monitoring helps inform potential future management action. OMKM participated in Pacific Islands Climate Change Cooperative workshops on climate change to help identify mitigation and adaptation strategies. A climate monitoring sea level to summit network plan is in preparation.

ID No.	Description	Status	Comments/Discussion
NR-6	Reduce threats to natural resources by educating stakeholders and the public about Maunakea's unique natural resources.	Ongoing	Rangers help to educate visitors about Maunakea as part of their daily activities. Resource orientation of those who work on the mountain including astronomy personnel, VIS and MKSS staff, Rangers, commercial tour operators and staff, and construction workers commenced in 2013. An online orientation is also available. A brief public / visitor orientation is complete and provided for scheduled group visits. See also CR-3 and EO-2.
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.5 Implementation Status of Items Related to Natural Resource: Ecosystem Protection, Enhancement & Restoration

ID No.	Description	Status	Comments/Discussion
NR-7	Delineate areas of high native diversity, unique communities, or unique geological features within the Astronomy Precinct and at Halepōhaku and consider protection from development.	Ongoing	Botanical survey of the UH Management Areas is completed. Biodiversity, wēkiu bug, and erosion and surficial geology surveys are ongoing. A study and mapping of wēkiu bug habitat is completed. Surveys for birds and bats are ongoing.
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).	Ongoing	Assisted DLNR with fencing natural population of Silverswords. Other areas will be fenced when areas are identified and needed.
NR-9	Increase native plant density and diversity through an outplanting program.	Ongoing	Māmane seedlings germinated from seeds found in the Halepōhaku area were planted near the VIS. Worked with DLNR and planted 200 Silversword seedlings in the Halepōhaku area. Collaborated with Kamehameha Schools to build plant propagation benches and start seedlings for eventual habitat restoration and enhancement at Halepōhaku. Germination of māmane seedlings continues. The construction of a small greenhouse at Halepōhaku for growing native plants was approved by BLNR as part of a project to improve the ingress/egress and parking at the VIS. Over 100 native plants were planted under the ingress/egress improvements permit.
NR-10	Incorporate mitigation plans into project planning and conduct mitigation following new development.	Ongoing	Mitigation and best management practices plans are required for projects as appropriate.
NR-11	Conduct habitat rehabilitation projects following unplanned disturbances.	Ongoing	Damage assessments and rehabilitation following unplanned disturbances are conducted on a case-by-case basis as needed. Generally, unplanned disturbances, such as vehicle oil leaks, occur on previously disturbed areas such as roadways, where humans frequent.
NR-12	Create restoration plans and conduct habitat restoration activities, as needed.	Ongoing	A study of wēkiu bug habitat restoration was initiated in 2015. A study and mapping of wēkiu bug habitat has been completed. Restoration plans and greenhouse for long-term program use are part of the project to improve the ingress/egress and parking at the VIS.
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.6 Implementation Status of Items Related to Natural Resource: Program Management

ID No.	Description	Status	Comments/Discussion
NR-13	Increase communication, networking, and collaborative opportunities to support management and protection of natural resources.	Ongoing	OMKM has established and continues to establish working relationships with the community and DLNR through working groups such as the Maunakea Environment Committee and Big Island Invasive Species Committee, Maunakea Watershed Alliance, Hawaii Ant Lab, and OHA.
NR-14	Use the principles of adaptive management when developing programs and methodologies. Review programs annually and revise any component plan every five years, based on the results of the program review.	Ongoing	Potential CMP revisions are identified in annual program documentation. Program plans, such as the Maunakea Invasive Species Management Plan, are updated and communicated at MKMB meetings as issues are identified. Completion of Envision Maunakea project.
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.7 Implementation Status of Items Related to Natural Resource: Inventory, Monitoring, and Research

ID No.	Description	Status	Comments/Discussion
NR-15	Conduct baseline inventories of high-priority resources, as outlined in an inventory, monitoring, and research plan.	Completed	Baseline surveys of wēkiu bugs, other arthropods, including invasive species have been completed. A botanical survey was completed in the Summer of 2011 and published in 2013. Studies related to permafrost, climate, and erosion are also complete. Baselines for high-priority resources in the UH Management Areas have been completed. Continued monitoring and research of those resources and other resources will be conducted under NR-16 and NR-17.
NR-16	Conduct regular long-term monitoring, as outlined in an inventory, monitoring, and research plan.	Ongoing	OMKM conducts annual wēkiu bug, alien and invasive species surveys. Botanical and arthropod surveys are conducted as part of the annual archaeological monitoring.
NR-17	Conduct research to fill knowledge gaps that cannot be addressed through inventory and monitoring.	Ongoing	OMKM funded a study to develop a long term model relating to climate change and potential impact to the summit ecosystem; a study of native arthropod habitats and vegetation association, arthropod food webs; analysis of historical weather climate conditions on the summit and meteorological and geological influences on insect and snowfall drops on the summit terrain to help inform wēkiu bug research; study to assess the presence and persistence of permafrost; surficial geology and erosion; and several studies related to the wēkiu bug including life history, genetics, habitat restoration, and habitat mapping. OMKM funded an international symposium on Tropical Alpine Ecosystems. Invited speakers were experts in research and management of alpine ecosystems. OMKM hopes to develop a network with other researchers and managers to gain knowledge to better manage Maunakea.

ID No.	Description	Status	Comments/Discussion
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.	Ongoing	Wēkiu bug and botanical data, infrastructure and signs have been mapped. A GIS database of resources surveyed utilizing ArcGIS and distributed as GoogleEarth layers has been developed; new data as available is added to this database.
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.8 Implementation Status of Items Related to Education and Outreach: Program Development

ID No.	Description	Status	Comments/Discussion
EO-1	Develop and implement education and outreach program	Ongoing	Volunteer, Orientation, Brochures (Safety, Culture, Resources, What is OMKM) are available. In-school visits (Hilo Intermediate, Hawai'i Academy of Arts and Sciences Public Charter School, Ke Ana La'ahana, Waiakea High, Kealakehe Elementary) occur regularly. Community organizations and members help support OMKM's volunteer program. Work with Kealakehe Elementary School to support their annual Science Showcase at the school. Outreach activities by researchers are conducted at various schools. OMKM research affiliate also helps advise young scientists with their science fair projects. Updates on OMKM activities are given to various community organizations. OMKM also participates in community events. The MKMB approved an Education and Outreach plan in July 2020. That plan addresses EO-1, 3, 5, 6, 7, and 8.
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.9 Implementation Status of Items Related to Education and Outreach: Education

ID No.	Description	Status	Comments/Discussion
EO-2	Require orientation of users, with periodic updates and a certificate of completion, including but not limited to visitors, employees, astronomy staff, contractors, and commercial and recreational users.	Ongoing	Resource orientation of those who work on the mountain including astronomy personnel, VIS and MKSS staff, Rangers, commercial tour operators and staff, and construction workers commenced in 2013. Orientation is available to all interested parties in-person or online. The University's Administrative Rules for Maunakea include provisions for orientation of all users.
EO-3	Continue to develop, update, and distribute materials explaining important aspects of Maunakea.	Ongoing	Materials on the cultural and natural resources, visiting safely and responsibly and Maunakea hazards are distributed at the VIS.
EO-4	Develop and implement a signage plan to improve signage throughout the UH Management Areas (interpretive, safety, rules and regulations).	Completed/ Ongoing	A sign plan was approved by the MKMB in 2016 and implemented in 2017. An inventory of sign locations on the UH Management Areas has been completed. Cultural and safety related signs have been installed.
EO-5	Develop interpretive features such as self-guided cultural walks and volunteer-maintained native plant gardens.	Completed/ Ongoing	Included as part of ongoing CIP funded project. The MKMB approved an Education and Outreach plan in July 2020. That plan addresses EO-1, 3, 5, 6, 7, and 8.

ID No.	Description	Status	Comments/Discussion
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.	Ongoing	See EO-1.
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.10 Implementation Status of Items Related to Education and Outreach: Outreach

ID No.	Description	Status	Comments/Discussion
EO-7	Continue and increase opportunities for community members to provide input to cultural and natural resources management activities on Maunakea, 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.	Ongoing	OMKM through the MKMB, Kahu Kū Mauna, and Environment Committee provide opportunity for members of the community and other organizations to participate in the management activities of the mountain. Bi-monthly volunteer activities provide an opportunity for the community to participate and share knowledge. Meetings with community groups and open houses were conducted to give the public an opportunity to provide input and feedback on administrative rules being developed by OMKM. Public hearings seeking public comments on a proposed draft were held in 2018.
EO-8	Provide opportunities for community members to participate in stewardship activities.	Ongoing	OMKM through the MKMB, Kahu Kū Mauna, and Environment provide opportunities for members of the community to participate in the management activities of the mountain. Bi-monthly volunteer activities provide an opportunity for the community to participate and share knowledge. Student projects and mentoring provides opportunities (science fair, legacy, etc.) for one-on-one interaction and more in-depth efforts.
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.11 Implementation Status of Items Related to Astronomical Resources

ID No.	Description	Status	Comments/Discussion
AR-1	Operate the UH Management Areas to prohibit activities resulting in negative impacts to astronomical resources.	Ongoing	Administrative rules, effective beginning January 2020, for the UH Management Areas incorporate policies approved by the University President while ensuring protections afforded to Native Hawaiian traditional and customary practices.

ID No.	Description	Status	Comments/Discussion
AR-2	Prevent light pollution, radio frequency interference (RFI) and dust.	Ongoing	Project proposals requesting the use of radio signals are reviewed by the Institute for Astronomy for potential interference with astronomical research activities. At the State level, the Starlight Reserve Advisory Committee was active from 2010 to 2015. Efforts made by UH and DBEDT during subsequent Legislative sessions to make the committee permanent have been unsuccessful. UH has been working closely with Hawai'i County officials on outdoor lighting issues. This has resulted in the adoption of public-health, wildlife, and astronomy-friendly LED lights to replace the previous low-pressure sodium lights. UH and the County are now requesting the State to use similar lights at Hawai'i Island airports and harbors. UH continues to provide advice on amendments to the Hawai'i County lighting ordinance.
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.12 Implementation Status of Items Related to Activities and Uses: General Management

ID No.	Description	Status	Comments/Discussion
ACT-1	Continue and update managed access policy of 1995 Management Plan.	Completed/ Ongoing	The BLNR approved the Public Access Plan for UH Management Areas in 2011. That plan contains principles and policies regarding public access. Section § 20-26-38 of the recently adopted Administrative Rules specifically addresses limits on access within the UH Management Area. It authorizes the University to close or limit vehicular access when needed for protection from hazardous conditions, to allow construction or maintenance activities, or to allow transportation of wide, heavy, or otherwise hazardous loads. It also allows the University to restrict access by private vehicles for public safety and welfare, for the protection of resources, and to reduce congestion. UH is in the process of updating the Master Plan in accordance with those rules.
ACT-2	Develop parking and visitor traffic plan.	Completed/ Ongoing	A CDUP was issued to implement the ingress/egress project at Halepōhaku, and the improvements were completed in 2019. OMKM Rangers assist staff at the VIS with the implementation of their interim parking plan to maintain order, accommodate as many vehicles as possible and to ensure the safety of visitors to the VIS. An automated vehicle counter counts the number of vehicles (differentiating public, commercial, tour, astronomy, etc.) that drive above Halepōhaku.
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.	Completed/ Ongoing	Rangers are present year-round from 7:15 am to 10:00 pm daily; DOCARE officers and Hawai'i County Police are called for assistance on an as needed basis.

ID No.	Description	Status	Comments/Discussion
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.	Ongoing	HAR § 20-26-28 limits the use of motorized vehicles to roads and trails designated for that purpose. Vehicle access to the top of Pu‘upoli‘ahu has been blocked since 2001 at the request of Kahu Kū Mauna. Commercial operators and film crews are required to stay on the road or within the footprint of existing facilities, unless granted permission by OMKM.
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.13 Implementation Status of Items Related to Activities and Uses: Recreational

ID No.	Description	Status	Comments/Discussion
ACT-5	Implement policies to reduce impacts of recreational hiking	Completed/ Ongoing	HAR § 20-26-21 limits hiking to designated trails and roads, except by written permit. The University has not yet developed a map depicting all of the trails that may be used.
ACT-6	Define and maintain areas where snow-related activities can occur and confine activities to slopes that have a protective layer of snow.	Ongoing	Generally, this is a self-regulated activity. People usually do not venture to areas where there is no snow. A map of areas where snow play generally occurs has been developed for internal use, but areas change depending on the weather and snow deposition. HAR § 20-26-39 specifically addresses snow play, restricting skiing, snowboarding, sledding, and other similar winter or snow sports as needed to: (i) maintain public safety and welfare; (ii) prevent damage to resources; and (iii) minimize conflicts among visitors. It specifically prohibits organized contests, meets, or competitions, snow play tours or other similar events for skiing, snowboarding, sledding or other forms of snow recreation or snow activities. It also prohibits operating a snowmobile, an all-terrain vehicle, or other motorized vehicle used for snow recreation anywhere in the UH Management Areas.
ACT-7	Confine University or other sponsored tours and stargazing activities to previously disturbed ground surfaces and established parking areas.	Ongoing	Star gazing activities on the UH Management Areas are limited to parking lots, or in areas in close proximity to the VIS. HAR § 20-26-28 requires any motorized or non-motorized vehicle or trailer to park in designated areas and use designated roads or trails.
ACT-8	Coordinate with DLNR in the development of a policy regarding hunting in the UH Management Areas.	Completed/ Ongoing	As made clear in HAR § 20-26-3(c), where overlapping jurisdictions pertaining to hunting are present (including administrative rules), DLNR’s hunting rules govern.
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.14 Implementation Status of Items Related to Activities and Uses: Commercial

ID No.	Description	Status	Comments/Discussion
ACT-9	Maintain commercial tour permitting process; evaluate and issue permits annually.	Ongoing	UH oversees commercial tour permits, a responsibility transferred to UH from BLNR. As prescribed in HAR § 20-26-61-64, the University may issue permits for conducting commercial tours or transporting passengers for hire within the UH management areas. Each permit application is evaluated on its own merits for compatibility with such things as the functions and purpose of UH management areas, consistency with existing approved management plans, potential effect on the surrounding resources, existing facilities and infrastructure, and the public's use of the area. In addition, each permit application is also evaluated for the quality of its educational aspects, the comprehensiveness of planned staff training, and its safety protocols.
ACT-10	Ensure OMKM input on permits for filming activities	Completed/ Ongoing	HAR § 20-26-65 stipulates that commercial video, digital, film, still photography, or any other visual and audio recordings taken within the UH management areas are prohibited without a written permit issued by the Hawai'i Film Office of the State of Hawai'i Department of Business Economic Development, and Tourism. It requires that the University review all permit applications involving the UH management areas and recommend approval or denial of each permit application, request that any film permit that is issued include specific conditions, and may request fees, insurance, performance bonds, or deposits to cover administrative and personnel expenses or potential damages to resources associated with the proposed activity.
ACT-11	Seek statutory authority for the University to regulate commercial activities in the UH Management Areas.	Completed	The promulgation of HAR Chapter 20-26 provides statutory authority for the University to regulate commercial activities in the UH Management Areas.
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.15 Implementation Status of Items Related to Activities and Uses: Scientific Research

ID No.	Description	Status	Comments/Discussion
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.	Ongoing	HAR § 20-26-62 authorizes the University to grant permits that allow activities for scientific, educational, or management purposes if they are consistent with the approved management plan, are compatible with the functions and purpose of the UH management areas, and do not have undue adverse effect on existing or previously approved research or on the surrounding resources. Proposals requiring ground disturbing activities or potential impact to the cultural and/or natural landscape are reviewed by Kahu Kū Mauna and MKMB. Permit by DLNR as appropriate.
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.16 Implementation Status of Items Related to Permitting and Enforcement: Laws and Regulations

ID No.	Description	Status	Comments/Discussion
P-1	Comply with all applicable federal, state, and local laws, regulations, and permit conditions related to activities in the UH Management Areas.	Ongoing	This is a condition of UH's leases with DLNR. Rangers monitor activities. Regular communication with DLNR's Division of Conservation and Resources Enforcement, County of Hawaii police, and Sheriff's department continues as demonstrated during TMT protests. Since 2006, Maunakea Rangers have been conducting biannual inspections of all facilities on the UH Management Areas for compliance with their CDUPs, and the University has undertaken or monitored corrective action as appropriate.
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.	Ongoing	Relevant CMP management actions were incorporated into the CDUA for the Thirty Meter Telescope project. The MKMB requires proposals for projects for Maunakea include a review and comments on how the proposer will comply with CMP action items relevant to the project.
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.	Completed	The Legislature granted UH authority to promulgate administrative rules in 2009. Act 132.
P-4	Educate management staff and users of the mountain about all applicable rules and permit requirements.	Ongoing	Included as part of the orientation and with new project start-up meetings. This will be addressed in administrative rules. Public hearings seeking public comments on a proposed draft were held in 2018.
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.17 Implementation Status of Items Related to Permitting and Enforcement: Laws and Enforcement

ID No.	Description	Status	Comments/Discussion
P-5	Continue coordinating with other agencies on enforcement needs.	Ongoing	OMKM coordinates with DOCARE on enforcement activities. Ranger observations are sent to DLNR, NAR, DOFAW, and US Fish & Wildlife Service.
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.	Completed	
P-7	Develop and implement protocol for oversight and compliance with Conservation District Use Permits.	Ongoing	OMKM Rangers conduct twice yearly inspections of all astronomy facilities for CDUP compliance.
P-8	Enforce conditions contained in commercial and Special Use permits.	Ongoing	Rangers' responsibilities includes oversight of commercial tour activities and special use permits issued by OMKM.
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.18 Implementation Status of Items Related to Infrastructure and Maintenance: Routine Maintenance

ID No.	Description	Status	Comments/Discussion
IM-1	Develop and implement an OMMP.	Completed/ Ongoing	An Operations Monitoring and Maintenance Plan (OMMP) was reviewed by Kahu Kū Mauna and approved by the MKMB. Implementation is ongoing.
IM-2	Reduce impacts from operations and maintenance activities by educating personnel about Maunakea's unique resources.	Ongoing	A cultural and natural resources orientation program has been developed and is implemented. Orientation sessions on resources and safety are conducted for OMKM and MKSS staff. This will be addressed in administrative rules. Public hearings seeking public comments on a proposed draft were held in 2018.
IM-3	Conduct historic preservation review for maintenance activities that will have an adverse effect on historic properties.	Ongoing	OMKM coordinates with DLNR and SHPD specifically often. Information regarding maintenance projects and proposals are provided to DLNR, they are then reviewed and approved as deemed appropriate by DLNR. Routine maintenance activities that do not involve ground disturbance or occur on previously disturbed land are performed as needed and do not require historic preservation review.
IM-4	Evaluate need for and feasibility of a vehicle wash station near Halepōhaku, and requiring that vehicles be cleaned.	Completed/ Ongoing	OMKM funded a study to evaluate the efficacy current measures to prevent the introduction of invasive species, including vehicle and equipment wash practices.
IM-5	Develop and implement a Debris Removal, Monitoring and Prevention Plan.	Ongoing	Trash from the HP facilities and VIS are removed daily. Each astronomy facility removes trash from their respective facilities. Rangers routinely check for and pick up trash and debris while on their daily patrols. Rangers pick up and map the location of trash at the parking lot near the trail head to Lake Waiau (NAR). The amount of trash decreased following the installation of a portable toilet. A draft plan is under review.
IM-6	Develop and implement an erosion inventory and assessment plan.	Ongoing	OMKM partnered with UH Hilo geography department to study surficial geology and cinder cone erosion issues. It is anticipated the inventory will be completed in 2021
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.	Ongoing	An inventory of all known aircraft and military wreckage was submitted to the Department of Defense for review and updating. OMKM is working with DOD, OCCL, and SHPD to determine appropriate plans for removal or preservation in place.
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.19 Implementation Status of Items Related to Infrastructure and Maintenance: Infrastructure

ID No.	Description	Status	Comments/Discussion
IM-8	Assess feasibility of paving the Mauna Kea Access Road.	Completed/ Ongoing	An engineering study related to the paving of the Mauna Kea Access Road from Halepōhaku to the summit was completed in 1984. This study was the basis for paving the road from the summit to about the boundary of the MKSR. Another study was prepared in 2017 of the damage caused by large storms over the past ten years. The report assessed repairs needed and potential cost. .
IM-9	Evaluate need for additional parking lots and vehicle pullouts and install if necessary.	Ongoing	As part of the CIP ingress/egress project at the VIS, additional parking was assessed and parking added. With TMT a recreational parking plan for Batch Plant (Park 3) was submitted to DLNR and approved. A visitor study initiated in 2019 by UH Mānoa will further inform any future efforts.
IM-10	Evaluate need for additional public restroom facilities in the summit region and at Halepōhaku, and install close-contained zero waste systems if necessary.	Ongoing	Initial consideration of converting the presentation room building into a rest and eating stop for commercial tours as a means of reducing congestion at the VIS and providing greater access by the independent travelers, has been put on hold until completion of the ingress/egress project is completed, or if another solution presents itself. MKSS is considering options for handling overcrowding at the VIS. Additional portable toilets are available at the summit to address restroom facilities needs at the summit. Waterless urinals were installed in the VIS men’s restroom.
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.20 Implementation Status of Items Related to Infrastructure and Maintenance: Sustainable Technologies

ID No.	Description	Status	Comments/Discussion
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.	Ongoing	The proposed Thirty Meter Telescope is incorporating energy efficiency in its design. MKSS installed a photovoltaic system at Halepōhaku; Gemini and Keck have installed photovoltaic systems on their respective summit facilities.
IM-12	Conduct energy audits to identify energy use and system inefficiencies, and develop solutions to reduce energy usage.	Ongoing	Energy audits are part of the photovoltaic system design process, completed or in progress at Gemini, Keck, and Halepōhaku.
IM-13	Conduct feasibility assessment, in consultation with Hawaii Electric Light Company, on developing locally-based alternative energy sources.	Ongoing	MKSS installed a photovoltaic system at Halepōhaku. Additional energy conservation and sustainable generation possibilities are discussed by UHH, MKSS, and astronomy facilities as opportunities arise.
IM-14	Encourage astronomy facilities to investigate options to reduce the use of hazardous materials in astronomy operations.	Ongoing	With the development of new technology, astronomy facilities are beginning to reduce their need to use hazardous materials. An example, is the TMT observatory, which will not be using mercury.
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.21 Implementation Status of Items Related to Construction Guidelines: General Requirements

ID No.	Description	Status	Comments/Discussion
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.	Ongoing	Included as part of the proposed TMT Management Plan in its CDUA.
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.22 Implementation Status of Items Related to Construction Guidelines: Best Management Practices

ID No.	Description	Status	Comments/Discussion
C-2	Require use of Best Management Practices Plan for Construction Practices.	Ongoing	Included as part of the proposed TMT Management Plan in its CDUA. A template for adaptation and use by others is also available.
C-3	Develop, prior to construction, a rock movement plan.	Ongoing	Included as part of the proposed TMT Management Plan in its CDUA.
C-4	Require contractors to provide information from construction activities to OMKM for input into OMKM information databases.	Ongoing	Included as part of the proposed TMT Management Plan in its CDUA.
C-5	Require on-site monitors (e.g., archaeologist, cultural resources specialist, entomologist) during construction, as determined by the appropriate agency.	Ongoing	Included as part of the proposed TMT Management Plan in its CDUA.
C-6	Conduct required archaeological monitoring during construction projects per SHPD approved plan	Ongoing	Included as part of the proposed TMT Management Plan in its CDUA.
C-7	Education regarding historical and cultural significance	Ongoing	Included as part of the proposed TMT Management Plan in its CDUA.
C-8	Education regarding environment, ecology and natural resources	Ongoing	Included as part of the proposed TMT Management Plan in its CDUA.
C-9	Inspection of construction materials	Ongoing	Included as part of the proposed TMT Management Plan in its CDUA.
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.23 Implementation Status of Items Related to Site Recycling, Decommissioning, Demolition and Restoration

ID No.	Description	Status	Comments/Discussion
SR-1	Require astronomy facilities to develop plans to recycle or demolish facilities once their useful life has ended, in accordance with their sublease requirements, identifying all proposed actions.	Ongoing	This will be part of the TMT decommissioning plan, with the TMT decommissioning funding plan approved by the MKMB in 2014.
SR-2	Require astronomy facilities to develop a restoration plan in association with decommissioning, to include an environmental cost-benefit analysis and a cultural assessment.	Ongoing	Included as part of the proposed TMT Management Plan in its CDUA.
SR-3	Require any future astronomy facilities to consider site restoration during project planning and include provisions in subleases for funding of full restoration.	Ongoing	Included as part of the proposed TMT Management Plan in its CDUA.
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.24 Implementation Status of Items Related to Considering Future Land Use: Facility Planning Guidelines

ID No.	Description	Status	Comments/Discussion
FLU-1	Follow design guidelines presented in the 2000 Master Plan.	Ongoing	The Design Review Process, which incorporated the 2000 Master Plan's design guidelines, were used in the review of the Thirty Meter Telescope project
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.	Completed	Areas previously mapped as off-limits for future land use through plans such as the 2000 Master Plan or CMP are used to limit any proposed activity. UH President Lassner confirmed that TMT was the last astronomy facility to be built on undisturbed land. Resource data must be part of any proposal for major land use requests. HAR § 13-5 allows for different types of land uses with each having its own requirements for preparing a land use application. Thus a single pre-prepared map cannot possibly address all potential scenarios.
FLU-3	Require cataloguing of initial site conditions for use when conducting site restoration.	Ongoing	TMT project completed a photo documentation of its site.
FLU-4	Require project specific visual rendering of both pre- and post-project settings to facilitate analysis of potential impacts to view planes.	Ongoing	TMT project completed a photo documentation.
FLU-5	Require an airflow analysis on the design of proposed structures to assess potential impacts to aeolian ecosystems.	Ongoing	Incorporated into the TMT project.
FLU-6	Incorporate habitat mitigation plans into project planning process.	Ongoing	Incorporated into the TMT project
FLU-7	Require use of close-contained zero-discharge waste systems for any future development in the summit region, from portable toilets to astronomy facility restrooms, if feasible.	Ongoing	Incorporated into the TMT project
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.25 Implementation Status of Items Related to Operation and Maintenance

ID No.	Description	Status	Comments/Discussion
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.	Completed	The MKMB meets regularly, holding numerous public meetings, which includes consultation with Kahu Kū Mauna Council. OMKM continues to submit CMP management actions (such as the OMMP) to MKMB. MKSS continues to maintain the road and public services, financially supported by the MKOs.
OI-2	Develop training plan for staff and volunteers.	Completed	OMKM requires all staff and volunteers to attend the Maunakea orientation. A training plan was submitted and approved by the MKMB; bi-monthly trainings of all staff is being conducted.
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.	Ongoing	OMKM has frequent contact in particular with its neighbor, DLNR on resource management issues. Rangers report unusual or suspicious behavior observed on DLNR lands to DLNR including DOCARE.
OI-4	Establish grievance procedures for OMKM, to address issues as they arise.	Complete/ Ongoing	The public has the opportunity to address grievances at the MKMB publicly held meetings. Public hearings seeking public comments on a proposed grievance procedure were held in 2018.
OI-5	Update and implement emergency response plan.	Ongoing	Emergency response plan is reviewed annually.
Source: 2020 Annual Report to BLNR: Appendix F			

Table 4.26 Implementation Status of Items Related to Monitoring, Evaluation, and Updates

ID No.	Description	Status	Comments/Discussion
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.	Ongoing	Reports are provided at the publicly held MKMB Meetings. UH has prepared and submitted annual reports to DLNR.
MEU-2	Conduct regular updates of the CMP that reflect outcomes of the evaluation process, and that incorporate new information about the resources.	Ongoing	Five-year CMP revision interval was initiated in 2014. EnVision Maunakea and administrative rules will play a role in the updating the CMP.
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 Maunakea and reflect stewardship matters resolved with DLNR.	Ongoing	UH is preparing an EIS for a new Maunakea land authorization. A Prep Notice was prepared and published in February 2018. UH is reviewing comments and is considering them in the development of the draft.
Source: 2020 Annual Report to BLNR: Appendix F			

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**Appendix A. 2020 Annual Report to the Board of Land and Natural
Resources, Status of the Implementation of the Mauna Kea Comprehensive
Management Plan**



**2020 Annual Report
to the
Board of Land and Natural Resources**

**Status of the Implementation of the
Mauna Kea Comprehensive Management Plan**

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Executive Summary

Comprehensive Management Plan Historical Perspective

Following the recommendation of the Office of the Auditor's 2005 report, *Follow-up Audit of the Management of Mauna Kea and the Mauna Kea Science Reserve*, the Office of Maunakea Management continued with its preparation of what was referred at the time as an integrated management plan. The process involved the development of two separate plans, cultural and natural resources management plans, with the intention of merging the two documents into one integrated plan, later coined Comprehensive Management Plan (CMP) by the Auditor.

Approval of the CMP by the Board of Land and Natural Resources formalized the State's management requirements for the University's management areas on Maunakea. The University's Board of Regents' acceptance of the responsibility to implement the CMP also delegated CMP implementation to the Office of Maunakea Management as the single entity to manage a comprehensive integrated plan.

Office of Maunakea Management

The Office of Maunakea Management (OMKM) was created when the Board of Regents approved the *Mauna Kea Science Reserve Master Plan* in June 2000. Together with two community-based volunteer advisory groups, Kahu Kū Mauna and Maunakea Management Board, the Board of Regents committed to community-based management. The Master Plan identified the need for a single entity to manage a comprehensive integrated plan to be based on the Island of Hawai'i housed within the University of Hilo and funded as a separate, ongoing program unit. Housing OMKM within the University system made a clear statement that the University accepted the responsibility for OMKM's function.

The role and responsibilities of OMKM involves not only land stewardship with the main focus on protecting the cultural, natural and scientific resources and managing public and commercial activities, but overseeing the project review process including construction and decommissioning processes. The latter is not the same as proposing projects that can range from camera and weather instrument installation to the addition of safety features to facilities to observatory development. ***Projects are proposed by the respective facility or the University and the role of OMKM, Kahu Kū Mauna, and Maunakea Management Board is to review these projects for compliance with the CMP, 2000 Master Plan, rules and regulations including DLNR's Conservation District rules, and subleases and leases.*** The Master Plan does not include as part of OMKM's, Kahu Kū Mauna's and Maunakea Management Board's scope of responsibilities the determination of the number of telescopes to construct and/or decommission. Those determinations are made outside of OMKM.

Implementation of Comprehensive Management Plan on Track

The CMP contains 103 management actions covering protection of the resources, managing access, activities and uses, education and outreach to management of mountain operations and the built environment. OMKM categorized its efforts in implementing the CMP's diverse range of responsibilities into five major categories: research and monitoring; resources management programs; education, training and outreach; visitor management; and permitting, enforcement and facility oversight. All of the CMP actions have either been implemented (completed), are ongoing, or are in stages of undergoing implementation. The majority of CMP actions are ongoing and are essential components of OMKM's stewardship responsibilities, in other words, as long as OMKM has land management stewardship responsibilities on Maunakea those activities will continue to be implemented.

In addition to Appendices listing descriptions of OMKM's activities and status of implementation for each CMP management action, this year's annual report contains additional Appendices detailing OMKM's stewardship functions and activities since its inception that are related to OMKM's categories of implementation.

1. Comprehensive Management Plan (CMP) Background

The State Auditor recommended in the December 2005 *Follow-Up Audit of the Management of Mauna Kea and the Mauna Kea Science Reserve*, State Auditor that the University of Hawai'i "develop, implement, and monitor a comprehensive management plan for natural, cultural and historic resources of the summit and Hale Pohaku area". The University prepared a Comprehensive Management Plan (CMP), and 2009, the Board of Land and Natural Resources (BLNR) approved the CMP. Upon approval, the CMP became the State's management plan for the University's management lands on Maunakea.

The CMP is consistent with the purposes and values of the State's Conservation District lands and OMKM's mission of achieving sustainable management and stewardship 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 CMP's overarching goal is to provide management strategies that protect, preserve, and enhance Maunakea Kea's resources.

A requirement of the Board of Land and Natural Resources approval of the CMP is the submittal of annual reports on the status of the implementation of the CMP.

2. Annual Report

As identified in the 2009 Mauna Kea Comprehensive Management Plan, management action MEU-1 states: OMKM shall produce an annual progress report on the management goals, objectives, and actions for the year and what progress was made towards meeting them. "This 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."

2.1 Overview of CMP Management Actions

The CMP contains 103 management actions categorized into four component plans which are further subdivided into sub-components (Table 1).

Table 1. CMP component plans.

CMP 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

2.2 Assigning Categories and Priorities

Each management actions was assigned into one of four categories. These categories represent time periods during which it was estimated the actions would be implemented.

Immediate	1 - 3 years
Short term	4 - 6 years
Mid-term	7 - 9 years

Long-term 10 + years

In a change from earlier reports, for the 2020 report OMKM has updated the five priority categories for reporting. These changes reflect evolving concerns regarding “Visitor Management” following the adoption of administrative rules; interest in the “Permitting, Enforcement and Facility Oversight” of facility compliance with Conservation District Use Permits, and infrastructure improvements at Halepōhaku and decommissioning progress of two telescopes. Research & Monitoring have been combined into a single reporting category as these programs have matured. “Education, Training and Outreach” and “Printed Materials & Public Forums” were consolidated having similar purposes. Efforts have been initiated in all of the categories and are described below.

Priority Categories

- 1) Research & Monitoring
- 2) Resources Management Programs
- 3) Education, Training, and Outreach
- 4) Visitor Management
- 5) Permitting, Enforcement and Facility Oversight

2.3 Reporting Definitions

2010-2011 Each management action was initially assigned one of four progress status designations: **As Needed**, **Short to Long Term**, **Ongoing**, or **Completed**.

2012 In 2012 the **Ongoing** category was further divided into two groups, **Ongoing** and **In Progress**, to distinguish management actions that are part of OMKM’s regular responsibilities (ongoing) and those that require specialized implementation (in progress).

2014-present Based on feedback from the Office of the Auditor, State of Hawaii, beginning with 2014, the definitions for Ongoing and In Progress were further refined. **Ongoing** refers to activities that have established processes in place and are performed as part of OMKM’s daily responsibilities. For example, processes for reporting disturbances to historic properties are established while actual reporting is **Ongoing** as necessary. **In Progress** refers to actions that require specialized implementation such as the development of policies or hiring consultants and researchers, and while efforts are **In Progress** the action or process is not yet complete.

Table 2. Evolution of the Definition of the Terms Ongoing and In-Progress (years 2010 through 2014)

2010 – 2011	2012 - 2013		2014
Ongoing are actions that are being implemented	Ongoing was divided into two groups		Auditor’s recommendation
	Ongoing are activities that are performed as part of OMKM’s daily responsibilities	In-Progress are actions that require specialized implementation, e.g., development of policies or hiring of consultants	Ongoing was further defined as activities that have established processes in place and are performed as part of OMKM’s daily responsibilities. In-Progress are actions that requires specialized implementation and while efforts are in-progress, the action or process is not yet complete.

Used in this report, the definitions are:

- **Short to Long Term:** Management action still to be implemented during its scheduled time period.
- **In Progress:** Management action that requires specialized implementation has been initiated, process is not yet complete.
- **Ongoing:** Management action is implemented and processes are in place to fulfill this requirement, actions will continue indefinitely because they are part of OMKM's continuing management responsibilities.
- **Completed:** Management action is completed.

2.4 Annual Reports are Cumulative

Each successive report builds upon the previous year's report, thereby the annual reports beginning with 2011 are cumulative. As an annual report, this submission provides additional detail on activities occurring in calendar year 2019.

3. Summary of Implementation Activities

Most management actions have either been implemented or are in progress. Many actions are considered 'ongoing' as they are long term, continuous land management responsibilities. Appendix F details the implementation status with explanations for individual CMP management actions. Appendix G details the cumulative annual progression of implementation status from 2010 to present.

Below is a summary of implementation activities in support of the management action status determination.

3.1 Research & Monitoring (Appendix A)

Following the implementation of studies and establishing baseline inventories to determine the presence, distribution, and abundance of a resource, the next step is monitoring to assess the status of the resource over time. Along with inventories and monitoring, data from research provides the basis for the development of resource protection programs. OMKM utilizes resources available within the UH system including faculty, graduate and undergraduate students, in its efforts to fulfill CMP mandates. Details on OMKM's activities related to research and monitoring is presented in Appendix A.

Cultural Resources

Historic Property Monitoring (

Following the completion of an archaeological inventory survey of the Maunakea Science Reserve and summit access road, annual assessments of the archaeological sites (historic properties) began in 2012. In compliance with the Long Term Historic Property Monitoring Plan, approved by SHPD in 2014, assessment of historic properties in the Astronomy Precinct and alongside the summit access road is conducted annually while the more remote sites are assessed on a three and five year rotational basis. Annual reports for these efforts are submitted to SHPD after consultation with the Kahu Kū Mauna Council on management action recommendations.

Collecting Information on Traditional and Customary Practices

In consultation with Kahu Kū Mauna, OMKM's process for collecting information on traditional and customary practices is through published documents from studies, oral histories, or through other formal methods of information gathering, such as environmental assessments and impact statements. Examples of published works include the 1999 "Oral History and Consultation Study for the Mauna Kea Science Reserve and Hale Pōhaku Complex Development Plan Update", 2005 archival project and oral history "Mauna Kea-Ka Piko Kaulana o Ka 'Āina", 2009 "Cultural Resource Management Plan", and various cultural assessments completed as part of HRS Chapter 343 mandates. Similar third party materials, such as the USGS Open File Report 2017-1043 "Conversing with Pelehonuamea: A workshop combining 1,000+ years of traditional Hawaiian knowledge with 200 years of scientific thought on Kīlauea volcanism" also incorporate information on Maunakea's traditional and customary practices. Additional partnerships within the UH-system and other State-agency partners, continue to be pursued.

Biological Resources

Arthropod (Wēkiu Bug and Alien Species) Monitoring

Monitoring of the wēkiu bugs and alien arthropods, which began in 2002 and 2007 respectively, is conducted annually. Beginning in 2013 monthly surveys are also made in and around the surrounding areas of the facilities at the 9,200 foot elevation while quarterly arthropod surveys are conducted at facilities at the summit.

Biodiversity of Arthropods

Field work for the 2011 study of the biodiversity of arthropods in the summit region in the Halepōhaku area is complete. Specimen curation and report writing are anticipated to be complete in 2020. As a result of OMKM's research and monitoring efforts, the species of native moth previously documented at Halepōhaku and the summit region were formally described in the scientific literature; <https://biotaxa.org/Zootaxa/article/viewFile/zootaxa.4545.2.7/38727> and found to actually be two distinct species. Additional state-of-the-science DNA PhD-level research is augmenting this research. The "Metabarcoding Maunakea Project" includes three objectives: (1) update existing databases of the arthropod species on Maunakea, (2) understand the diet (food webs) of native and endemic species using metabarcoding, and (3) use of this dietary data to understand the impacts of invasive species. This study is anticipated to continue into 2022.

Wēkiu Bug

A study of the characterization and mapping of wēkiu bug habitat was completed in 2016. A study on the restoration of wēkiu bug habitat that was initiated in 2015 culminated in the publication of a thesis in early 2018. A PhD candidate is studying wēkiu bug microbial endosymbionts (i.e. gut bacteria) to understand the evolutionary shifts in diet and habitat from seed eating *Nysius* to the carnivorous wēkiu bug. This research is also anticipated to continue into 2022.

Botanical Monitoring

Monitoring of botanical resources is completed in conjunction with the yearly historic property monitoring.

Vertebrate Biology

Begun in 2017 and continuing through 2021, the study on the distribution of native Hawaiian birds and bats within the University of Hawai'i management areas uses radar and acoustic technologies to identify the areas of bird and bat habitat use on Maunakea.

Geology, Hydrology, and Erosion

Lake Waiau Photo Monitoring

While not part of UH's managed lands, in a cooperative effort with DLNR's Natural Area Reserve, OMKM rangers photo document monthly the level of Lake Waiau in the Mauna Kea Ice Age Natural Area Reserve, and periodically hike to the adze quarry to assess conditions.

Study of Erosion Processes

A multi-year study of surface erosion processes on cinder cones that was initiated in 2014 is anticipated to conclude in 2020. A second iteration of terrestrial LiDAR mapping (detailed digital elevation mapping) was completed in 2017. In 2018 field work included data collection in the Halepōhaku area while in 2019 the Maunakea Summit Access Road corridor was added to the study area. A final round of data collection occurred in 2020. This study will help to better understand natural erosion as well as help characterize arthropod habitat.

Permafrost

OMKM funded a study to assess the presence of permafrost and whether conditions for the formation of permafrost still exist—this project is transitioning to a monitoring phase to document the long-term status of permafrost on Maunakea. The publication "The Coldest Places in Hawaii: The Ice-Preserving Microclimates of High-Altitude Craters and Caves on Tropical Island Volcanoes" characterized unique climate phenomena found on Maunakea (<https://doi.org/10.1175/BAMS-D-17-0238.1>).

Groundwater Hydrology

A groundwater hydrology study was begun in late 2017 and is anticipated to include up to 5 years of data collection, looking at sources of groundwater in west Hawai'i, including sensors at the summit and at Halepōhaku.

Observatories Assist with Volcano Threat Assessment

The U.S. Geological Survey national volcanic threat assessment was updated, addressing the ongoing Kīlauea eruption as well as Maunakea and other Hawaiian volcanoes. Low-light cameras developed by the astronomical observatories installed at the summit with views of the eruption and lava flow areas, proved extremely helpful in monitoring eruption activities.

Weather and Climate Research

Climate Change Models

A multi-year study developing climate change models to determine impacts to the summit ecosystem 50-years in the future is available in a public data archive (<http://thredds.soest.hawaii.edu:8080/thredds/catalog/downscaling/catalog.html>).

Long-Term Temperature Records

A separate study integrating long-term temperature records and other types of climate data for earlier years when temperature was not recorded was completed and a journal manuscript is in review. Research into climate processes for this plan was published as "Temperature Trends in Hawai'i: A Century of Change, 1917–2016"; <https://rmets.onlinelibrary.wiley.com/doi/abs/10.1002/joc.6053>. The article "Snow cover in Hawai'i (1893–1953) and its effect on ground temperature" was published as a result of coordination across several research projects, with a Farrington High School graduate (now a college undergraduate) as the lead author; <https://doi.org/10.1080/15230430.2019.1600963>.

Vog Monitoring

Sulfur dioxide sensors were installed at Halepōhaku to help assess vog distribution and allow visitors to better manage public health concerns; <https://tatacenter-airquality.mit.edu/hawaii-vog>.

Weather Monitoring

The above studies in conjunction with development of a plan to improve weather monitoring on the summit as part of a sea level to summit network of weather stations will help to track changes in weather and climate over the long term and will provide data to evaluate altitudinal changes and impacts on ecosystems from sea level to the summit.

Invasive Species Threats

Measures to Prevent Introduction of Invasive Species

In 2015, OMKM initiated a study to evaluate measures to prevent the introduction of invasive species, in particular the inspections of vehicles and equipment. This included an analysis of the feasibility of a vehicle washing facility as a means of helping to prevent the introduction of invasive species. This study concluded in early 2018 and provides management-specific recommendations as part of a MS thesis.

Invasive Species Protocols - Updates

Invasive species prevention protocols were updated in 2018 addressing relevant recommendations from the 2018 MS thesis research (above).

Other Studies

Visitor and Commercial Tour Capacity Study

In collaboration with UH Mānoa's School of Travel Industry Management, OMKM initiated a study in 2019 to assess the capacity for commercial tour operations and public visitation on UH's managed lands. Data collection efforts have been hampered by road closures associated with the 2019 start-up efforts of the Thirty Meter Telescope project and reduced activity in 2020 due to COVID-19 pandemic.

3.2. Resource Management Programs (Appendix B)

Resource management programs may be policies, plans, or long-term action programs which purpose is to preserve or protect the resources, or to help ensure the health and safety of those visiting and working on the mountain. The adoption of administrative rules in January 2020 will necessitate careful review of policies related to resource management, with potential concurrent updates to practices and procedures. Details on OMKM's resource management programs are listed in the Appendix B.

Cultural Resources

OMKM, together with Kahu Kū Mauna, developed policies for the construction of new cultural features, including the stacking of rocks, the scattering of human remains, placement of offerings, buffers around historic properties and visitation and use of ancient shrines. The Maunakea Management Board (MKMB) approved these policies in early 2018 after extensive community consultation held over a period of several years by Kahu Kū Mauna.

Invasive Species

Data from surveys and studies provide valuable information for developing management programs to protect the resources such as the endemic wēkiu bug. Invasive flora and fauna are a concern because of their potential impact not only on the wēkiu bug, but also on other native species, and on the "health" of Maunakea's unique ecosystem. OMKM's invasive species prevention, response and control plan is actively being implemented, especially regarding observatory related activities. Preventing the introduction of predatory ants remains a high priority. The adaptive-management invasive species plan is periodically reviewed and updated, with annual reports prepared and made publicly available.

Removal of Invasive Weeds

OMKM continues its efforts to remove fireweed (*Senecio madagascarensis*). While on patrol, rangers remove fireweed found along the road and in the summit areas. OMKM's invasive weed pull program brings community volunteers to the Halepōhaku area to pull fireweed, mullein and other invasive plants. It is OMKM's goal to manage invasive weeds and to revegetate the area with native vegetation.

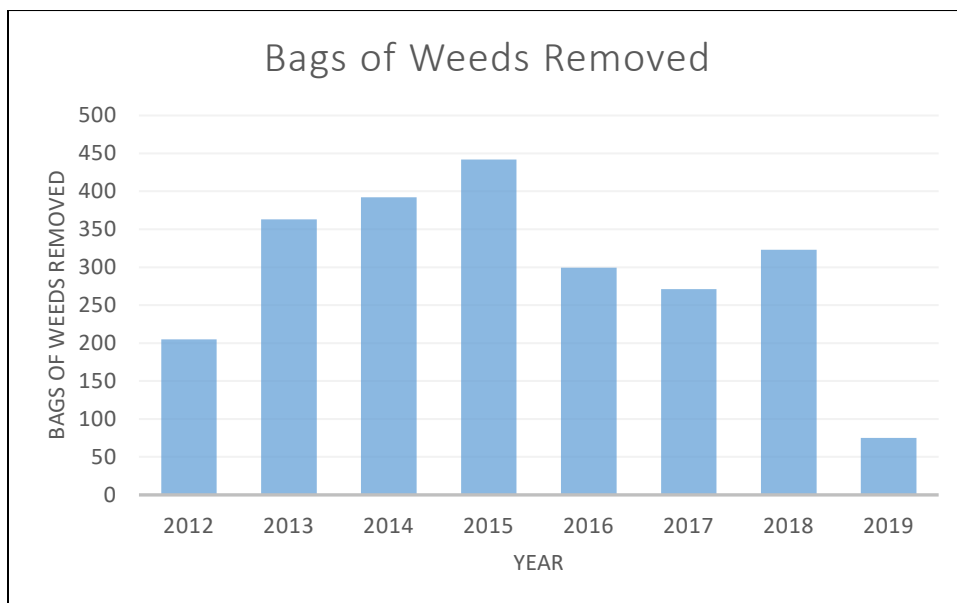


Figure 1. Bags of weeds removed from UH managed lands by volunteers. The 2019 quantity is lower than otherwise due to the extended road closure associated with Thirty Meter Telescope (TMT) start-up attempts and corresponding lack of access by staff and volunteers.

Inspections to Mitigate Risk

As part of its invasive species prevention and control program a qualified biologist conducts inspections of construction materials and other activities as identified in the “Maunakea Invasive Species Management Plan”. Inspections document materials being delivered, remediation required, deliveries denied entry, and other aspects of activity on Maunakea.

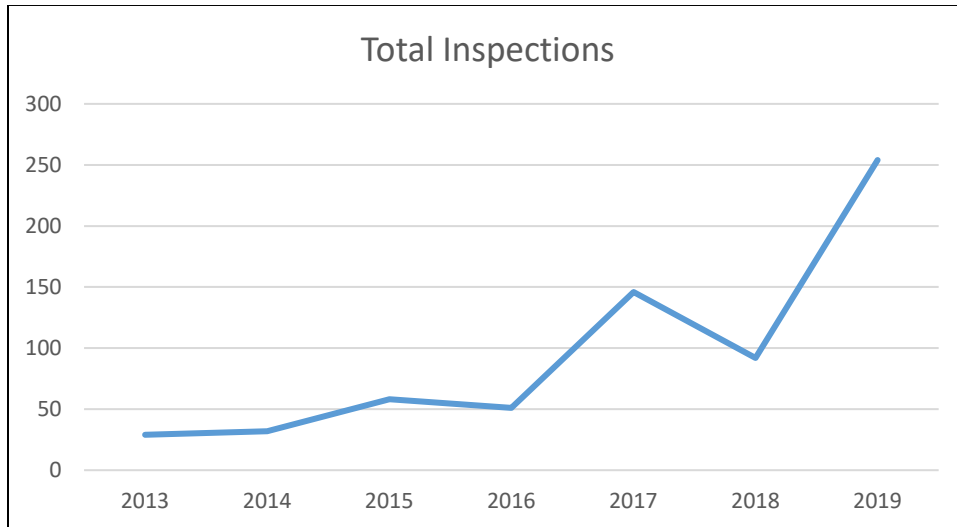


Figure 2. Number of invasive species inspections conducted each year. Quantities have been increasing due to awareness as the program presence becomes well-established. The elevated numbers in 2019 reflect construction activity associated with Visitor Information Station parking improvements. 2020 data not shown.

Native Plant Propagation

A Capital Improvement Project (CIP) that created new parking at the Visitor Information Stations (see *Infrastructure Safety Improvements* below) included approval for the installation of a greenhouse for propagating native plants, including māmane to replace trees removed in addition to other native plants for revegetating the Halepōhaku area. Planning and community outreach for this new greenhouse is ongoing.



Figure 3. A feral pig near the summit of Maunakea in October 2014. Such observations of animals is unusual in the Maunakea Science Reserve. Hunting rules fall under the jurisdiction of the Department of Land and Natural Resources (DLNR). The Office of Maunakea Management supports DLNR wildlife management by reporting such sightings, monitoring for impacts, and providing support as requested.

3.3 Education, Training, and Outreach (Appendix C)

One of the key tenets of the Public Access Plan is that “an informed public is best prepared to make good decisions and act responsibly.” OMKM also recognizes the importance of establishing community relationships and keeping them informed of OMKM’s activities. Details on OMKM’s activities related to outreach, education and training are provided in Appendix C.

Education and outreach efforts include the development of educational materials, such as brochures, signage and the dissemination of materials, OMKM regularly updates its heritage and resources guide (brochure). This guide along with the safety brochure, “*Visiting Maunakea Safely and Responsibly*,” are distributed at the Visitor Information Station (VIS) at the 9,200 foot elevation and at the ‘Imiloa Astronomy Center. OMKM also seeks opportunities to speak to community groups and organizations about OMKM’s activities.

After preparation by staff and consultation with the community, a draft “Maunakea Education & Outreach Plan: Maunakea Comprehensive Management Plan Management Action EO-1” was submitted to the Maunakea Management Board for review and approval in December 2019. The Board deferred taking action on the item to allow the University of Hawai‘i system additional time for discussions regarding the reorganization of the Office of Maunakea Management into a to-be-determined structure. After additional time to review and discuss the plan, it was ultimately approved by the Board in July 2020.

Orientation

The OMKM Maunakea Orientation program was launched in 2012. It is a requirement that all observatory and support staff (both office and on-mountain), vendors, construction workers, mid-level support and VIS staff, UH employees, and commercial tour drivers attend the orientation. An online version with an assessment quiz is available as a more efficient means of delivery and an alternative to in-person sessions. A video orientation for visitors will also be developed to be shown in the VIS. An orientation

plan, approved by the Management Board and DLNR guides implementation and identifies a renewal requirement every 3 years unless otherwise mandated by a permit. See Appendix C for a list and number of orientation sessions and number of certificates issued by OMKM since 2012.

Training

Beginning in 2016, a staff/employee training program was initiated. All OMKM and Maunakea Observatory Support Services employees are required to attend.

Volunteer Program

Since its inception in the Spring of 2012, OMKM's community volunteer weed pull program has held 58 events, filled over 2,400 bags of weeds by nearly 1,500 volunteers putting in over 10,400 hours. Groups participating in 2019 include various UH Hilo student groups, local primary school students and families, Observatories, and employee organizations, and environmental science students.

Outreach

OMKM seeks opportunities to share with the community its activities. OMKM also participates in school and community events showcasing the natural resources found on Maunakea, fun science and keiki activities.

As part of their educational efforts with young children, researchers working on OMKM projects have been going to schools to demonstrate the use of equipment that is used in their scientific studies, such as unmanned aerial vehicles (drones), shares examples of resources such as insect collections, and conducts experiments with the students. Others mentor students, including those who wish to conduct and enter the results of their studies in the State science fair.

3.4 Visitor Management (HAR 20-26) (Appendix D)

OMKM Maunakea Rangers

The Maunakea Rangers monitor activities on UH's managed lands on a daily basis. They record pertinent data including the number of vehicles by type (4- vs. 2-wheel drive, observatory, commercial and motorcycles) and observations of visitor activities, including hikers, bikers, vehicle speeds, trash, etc. Through their interactions with the public they help to educate people about Maunakea, including the cultural significance, environmental uniqueness, science, and how to visit safely. Many of the management actions relating to public and commercial activities, along with trash pick-up and removal, are carried out by the Rangers as part of their daily responsibilities. Rangers provide first responder first aid and assist in the coordination with County of Hawai'i emergency responders in search and rescue efforts. In addition, twice annually the rangers conduct inspections of the summit and Halepōhaku facilities for compliance with their conservation district use permits.

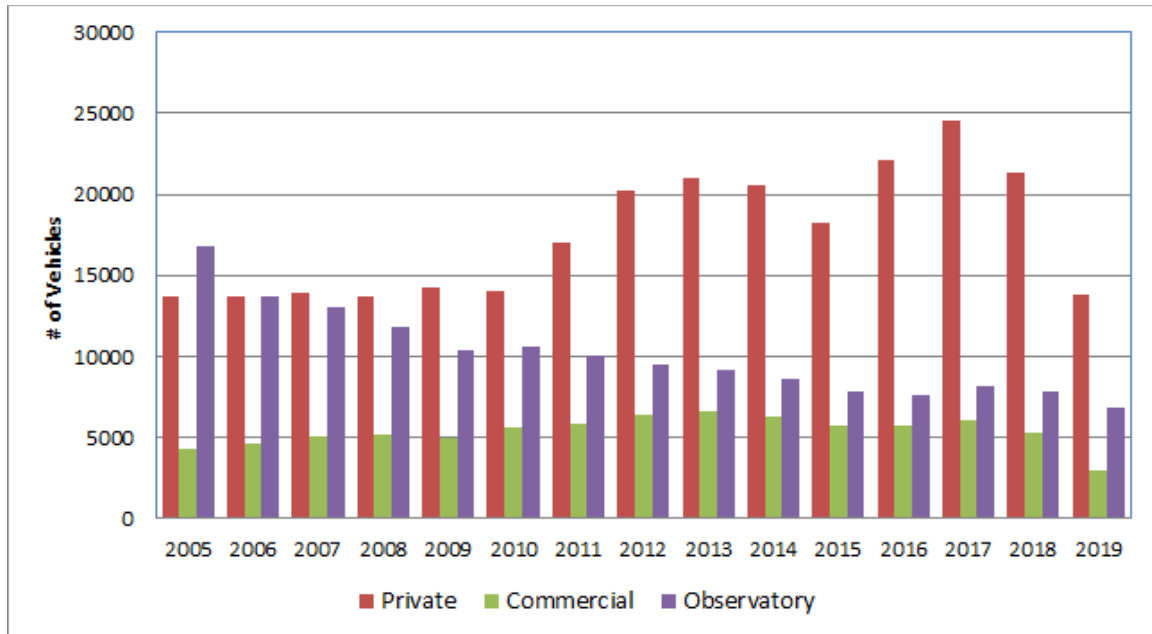


Figure 4. Total Yearly Vehicle Counts by Types of Users. Since 2005: Observatory vehicles have declined, commercial vehicles slightly, private vehicles have greatly increased and dominate traffic.

The Maunakea Summit Access Road is a unique public resource in the State. Maunakea Observatories Support Services (MKSS), an operation of the Maunakea Observatories, operates the only snow removal operations in Hawai'i. The steep road presents both safety challenges as well as is demanding of both vehicles and drivers. Road maintenance by MKSS also provides safe access for the public.

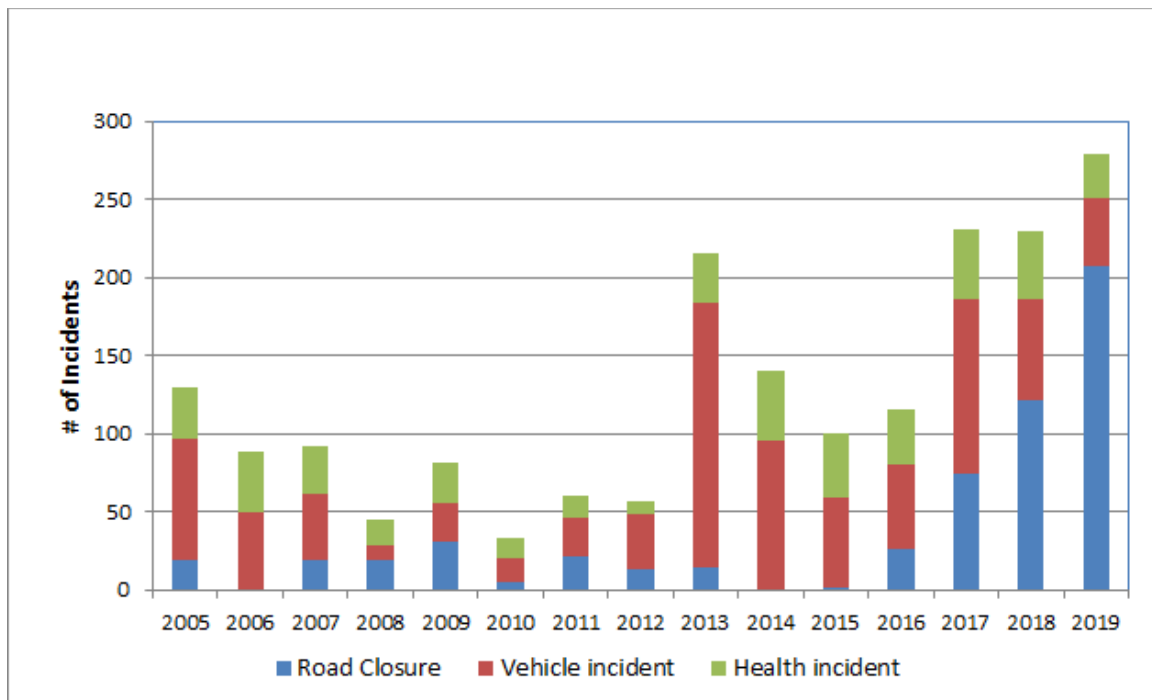


Figure 5. Yearly road closures, vehicle incidents, and health incidents; 2005 to 2019. Consistent road closure data record-keeping was first fully implemented in 2017 after addressing issues with use of road-ice sensors for safety purposes and installation of the automated vehicle counter.

The Maunakea Ranger corps has a target staffing level of seven full-time and one part time rangers. This allows OMKM to schedule three rangers for duty and ensures a minimum of two rangers on duty should one ranger be sick or on vacation.

UH Internal Audit of Maunakea Support Services and Office of Maunakea Management

A UH internal audit of OMKM's and MKSS' finances was performed in 2018 and a report was presented to the UH Board of Regents Committee on Independent Audit in December 2018. The audit concluded that the "University entities involved with Maunakea have developed processes and procedures to appropriately account for their respective transactions in connection with their management of Maunakea." The audit evaluated university funds, lease payments and external funds received in support of stewardship, management, education and other activities related to Maunakea.

Administrative Rules

In 2018 draft administrative rules were reviewed by Kahu Kū Mauna and the Mauna Kea Management Board and a recommendation was submitted to the Board of Regents who approved the draft rules for public hearings. In July 2018, Governor Ige gave his approval to move ahead with public hearings. Pursuant to HRS Chapter 91, public hearings were held in September 2018. Changes to the rules based on public comments received were made and a second round of public hearings held in 2019. The UH Board of Regents adopted the rules on Nov. 6, 2019 after a special 11-hour meeting at UH Hilo, where 99 people testified.

There are 15 CMP management actions that require administrative rules for implementation. These include categories involving natural and astronomy resources, education and outreach, infrastructure and maintenance, infrastructure and maintenance, and in particular, activities and uses. Administrative rules were approved by Governor Ige in January 2020.

Vehicle Counter

An automated vehicle counter was installed in 2015 to count the number of vehicles that drive above Halepōhaku. This counter, through a radio-frequency identification system, is able to identify observatory, UH, and commercial tour vehicles that drive to the summit. A portable vehicle counter installed in 2018 is being used in conjunction with the automated counter to help determine the number of vehicles go only to the VIS.

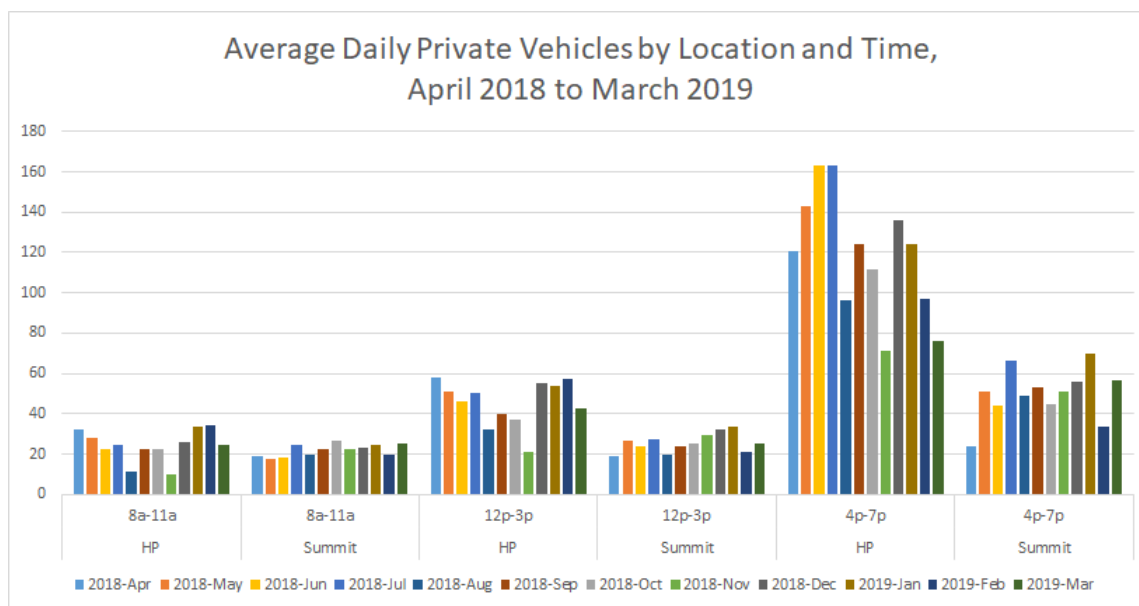


Figure 6. Average Daily Private Vehicles by Location and Time, April 2018 thru March 2019. Each day, the heaviest summit traffic occurs during sunset. Yet, even during the heavy sunset period, most vehicles stay at HP rather than continue to the summit.

Road Condition Sensors

A test road condition sensor installed in 2013 has shown the device accurately senses the presence of ice on the road. Two additional sensors have been installed along hazardous road sections prone to the development of ice, in particular black ice. When ice is detected the sensors automatically send email notifications to rangers who take action such as closing the road to protect the safety of the visiting public. Installation of additional sensors will be based on demonstrated utility of the first three in a network configuration.

3.5 Permitting, Enforcement, and Facility Oversight (Appendix E)

The CMP identifies oversight of Conservation District Use, commercial tour, special use, and other permit compliance as a critical function of OMKM. Such oversight is essential for both resource protection as well as public safety. Oversight functions for commercial tour, special use, and other permit types is addressed in preceding sections of this report. This portion addresses facilities, including observatories, support functions, and the Visitor Information Station facilities.

Operations Monitoring, and Maintenance Plan (OMMP)

An OMMP is implemented and identify maintenance needs, protocols and strategies that minimizes impacts to the resources and ensures that permittees comply with the conditions of their CDUPs. As part of the OMMP each observatory and MKSS is required to submit a description of anticipated projects over a five-year period. These five-year outlook of projects are updated annually and presented to Kahu Kū Mauna who determines the level of review for each project. When projects are submitted to OMKM for approval, those not requiring further review can be taken directly to the MKMB. Those requiring further review are presented first to Kahu Kū Mauna followed by review and approval by the MKMB.

CMP Compliance

Twice annually OMKM rangers conduct inspections of all summit facilities for compliance with their Conservation District Use Permits.

CMP Actions and Mitigation

As a requirement of the MKMB, applicants of projects are required to review the CMP and submit measures to comply with relevant CMP actions as part of the project's proposal. When applicable, mitigation measures are also included in the proposals.

Infrastructure Safety Improvements

Parking, vehicle and pedestrian flow, and visitor capacity concerns are addressed in the improvements to parking and safe drop off and pickup of visitors at the VIS. In compliance with CMP IM-9, the project involved the construction in 2019 of a new paved parking lot and an ingress access lane both are which are on the same side of the road as the VIS. Summit Access Road repair and improvements were also evaluated. The permit for this project included the requirement that a minimum of 130 māmane trees be planted within two years of completion, with no less than an 80% survival rate (104 trees). As of December 26, 2019 there were 121 māmane, 17 'āweowe, 1 puakala, 25 pāwale, and 12 'ena'ena surviving seedlings in the project area. While restoration efforts in 2019 benefitted from relatively moist climate conditions, mortality rates associated with 2018-2019 efforts for this project often exceed 50% due to frost or dry conditions. Thus, sustained revegetation efforts will continue in 2020. Capital improvement project funds were provided for this project.

Observatory Decommissioning

The Caltech Submillimeter Observatory (CSO) announced their intent to decommission in 2009. They submitted a "Notice of Intent" (NOI) to decommission to UH for approval under the auspices of the 2010 Mauna Kea Observatories Decommissioning Plan, and their NOI was approved in 2016. In January 2020 Caltech provided a detailed schedule which anticipates concluding the deconstruction, removal, and restoration processes in 2022.

The UH Hilo "Hökū Ke'a" Educational Observatory submitted their NOI in 2015 for approval by the Maunakea Management Board. Their NOI was approved by MKMB in February 2020 after assurances

were made by UH Hilo that undergraduate astronomy opportunities would not be lost. UH Hilo is proceeding with the decommissioning process as described in the 2010 Mauna Kea Observatories Decommissioning Plan and anticipates completing restoration efforts in 2023.

Observatory Planning & Construction

Thirty Meter Telescope (TMT) construction permits were approved by the Board of Land and Natural Resources (BLNR) in 2017 and upheld through various court challenges. Construction start-up efforts were attempted on July 15, 2019—however no access to UH managed lands on Maunakea occurred by TMT partners due to a protest-related road closure. The road closure ended on December 28, 2019.

Planning and project scoping for a new educational telescope for UH Hilo, to replace the Hōkū Ke‘a facility but at a location other than the Maunakea summit region, began in 2015 and is ongoing.

Appendix A: Research & Monitoring

Research & Monitoring of Cultural and Natural Resources

CULTURAL RESOURCES

FINAL REPORT Long-Term Historic Property Monitoring Plan for the University of Hawaii Management Areas on Mauna Kea, Ka'ohe Ahupua'a, Hamakua District, Hawai'i Island, State of Hawai'i. TMK: (3)4-4-015:009, 12 <i>Prepared for:</i> Office of Mauna Kea Management University of Hawaii, Hilo 640 North A'ohoka Street, Suite 203 Hilo, HI 96720 April 2014 PACIFIC CONSULTING SERVICES, INC. 720 Iwilei Road, Suite 424, Honolulu Hawaii 96817

FINAL REPORT Burial Treatment Plan for Burial Sites in the Mauna Kea Science Reserve and the Mauna Kea Access Road Corridor, Ka'ohe Ahupua'a, Hamakua District, Island of Hawai'i. TMK: (3) 4-4-015:009 and (3) 4-4-015:por.001 <i>Prepared for:</i> Office of Mauna Kea Management University of Hawaii, Hilo 640 North A'ohoka Street, Suite 203 Hilo, HI 96720 July 2014 PACIFIC CONSULTING SERVICES, INC. 720 Iwilei Road, Suite 424, Honolulu Hawaii 96817
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2012	Draft Report, [Revised] 2012 Assessment of Historic Properties within Three University of Hawaii Management Areas on Mauna Kea, Ka'ohē Ahupua'a, Hāmākua District, Hawai'i Island, State of Hawai'i. September, 2017. Pending final review by SHPD.
2013	Draft Report, 2013 Assessment of Historic Properties within Three University of Hawaii Management Areas on Mauna Kea, Ka'ohē Ahupua'a, Hāmākua District, Hawai'i Island, State of Hawai'i. March, 2018. Pending review by SHPD
2014	Draft Report, Long-Term Monitoring of Historic Properties within Three University of Hawaii Management Areas on Mauna Kea, Ka'ohē Ahupua'a, Hāmākua District, Hawai'i Island, #3 (2014). October, 2016. Pending review by SHPD
2015	Draft Report, 2015 Assessment of Historic Properties within Three University of Hawaii Management Areas on Mauna Kea, Ka'ohē Ahupua'a, Hāmākua District, Hawai'i Island, State of Hawai'i. May, 2018. Pending review by SHPD
2016	Draft Report, 2016 Assessment of Historic Properties within Three University of Hawaii Management Areas on Mauna Kea, Ka'ohē Ahupua'a, Hāmākua District, Hawai'i Island, State of Hawai'i. June, 2018. Pending review by SHPD
2017	Draft Report, 2017 Assessment of Historic Properties within Three University of Hawaii Management Areas on Mauna Kea, Ka'ohē Ahupua'a, Hāmākua District, Hawai'i Island, State of Hawai'i. July, 2018. Pending review by SHPD
2018	Draft Report, 2018 Assessment of Historic Properties within Three University of Hawaii Management Areas on Mauna Kea, Ka'ohē Ahupua'a, Hāmākua District, Hawai'i Island, State of Hawai'i. December, 2018. Pending review by SHPD
2019	Draft Report, 2019 Assessment of Historic Properties within Three University of Hawaii Management Areas on Mauna Kea, Ka'ohē Ahupua'a, Hāmākua District, Hawai'i Island, State of Hawai'i. February, 2020. Pending review by SHPD

NATURAL RESOURCES

2002	Annual surveys of the wēkiu bug begin
2007	Annual surveys of other arthropods begin
2007-2008	Results of the 2007-2008 Alien Species and Wekiu Bug (<i>Nysius wekiuicola</i>) Surveys on the Summit of Mauna Kea, Hawai'i Island. http://www.malamamaunakea.org/uploads/environment/EnvironmentDocuments/BM_2007-2008_AlienArthropod-Wekiubug.pdf
2009	Results of the 2009 Alien Species and Wēkiu Bug (<i>Nysius wekiuicola</i>) Surveys on the Summit of Mauna Kea, Hawai'i Island. http://www.malamamaunakea.org/uploads/environment/EnvironmentDocuments/BM_2009_AlienArthropod-Wekiubug.pdf
2010	Results of the 2010 Alien Species and Wēkiu Bug (<i>Nysius wekiuicola</i>) Surveys on the Summit of Mauna Kea, Hawai'i Island. http://www.malamamaunakea.org/uploads/environment/EnvironmentDocuments/BM_2010_AlienArthropod-Wekiubug.pdf
2011	Results of the 2011 Alien Species and Wēkiu Bug (<i>Nysius wekiuicola</i>) Surveys on the Summit of Mauna Kea, Hawai'i Island.

	http://www.malamamaunakea.org/uploads/environment/EnvironmentDocuments/BM_2011_AlienArthropod-Wekiubug.pdf
2012	Results of the 2012 Alien Species and Wēkiu Bug (<i>Nysius wekiuicola</i>) Surveys on the Summit of Mauna Kea, Hawai'i Island. http://www.malamamaunakea.org/uploads/environment/EnvironmentDocuments/BM_2012_AlienArthropod-Wekiubug.pdf
2013	Results of the 2013 Alien Species and Wēkiu Bug (<i>Nysius wekiuicola</i>) Surveys on the Summit of Mauna Kea, Hawai'i Island. http://www.malamamaunakea.org/uploads/environment/MKISMP/OMKM_2013InvasiveSpeciesReport_20150521.pdf
2014	2014 Invasive & Native Species Monitoring Report http://www.malamamaunakea.org/uploads/environment/MKISMP/OMKM_2014InvasiveSpeciesReport.pdf
2015	2015 Invasive & Native Species Monitoring Report – in review
2016	2016 Invasive & Native Species Monitoring Report – in preparation
2017	2017 Invasive & Native Species Monitoring Report – in preparation
2018	2018 Invasive & Native Species Monitoring Report – in preparation
2019	2019 Invasive & Native Species Monitoring Report – in preparation

Photo Documentation

Photographic monitoring of the Road Corridor helps document the distribution, abundance, and seasonality of fireweed (*Senecio madagascariensis*) on Maunakea.

<http://www.malamamaunakea.org/uploads/environment/EnvironmentDocuments/RdCorridorSummary.pdf>

Lake Wai'au time series of water level photographs, 2012 – present.

http://www.malamamaunakea.org/uploads/environment/EnvironmentDocuments/LakeWaiau_2012-present-all_PhotoComparison.pdf

Research Activities

Surveys and studies on Historic Properties and cultural resources	2005 – 2009. Archaeological inventory of historic properties of the Science Reserve, summit access road and Halepōhaku. 2004 - 2006. Archival study and compilation of native traditions, historical accounts, and oral history interviews for Mauna Kea. 2005 – 2009. Archaeological inventory of historic properties of the Science Reserve, summit access road and Halepōhaku.
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Surveys and studies on: • Geology and erosion • Climate and weather	2006 – Climatological analysis of meteorological observations at the summit of Maunakea 2007 – Review Mauna Loa weather data dating back to 1958 to assess climate conditions on Maunakea to help with wēkiu bug research 2012 – 2018. Study to assess presence of permafrost and whether conditions for formation of permafrost still exist. 2011– 2017. A multiyear study on the development of a climate change modeling program to help forecast climate change on the summit to help determine impacts to the summit ecosystem. 2012 – High Altitude Climate of the Island of Hawai'i publication. 2013 – ongoing. OMKM is working with the Department of Geography at UH Manoa on the development of a sea level to summit weather monitoring network to help track climate change. OMKM's participation is to help the location and installation on weather station on the summit. 2014 –ongoing. Surficial study of the geology and erosion in cinder cone environments above 12,500'. High-resolution topographic maps, and imagery have been completed. 2013 – 2016. Study to extend the long term temperature records for the State of Hawaii by integrating other climate data for earlier years when temperature was not recorded.
Surveys on human activities and needs:	2001 – ongoing. Rangers continue to submit daily reports on human activities; data are input in a database. 2015 – ongoing. An automated vehicle counter keeps a real time count of all vehicles traversing above Halepōhaku. Rangers also conduct daily counts of vehicles identifying 2 wheel vs 4 wheel drive vehicles. 2018 – ongoing. Rangers install an axle vehicle counter to assess in conjunction with the automated vehicle counter, the number of vehicles that go only to Halepōhaku. 2019 – ongoing. A study of visitor activities and carrying capacity.
Ongoing surveys and studies of the wēkiu bug and other arthropods	2006 – 2011 Modeling the ecology of the wēkiu bug's Maunakea environment 2011 – A study of how geology (pu'u and terrain), wind speeds and direction influence insect and snow pack deposits on the summit to help supplement wēkiu bug research. 2011 – 2018. Multi-year survey of the summit region and at the mid-level area at 9,200 ft elevation to assess the biodiversity of arthropods. Including a 2016 MS Thesis on biodiversity in the Halepōhaku area. 2012 – 2018. Study to assess presence of native and non-native plant and arthropod species. 2014 – 2016. A study evaluating the characterization and mapping of wēkiu bug habitat has been completed. 2015 – ongoing. A multi-year wēkiu bug habitat restoration plan is being implemented, also part of the TMT CDUP requirements. OMKM is currently supporting this management action. 2016 – Habitat mapping of wēkiu bugs using existing remote sensing and arthropod trap data. 2017 – ongoing. Study to investigate diet and parasite loads in alpine arthropods.
Alien and invasive species	2012 – 2015. Development of an invasive species management plan. It is composed of modules addressing various aspects of the invasive species prevention, response, and control. Implementation is ongoing 2015 – 2018. A study to evaluate measures to prevent the introduction of invasive species, in particular the inspection of vehicles and equipment was initiated in 2015.

Other (Flora and Fauna) Studies	2016 – ongoing. Initiated seabird, forest bird and bat inventory study
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Monitoring Activities

Historic Properties (archaeological sites)	2011– ongoing. On a monthly basis, OMKM Rangers photo document the level of Lake Waiau in DLNR's Maunakea Ice Age Natural Area Reserve (MKIANAR). Rangers also periodically hike to the adze quarry in the MKIANAR) to assess conditions. Rangers pick up and remove trash from their hikes into the MKIANAR. 2012 – ongoing. Annual archaeological monitoring of historic properties (archaeological sites). The Long-Term Historic Monitoring Plan was approved by State of Hawaii Historic Preservation Division (SHPD) in 2014. 2014 – SHPD approved the Long Term Historic Properties Monitoring Plan for UH Managed lands on Maunakea.
Wēkiu bug and alien species.	2002 – ongoing. Annual surveys on wekiu bug have been conducted since 2002. 2007 – ongoing. Annual surveys of alien species are conducted on UH Managed lands
Invasive species	2013 – ongoing. Monthly surveys for invasive species are conducted at the facilities at the mid-level, 9,200 ft elevation, including the VIS and the support facilities. 2013 – ongoing. Quarterly surveys for invasive species are conducted at all the summit facilities for invasive species. 2013 – ongoing. Natural resources personnel accompany archaeologists in their annual monitoring to assess sites and surrounding areas for native and invasive species
Flora	2013 – ongoing. Annual surveys of historic properties and wēkiu bug habitat include collection of vegetation presence and abundance.

Appendix B: Resource Management Programs

Selected publications related to resource management programs along with a summary of activities, are listed below.

Maunakea Invasive Species Management Plan and appendices

Maunakea Invasive Species Management Plan. 2015. PCSU Technical Report v191.

Standard Operating Procedures (SOPs): detail and instructions for all mountain users.

SOP 01: Cleaning of Vehicles and Personal Belongings. v1.3. (pdf)

SOP 02: Inspection of Vehicles, Construction Materials, Scientific Equipment, & Supplies. v1.3. (pdf)

SOP 03: Cafeteria Food Shipments (Receiving). v1.0. (pdf)

SOP 10: Invasive Invertebrate Early Detection Surveys of Facilities. v1.0. (pdf)

SOP 11: Annual Alien Invertebrate Early Detection & Wēkiu Bug Monitoring. v1.1. (pdf)

SOP B: Maunakea Vertebrate Threats, Identification, Collection, and Processing Guide. v1.1. (pdf)

SOP C: Maunakea Invertebrate Threats, Identification, Collection, & Processing Guide. v1.0. (pdf)

SOP D: Maunakea Plant Threats, Identification, Collection & Processing Guide. v2.2.(pdf)

SOP Z: Revising the Invasive Species Management Plan. v1.1. (pdf)

Invasive Species Inspections

Inspections of large vehicles and their loads for invasive species began in 2013. To date 808 large vehicles and loads have been inspected. Of the total number of vehicles inspected 782 vehicles passed inspections and were approved immediately or after quick remediation, 17 were rejected and required re-inspection, and 9 were non-compliant, that is no requests for inspections were made prior to proceeding to the mountain

	2013	2014	2015	2016	2017	2018	2019	2020
Keck	2		14	11	15	21	51	17
Subaru	3	8	17	11	30	16	10	4
JCMT							1	
UKIRT						2	5	
UH88			1	1	57	2	8	7
IRTF	2			1	1	10	2	1
CFHT	11		3		4	10		3
SMA				10	19	16	21	6
CSO			4					
UH24						3		
VLBA			4			2	1	
Gemini	4	12	9	13	13	9	6	
TMT*		14	18				75	
MKSS/VIS	6	11	4	5	8	2	150	1
Subtotal Total	28	45	74	52	147	94	330	39
Rush	NR	NR	NR	NR	NR	NR	110	16
No Rush	NR	NR	NR	NR	NR	NR	220	23
Remediation	4	12	19	8	15	10	58	2
No Remediation	24	33	55	44	132	84	272	37
Approved	28	43	71	52	146	90	316	37
Rejected		2	3		1		11	
Non-compliance						4	3	2

*The majority of invasive species inspections for the TMT were conducted by the Big Island Invasive Species Committee (BIISC).

Rush/ No Rush: Note: Information on whether a request was a rush was not recorded (NR) until 2019. Rush inspections are those that were not requested in advance (four days prior) to the scheduled delivery.

Remediation/ No remediation: Remediation occurred when there was a cleanliness or invasive species concern with the load or vehicle. Most remediation actions entailed pressure washing or vacuuming. *No remediation* are vehicles or loads that did not have a cleanliness or invasive species concern.

Approved/ Rejected/ Non-compliance: Vehicles and loads that were clean and free of invasive species passed inspection and were *approved*. Vehicles and loads for which remediation could not occur quickly such as from power washing or vacuuming were *rejected* and required re-inspection after the concern was addressed. *Non-compliance* was documented when vehicles or loads did not request an invasive species inspection and traversed to UH managed lands without approval.

Resource Management Programs

Polices and plans related to cultural resources	2012 – 2014. A burial treatment plan was reviewed by the Hawaii Island Burial Council and approved by the Division of Historic Preservation. It contains a schedule for monitoring. 2012 – 2018. Policies relating to the placement and removal of offerings, the scattering of human remains, the construction of new cultural features including the stacking of rocks were developed by Kahu Kū Mauna. In 2016 following public consultation Kahu Kū Mauna approved the policies. The MKMB felt that more community consultation was required before finalizing the policy. Community consultation on these policies then resumed and following this additional consultation, MKMB approved in 2018. 2016 – ongoing. The U.S. Department of Defense was contacted to begin the review process prior to any removal efforts of military aircraft. 2016 – 2017 Kahu Kū Mauna initiates consultation with Native Hawaiians on protocols per CMP. Advertisements placed in Hawai'i Tribune Herald, Honolulu Star Advertiser December, 11, and 18, 2016; January 5, February 12, March 19, April 16 and May 7, 2017; West Hawai'i Today, similar dates as Hawai Tribune for 2017; Office Hawaiian Affairs, Ka Wai Ola, Months of December 2016 thru May 2017. Kuka Kuka session held on May 21, 2016, including petitioners of TMT contested case, OHA, DHHL, DLNR, and members of the Hawaiian community.
Invasive species control	2012 – ongoing. An active volunteer program to remove fireweed (<i>Senecio madagascariensis</i>) and other invasive plants continues at the mid-level area. Rangers continue to remove fireweed in the upper elevations. 2013 – ongoing. The Hawaii Ant Lab and Big Island Invasive Species Committee continue to support implementation of the Invasive Species Management Plan by providing technical support, and assisting with inspections and monitoring work. 2015 – ongoing. The Maunakea Invasive Species Management Plan was approved by the MKMB. It is composed of modules addressing various aspects of the invasive species prevention, response, and control. Implementation is ongoing.
Wēkiu bug management plan and habitat restoration plan.	Data from wēkiu bug, invasive/alien arthropod, biodiversity arthropod studies, topography and wēkiu bug food distribution, and climate studies inform updates to management plans and habitat restoration plans for the bug.
Public facilities	2013 – ongoing. Road condition ice-sensor installed on the summit ridge to test the concept. After proving to be reliable, 2 additional sensors

	installed and integrated into road condition assessments and decision-making regarding safe operations. 2014 – 2018. CIP funds are used to construct improvements to the ingress and egress at the VIS and to address parking and pedestrian flow. An Environmental Assessment was prepared and published in 2017. A CDUA was submitted for DLNR and a CDUP was approved in June 2018. Funds were also used to study the condition of the summit loop road, make recommendations for repair, including estimated costs. 2015 – ongoing. An automated vehicle counter was installed to count the number of vehicles (differentiating: public, commercial, tour, observatory, etc.) that drive above Halepōhaku. 2018 – ongoing. Rangers install an axle vehicle counter to assess in conjunction with the automated vehicle counter, the number of vehicles that go only to Halepōhaku.
Develop and maintain a GIS and database program.	2013 – ongoing. A GIS-based data storage and reporting system has been developed. The system is continuously being expanded and enhanced. 2001 – ongoing. Rangers have been and continue to submit daily reports summarizing their observations and their activities, including documenting number of vehicles, hikers, incidents, permitted and unpermitted commercial tour operators, etc. 2014 – ongoing. An automated vehicle data collection system is operational recording individual observatory, permitted commercial tours, and OMKM vehicles using radio frequency identification tags (RFID) and general public vehicles.
Native Plan Restoration	2013 – 2014. Community volunteers plant over 200 'Āhinahina (silversword) for DLNR in the Forest Reserve. 2015. Construct benches for native plant restoration 2016 – 2017. Summer interns test seed collection and propagation methods for native plants. 2018. Propagation and outplanting of māmane, 'aweoweo, pāwale, puakala, 'ena'ena under CDUP HA-3812 (VIS parking improvements). 2019. Continued propagation and out planting of māmane, 'aweoweo, pāwale, puakala, 'ena'ena under CDUP HA-3812 (VIS parking improvements).
Other Plans and activities	2001. OMKM ranger program established. 2007 – ongoing. Biannual inspection of facilities for compliance with their CDUPs 2009. BLNR approved the Maunakea Comprehensive Management Plan (CMP) 2010. BLNR approved the Cultural and Natural Resources Management Plans, Public Access Plan and the Decommissioning Plan, sub-plans to the CMP. 2012 – ongoing. Beginning in 2012 applicants of projects are required to review the Comprehensive Management Plan (CMP) and submit measures to comply with relevant CMP actions as part of their project proposals. When applicable, mitigation measures are included in the project proposal. 2016 – Completed/ongoing. An Operations, Monitoring, and Maintenance Plan has been developed. The plan recognizes the need to identify maintenance needs, protocols and strategies that minimizes impacts to the resources and ensures that permittees comply with the conditions of their CDUPs. It also serves as a reporting mechanism for CMP compliance activities calls for the coordination of maintenance activities and schedules. 2015. Caltech Submillimeter telescope submitted its Notice of Intent (NOI) to decommission initiating the decommissioning process for its observatory

	on the summit. MKMB approved the NOI in 2016. Pursuant to the Decommissioning Plan (DP) for Mauna Kea Observatories, OMKM is overseeing the decommissioning process and Caltech is preparing all necessary documents, including Environmental Assessment (EA), Conservation District Use Permit application and DP requirements. An EA is currently being prepared. 2015. UH Hilo submitted its Notice of Intent to decommission initiating the decommissioning process for its summit observatory, Hōkū Ke'a. Public testimony against the decommissioning of UH Hilo's educational telescope resulted in the MKMB deferring approval of the NOI. OMKM is overseeing the decommissioning process and UH Hilo is responsible for carrying out the DP requirements. In 2018, UH Hilo removed the non-operational telescope from inside its summit facility. 2016 – ongoing. A staff/employee training plan was prepare and has been implemented. All OMKM and Maunakea Observatory Support Services are required to attend. 2017 – ongoing. A Sign Plan was approved by the MKMB. This plan helps ensure appropriate review and consistency in sign design and use. 2018 – ongoing. An Orientation plan was prepared, approved by the Maunakea Management Board and Department of Land and Natural Resources. This plan addresses requirements for visitors, employees/permittees/contractors, as well special orientation requirements as may be mandated in permits.
Signs	2012 – An inventory and map of all the signs on UH's managed lands was completed. The inventory of the signs on UH managed lands is being updated. 2017 – ongoing. A Sign Plan was approved by the MKMB. Installation of signs still requires DLNR approval, the plan helps ensure appropriate review and consistency in design and use. With input from Rangers and Kahu Kū Mauna, signs were installed to highlight cultural awareness and safety issues.

Appendix C: Education, Training, and Outreach

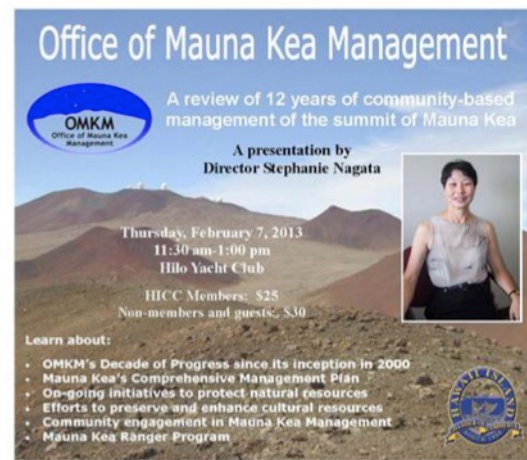
OMKM community engagement and outreach

OMKM COMMUNITY UPDATES (CMP EO-3)

Oct. 9, 2008	Rotary Club of Volcano, OMKM stewardship
Aug. 16, 2009	UH Hilo Chancellor's advisory group; OMKM stewardship
Apr. 8, 2009	Board of Land and Natural Resources, OMKM stewardship
Oct. 1, 2009	UH President M.R.C Greenwood; OMKM stewardship
Oct. 14, 2009	Senate Higher Education Committee; OMKM stewardship
Dec. 5, 2009	Visitor Information Station, Universe Tonight; OMKM stewardship
Mar. 25, 2010	Board of Land and Natural Resources; OMKM's proposed CMP subplans
Apr. 8, 2010	Board of Land and Natural Resources, update of CMP implementation; OMKM stewardship
Sept. 9, 2010	Kona Town Hall at Old Airport; OMKM stewardship
Apr. 2 2011	Visitor Information Station, Universe Tonight; update on OMKM stewardship
Oct. 10, 2011	OHA visit to Maunakea; OMKM stewardship
Feb. 28, 2012	Administrators and Educators; OMKM stewardship
Jun, 15, 2012	Institute for Astronomy External Review; OMKM stewardship
Jul. 3, 2012	OMKM's resource library
Jul. 24, 2012	UH Manoa Chancellor; OMKM stewardship
Sept.14, 2012	Hawaii Island Realtors Tradeshow; OMKM stewardship and UH commitment to community-based management
Dec. 12, 2012	Big Island Representatives; OMKM stewardship and commitment to community-based management
Dec. 27, 2012	Big Island Invasive Species Committee; outreach needs for invasive species management
Feb. 5, 2013	Rotary Club of South Hilo; OMKM stewardship and UH commitment to community-based management
Feb. 7, 2013	Hawaii Island Chamber of Commerce; General membership meeting; 12 Years of community-based management of the summit of Mauna Kea
Feb. 22, 2013	Rotary Club of Hilo; OMKM stewardship and commitment to community-based management
Mar. 22, 2013	Hawaii Leeward Planning Conference; OMKM stewardship
Apr. 9, 2013	Rotary Club of Pahoa; OMKM stewardship and UH commitment to community-based management
May 10,2013	Board of Land and Natural Resources; update on CMP implementation & OMKM stewardship



- May 16, 2013 Rotary Club of Volcano; OMKM stewardship and UH commitment to community-based management
- May 20, 2013 Lions Club of Kona; OMKM stewardship and UH commitment to community-based management
- Jun. 5, 2013 Rotary Club of North Hawaii; OMKM stewardship and UH commitment to community-based management
- Jun. 8, 2013 Keawe Vredenburg, Hui Kako`o; Decommissioning Plan
- Jun. 19, 2013 Rotary Club North Hawaii; OMKM stewardship and UH commitment to community-based management
- Jul. 22, 2013 Keawe Vredenburg; OMKM stewardship and UH commitment to community-based management
- Jul. 24, 2014 UHH Astronomy and Physics Department; OMKM stewardship
- Aug. 14, 2013 David Tarnas; OMKM stewardship and UH commitment to community-based management
- Sept. 18, 2013 Keaukaha Community Association; update on OMKM activities
- Sept. 20, 2013 Kiwanis; OMKM Stewardship and commitment to community-based management
- Nov. 3, 2015 TMT Pacific Astronomy & Engineering Summit; summit of local and international students; OMKM stewardship of Maunakea.
- Nov. 12, 2013 Association of Hawaiian Civic Club Convention; OMKM Presentation
- Nov. 13, 2013 Keaukaha Community Association; OMKM up dates
- Nov. 13, 2013 Association of Hawaii Civic Club Hawaii Council; Decade of Stewardship
- Dec. 5, 2013 Rotary Club of Kona; OMKM Stewardship and commitment to community-based management
- Dec. 7, 2013 Pi'ihonua Hawaiian Homestead Association; update on OMKM stewardship activities
- Apr. 1, 2014 Rotary Club of Pahoa Sunset; OMKM Stewardship
- May 9, 2014 Board of Land and Natural Resources; update of CMP implementation; OMKM stewardship



Oct. 27, 2014 Association of Hawaiian Civic Club Convention Waikoloa; educational display

Nov. 16, 2014 Department of Hawaiian Homelands; partnership proposal Humuula sheep station and shuttle program involving beneficiaries' participation

May 2, 2015 Kau Coffee Festival; OMKM Outreach table ongoing stewardship efforts on Maunakea

May 19, 2025 Hamakua Development Corporation; series of presentation during the TMT protest; OMKM stewardship

Jun. 12, 2015 Board of Land and Natural Resources, update of CMP implementation; OMKM stewardship

Sept. 9, 2015 Community meeting with the Governor; Community involvement with Maunakea Management and OMKM stewardship

Jan. 28, 2016 Association of American University Women; OMKM stewardship

Apr. 1, 2016 Hawaii Leeward Planning Conference; update on OMKM activities

Mar. 16, 2016 Presentation on resources and stewardship of Maunakea to Hawaii Community College "Forest Team" class

Mar. 23, 2016 Japanese Chamber of Commerce & Industry Hawaii General Membership Meeting; expo display

Mar. 26, 2016 Panaewa Hawaiian Home Lands Community Association; update on OMKM stewardship activities

Mar. 30, 2016 Rotary Club of North Hawaii; OMKM stewardship activities

Apr. 1, 2016 Hawaii Leeward Planning Conference; OMKM stewardship activities

Apr. 5, 2016 Kona Kohala Chamber Luncheon with Mayor Kenoi and Business Expo; Informational booth

Apr. 22, 2016 UH Hilo Earth Day OMKM Booth Coloring station centered on native plants and animals.

May 02, 2016 Maunakea site tour Tom Callis, Hawaii Tribune-Herald; environmental resources; cultural connections, OMKM stewardship activities

May 17, 2016 Rotary Club of Kona Mauka; OMKM stewardship activities

May 19, 2016 Rotary Club of Kona; OMKM stewardship activities

May 20, 2016 Rotary Club of Hilo; OMKM stewardship activities

May 24, 2016 Native Hawaiian Presentation; Keahi Warfield, Patrick Kahawaiolaa, Bill Brown, Mapuana Waipa - Pueo committee; Herc Freitas Beneficiary; Bill Walter, Kama'aina/business; Mike Kaleikini, Hawaiian/business; Kirstin Kahaloa, Hawaiian /business; Kalepa Babayan, Hawaiian/navigator; Newton Chu, PUEO attorney; Jacque Hoover, Hawaiian/business; Greg Mooers, Maunakea Management Board (MKMB); Greg Chun, MKMB; Leningrad Elarinoff former County Councilman; Rich Matsuda, local community/astronomy; Paul Coleman, Hawaiian/astronomy, Heather Kaluna, Hawaiian/astronomy; Mailani Neal Hawaiian/astronomy; Mary Begier, business; Barry Taniguchi, community/business; Ron Terry, community/environment; Hannah Springer, MKMB

May 26, 2016 Rotary Club of Kona; OMKM stewardship activities

May 27, 2016 Rotary Club of Hilo; OMKM stewardship activities

Jul. 14, 2016 Community meeting with the Governor; Paul Coleman, Heather Kaluna, Mike Kaleikini, Nikki Thomas (student), Dash Stevens, Kevin Silva (student), Devin Chu (grad student),

Ron Terry, Hannah Springer, Myles Yoshioka, Russell Arikawa, Marianne Takamiya, Pierre Martin, Thayne Curry

Jul. 19, 2016	Rotary Club of South Hilo; OMKM stewardship
Jul. 29, 2016	Rotary Club of Hilo; OMKM stewardship
Sept. 15, 2016	Meeting with Mayor Kim; OMKM stewardship
Sept. 26, 2016	Rotary Club of Kona ; OMKM stewardship activities
Oct. 3, 2016	State Legislative visit to Maunakea; OMKM stewardship
Oct 12, 2016	Senator Kai Kahele; Senator Lorraine Inouye, Representative Mark Nakashima; Representative Cindy Evans; Representative Cliff Tsuji; Representative Richard Onishi; Governor's East Hawaii Liaisons, Will Oakbe and Susan Kim
Oct. 13, 2016	Legislative visit to Maunakea; OMKM stewardship
Jan. 8, 2017	Media site visit to Mauna Kea with Tom Callis
Mar. 2, 2017	Kona-Kohala Chamber of Commerce Mayor's Luncheon; OMKM Outreach table ongoing stewardship efforts on Maunakea
Aug. 28, 2017	Regent Higaki, briefing on UH's proposed Administrative Rules
Sept. 7, 2017	Hawaii Business Roundtable, Honolulu; OMKM Stewardship
Sept. 27, 2017	Hawaii Island Chamber of Commerce Board of Directors: history of astronomy and UH process for review of astronomy projects and limiting impacts, such as the TMT project
Oct. 3, 2017	Hawaii Island Chamber of Commerce Government Affairs Committee; Ongoing stewardship efforts on Maunakea
Oct. 24, 2017	Sherry Bracken interview with Stephanie Nagata talks in-depth about OMKM and its day-to-day management of Maunakea Science Reserve. Engaging 30-minute interview.
Nov. 7, 2017	House Finance Committee; OMKM stewardship
Nov. 14, 2017	Rotary Club of Kona Mauka; ongoing stewardship on Maunakea
Nov. 17, 2017	State House Finance Committee visit to Maunakea; OMKM stewardship
Dec. 1, 2017	Hilo Kiwanis; OMKM stewardship
Dec. 5, 2017	Wendy Laros, Executive Director Kona Kohala Chamber of Commerce; briefing on OMKM stewardship
Dec. 5, 2017	Susan Kim, Governor's Hawaii Island Liaison; briefing on update on OMKM stewardship
Dec. 5, 2017	Jacqui Hoover, Executive Director for Leeward Planning Conference and Hawaii Island Economic Development Board; update on OMKM stewardship
Dec. 14, 2017	DLNR Admin staff: OMKM Stewardship
Dec. 20, 2017	Mayor Kim; Barry Taniguchi, former chair of MKMB and Stephanie Nagata, Director of OMKM on the management of Maunakea and the Mayor's vision for Maunakea
Jan. 16, 2018	Board of Land and Natural Resources; update on OMKM stewardship
Feb. 20, 2018	Kona Kohala Chamber of Commerce; update on stewardship of Maunakea



Mar. 2, 2018 Waimea Community Association Presentation; ongoing stewardship efforts on Maunakea

Mar. 6, 2018 Hawaii Island Chamber of Commerce; General membership meeting, OMKM's long-term management milestones and stewardship

Mar. 29, 2018 Visitor Information Station staff; OMKM stewardship

Apr. 7, 2018 Hawaii Leeward Planning Conference; legislative update

Apr. 23, 2018 Arcadia Retirement Residence, Honolulu; OMKM stewardship

May 14, 2018 Japanese Chamber of Commerce & Industry of Hawaii; OMKM update of stewardship of Maunakea

Sept. 4, 2018 RCUH Board; OMKM stewardship

Sept. 18, 2018 Kona Lions, OMKM update of stewardship of Maunakea

Oct. 11, 2018 Hawaii County Administration Cabinet; presentation to Mayor Kim's cabinet about OMKM long-term stewardship of Maunakea

Oct. 16, 2018 Maunakea Observatories Outreach Committee: OMKM stewardship of Maunakea

Oct. 24, 2018 Kiwanis Club Kona; OMKM briefing, OMKM stewardship

Oct. 26, 2018 Speaker Saiki visit to Maunakea; briefing on start of astronomy on Maunakea, creation of OMKM and OMKM's stewardship of Maunakea

Nov. 8, 2018 West Hawaii Community Forum; panel discussion and Q & A about stewardship of the mountain. Panelists: Stephanie Nagata, Director, OMKM; Greg Chun, Maunakea Management Board; Fritz Klasner, Natural Resources Program Manager, OMKM, Wally Ishibashi, Senior Advisor, OMKM; Scotty Paiva, Chief OMKM Ranger

Nov. 9, 2018 Rotary Club of Hilo; update on OMKM stewardship of Maunakea

Nov. 13, 2018 Maunakea Task Force; update on OMKM stewardship of Maunakea

Nov. 27, 2018 Business law class, UH Hilo. Peter Kubota instructor; OMKM stewardship role and responsibilities, commitment to community-based management

Nov. 28, 2018 Dru Kanuha; briefing on OMKM stewardship of Maunakea

Dec. 14, 2018 Maunakea Management Board; OMKM presentation to board members on Management of Maunakea, UH commitment to community-based management

Dec. 19, 2018 Rotary Club of Hilo Bay; update on OMKM's management of Maunakea

Feb. 7, 2019 Rotary Club of Kona; OMKM Stewardship

Jan. 25, 2019 Board of Land and Natural Resources: updated on OMKM stewardship

Feb. 5, 2019 Waikoloa Lions; OMKM stewardship

Jan. 16, 2019 Leimomi Kahn, President, Hawaiian Affairs Caucus of the Democratic Party; briefing on OMKM stewardship

Feb. 19, 2019 Hawaiian Affairs Caucus, Democratic Party; overview of OMKM's stewardship of Maunakea

Mar. 5, 2019 Hawaii Electric Light Company; OMKM stewardship

Mar. 15, 2019 Kona-Kohala Chamber of Commerce Luncheon with Mayor Kim; OMKM information table and display on stewardship

Apr. 2, 2019 Hawaii Island Portuguese Chamber of Commerce: OMKM stewardship

Apr. 4, 2019	Carpenters Union; OMKM stewardship
Jul. 3, 2019	Staff for US. Congresswoman, Tulsi Gabbard; briefing on OMKM's stewardship of Maunakea
Jul.19, 2019	Pohakuloa Advisory Council (PAC) at Pohakuloa Training Area; OMKM stewardship and admin rules
Jul. 30, 2019	Rotary Club of Kona Mauna; OMKM stewardship
Aug. 27, 2019	Board of Regents; OMKM stewardship
Oct. 16, 2019	House Higher Education Committee; OMKM stewardship
Jan 4-8, 2020	American Astronomical Society convention; OMKM outreach booth display and materials on OMKM's stewardship activities on Maunakea
Mar.11, 2020	Rotary Club of North Hawaii; OMKM stewardship of Maunakea and misinformation about management of the mountain.

COMMUNITY OUTREACH EVENTS (CMP CR- 3 and EO-6)

- Sep. 1, 2012 Universe Tonight presentation at the Onizuka Center for International Astronomy Visitor Information Station, on arthropods and stewardship.
- Mar. 4, 2013 Presentation to UH Hilo undergraduate astronomy class on Maunakea's resources, stewardship and heritage.
- Mar. 19, 2013 Support a "Flat Stanley" traveling primary school visit to Maunakea Observatory base facilities and OMKM.
- Jul. 11, 2013 Presentation to visiting University of Victoria, Canada graduate biology class on Maunakea biology.
- Nov. 27, 2013 Permafrost presentation at Hilo Intermediate School by Dr. Kenji Yoshikawa of University of Alaska-Fairbanks; including discussion of permafrost on Maunakea and installation of soil-temperature probe network in the school-yard.
- Dec. 7, 2013 OMKM participated in the 'Imiloa Palila Palooza with displays on resources and provided youth activities.
- Mar. 25, 2014 Hawai'i Academy of Arts and Sciences (HAAS) presentation on Maunakea's resources.
- Oct. 24, 2014 Permafrost presentation at Hilo Intermediate School by Dr. Kenji Yoshikawa of University of Alaska-Fairbanks.
- Dec. 13, 2014 Waikoloa Elementary and Middle School Winter Festival. Children's science activities and stewardship display
- Apr. 23, 2015 Kealahkehe Elementary School Science Showcase; coordinated with OMKM researchers, other state agencies and Maunakea children activities related to native plants and animals including coloring activities, natural resources trading cards, science stations
- May. 16, 2015 Hawai'i Volcanos National Park 'BioBlitz; provided entomological technical support
- May 28, 2015 OMKM Open House at Halepōhaku on OMKM stewardship for those protesting the TMT project a total of 22
- Jun. 8, 2015 OMKM sponsor Mike Lee's presentation on Kilo Hōkū
- Aug. 2, 2015 Organized and sponsored "Aloha Art Festival at 'Imiloa; event organized by OMKM's PIPES intern as a way of bringing together stakeholders on Maunakea in midst of the TMT protest
- Aug. 14, 2015 Permafrost presentation at Hilo Intermediate School by Dr. Kenji Yoshikawa of University of Alaska-Fairbanks
- Feb. 26, 2016 16th Annual Dryland Forest Symposium; display and educational booth on OMKM stewardship
- Apr. 21, 2016 Kealahkehe Elementary School Science Day; coordinate with other State agencies on



- Apr. 22, 2016 Earth Day at UH Hilo; youth activities and information on OMKM stewardship
- Apr. 22, 2016 Presentation at Ke Ana La'ahana PCS career day on resource management careers and Maunakea.
- Apr. 26, 2016 Panaewa and Keauhaka Homestead Associations Prince Kuhio Day Celebration; OMKM and Maunakea Observatories provide children's science activities, display of Maunakea arthropods and coloring activities and solar telescopes booth displays, science and children activities
- Apr. 30, 2016 AstroDay, an annual science and astronomy education event sponsored by the Maunakea Astronomy Outreach Committee (MKAOC); OMKM stewardship display and children's activities
- Jun. 28, 2016 Jessica Kirkpatrick presents "Endemic Insects of Maunakea" at Lyman Museum
- Jul. 12, 2016 OMKM UH Hilo sponsored research graduate students "What's Bugging the Mountain", entomological research on Maunakea; as part of the Hawai'i Volcanoes National Park "After Dark in the Park" series.
- Aug. 27, 2016 Hawai'i Volcanoes National Park "BioBlitz" citizens science effort; provided entomological technical support.
- Sept. 1-5, 2016 Volunteer support at the IUCN World Conservation Congress in Honolulu.
- Sept. 15, 2016 Presentation and demonstration at UH Hilo on non-intrusive geophysical techniques, such as permafrost measurements, by Dr. Matthias Leopold (University of Western Australia).
- Sept. 24, 2016 PUEO-KOYD Hōkūalaka'i Work Day, Sea-Sky event; youth activities; OMKM stewardship
- Feb. 23, 2017 Kealakehe Elementary School Science Day; children science activities, coloring station and trading cards featuring native plants and animals.
- Mar. 21, 2017 Aunt Mimi's AstroBash at Kailua-Kona Library; educational table with children's natural resources activities.
- Apr. 8, 2017 Presentation at Hawaii Academy of Arts & Sciences elementary school on Maunakea resources.
- Apr. 8, 2017 Tropical Living Festival, Hawaii Academy of Arts and Sciences; Children's natural resources coloring and trading card activities.
- Apr. 11, 2017 Presentation to Dept. of Education staff on Maunakea stewardship, organized by Gemini Observatory.
- Apr. 21, 2017 Earth Day at UH Hilo; OMKM Outreach table ongoing stewardship efforts on Maunakea
- May 6, 2017 Visitor Information Station Universe tonight series at Halepōhaku on OMKM stewardship
- May 6, 2017 AstroDay Event in Hilo; OMKM kids activities table and OMKM stewardship information
- July 8, 2017 Hawai'i Volcanoes National Park "BioBlitz" citizens science effort; provided entomological technical support.



- Oct. 14, 2017 Presentation to volunteer appreciate dinner for volunteers of the Visitor Information Station on Maunakea resources.
- Oct. 21, 2017 Na Kilo Palekai, Keaukaha community wa'a, science, navigation event; OMKM exhibit and educational display
- Nov. 4, 2017 Inaugural AstroDay Kona; OMKM stewardship and educational display
- Dec. 8, 2017 Presentation to Dept. of Education staff on Maunakea stewardship, organized by Gemini Observatory
- Mar. 1, 2018 Kealakehe Elementary School Science Day; children science activities, coloring station and trading cards featuring native plants and animals
- Mar. 9, 2018 Mountain View Elementary Open House; displays
- Mar. 28, 2018 Waikoloa Elementary School presentation on the wēkiu bug
- Apr. 20, 2018 UH Hilo Earth Day; OMKM Outreach table ongoing stewardship efforts on Maunakea
- Apr. 26, 2018 Keaukaha Elementary School Ohana Night; OMKM exhibit on stewardship and educational display



May 5, 2018 Astroday Hilo; annual event sponsored by the Maunakea Observatories Outreach Committee featuring children's science activities; OMKM stewardship exhibits and natural resources displays

Jun. 30, 2018 Presentation on Science Camps of American as part of weed pull event

Sept. 17, 2018 Volcano School of Arts and Sciences presentations on entomology.

Nov. 26, 2018 Windward Community College geology class, presentation on vegetation of Maunakea.

- Dec.12, 2018 IfA hosts PUEO Open House; OMKM Outreach table ongoing stewardship efforts on Maunakea
- Jan. 14, 2019 Present to TCBES graduate course in Organizational Management and Logistics as related to Natural Resource Management on Maunakea.
- Mar. 1, 2019 DLNR's Division of Forestry and Wildlife's Napu'u Conservation Project Bio-Cultural Festival at Pu'uwa'awa'a; mini arthropod trapping and identification field activities for elementary students
- Apr. 11, 2019 Kealakehe Elementary School Science Night; OMKM table and display on stewardship.
- Apr. 18, 2019 Mountain View Public Library; Bug-ology for school grade school kids; display of Maunakea bugs
- Apr. 23, 2019 Keaukaha Science Technology Engineering Art Math (STEAM) night; OMKM outreach table ongoing stewardship efforts on Maunakea; activities for kids

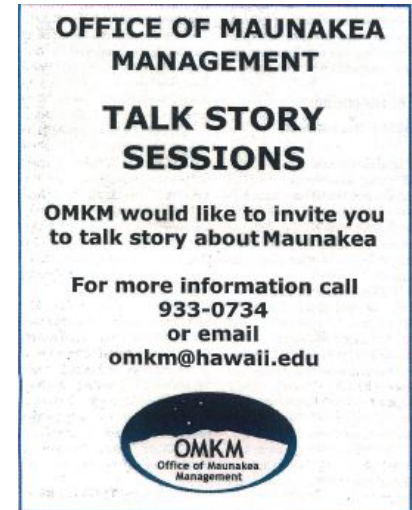
- Apr. 26, 2019 UH Hilo Earth Day; OMKM outreach table ongoing stewardship efforts on Maunakea
- May 4, 2019 AstroDay, an annual science and astronomy education event sponsored by the Maunakea Astronomy Outreach Committee (MKAOC); OMKM stewardship display and children's activities
- Jun. 5, 2019 Wēkiu bug presentation and interactive activity for 'Imiloa's Insect Camp
- Jul. 24, 2019 Wēkiu bug presentation and interactive activity for 'Imiloa's Insect Camp
- Oct. 25, 2019 Imiloa Halloween event; theme cool, creepy, and crawly insects of Maunakea, youth activities
- Oct. 25, 2019 Presentation to Institute for Astronomy graduate student seminar on Maunakea stewardship
- Oct. 27, 2019 HE'E Hawaii Explorations Expo; Information booth at Afook-Chinen Civic Auditorium on OMKM stewardship of Maunakea
- Nov. 2, 2019 Presentation at 'Imiloa teachers workshop on Maunakea stewardship
- Feb. 14, 2020 Mountain View Elementary School visit/Open House at Institute of Astronomy in Hilo; Wēkiu bug life cycle, bug headbands, arthropod collection
- Feb. 23, 2020 'Imiloa Astronomy Center birthday celebration; Theme: Reduce, Reuse, Recycle, Refuse, Re purpose; OMKM display related to stewardship and critters found on Maunakea.
- Apr. 13, 2020 Presentation on resources and stewardship of Maunakea to Hawaii Community College "Forest Team" class.
- May 6 2020 Record a video session for upcoming "'Imiloa @ Home" series on the wēkiu bug.



CMP CULTURAL POLICIES OUTREACH (CMP: CR-1, , 5, 6, 7, 8, 9, and 12)

Kahu Kū Mauna through OMKM invites the community to talk story. Ads were run for several months in the *Hawaii Tribune Herald*, *West Hawaii Today*, *Honolulu Star Advertiser*, and Office of Hawaiian Affairs' *Ka Wai Ola*. to reach a wide as possible audience. Pursuant to the CMP, Kahu Ku Mauna also met with the Office of Hawaiian Affairs and the Royal Order of Kamehameha to discuss cultural matters related to Maunakea.

- Oct. 13, 2010 Meeting with representatives of the Royal Order of Kamehameha regarding care taking of the summit lele.
- Oct. 18, 2011 Presentation to OHA trustees and staff on OMKM's stewardship role and responsibilities while on their visit to Maunakea
- Feb. 4, 2013 Presentation given OHA trustees and staff on OMKM's stewardship role and responsibilities on their visit to Maunakea.
- Dec. 17, 2020 Kahu Kū Mauna met with OHA representatives to discuss ahu building and removal on Maunakea.
- May 21, 2016 Kahu Kū Mauna convenes a talk session with members of Native Hawaiian community to discuss Cultural Resources management actions regarding setting polices and/or guideless related to cultural activities. Attendees included representatives from DLNR, OHA, DHHL, petitioners of the TMT contested case, and others from the Hawaiian community.
- Dec.2016 - May 2017 Ads were run in the following newspapers and OHA's *Ka Wai Ola* newsletter inviting members of the community to talk story.



Date of Ad	Hawaii Tribune Herald	Honolulu Star Advertiser	West Hawaii Today	Office of Hawaiian Affairs Ka Wai Ola
Dec. 11, 2016	X	X		Dec. 2016
Dec. 16, 2016	X	X		
Jan. 5, 2017			X	Jan. 2017
Jan. 15, 2017	X	X		
Feb. 12, 2017	X	X	X	Feb. 2017
Mar. 19, 2017	X	X	X	Mar. 2017
Apr. 16, 2017	X	X	X	Apr. 2017
May 7, 2017	X	X	X	May 2017

Nov. 19, 2019 Correspondence with the Royal Order regarding the caretaking of the summit ahu.

SYMPOSIUMS, CONFERENCES AND SPECIAL EVENTS (CMP EO-3)

- Jun. 6, 2012 Transit of Venus viewed from Maunakea; OMKM and Maunakea Observatories Support Services coordinated anticipated heavy public attendance to view the rare transit of Venus event. Organized commercial tour operators to provide free public transportation to the summit; police and emergency services.
- Aug. 4-8, 2012 OMKM sponsored and hosted an international scientific symposium titled "Vulnerable Islands in the Sky: Science and Management of Tropical Island Alpine & Sub-Alpine Ecosystems". Symposium was co-coordinated by UH Hilo Professor Jim Juvik. Symposium site was Hawaii Pacific Academy in Waimea. Symposium participants came from England, Scotland, Canary Islands, South Africa, Australia, Japan, and the US, including Hawaii. Symposium was funded in part by the Gordon and Betty Moore Foundation
- Nov. 27, 2012 National Park Service climate change scenario planning workshop for Hawai'i Island parks and protected areas; participated in workshop activities.
- May 20, 2014 Hawaii Geographic Information Coordinating Council Geospatial Expo. Presentation by Amber Stillman on "3D Landscape Maps for University Managed Lands on Maunakea".
- Jun. 3-4, 2014 West Hawai'i Science Technology Engineering & Math (STEM) camp. Present on maps and drones to primary schools students at summer camp. A partnership with STEM Works and Kealakehe Robotics.
- Jun. 25, 2014 Hawai'i Ecosystem Meeting. Rapid-presentation on Arthropod Monitoring on Maunakea.
- Jul. 15, 2014 Hawaii Conservation Conference, presentations by Jessica Kirkpatrick (Monitoring Arthropod Communities on Maunakea) and Amber Stillman (3D Landscape Maps for University Managed Lands on Maunakea).
- Nov. 1, 2014 Special issue of Arctic, Antarctic, and Alpine Research, Volume 46, No. 4 (2014 University of Colorado) on "Losing the High Ground: rapid transformation of tropical island alpine and subalpine environments". This issue is devoted to the proceedings of the 2012 symposium, "Vulnerable Islands in the Sky: Science and Management of Tropical Island Alpine & Sub-Alpine Ecosystems" sponsored by OMKM.
- Nov. 17, 2014 Entomological Society of America, presentation by Dr. Jesse Eiben with Jessica Kirkpatrick as co-author. "Life tables and population growth modeling guide conservation actions for an alpine restricted rare insect, the wēkiu bug, *Nysius wekiuicola*, in Hawai'i"
- Apr. 4, 2015 Pacific Entomology Conference in Honolulu, presentation titled "The Variability in Taxa, Distribution, and Abundance of Species on Maunakea: Comparing 3 years of data: 2013 -2015"
- Apr. 20, 2015 Attend UH Hilo TCBES Research Symposium, presentations titled "Maunakea Natural Resource Program" and "The Variability of Taxa, Distribution, and Abundance of Arthropods on Maunakea: Comparing 2 years of data – 2013 & 2014".
- Apr. 5, 2016 Pacific Entomology Conference in Honolulu with poster titled "Arthropod Monitoring on Maunakea: Biodiversity & Threats" and presentation titled "Intra- and inter-annual distribution and density fluctuations of high alpine restricted arthropods on the summit of Maunakea, Hawaii"
- Jan. 9, 2017 Pacific Islands Climate Change Cooperative's multi-year Hawaiian Islands Terrestrial Adaptation Initiative—Hawai'i Vulnerability Assessment & Scenario Planning Workshop: participate to contribute to discussions on high-elevation habitats.

- Feb. 15, 2017 Big Island Weed Management Forum; presentation on the OMKM's Maunakea Invasive Species Management Plan.
- Jun. 20, 2017 American Association for the Advancement of Science (AAAS) Pacific Division meeting in Waimea: OMKM sponsored session on High Altitude Climate Change Trends and Alpine Ecosystem Impacts in Hawai'i
- Jun. 20, 2017 American Association for the Advancement of Science (AAAS) Pacific Division meeting in Waimea: OMKM sponsored session: "Student Science Conference" for middle and High School student science projects. A partnership which also included the Hawaii Science and Technology Museum, AAAS, and Mary Begier Realty.
- Jul. 18, 2017 Hawaii Conservation Conference, presented poster titled "Collaborative and Integrative Management of Invasive and Rare Species on UH Managed Lands of Maunakea".
- Jul. 10, 2018 Hawaii Conservation Conference, presented poster titled "An Assessment of Wēkiu Bug Populations on Cinder Cones of the Maunakea Volcano, Hawai'i Informs Habitat Restoration and Conservation Efforts".
- Nov. 19, 2019 Entomological Society of America; presented: "Describing two diurnal Agrotis species (Lepidoptera: Noctuidae) in the subalpine and alpine regions (3000-4205m) on Hawai'i Island, Hawai'i".

COMMUNITY VOLUNTEERS MĀLAMA MAUNAKEA (CMP EO-8)

The monthly Mālama Maunakea campaign focuses to protect the fragile resources on the mountain from the gravel road section of the Mauna Kea Access Road from the approximate 9,000' to 12,000' elevation.

The volunteer day begins with project orientation and acclimation to the high elevation. From 10 am until 12 noon volunteers pull fireweed along the Mauna Kea Access Road followed by lunch. Wrap up fireweed pulling and a brief tour of Mauna Kea resources completes this fulfilling day on the mountain.



In 2013, OMKM and volunteers assisted DLNR's Division of Forestry and Wildlife with planting several hundred 'Ahinahina (silversword) in the Mauna Kea Forest Reserve.



Mālama Maunakea Volunteer Weed Pull and Planting Facts

- Invasive species weed pull Mālama Maunakea campaign began in 2012 in an effort to protect the mountain's native resources and landscape
- Held generally on a Saturday morning
- While volunteers acclimate, they are given a project orientation, before pulling weeds for about two-hours.
- They are given an interpretive walk pointing out native plants and discussion on the native ecosystem
- Weed pull help prepare areas for future native plan restoration projects
- 58 separate weed pull events
- 1,493 community volunteers
- 10,457 volunteer hours
- 2,414 garbage bags of weeds pulled
- Planted than 300 native plants near Halepōhaku
- OMKM is propagating plants for future restoration efforts in the Halepōhaku area

Volunteer Groups

Volunteer groups who participated in the OMKM's weed pull and planting events:

- Hawaii Island Chamber of Commerce
- Circle K (Kiwanis youth)
- Interact (Rotary Youth)
- Hawaii National Guard Youth Challenge Academy
- Pōhakuloa Training Area staff
- UH Hilo classes and groups
- Observatory staff
- Commercial Tour permittees
- Hawaii Government Employees Association



- University faculty and staff
- school groups (Ke Ana La'ahana, Waiakea High School, Hilo High School, Christian Liberty Academy)
- members of the general community



Year	No. of Projects	No. of Volunteers	Hours	Bags of Weeds
2012	8	114	873	205
2013	8	236	1747	363
2014	9	283	1,945	392
2015	7	228	1,710	442
2016	8	200	1,500	300
2017	6	165	1238	271
2018	8	200	1,080	323
2019*	3	44	308	75
2020**	1	23	58	43

* Road closed to public access from mid-July to late December due to protest activity

** Only one event held due to the Covid-19 pandemic

ORIENTATION (CMP EO-2)

Consistent with an orientation plan prepared with input from Kahu Kū Mauna and the Maunakea Management Board, and approved by DLNR, OMKM conducts orientations relating to the cultural and environmental significance to those who work on UH's managed lands including observatory and UH personnel, contractors and vendors, and commercial tour operators. Sessions are usually held in Hilo, with rotating visits by presenters to West Hawai'i tour companies and observatories.

In 2016 OMKM launched an online video version of the orientation as a more efficient means of reaching contractors, vendors, visiting staff, or other interested parties.

Regular feedback is solicited from Kahu Kū Mauna and attendees. A three-year refresher interval requirement has been adopted unless otherwise mandated by permit.

Currently there are approximately 1,500 individuals with a current, valid orientation certificate.

Orientation Sessions

2012	6 successfully completed orientations Sessions held: 2 November
2013	568 successfully completed orientations Sessions held: 22 April, 6 June, 21 15 July, August, 27 August, 5 September, 10 September, 19 September, 1 October, 9 October, 23 October, 1 November, 5 November, 8 November, 14 November, 18 November, 26 November, 9 December, 13 December, 16 December, 19 December
2014	361 successfully completed orientations Sessions held: 13 March, 21 March, 24 March, 31 March, 14 April, 16 May, 18 June, 11 July, 6 August, 12 August, 14 August, 15 August, 26 August, 4 September, 15 September, 29 September, 27 October, 20 November, 12 December
2015	561 successfully completed orientations Sessions held: 13 January, 9 February, 19 February, 23 February, 2 March, 5 March, 9 March, 16 March, 23 March, 30 March, 13 April, 28 April, 11 May, 26 May, 5 June, 29 June, 14 July, 27 July, 24 August, 2 September, 17 September, 1 October, 14 October, 21 October, 6 November, 10 November, 3 December, 17 December
2016	429 successfully completed orientations Sessions held: 8 January, 25 January, 9 February, 25 February, 8 March, 24 March, 14 April, 26 April, 9 May, 10 May, 12 May, 16 May, 25 May, 9 June, 23 June, 12 July, 27 July, 11 August, 29 August, 7 September, 21 September, 12 October, 14 October, 25 October, 7 November, 29 November, 2 December, 15 December.
2017	528 successfully completed orientations Sessions held: 11 January, 18 January, 8 February, 7 March, 18 March, 24 March, 24 April, 8 May, 17 May, 22 June, 12 July, 22 September, 10 October, 15 November, 11 December
2018	498 successfully completed orientations Sessions held: 16 January, 14 February, 6 March, 12 April, 23 May, 13 June, 2 July, 13 July, 6 August, 10 August, 12 September, 16 October, 29 October, 8 November, 4 December
2019	786 successfully completed orientations Sessions held: 9 January, 13 February, 8 April, 15 May, 15 August, 7 November, 3 December
2020	217 successfully completed orientations as of 31 May 2020 Sessions held: 22 January, 6 February, 19 March, 15 April, 5 May

Maunakea User Orientation & Assessment

To receive credit for the Maunakea User Orientation with the Office of Maunakea Management (OMKM):
 1) Watch the video below (or at <https://youtu.be/3dhu2JF6e88>)
 2) Complete the assessment quiz below, answering all questions. You must correctly answer at least 75% of the questions to receive credit.
 3) OMKM staff will review your assessment quiz score and either issue a certificate or notify you if the assessment needs to be retaken (in which case we'll email you a new quiz link). Certificates are typically issued within two (2) working days after the assessment is completed.

The Maunakea Comprehensive Management Plan includes a requirement of an orientation for all observatory staff, tour operators, support staff, contractors, vendors, Rangers, etc. prior to working on or in support of activities on UH Managed lands (see page 7-22, Management Action EO-2 for details, http://www.malamamaunakea.org/uploads/management/plans/CMP_2009_PDF#page=131). This orientation must be repeated every three (3) years, more frequently if required by a permit, or as directed by the Maunakea Management Board.

To attend an orientation session in person, see the Office of Maunakea Management calendar at: <http://www.malamamaunakea.org/about-us/calendar>

Email maunakea-orientation@pshawaii.edu if you have questions.

* Required

Maunakea User Orientation video



INFORMATION MATERIALS (CMP EO-3)

OMKM developed and prints brochures and other printed materials for distribution at community and are available for public distribution at the VIS, 'and other public venues, or distributed at public and outreach events

2002 – ongoing Visiting Maunakea Safely and Responsibly brochure.

“What is OMKM” brochure role and responsibility of OMKM and community-based management

2012 OMKM social media presence initiated with a Facebook page.

2013 Maunakea Resource brochure

2015 Social media posts (Instagram, Twitter and Facebook) about resources of Maunakea, issues and relevant science

Line art of Maunakea flora and fauna prepared for use as “coloring” sheet with youth activities.

Temporary tattoos of Maunakea resources prepared for public distribution.

Trading cards of the wēkiu bug, māmane, Palila, 'Ahinahina, and cydia moth prepared.

Life Cycle of a Wēkiu bug! Wheel diagram prepared in partnership with DLNR's Division of Forestry and Wildlife

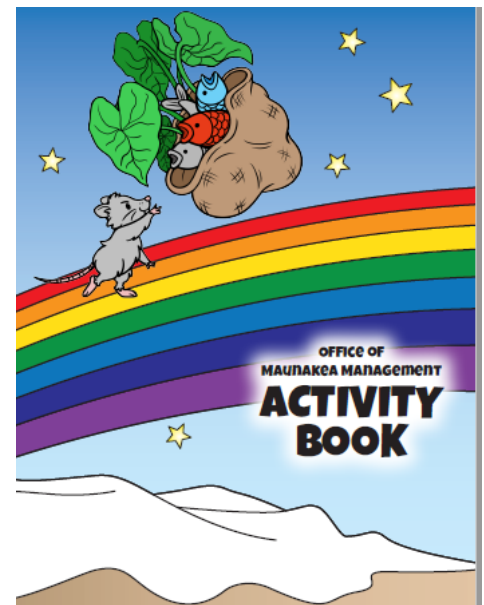
2016 - ongoing. Update of resource brochure containing information about the resources and significance of Maunakea incorporating community and Kahu Kū Mauna input. The revised brochure is entitled “Maunakea Heritage and Natural Resource Guide” and is available both online, in print, and in Japanese courtesy of translation support provided by Subaru Telescope. The back side is also available as a poster.

2016 Maunakea 'Ahinahina (silversword) postcard produced for public distribution

2016 YouTube video: Maunakea 3D perspective flyover animation: <https://youtu.be/6Guol97jftM>

2017-ongoing Youth activity book prepared. Updated and reprinted in 2019.

2019 Book published: The Hawaiian Wēkiu Bug - Laurie Waite Flores. A bilingual non-fiction book written in both English and Hawaiian on the Hawaiian Wēkiu Bug. Illustrations by children of Hawaii



Social media posts begins emphasizing public events and news releases, minimizing “attractive” element that would tend to draw additional visitors to Maunakea

EDUCATIONAL PROGRAMS (CMP EO-6)

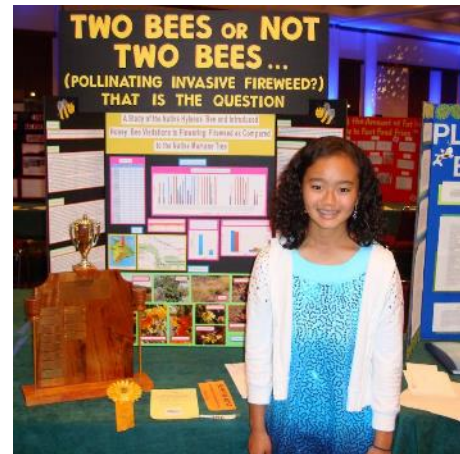
Science Fair/Project mentoring support

2012-2013 Anne Nakamoto, Waiakea Intermediate School student. Project titled “Two Bees or Not Two Bees... (Pollinating Invasive Fireweed?), That is the Question.”

2013-2014 Anne Nakamoto, Waiakea Intermediate School student. Project titled “Ant Appetites: A study of the Food Preferences of the Recent Invader *Cardiocondyla kagutsuchi* in Hale Pōhaku”.

2014-2015 Israel Stillman, Kamehameha Schools Senior Legacy Project. Halepōhaku area native plant documentation and restoration.

2016-2017 Megan Nakamoto, Waiakea Intermediate School student. Project titled “The Itsy Bitsy Spider—That Lives on Mauna Kea”.



Ka piko kaulana o ka 'āina

The famous summit of the land

Hawaiian creation chants compress time and space narrowing the distance between earth and sky. Maunakea connects Hawai'i to the heavens.

Mālie 'ikea ka moku me ka honua
Serenely visible are island and earth.
Pa'a ia lewa lani i ka lima 'ākau o Wākea
Held in heavenly space by the right hand of Wākea

'O ka moku iā ho'i ko lalo nei
Down here shall be an island
'O wai iā ho'i ko lano, 'o wai iā?
Who shall be above - Who?
'O ka ao, 'o ia ho'i ka
The cloud, that is who it shall be.

'O ke ao ho'i hā ko lano nei
A cloud shall be up here
'O wai iā auani' ko lalo iā?
Who shall be below?
'O ka mauna, 'o ia ho'i
The mountain, that is who it shall be
'O hānau ka mauna o Wākea
Born of Wākea* was the mountain.

Lines taken from a genealogical birth chant composed for Ka'iākeakū.
Ka'iākeakū III
*Wākea, main Hawaiian male creator.

WĒKIU BUG

Wyeius weikiuensis

The weikiu bug is found only on the summit of Maunakea. This tiny 1.4 to 1.8 mm long insect survives the freezing temperatures, wind and strong winds at the top of Maunakea by adapting to its surroundings. It feeds on dead or dying insects that are blown up from lower elevations.

MĀMANE

Sophora chrysophylla

Maunakea trees are emblematic of Hawai'i, towering they are only found there. On Maunakea, māmane are the most common tree, 1,000 feet elevation and defines the world's alpine zone tree line area. Māmane tree populations have been drastically reduced, most likely due to heavy sheep and goats grazing. Native species like Pūhā and Pūhā are also on the decline, which are precursors to many other species.

KILO HŌKO Astronomy

Maunakea has extensive knowledge of the heavenly bodies. Like many world cultures, navigational systems were passed down orally by associating them with significant cultural stories and charts. The entire location, even its dark sites, stellar constellations, animal (dead cover) - 125 days per dead tree, and transparency of the atmosphere to infrared radiation make the summit of Maunakea ideal for modern astronomy. The combination of astronomical, cultural, and scientific knowledge, and submillimeter wave-length telescopes provide synergy and opportunities to study the sky from multiple perspectives.

NĀHIKU

HĀNAIKAMALAMA

TRADITIONAL IMPORTANCE

Maunakea is a recognized Hawaiian cultural site. It is a storied place of cultural, spiritual and archaeological significance where appropriate and respectful behavior is expected.

NATURAL HISTORY

Formed at one million years old, Maunakea is an active shield volcano that erupted 1,500 years ago. Over 1 million years of glacial erosion during the past 200,000 years with the most recent activity about 5,000 years ago. Maunakea is an isolated laboratory that reflects the story of our history. Scientific study volcanic processes and geologic evolution of Hawaii volcanoes, the chemical and physical properties of lava, and the changing time and composition of volcanic materials (such as soil) using water samples collected by daily flows (flow types). The lava and flows of rare basaltic andesite and rhyolite are unique and a window into volcanic processes. In 1977 Maunakea was listed as a National Natural Landmark.

PU'U Cinder Cones

Maunakea has cinder cones scattered around the larger Maunakea volcano. Each cone formed during a brief eruption in which that cone may have produced only a few flows. The cones, often volcanic fragments of lava, were formed as rising magma was ejected out of the cinder cone into the air.

The summit cinder cone of pu'u on Maunakea, Kilauea, is known as "Kilauea's red hot" and is said to be visited by the gods. The summit of the pu'u is said to be visited by the gods. The summit of the pu'u is said to be visited by the gods. The summit of the pu'u is said to be visited by the gods.

MĀLAMA 'ĀINA take care of the land

- Damage to Hawai'i's premier natural resources is subject to penalties as defined in Hawai'i State Revised Natural Resources Code (HRS 171-121 and 171-122).
- Do not harm, remove or kill any plants or animals.
- Appreciate the spectacular views and nature's quiet beauty.
- Do not move or remove any rocks, debris or offerings. Do not pile or stack rocks. Please remove offerings after completion of ceremonies.
- Order and flow is easily confused. Drive, park and access only in designated areas. Drive slowly and carefully if possible.
- Security items that could escape in high winds and dispose of trash properly including snowday items.
- Vehicle break downs and accidents are common. Keep vehicles in good working condition, drive safely, avoid on designated roads, follow posted speed limits, do not pass and use left lane, require at the VTS about 10 minutes and weather conditions.
- Avoid introducing non-native species. Non-native species can be spread by hitchhiking on personal belongings, equipment and offerings. Please clean hiking shoes, clothing and vehicles before entering. If any pet, any wild animal, or any other animal is brought, please do not feed it.

WAO AKUA

The realm of the gods and spirits was above the clouds and below the clouds. The realm of the gods and spirits was above the clouds and below the clouds. The realm of the gods and spirits was above the clouds and below the clouds.

WAO LAALĀU

The realm of the spirits in the region of the clouds. The realm of the spirits in the region of the clouds. The realm of the spirits in the region of the clouds.

WAO NAHELE

The realm of the spirits in the region of the clouds. The realm of the spirits in the region of the clouds. The realm of the spirits in the region of the clouds.

HISTORIC ORIGINS

Native Hawaiian oral traditions tell us that Maunakea is a sacred place. Maunakea is a sacred place. Maunakea is a sacred place.

Class Project

- Jan- Jul, 2013 UH Hilo Computer Science class project “Team Poliahu” won the 2013 U.S. Imagine Cup and competed in the worldwide finals in Russia. Dr. Keith Edwards was the class instructor, Dr. Don Thomas and Fritz Klasner provided assistance in developing a project proposal. They initially developed a software app that could track native and invasive plant species using smart phones and GPS functionality.
- Feb. 2013 UH Hilo graduate entomology class visited Halepōhaku to learn about arthropod collecting methods.
- Jun. 2018 Christian Liberty School, 7th grade Environmental Science class visited Maunakea and assisted with arthropod collections, learned about analyzing data, presenting results, and Maunakea stewardship.

Research

In order to gain a better understanding and to develop management programs to protect the resources it is necessary to first identify and study the resources. OMKM funded numerous studies utilizing the expertise within the University System. These studies engaged a principal research investigator and graduate students. The following graduate students and internships are or were engaged to research or assisted OMKM with its stewardship responsibilities:

PhD Graduates/Candidates

- Jesse Eiben UH Mānoa; Entomology. 2012. Applied conservation research of the wēkiu bug in Hawai‘i: Life table analysis, population genetics, and phylogenetics create a holistic view of a rare and unique species
- Brad Reil UH Mānoa; Entomology. In Progress. Food web study in the summit ecosystem
- Heather Stever UH Mānoa; Entomology. In Progress. Study of diet and parasite loads in alpine arthropods

Master’s Degree Graduates/Candidates

- Sarah da’Cote UH Mānoa. Meteorology. 2006. Climatological Analysis of Meteorological Observations at the Summit of Mauna Kea.
- Leigh Anne Eaton UH Mānoa. Meteorology. 2011. Modeling the Ecology of the Wēkiu Bug’s Mauna Kea Environment.
- Heather Stever UH Hilo. Tropical Conservation Biology and Environmental Science. 2016. Arthropod Diversity Estimates for Three Native Subalpine Plant Species on the Maunakea Volcano of Hawai‘i Island.
In 2016 Ms. Stever was awarded first place in the 15-minute graduate student oral competition at the 2016 International Congress of Entomology in Orlando, Florida.
- Nathan Stephenson UH Hilo. Tropical Conservation Biology and Environmental Science. 2016. High Resolution Habitat Suitability Modeling for a Narrow-Range Endemic Alpine Hawaiian Species.
- Marie McKenzie UH Mānoa. Geography. 2016. Regional Temperature Trends in Hawai‘i: A Century of Change, 1916-2015.
- Jessica Kirkpatrick UH Hilo. Tropical Conservation Biology and Environmental Science. 2018. An Assessment of *Nysius wekiuicola* Populations and Thermal Microhabitat Conditions on Cinder Cones of the Maunakea Volcano, Hawai‘i.

Jorden Zarders	UH Hilo. Tropical Conservation Biology and Environmental Science. 2018. Invasive Arthropod Monitoring Assessments of Construction and Facility Activities on Maunakea, Hawai'i.
Bret Mossman	UH Hilo. Tropical Conservation Biology and Environmental Science. In progress. Seabird and bat inventory

Interns

2012	Jessica Kirkpatrick – arthropod monitoring (partnered with Dr.J.Eiben, UH Hilo)
2013:	Kerri Nakatsu – invasive species plan development (partnered with Hawaii Ant Lab)
2013:	Amber Stillman – spatial data support (partnered with Dr.R.Perroy, UH Hilo)
2014:	Darcy Yogi – invasive species plan development (partnered with Hawaii Ant Lab)
2014:	Margaux Mellot – erosion monitoring (partnered with Dr.R.Perroy, UH Hilo)
2015:	Christian Kapono – Aloha Art Festival (partnered with 'Imiloa)
2015:	Tisha Piilani-Pelanca – monitoring implementation (partnered with HCC Forest Team)
2015:	Sean Kirkpatrick – erosion monitoring (partnered with Dr.R.Perroy, UH Hilo)
2016:	Ku'upua Kiyuna – review of draft administrative rules
2016:	Kialoa Mossman – erosion monitoring (partnered with Dr.R.Perroy, UH Hilo)
2016:	Koa Akima – monitoring implementation (partnered with HCC Forest Team)
2017:	Jake Martin – snowcover and permafrost (partnered with Dr.N.Schorghofer, UH Mānoa)
2017:	Shola Kahiapo – vegetation restoration
2018:	Sebastian Wells – bird, bat, and arthropod monitoring (partnered with Dr.P.Hart, UH Hilo)
2018:	Uli'i Miyajima – permafrost and snow-cover (partnered with Dr.N.Schorghofer, UH Mānoa)
2018:	Timothy Aaron Medina – erosion monitoring at Halepōhaku (partnered with Dr. R.Perroy, UH Hilo)
2019:	Pili Quinories – information sheets of Maunakea plant species
2020:	To Be Determined – Summer 2020 intern for the seabird and bat acoustic data analysis project (partnering with Dr. P.Hart, UH Hilo)

MAUNAKEA SPEAKER SERIES (CMP EO-3)

OMKM in collaboration with 'Imiloa Astronomy Center and the Department of Physics and Astronomy, University of Hawai'i Hilo. Launched a monthly lecture series giving community members unprecedented access to scholars and their knowledge-based work.

The Maunakea Speakers Series brings scholars to Hilo to present on diverse subjects including culture, fauna, biodiversity, climate change, botany, geophysics and other topics; all components of the immense resource diversity found on Maunakea.

Oct. 24, 2014: K.Yoshikawa, University of Alaska-Fairbanks. Tropical Mountain Permafrost

Nov. 20, 2014: N.Schorghofer, UHM. The History of Snow & Ice on the Summits of Hawai'i

Feb. 9, 2017: R.Fleischer, Smithsonian. Birds of Paradise Lost: Evolution, Extinction and Conservation of Hawai'i's Birds

Mar 23, 2017: JB Friday, UH Mānoa CTAHR. Raising Awareness of Rapid 'Ōhi'a Death

Apr. 20, 2017: H.Stever, UH Hilo TCBES. Arthropod Diversity in the Subalpine Region of Maunakea

May 18, 2017: J.Licata, Rutgers U. A Study of a Tropical Alpine Lake, Past and Present

May 31, 2017: N.Stephenson, UH Hilo TCBES. Using Environmental Data to Model Habitat Suitability on Maunakea

Jun. 15, 2017: M.B.Laycheck & D.Simons, CFHT. Maunakea Scholars Share their Observation Experience

Aug 24, 2017: P.Mills. Tracing the Movement of Ancient Hawaiian Adzes through the Islands

Sept. 26, 2017: S.Businger. Past and Future Climate on Maunakea

Oct. 17, 2017: K.Hon. Growth and Evolution of Maunakea Volcano, A Geologic Story of Sibling Rivalry

Nov. 17, 2017: K.Baybayan. He Lani Ko Luna, A Sky Above, "In losing the sight of land, you discover the stars"

Jan. 11, 2018: Big Island High School Students: insights from Science Fair Projects

Feb. 1, 2018: E.Schmidt. 10 Years of Lunar Eclipse Photometry

Feb. 22, 2018: R.Lyman. Maunakea Weather Center More than Forecasting Passing Showers

Mar.14, 2018: M.Chun.Maunakea – What Makes it the Best Astronomical Site in the World

Apr. 26, 2018: R.Perroy. Mapping Changes at the Maunakea Summit

May 10, 2018: R.Hart. Keeping up with the Coast: Quantifying Shoreline Change on Hawai'i Island

June 21, 2018: D.Thomas. New Insights into the Groundwater Hydrology of Mauna Kea and Hawaii Island

Jul. 19, 2018: M.B. Laychack & D.Simons. Dark Nebula, Dwarf Galaxies from Students who explore them, Honoka'a Maunakea Scholars

MAUNAKEA SPEAKER SERIES
A Monthly Scholar-Focused Presentation
In Partnership with Office of Maunakea Management,
'Imiloa Astronomy Center and UH Hilo Dept. of Physics & Astronomy

HE LANI KO LUNA, A SKY ABOVE
"IN LOSING THE SIGHT OF LAND, YOU DISCOVER THE STARS"

Presented by Kalepa Baybayan
Navigator in Residence, 'Imiloa Astronomy Center of Hawai'i

Thursday, November 30 • 7pm to 8pm
UH Hilo, Wentworth Hall • Room #1

Kalepa Baybayan will share his knowledge of deep-sea voyaging and oceanic wayfinding, the indigenous system of orientation and navigation at sea. His talk will also cover the recently completed Malama Honua Worldwide Voyage and the epic journey of the iconic double-hulled sailing canoe, Hukule'e, which traveled 42,000 nautical miles over 3 years, visiting 150 ports in over 20 countries, while training a new generation of navigators, educators, scientists, and community stewards.

'IMILOA
Astronomy Center of Hawai'i

UNIVERSITY OF HAWAII
HILO

OMKM
Office of Maunakea Knowledge Management

MAUNAKEA SPEAKER SERIES IS FREE AND OPEN TO THE PUBLIC.
On-campus parking is open and available without charge after 4:00pm.

- Sept. 20, 2018: M.Montgomery. Managing Ants on the Big Island: How to keep the Beasts at Bay
- Oct. 18, 2018: S.Cordell. USFS/IPIF/HETF, The Hawaii Experimental Tropical Forest
- Nov. 15, 2018: G.Gerrish. The Plants and Vegetation of Maunakea from Tree-line to Summit
- Dec. 20, 2018: J.Eiben. What's Up on Maunakea? Insect diversity and Ecosystem Monitoring for Conservation and Land Management
- Jan. 10, 2019: Hilo School Students, Sharing Science Fair Projects
- Mar. 21, 2019: J.Juvik. The Only Way is Up? How are Mauna Kea and Mauna Loa Alpine Plants Responding to Rapid Climate Change?
- Apr. 4, 2019: E.Rehm. What's Slowing Forest Restoration at Hakalau Forest National Wildlife Refuge?
- May 30, 2019: H.Stever/J.Eiben. Evolution of an Oddity: An Exploration of the Wēkiu Bug's Isolation and Adaptations on Maunakea
- June 19, 2019: L.Hunter. Tapping into Local Science and Technology Talent—The Akamai Internship Program
- Jul 3, 2019: M.B. Laychak & D.Simons. Hot Stars and Dark Matter from the students of Maunakea Scholars



OMKM AND ASTRONOMY Enewsletters (CMP EO-3)

OMKM eNews

In 2012 OMKM began publishing an eNewsletter about OMKM activities. The eNews is distributed to about 3,500 individuals. Our newsletters are reviewed by approximately 32% compared to open industry rate of 12%.

OMKM eNewsletters	Date Sent
OMKM Volunteer Call	July, 2012
OMKM Symposium	Sept, 2012
Hawaii Island Realtors Trade Show	Sept, 2012
Maunakea Safety	Nov, 2012
New MKMB Members (Chun & Springer)	Dec, 2012
OMKM Volunteer Call	Jan, 2013
Invasive Species Mgt Plan in Progress	Jan, 2013
Armandroff Appointed	Feb, 2013
Science Project (Ann Nakamoto)	Mar, 2013
OMKM Cultural Mission	April, 2013
OMKM Community Hero Award	April, 2013
OMKM Volunteer Call	May, 2013
Volunteers Plant Silverswords	May, 2013
Hawaii Island Students Earn National Distinction	June, 2013
Babayan Viewpoint and Kahu Ku Mauna chair	June, 2013
OMKM Volunteer Call	Sept, 2013
Maunakea Wekiu Bug	Oct, 2013
OMKM Volunteer Call	Oct, 2014
Setting the Record Straight	Oct, 2014
Sponsored Talk "History of Snow & Ice	Nov, 2014
Volunteer Hours Spent Recap	Dec, 2014
Alpine Study Released	Dec, 2014
Master Lease EIS Call for Comments	Jan, 2015
Completion of MKISP	March, 2015
Kealakehe School Science Fair	May, 2015
OMKM Rule Making Open House	May & June, 2015
OMKM Volunteer Call	Nov, 2015
OMKM Volunteer Call	Jan, 2016
OMKM Hire (Ruddle)	Feb, 2016
UH OpEd "On Track"	Feb, 2016
OMKM Volunteer Call	April, 2016
OMKM Panaewa Community Outreach	April, 2016
OMKM Kealakehe Elementary School Outreach	May, 2016
OMKM, A Decade Plus of Stewardship	June, 2016
Kirkpatrick Lecture	June, 2016

OMKM eNewsletters	Date Sent
Kona Kohala Chamber of Commerce Pualu Award	June, 2016
OMKM Heritage Guide Brochure	July, 2016
OMKM Volunteer Call	August, 2016
OMKM Volunteer Saturday	August, 2016
Draft rules for Maunakea lands	October 10, 2016
Stever Wins Competiion	October 21, 2016
Advancing the Mission of OMKM: A Look Back	December 20, 2016
West Hawaii today balance article	January 2017
Volunteer Call	March 11, 2017
Announces a Public Comment Period	March 8, 2017
EnVisioning Maunakea's Future	March 17, 2017
Alpine Lake Atop Mauna Kea (WHT article)	March 20, 2017
Astro Bash	March 24, 2017
Kealkehe Science Day	March 30, 2017
OMKM Honored by HHF	April 19, 2017
Fostering Science Discoveries in Young Students	April 24, 2017
Lassner Recognizes OMKM Award	April 27, 2017
Graffiti Damage	May 9, 2017
OMKM Volunteer Summer	June 30, 2017
OMKM Chamber Award	July 3, 2017
OMKM Successful Management	August 28, 2017
Final EA on VIS Improvements	Sept. 6, 2017
OMKM PIPES Yogi	Sept. 27, 2017
Last Permafrost in Hawaii	October 18, 2017
OMKM on LAVA 105 Community Corner	October 24, 2017
OMKM Successful Management (Repeat)	November 9, 2017
OMKM 2017 Weed Pull Review	November 30, 2017
OMKM CSO Decommission	December 4, 2017
Preserving and Protecting Cultural Resources	Jan. 30, 2018
Public Hearing on Proposed Land Use within the Conservation District	Feb 14, 2018
Honolulu Star Advertiser Poll	Feb 23, 2018
ESPIN Maunakea Land Authorization	March 6, 2018
EnVision Maunakea Report Released	April 5, 2018
Rep Nakashima letter of recommendation	April 17, 2018
OMKM PIPES Kiyuna	April 30, 2018
A New Era of Stewardship on Maunakea	May 24, 2018
Volunteer Call	June 15, 2018
Update on University's Administrative Rules Process for Maunakea	August 1, 2018
UH Asking for Public Input on Maunakea Rules for Public and Commercial Activities	August 20, 2018

OMKM eNewsletters	Date Sent
Honolulu Star Advertiser Article	August 31, 2018
Hawaii Business magazine's article on the economic and educational contributions of astronomy to Hawai'i Island	Sept. 17, 2018
UH BOR approved the appointments of six members of the community-based Maunakea Management Board	Sept. 21, 2018
UH Asking for Public Input on Maunakea Rules for Public and Commercial Activities	Sept. 24, 2018
UH BOR approved the appointments of six members of the community-based Maunakea Management Board	Sept. 29, 2018
Help Mālama Maunakea	Oct. 30, 2018
MAUNAKEA: Stewardship of the Mountain Forum	Nov. 1, 2018
Maunakea Visitor Information Station begins improvements; stargazing and operating hours impacted	Nov. 28, 2018
Internal Audit Finds No Irregularities	Dec. 18, 2018
Honolulu Star Advertiser Viewpoint	Dec. 27, 2018
The University of Hawai'i is asking for public comment on the latest draft of the proposed administrative rules for public and commercial	Feb. 13, 2019
Greg Chun In the News	Feb. 25, 2019
Imiloa Turns 13!	Mar. 8, 2019
Maunakea Permafrost	Mar 11, 2019
The University of Hawai'i is asking for public comment on the latest draft of the proposed administrative rules for public and commercial	Mar. 13, 2019
OMKM joins DLNR DOFAW's Nāpu'u Conservation Project Bio-Cultural Blitz at Pu'uwa'awa'a	Mar 25, 2019
Volunteer Call	April 9, 2019
Volunteer Call	April 11, 2019
UH Hilo professor names black hole capturing world's attention	April 11, 2019
UH Hilo requesting second round of public hearings for Maunakea administrative rules	April 17, 2019
The University of Hawai'i invites the public to provide feedback on the latest draft of the proposed administrative rules to govern public and commercial activities on UH -managed lands on Maunakea	April 29, 2019
Board of Regents to consider proposed Maunakea administrative rules at August meeting	July 12, 2019
OMKM Conducting Maunakea Public & Commercial Tour Capacity Study	Aug. 9, 2019
Two Maunakea Observatories Support Services vehicles vandalized	Sept. 12, 2019
Statement on the passing of Barry Taniguchi	Sept. 23, 2019
Regents Consider Rules	Nov. 1, 2019
Maunakea Rules Show Good Faith	Nov. 5, 2019
Regents approve proposed Maunakea administrative rules	Nov. 12, 2019
The University of Hawai'i Board of Regents approved a draft of the administrative rules	Nov. 26, 2019
Gov. Ige Approves Regulations	Jan. 14, 2020

OMKM eNewsletters	Date Sent
Volunteer Call	Jan 30, 2020
A Highlight of Administrative Rules for Public Activities	Feb 3, 2020
Malama Maunakea Mahalo	Feb 14, 2020
Decommissioning of two telescopes on University of Hawai'i-managed lands	Mar 2, 2020
Volunteer Call	Mar 9, 2020
Maunakea visitor center closing temporarily	Mar 16, 2020



OFFICE OF MAUNAKEA MANAGEMENT NEWS

March 2,



UNIVERSITY of HAWAII NEWS

Academic Research People Community Athletics Administrative By Cam

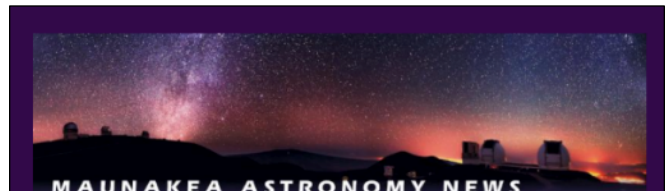
decommissioning of 2 Maunakea telescopes expected to be complete by 20

decommissioning of two scopes on University of Hawai'i-
aged lands on Maunakea is
actively scheduled to be
pleted by 2023. This is
ording to an update provided by
iversity to the UH Board of
ents (BOR) at the board's
uary 20 meeting
H West O'ahu. The California
tute of Technology (Caltech)
millimeter Observatory and the UH Hilo Hoku Ke'ateaching telescope
making progress in the extensive decommissioning process, according
H Executive Director of Maunakea Stewardship Greg Chun, who
ided the update to the regents.



Decommissioning of 2 Maunakea telescopes
expected to be complete by 2023

BOR adopted a resolution in November 2019 directing UH leadership
ngthen its stewardship of Maunakea and report back regularly on the
press of 11 action items. The first action item in the resolution is the



MAUNAKEA ASTRONOMY NEWS

January 17, 2020



W. M. KECK OBSERVATORY

Astronomers Discover Class Of Strange Objects Near Our
Galaxy's Enormous Black Hole

Posted January 15, 2020

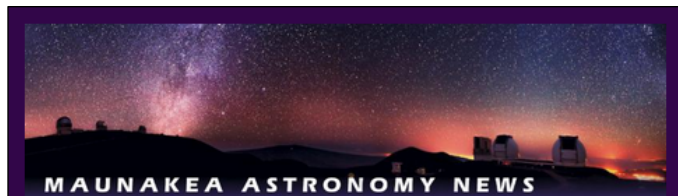
Maunakea, Hawaii - Astronomers from UCLA and W. M. Keck Observatory have discovered four
more bizarre objects at the center of our galaxy, not far from the supermassive black hole called
Sagittarius A*, that are now forming a class of their own.

The study, which is part of UCLA's Galactic Center Orbits Initiative, consists of 13 years of data
taken from Keck Observatory on Maunakea in Hawaii; the results published online today in the
journal Nature.

"\"These objects look like gas but behave like stars,\" said co-author Andrea Ghez, UCLA's Lauren
B. Leightman and Arthur E. Levine Professor of Astrophysics and director of the UCLA Galactic
Center Group.

This new class of objects, called G objects, look compact most of the time and stretch out when
their orbits bring them closest to the black hole. Their orbits range from about 100 to 1,000 years,
said lead author Anna Ciurlo, a UCLA postdoctoral researcher.

[Click to read the study while participating in Keck Observatory's Virtual Scholars Program and](#)



MAUNAKEA ASTRONOMY NEWS

April 12, 2018



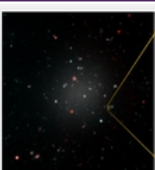
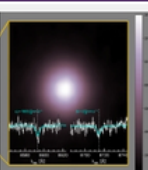
W. M. KECK OBSERVATORY

Maunakea, Island of Hawai'i

**Dark Matter is a No Show in
Ghostly Galaxy**

Maunakea, Hawaii -Galaxies and dark matter go hand in hand; you typically don't find
one without the other. So when researchers uncovered a galaxy, known as NGC1052-
DF2, that is almost completely devoid of the stuff, they were shocked.

"Finding a galaxy without dark matter is unexpected because this invisible, mysterious
substance is the most dominant aspect of any galaxy," said lead author Pieter van
Dokkum of Yale University. "For decades, we thought that galaxies start their lives as
blobs of dark matter. After that everything else happens: gas falls into the dark matter
halos, the gas turns into stars, they slowly build up, then you end up with galaxies like
the Milky Way. NGC1052-DF2 challenges the standard ideas of how we think galaxies
form."

(Left) The ultra-diffuse galaxy is rich with globular
clusters, which hold the key to understanding this
mysterious object's origin and mass. (Right) A
closer look at one of the globular clusters within th
galaxy, which are all much brighter than typically
seen, with the brightest emitting almost as much
light as the brightest globular cluster within the
Milky Way. The spectrum, obtained by Keck
Observatory, shows the calcium absorption lines
used to determine the velocity of this object. 10
clusters were observed, providing the information
needed to determine the mass of the galaxy,
revealing its lack of dark matter.

CREDIT: W. M. KECK OBSERVATORY/GEMINI
OBSERVATORY/NSF/AURA/J. MILLER/J. POLLARD



OFFICE OF MAUNAKEA MANAGEMENT NEWS

December 20, 2016

Advancing the Mission of OMKM: A Look Back
by Stephanie Nagata, OMKM Executive Director

As 2016 comes to a close, I thought I would take this time to reflect on how the Office of
Maunakea Management (OMKM) has advanced its mission since our formation in 2000.
The priority at OMKM has, and continues to be the protection of Maunakea's unique
cultural, natural and scientific resources for generations to come. The successful
management of the large, diverse and remote acreage on Maunakea under OMKM's care is
the result of a deliberate process involving the Hawaii Island community.




At the time of our formation in 2000, one of OMKM's first priorities was to identify the
resources and establish baseline data to be used to assess the status of the resources over
time. Surveys, each involving multiple years of field work, were put into action. We now
have baseline data for archaeological sites, wēkiu bug, other native arthropods, botanical
resources, climate, and weathering/erosion processes.

BLNR 2020 Annual Report: Appendix C

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July 2020

Astronomy eNews

The Astronomy e-news focuses on discoveries and scientific advances made by observatories on Maunakea. The newsletter is distributed to approximately 2,500 individuals with an open rate of 27% compared to the 12% open rate industry average.

Astronomy eNewsletters	Publication Date
50 Years of Astronomy	February 25, 2015
Journey Through the Universe Celebrating Exploration and The Joys of Science and Astronomy	February 26, 2015
Mauna Kea Telescopes: The Business of Astronomy Is Not an Easy One	May 5, 2015
Statewide Economic Impact of Astronomy Tops \$168 Million	March 23, 2015
Students Seek Maunakea Observatories' Internships and Job Opportunities At UH Hilo Career Expo	October 15, 2015
W. M. Keck Observatory Celebrates 25 Years Since First Light	Nov. 24, 2015
Island Voices: UH engaged in positive stewardship of Mauna Kea for generations to come	December 9, 2015
NASA Honors Keck Observatory for Opening its Archive to the Public	December 14, 2015
2016 Akamai Summer Internship Program	Feb 5 2016
Stargazing at Imiloa Astronomy Center	February 24, 2016
Maunakea Scholars, a new programs being launched	March 4, 2016
Kapolei Students chosen for telescope time	March 7, 2016
Governor Ige proclaims "Journey through the Universe Week" in support of Maunakea Observatories	March 9, 2016
Waiakea High Students Win Opportunity to Use Mauna Kea Telescope	March 17, 2016
HI STAR Astronomy Camp Celebrates 10 Years of Success Weeklong Residential Camp Mentors High School Students	March 18, 2016
Camp 'IMI-Possible: Mapping the Night Time Sky with Keiki Explorers	March 28, 2016
UH Hilo undergraduate Jasmin Silva conducting astronomy research on structure of galaxies	April 28, 2016
UH Hilo undergraduate Derek Hand Conducting Astronomy Research on Merging Galaxies	May 4, 2016
AstroDay	May 10, 2016
Akamai Workforce Initiative Announces 2016 Summer Interns	May 25, 2016
Maunakea Scholars Program Wraps Up Its First Year	June 1, 2016
Pioneering Education Through Innovative Partnerships	June 18, 2016
Earth-like planets among 100+ identified by UH, astronomers and NASA	July 18, 2016
Working Together, Mauna Kea Observatories Help Discover More Than 100 New Planets	July 28, 2016
More students to view the stars; UH-Hilo undergrads allotted telescope time	August 2, 2016
Astronomy Benefits Hawaii	September 9, 2016
Imiloa Presents Dr. Richard Green, Director of UKIRT Observatory	September 16, 2016
Daniel K. Inouye Solar Telescope on track to be operational in 2019	October 10, 2016
Solar System Walk Canada-France-Hawai'i Telescope and W.M. Keck Observatory host beloved annual event	November 2, 2016
Maunakea Scholars To Provide More Hawai'i Students With World-Class Telescope Time	November 9, 2016
CFHT Producing Great Science Since 1979	December 2, 2016
Summer 2017 Akamai Internship Program Application Process Opens	December 19, 2016
Three Kalani High School students were awarded time; Mauna Kea Scholars program	December 28, 2016

Astronomy eNewsletters	Publication Date
Maunakea Observatories Award Nanakuli and Kapolei High School Students With Research Time	February 8, 2017
The arrival of SCEXAO at Subaru	February 17, 2017
Some of the most amazing discoveries are being made from the telescopes on Maunakea.	March 8, 2017
Aunty Mimi's Astro Bash	March 17, 2017
Free stargazing program at the Maunakea Visitor Information Station (VIS)	April 5, 2017
Dr. Brittany Kamai Presents "Catching Waves from Black Holes" Tonight at UH Hilo Science and Technology!	April 17, 2017
W. M. Keck Observatory Achieves First Light with New Instrument	April 21, 2017
Celebrate Hawai'i Astronomy at AstroDay	April 26, 2017
W. M. Keck Observatory Hosts Quadruple Whammy	May 11, 2017
UH Institute for Astronomy Open House Highlights	May 8, 2017
Student at Kea'au High School Wins 2017 Maunakea Coin Contest!	May 26, 2017
Astronomy Shines at 16th Annual Hilo AstroDay	June 1, 2017
UH News	June 2, 2017
W. M. Keck Observatory data leads to first of its kind test of Einstein's theory of General Relativity	June 16, 2017
Maunakea Skies	July 18, 2017
Research Team Using Data from James Clerk Maxwell Telescope Makes Discoveries	July 28, 2017
Could they be a future target for interstellar colonization?	August 10, 2017
Akamai Internships Produce Successful Astronomy Projects	August 29, 2017
Hawaii Students Participate in Summer HI STAR Program	August 30, 2017
Canada France Hawaii Telescope to Host Manufacturer Open House Oct. 6 Call to Big Island Manufacturing Network!	September 26, 2017
Astronomy to be Featured at Hawaii Innovation Initiative Forum in Honolulu	October 2, 2017
Maunakea Scholars	October 26, 2017
AstroDay is Coming to Kona	October 23, 2017
UH News	October 30, 2017
First AstroDay in West Hawaii a Success!	November 7, 2017
Celebration of Fifty Years of Astronomy on Maunakea	November 13, 2017
Akamai	November 29, 2017
Astronomy Student Stars Kick Off Maunakea Scholars Awards Season	December 1, 2017
Unexpected Discovery	December 28, 2017
W. M. Keck Observatory Awarded NSF Grant	January 5, 2018
Presentation by Dr. Kip Thorne, Nobel Prize Winner and World-Renowned Astrophysicist	January 2, 2018
A discovery made by a Hilo High School alumnus	March 8, 2018
Applications are now being accepted for the 2018 Women's STARS (STEM Aerospace Research Scholars) Program,	March 30, 2018
Dark Matter is a No Show in Ghostly Galaxy	April 12, 2018
Celebrate Science at AstroDay!	April 25, 2018
Andrea Ghez, Director of the UCLA Galactic Center Group Presents "The Monster at the Heart of our Galaxy	July 24, 2018
UH Asking for Public Input on Maunakea Rules for Public and Commercial Activities	August 21, 2018
AstroDay Returns to Kona	September 21, 2018
Hawaii High School Student scores highly coveted telescope time to study 'Tatooine' at Keck Observatory	November 30, 2018
Selection of Hawaiian names for two major astronomical discoveries.	January 29, 2019
UH News: Manoa Academy teams up with Maunakea scholars	January 11, 2019
Submillimeter Array (SMA) Call for Standard Proposals	February 12, 2019

Astronomy eNewsletters	Publication Date
Unusual Galaxies Defy Dark Matter Theory	March 28, 2019
Astronomers this morning are set to unveil the first image of a black hole using the combined power of a global network of telescopes,	April 10, 2019
Was Einstein Right? Hawaii and the Event Horizon Telescope	April 12, 2019
The 18th Annual AstroDay Comes to Hilo Saturday, May 4!	April 17, 2019
Pōwehi Day Proclamation	April 19, 2019
Mt. View Elementary School Visits Institute for Astronomy Hilo	April 23, 2019
Keck Observatory Welcome Riley Atkinson	June 18, 2019
Remembering the Father of Keck Observatory	June 21, 2019
UH News UH team successfully locates incoming asteroid	June 26, 2019
Two UH astronomers part of international team that agrees on a natural origin for 'Oumuamua	July 8, 2019
Hawai'i Astronomer Wins Canadian Award	July 15, 2019
W.M. Keck Observatory presents A Primitive Planetesimal In The Kuiper Belt Explored By New Horizons	July 18, 2019
Astronomers to deploy breakthrough technology at UH telescope	August 15, 2019
Critical observation made on Maunakea during first night of return to operations	August 20, 2019
Two Maunakea telescopes were part of an international collaboration that won the \$3 million 2020 Breakthrough Prize in Fundamental Physics award	September 6, 2019
UCLA astronomers notice brightest light in 24 years of observations	September 13, 2019
AstroDay West Hawaii	October 22, 2109
NASA Scientists Confirm Water Vapor on Europa	November 19, 2019
W.M. Keck Observatory Astronomy Talk	January 3, 2020
Astronomers from UCLA and W. M. Keck Observatory have discovered four more bizarre objects at the center of our galaxy	January 17, 2020
W.M. Keck Observatory Astronomy Talk	February 26, 2020
Maunakea Observatories launch virtual outreach program during suspension of telescope operations	March 26, 2020
Astronomy Rebuilt Hawai'i Island's Economy After 1960 Tsunami	April 6, 2020
Hawaii Astronomer Discovers Massive Extrasolar Planet with Maunakea Telescope	April 29, 2020
Maunakea Observatories Reopen	May 15, 2020
New Direct Images Captured with W. M. Keck Observatory's Upgraded Adaptive Optics System Lead to First Independent Confirmation of PDS 70 Protoplanets	May 19, 2020
Astronomers See Cosmic Ring of Fire	May 28, 2020

STEWARDSHIP RECOGNITION

Mar. 6, 2013 Mary Begier awarded the *Community Hero Award* by the Hawaii Invasive Species Council as a shining example of dedication to prevent invasive species. Ms. Begier assisted OMKM in developing and implementing the volunteer weed pull program



Jun. 24, 2016 Kona Kohala Chamber of Commerce. OMKM awarded Pualu Award for Environmental Awareness



May 19, 2017 Historic Hawaii Foundation; OMKM recognized with Preservation Commendation Award for its Long-term Historic Property Monitoring Plan for UH Managed Lands on Maunakea



Jun. 30, 2017 Kona Kohala Chamber of Commerce; OMKM awarded the Pualu Award for Culture and Heritage.



Appendix D: Visitor Management (HAR 20-26)

Hawai'i Administrative Rules, Chapter 20-26

Approved rules are available online at <https://www.hawaii.edu/offices/bor/adminrules/chapter26.pdf>.

ADMINISTRATIVE RULES (HAR 20-26)– (CMP P-3)

In the 1998 audit report on the management of Maunakea, the State Auditor recommended that the University develop administrative rules to address public activities including access to protect the resources. Development of rules was one of the first matters addressed by OMKM during the month the MKMB was established in October 2000. In early 2001 OMKM began drafting rules, but later discovered UH did not have legal authority to promulgate rules. It took several years, until 2009 when the Legislature granted UH rule making authority. The 2010 BLNR approved CMP supplemental Public Access Plan provided principals and policies for the development of the rules. In January 2020, Governor Ige approved the rules.

Administrative rules “provide for the proper use, management, and protection of cultural, natural, and scientific resources of the UH management areas; to promote public safety and welfare by regulating public and commercial activity within the UH management areas; to ensure safe and appropriate access to the UH management areas for the public; and to foster co-management with the Department of Land and Natural Resources in UH management areas.”

COMMUNITY ENGAGEMENT AND OUTREACH

Oct. 10, 2000	Maunakea Management Board (MKMB) begin drafting rules
Mar. 13, 2001	MKMB update: OMKM drafting rules
Mar. 29, 2001	Kahu Kū Mauna update: OMKM drafting rules
July 22, 2003	MKMB update: OMKM requests review whether UH has statutory authority to promulgate administrative rule making
Oct. 28, 2003	MKMB update: OMKM and UH System discuss UH's process for rule making
Aug. 31, 2005	MKMB update: UH was unsuccessful in obtaining legislative authority to promulgate rules
Nov. 15 2005	Kahu Kū Mauna update: UH was unsuccessful in obtaining legislative authority to promulgate rules; will go back to the legislature seeking statutory authority
Jan. 21. 2007	Kahu Kū Mauna update: suggested rules of conduct for visitors and rangers
Sept. 11, 2007	MKMB update: UH to review making rule making as part of the Comprehensive Management Plan development process
Sept. 25, 2007	Kahu Kū Mauna update: reported that DLNR believed UH had authority to develop rules but that authority was unclear
Feb. 5, 2009	MKMB update: Again seeks legislative authority to promulgate rules
June 25, 2009	Kahu Kū Mauna update: Governor Lingle approved Act 132 granting UH authority to promulgate rules
May 19, 2010	MKMB update: UH legal counsel to assist OMKM with the development of rules and establish procedures for handling fines
Feb. 9, 2011	Kahu Kū Mauna update: consultant Jeff Melrose provided a summary of the draft rules
Mar. 22, 2011	Consultation with OHA
Mar. 2011	Note: rule making put on hold due to concerns of ex parte communication between UH and DLNR while UH was involved in a contested case proceeding
Apr. 13, 2011	Kahu Kū Mauna update: Council members raised concerns, including ensuring commercial tour providing passengers with correct information
May 19, 2011	Consultation with OHA
June 6, 2013:	Big Island Legislative Briefing; OMKM briefing on rule making

June 17, 2013: Big Island Legislative Briefing; Representatives Mark Nakashima, Richard Onishi, and Clift Tsuji; OMKM briefing on rule making

June 19, 2013: Big Island Legislative Briefing; Senator Malama Solomon and Representative Cindy Evans; Discussion Topic: OMKM briefing on rule making

July 29, 2013: Big Island Legislative Briefing; Senator Russell Ruderman and Representative Faye Hanohano; OMKM briefing on rule making

Aug. 1, 2013 Ross Birch, Executive Director Big Island Visitors Bureau; OMKM briefing, rule making

Aug. 14, 2013 MKMB update: Rule making will resume following issuance of permit to the TMT.

Oct. 4, 2013: Keawe Vredenburg; OMKM briefing on rule making

Oct. 16, 2013: David Tarnas OMKM briefing on rule making

Nov 13, 2013: Rotary Club of North Hawaii; OMKM briefing on rule making

Mar. 12, 2014 Kahu Kū Mauna update: provided an overview of commercial tour permits and they addressed in the administrative rules

May 12, 2014 Kahu Kū Mauna update: reviewed a draft of the rules

June 19, 2014 OMKM rule making community outreach: Mike Kaleikini, Hawaii Island Chamber of Commerce; Jon Miyata, Hawaii Island Chamber of Commerce and Ivan Nakano, Japanese Chamber of Commerce & Industry of Hawaii

June 24, 2014 OMKM rule making community outreach; Mary Begier, Hawaii Island Realtors & Hawaii Island Chamber of Commerce; Bill Brown, Panaewa Hawaiian Homes Community Assoc.; Chuck Erskine, Hawaii Island Chamber of Commerce; David Honma, Japanese Chamber of Commerce & Industry of Hawaii; Lillian Kaeha, Panaewa Community Alliance; Ka'iu Kimura, 'Imiloa & Hawaii Island Chamber of Commerce; Susan Lee Loy, Hawaii Island Realtors; Toby Taniguchi, KTA Super Stores; Nico Verissimo, UH Foundation

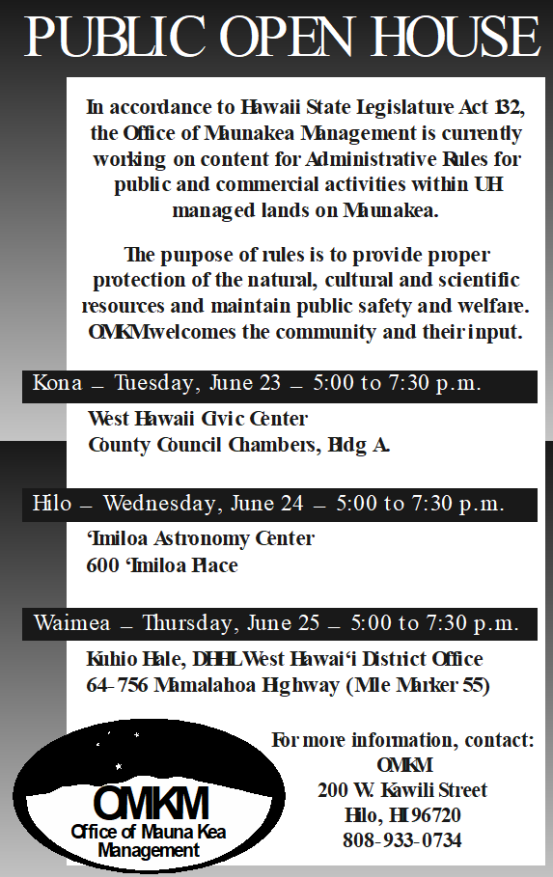
July 9, 2014 OMKM rule making community outreach; Bill Brown, Panaewa Hawaiian Homes Community Association, Roberta Chu, Hawaii Island Economic Development Board; Louis Hao, Dept. of Hawaiian Home Lands; Nani Kaeha, Panaewa Community Alliance; John McBride, Hawaiian Village Tours; Judi Meyers, ILWU & Hilo Pensioners' Club; Alike Toledo, Miles Yoshioka, Hawaii Island Chamber of Commerce

July 17, 2014 OMKM rule making community outreach; Thomas Anthony, Hui Pu Laka Hawaiian Civic Club; Dean Au, Carpenter's Union; Jo-Anna Herkes, SSFM International; Harvey Keliikoa, Hui Lu Laka; Kimo Lee, Kimo; Hawaii Island Chamber of Commerce; Mike Miyahira, Japanese Chamber of Commerce & Industry of Hawaii; Craig Shiroma, Japanese Chamber of Commerce & Industry of Hawaii; Barry Taniguchi, KTA Super Stores; Jere Usui, Japanese Chamber of Commerce & Industry of Hawaii

Aug. 1, 2014 OMKM rule making community outreach; Tracey Fosso, Kona-Kohala Chamber of Commerce; Vivian Landrum, Kona-Kohala Chamber of Commerce; Dale Suezaki, Kona-Kohala Chamber of Commerce

Aug. 13, 2014 OMKM rule making community outreach; Patrick Kahawaiola'a, Keaukaha Community Association; Laua'e Kekahua, Maku'u Farmers Assn.; Kekoa, Jeffrey, Ka'u Hawaiian Homelands Association ; Bea Iwalani Masoe, Panaewa Hawaiian Homelands Community Association; Howard Pe'a, Keaukaha-Panaewa Farmers Association; Shirley Pedro, Maku'u Farmers Assn.; Skylark Rossetti, Kaumana Hawaiian Homestead Association; Duncan Seto, Kaumana Hawaiian Homelands Association

- Aug. 20, 2014: OMKM rule making community outreach; Keaukaha Community Association: Alberta Andaya, Herks Freitas, Leife Hao, Louis Hao, Mike John, E Raynette Kahawaiola'a, Herring Kalua, John Kanui, Lillian Keliipio, Darren Lee, Darren, John McBride, Lorraine Medeiros, Lorena Nelson, Raynette Shibata, Herbert Suganuma, Nathan Suganuma. Panaewa Hawaiian Homes Community Association: Milton Kalai, Ronald Kodani, Elizabeth-Ann Kaeha, Nani Kaeha, Camille Mehau, Terri Napeahi, Marissa Harman, Kamehameha Schools; Aoloa Santos, Department of Hawaiian Homelands. Alikea Toledo
- Aug. 25, 2014 OMKM rule making community outreach; Krista Anderson, North Hawaii Community Hospital; Jim Du Pont, Department of Hawaiian Homelands, West Hawaii District; Jacqui Hoover, Hawaii Island Economic Development Board; Pete Lindsey, Retired Laborers' International Union, Local 368; Nancy Carr Smith, Waimea Community Association; Keawe Vredenburg, Hawaiian Historian.
- Aug. 28, 2014 OMKM rule making community outreach with UH permitted commercial tours: Doug Arnott, Arnott's Lodging & Hiking Adventures; Glory Guerpo, Arnott's Lodging & Hiking Adventures; Eldon Lindsey, Robert's Hawaii Tours; Aki Miyatani, Hawaiian Haoles dba Hawaiian Eyes; Kenji Mizoguchi, Meridian H.R.T.; Hiroko Monson, Robert's Hawaii Tours; Emmy Ogawa, Taikobo; Rob Pacheco, Hawaii Forest & Trail; Kasi Sagawa, Jack's Tours; Mike Sessions, Mauna Kea Summit Adventures; Sunny Takeishi, Taikobo; Pat Wright, Mauna Kea Summit Adventures
- Sept. 2, 2014 OMKM rule making community outreach; Tommy Hickcox, Ahuena Heiau Inc.; Shane Nelsen, Kuakini Hawaiian Civic Club, OHA & Kahu Ku Mauna; Chris Ramos, Kuakini Hawaiian Civic Club; Alana Yamamoto, Kuakini Hawaiian Civic Club
- Sept. 3, 2014 OMKM rule making community outreach; Maile David, Deputy County Clerk & Councilperson-Elect; Karen Eoff, HI County Council Dist. 8; David Kaapu, Kona Attorney/Commissioner Department of Hawaiian Homelands; Maurice Kahawaii, Kona Hawaiian Civic Club and Royal Order of Kamehameha; Dru Kanuha, HI County Council Dist. 7 – Kona; Nicole Lui, Cultural Consultant for La'aloa Ext.; Byron Moku, Hokuli'a Cultural Resources Management; Cindi Punihaole, The Kohala Center; James Resor, Pacific Media Group (KAPA); Sharon Sakai, Kohanaiki Marketing Director
- Sept. 9, 2014 Kahu Kū Mauna update: Council suggested restricting access to manage for safety and to have more on managing visitors
- Sept. 11, 2014 OMKM rule making community outreach; Colin Aspin, UH 2.2 Telescope; Lars Bergnut, NASA Infrared Telescope; Rob Christensen, Smithsonian Submillimeter Array; Diego Correa, Gemini Telescope; Sandra Dawson, Thirty-Meter Telescope; Richard Green, University of Arizona; Bill Hancock, Very Long Baseline Array; Kevin Ho, Canada-France-Hawaii Telescope; Stewart Hunter, Mauna Kea Observatories Support Services; Chris Laude, Chris, Joint Astronomy Center; Rich Matsuda, W.M. Keck Observatory; Joe McDonough, Visitor Information Station; Ralph Toyofuku, Subaru Telescope
- Sept. 16, 2014 MKMB update: OMKM conducts community engagement on rules; next step is to hold open houses
- Oct. 14, 2014 Kahu Kū Mauna update: draft rules update
- Nov. 18, 2014 Kahu Kū Mauna update: draft rules update

May 6, 2015	Kahu Kū Mauna update: timeline on rules development	 PUBLIC OPEN HOUSE In accordance to Hawaii State Legislature Act B2, the Office of Maunakea Management is currently working on content for Administrative Rules for public and commercial activities within UH managed lands on Maunakea. The purpose of rules is to provide proper protection of the natural, cultural and scientific resources and maintain public safety and welfare. OMKM welcomes the community and their input. Kona – Tuesday, June 23 – 5:00 to 7:30 p.m. West Hawaii Civic Center County Council Chambers, Bldg A Hilo – Wednesday, June 24 – 5:00 to 7:30 p.m. Imiloa Astronomy Center 600 Imiloa Place Waimea – Thursday, June 25 – 5:00 to 7:30 p.m. Kuhio Hale, DHHL West Hawai'i District Office 64-756 Mamalahoa Highway (Mile Marker 55) For more information, contact: OMKM 200 W. Kawili Street Hilo, HI 96720 808-933-0734 
June 23, 2015	UH Administrative Rules Public Open House Kona; West Hawaii Civic Center; 35 signed in.	
June 24, 2015	UH Administrative Rules Public Open House, Hilo; Imiloa Astronomy Center in Hilo; 74 signed in	
June 25, 2015	UH Administrative Rules Public Open House; Waimea; Kuhio Hale; 28 signed in	
Jul. 16, 2015	Consultation with OHA	
Aug. 25, 2015	MKMB update: Report on open houses, including mini surveys taken by attendees	
Oct. 16, 2015	Kahu Kū Mauna update: reported OMKM consulting with OHA	
June. 2, 2016	Kahu Kū Mauna update: expressed concern on about enforceability	
June 22, 2016	MKMB update: Legal review of draft of rules completed	
Sept. 8, 2016	Kahu Kū Mauna update: update rules development	
Oct. 4, 2016	MKMB reviewed and approved draft of administrative rules and recommended that the BOR request the Governor to authorize holding public hearings	
Feb. 4, 2017	MKMB update: reported that the Governor requested the University not submit rules to him; he was working on a multi-stakeholder framework and he expressed working together on the rules that would help support the new framework	
Nov. 28, 2017	MKMB update: No word from the Governor on the rules. MKMB approved a motion seeking legal opinion on what authority OMKM has in the absence of rules	
Feb. 16, 2018	Consultation with OHA	
Jan 8, 2018	Consultation with OHA; President Lassner and J. Doane	
Jan. 30, 2018	MKMB update: Rules are going through another review by legal counsel	
Apr 13, 2018	Consultation with OHA	
May 22, 2018	MKMB update: Governor gives UH the go-ahead to proceed with rule making	
June 7, 2018	BOR approves request seeking Governor's approval to hold public hearings on draft rules	
July 23, 2018	Governor approves UH's request to hold public hearings	
Aug. 20, 2018	Consultation with OHA	
Aug. 28, 2018	Consultation with UH Permitted commercial tour operators	
Sept. 24, 25,	UH proposed administrative rules (Chapter 20-26, HAR) Public Hearings – Oahu:	

26 & 28, 2018 Cancer Center; Hawaii Island – Imiloa, Waikoloa Elementary and Middle School; and Maui – Maui College

Oct. 9, 2018 Kahu Kū Mauna update: Council reviews rules

Feb. 6, 2019 Community consultation on UH Administrative Rules

Feb. 8, 2019 Community consultation on UH Administrative Rules

Feb. 12, 2019 Kahu Kū Mauna update: summary of public hearings

Feb. 26, 2019 Consultation with staff of Kona Kohala Chamber of Commerce

Feb. 26, 2019 Consultation with staff of Island of Hawaii Visitors Bureau

Feb. 27, 2019 Consultation with Waimea Community Association

Mar. 3, 2019 Consultation with UH Manoa faculty

Mar. 4, 2019 Consultation with OHA

Mar. 27, 2019 Kahu Kū Mauna update: progress on development of rules

Apr. 2, 2019 MKMB update: Reviewed rule making development starting with the 1998 audit of the management of Maunakea; summarized the content of the current draft of the rules;

Apr. 4, 2019 Consultation with OHA

June 7, 2018 BOR approves request seeking Governor's approval to hold public hearings on draft rules

July 23, 2018 Governor approves UH's request to hold public hearings

Sept. 24, 25, 26 & 28, 2018 UH proposed administrative rules (Chapter 20-26, HAR) Public Hearings – Oahu: Cancer Center; Hawaii Island – Imiloa, Waikoloa Elementary and Middle School; and Maui – Maui College.

Oct. 18, 2018 BOR instructs administration to draft revisions to the rules and return with revisions for review

Feb.-Mar. 2019 Community consultation on rules are held; revisions are made based on testimony received in Sept. 2018 hearings and 2019 community consultation

Apr. 18, 2019 BOR approves request to hold a second round of public hearings

June 3, 4, 5, 7, 2019 UH proposed administrative rules (Chapter 20-26, HAR) Public Hearings – Oahu: Manoa Elementary & School; Hawaii Island – Waiakea Elementary School and Waikoloa Elementary and Middle School; and Maui – Pomaikai Elementary School

Aug. 13, 2019 MKMB update: reported changes were made to the rules based public comments during the September 2018 public hearings leading to a second round of public hearings

Sept. 17, 2019 Kahu Kū Mauna update: Suggested clarifying language for the rules; Council to draft statement supporting enforcement of rules

Sept. 27, 2019 MKMB update: reported minor clarifying changes are being made including those requested by Kahu Kū Mauna

Nov. 6, 2019 BOR approves to adopt rules, with deletion of section 20-26-62, HAR.

Jan. 13, 2020 Governor Ige approved rules. Rules became effective on January 23, 2020.

Appendix E: Permitting, Enforcement, and Facility Oversight

Community project review and compliance

COMMUNITY PROJECT REVIEW (CMP OI-1 and IM-1)

The foundation of the 2000 Maunakea Science Reserve Master Plan is community-based management of the University's managed lands on Maunakea. The Master Plan called for the establishment of the MKMB and Kahu Kū Mauna, two advisory boards comprised of volunteers from the Hawai'i Island community. Proposed projects are reviewed first by OMKM for compliance with the DLNR Conservation District Rules, and since 2009, the CMP. OMKM submits and reviews the projects with Kahu Kū Mauna whose views and suggestions are included in OMKM's report to the MKMB. The MKMB reviews projects in meetings that are publicly noticed according to Sunshine requirements, and approves, or in the case of major projects, makes recommendations to the University.

CMP OI-1 calls for maintaining "OMKM, MKMB and Kahu Kū Mauna in current roles, with OMKM providing local management of the UH Management Areas". In their capacity as advisory boards to the University, they review projects proposed projects. CMP IM-1, Operations, Monitoring and Maintenance Plan includes an annual reporting requirement by all observatories and Maunakea Observatory Support Services describing projects each facility anticipates will occur over the next 5-years.. Kahu Kū Mauna reviews the outlook plans and if they rate the project as having minimal impact or routine they do not need to review the project when it is submitted to OMKM. Those classified as "In Depth Consultation" require review by Kahu Kū Mauna. MKMB reviews all projects regardless of classification.

Since 2000, OMKM, Kahu Kū Mauna and MKMB have reviewed over 300 projects.

CDUP PERMIT INSPECTIONS (P-1 and P-7)

The CMP calls for compliance with all applicable regulations, and permit conditions related to activities in the UH managed areas. These include compliance with the DLNR's permits. Since 2006, OMKM has been conducting biannual inspections of all facilities for compliance with DLNR's permits. If a facility is out of compliance it is required to take remedial action.

Appendix F: Implementation Status

Implementation Status of Maunakea CMP Management Actions.

MKMB = Maunakea Management Board; MKSS = Maunakea Observatories Support Services; OMKM = Office of Maunakea Management; VIS = Visitor Information Station

COMPONENT PLAN: UNDERSTANDING AND PROTECTING MAUNA KEA'S RESOURCES			
		Implementation Status	Comments
NATIVE HAWAIIAN CULTURAL RESOURCES			
Management			
CR-1	Kahu Kū Mauna shall work with families with lineal and historical connections to Maunakea, cultural practitioners, and other Native Hawaiian groups, including the Maunakea Management Board's Hawaiian Culture Committee, toward the development of appropriate procedures and protocols regarding cultural issues.	Ongoing	Identification of lineal and historical connections was part of the development and State Historic Preservation division approval (2014) of the Burial Treatment Plan (see CR-13). Solicitations were made through announcements in the daily newspapers and the OHA newsletter. There were no responses to the solicitations but OMKM continues to seek out individuals as part of its interaction and relationship building with the community. Fall 2013 the Hawaii Island Burial Council officially recognized several individuals as cultural descendants of Ka'ohē Ahupua'a. OMKM places ads over a period of several months in <i>Hawaii Tribune Herald</i>, <i>West Hawaii Today</i>, <i>Honolulu Star Advertiser</i> and OHA's <i>Ka Wai Ola</i> inviting community to participate in talk story sessions. Kahu Kū Mauna. May 21, 2016, Kahu Kū Mauna hosts a talk story session on matters related to CMP management actions, representatives from DLNR DHHL OHA and members of the Native Hawaiian community attended.
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.	Ongoing	An application for the designation of the summit region of Maunakea as a Traditional Cultural Property has not yet been prepared for filing by State Historic Preservation Division with the appropriate Federal agency.
CR-3	Conduct educational efforts to generate public awareness about the importance of preserving the cultural landscape.	Ongoing	Rangers through their interactions with the visiting public help to educate and raise awareness about Mauna Kea. An informational brochure on cultural and natural resources was developed in 2014, revised in 2016, with periodic updates since then. OMKM sends out eNewsletters informing the public about OMKM and its activities. Resource orientation of those who work on the mountain including observatory personnel, VIS and MKSS staff, rangers, commercial tour operators and staff, and construction workers commenced in 2013. An online orientation is also available. A brief public / visitor orientation is complete and provided for scheduled group visits.

COMPONENT PLAN: UNDERSTANDING AND PROTECTING MAUNA KEA'S RESOURCES

		Implementation Status	Comments
Cultural Practices			
CR-4	Establish a process for ongoing collection of information on traditional, contemporary, and customary cultural practices.	Ongoing	Archival and oral history (Mauna Kea-Ka Piko Kaulana o Ka 'Āina); Cultural Resources Management Plan; various cultural analyses completed as part of Chapter 343 mandates; Maunakea topics included by related agencies such as USGS subject matter reviews; and other studies.
CR-5	Develop and adopt guidelines for the culturally appropriate placement and removal of offerings.	Completed	In 2016, Kahu Kū Mauna reviewed and approved the wording of draft policy guidelines. Approval by MKMB occurred in early 2018 after additional consultation by Kahu Kū Mauna. Administrative rules for UH's managed lands, effective beginning January 2020, incorporate policies approved by the University President while ensuring protections afforded to Native Hawaiian traditional and customary practices. Note: CR-5 overlaps with CR-7 (constructing new Hawaiian cultural features) being that offerings are usually associated with the construction of new features.
CR-6	Develop and adopt guidelines for the visitation and use of ancient shrines.	Completed	In 2016 Kahu Kū Mauna drafted and the MKMB approved the policy. Administrative rules for UH's managed lands, effective beginning January 2020, incorporate policies approved by the University President while ensuring protections afforded to Native Hawaiian traditional and customary practices.
CR-7	Kahu Kū Mauna shall take the lead in determining the appropriateness of constructing new Hawaiian cultural features.	Completed	In 2012, Kahu Kū Mauna reviewed a draft of a process. In 2016 Kahu Kū Mauna re-evaluated the policy and held a consultation session that included OHA. Approval by MKMB occurred in early 2018 after additional consultation by Kahu Kū Mauna. It is noted that the proposed policy acknowledges there are existing statutes and other agency rules governing this type of activity.
CR-8	Develop and adopt a management policy for the UH Mgt. Areas on the scattering of cremated human remains.	Completed	In 2012 Kahu Kū Mauna developed and approved a draft policy. In 2016 Kahu Kū Mauna re-evaluated the policy and held a consultation session that included OHA. Approval by MKMB occurred in early 2018 after additional consultation by Kahu Kū Mauna. Administrative rules for UH's managed lands, effective beginning January 2020, incorporate policies approved by the University President while ensuring protections afforded to Native Hawaiian traditional and customary practices.
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.	Completed	In 2012 Kahu Kū Mauna approved a draft policy. In 2016 Kahu Kū Mauna re-evaluated the policy and held a consultation session that included OHA. Approval by MKMB occurred in early 2018 after additional consultation by Kahu Kū Mauna. CR-7 was combined with CR-9 under the guidance of Kahu Kū Mauna who pointed out that the "stacking of rocks" may be a cultural features.

COMPONENT PLAN: UNDERSTANDING AND PROTECTING MAUNA KEA'S RESOURCES

		Implementation Status	Comments
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.	Completed	SHPD approved OMKM's long term historic properties monitoring plan; monitoring is ongoing according to the plan's schedule.
CR-11	Complete an archaeological survey of the portions of the Summit Access Road corridor that are under UH management.	Completed	An archaeological survey of the Maunakea Science Reserve and summit access road was completed in 2009.
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.	Completed	In 2012 Kahu Kū Mauna determined that this should be reviewed on a case-by-case basis. They identified criteria for when to consult for routine (minimal impact) project proposals, as well as with future development. In 2016, Kahu Kū Mauna revised their policy. MKMB approved their policy.
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, recognized lineal or cultural descendants, and SHPD.	Completed	SHPD reviewed and approved the Burial Treatment Plan for Mauna Kea in 2014.
CR-14	Immediately report any disturbance of a shrine or burial site to the rangers, DOCARE, Kahu Kū Mauna Council, and SHPD.	Ongoing	Rangers report disturbance to OMKM and OMKM in turn notifies other parties.

COMPONENT PLAN: UNDERSTANDING AND PROTECTING MAUNA KEA'S RESOURCES			
		Implementation Status	Comments
NATURAL RESOURCES			
Threat Prevention and Control			
NR-1	Limit threats to natural resources through management of permitted activities and uses.	Completed/ Ongoing	OMKM consulted with agencies on a draft of administrative rules governing public and commercial activities. Public hearings seeking public comments on a proposed draft were held in 2018. Administrative rules, effective beginning January 2020, for UH's managed lands incorporate policies approved by the University President while ensuring protections afforded to Native Hawaiian traditional and customary practices. An Operations, Monitoring and Maintenance Plan (OMMP) relating to the coordination of maintenance plans, activities and schedules was developed and approved by the MKMB, and is being implemented.
NR-2	Limit damage caused by invasive species through creation of an invasive species prevention and control program.	Completed/ Ongoing	The Maunakea Invasive Species Management Plan is approved and implemented. Additional topics are addressed as situations arise, and procedures are developed based on scientific, management board, and community feedback. A volunteer program was established to pull invasive weeds on UH's managed lands with emphasis in the Halepōhaku area. Beginning in 2007 OMKM conducted annual surveys of invasive arthropod species on UH's managed lands. This program was expanded to include monthly monitoring at the facilities at the 9,200 ft mid-level facilities, and quarterly monitoring of the summit facilities. Rapid response strategies were drafted as part of the Invasive Species Management Plan. Inspections of heavy equipment, construction material, and other items too large to be carried by an individual occur prior to coming on to UH's lands. Specific requirements are part of the Invasive Species Management Plan. A MS Student evaluated program efficacy as part of his 2018 thesis, with management recommendations incorporated into OMKM policies and procedures. Beginning in 2013 to July 2020, a total 808 large vehicles and loads were inspected. 782 passed initial inspection or following quick remediation and were approved, 17 were rejected and required re-inspection, and 9 were non-compliant, that is, no requests for inspections were made prior to proceeding to the mountain.
NR-3	Maintain native plant and animal populations and biological diversity.	Ongoing	Non-native plants and arthropods are monitored. The Division of Forestry and Wildlife is completing a circum-Maunakea fence and ungulate removal from Palila critical habitat. OMKM staff investigated māmane leaf curl frequency at Halepōhaku (plant disease response) in coordination with UHH scientists. Arthropod food webs and parasites are being investigated.
NR-4	Minimize barriers to species migration to help maintain populations and protect ecosystem processes and development.	Ongoing	OMKM coordinates with Forest Reserve, Natural Area Reserve, and Department of Land and Natural Resources technical staff to identify issues, craft appropriate responses, and investigate concerns regarding ecosystems and populations.

NR-5	Manage ecosystems to allow for response to climate change.	Ongoing	OMKM coordinates with Forest Reserve and Natural Area Reserve staff to ensure management activities do not inadvertently impede natural ecosystem response. Research into climate change forecast downscaling and climate monitoring helps inform potential future management action. OMKM participated in Pacific Islands Climate Change Cooperative workshops on climate change to help identify mitigation and adaptation strategies. A climate monitoring sea level to summit network plan is in preparation.
NR-6	Reduce threats to natural resources by educating stakeholders and the public about Mauna Kea's unique natural resources.	Ongoing	Rangers help to educate visitors about Maunakea as part of their daily activities. Resource orientation of those who work on the mountain including observatory personnel, VIS and MKSS staff, rangers, commercial tour operators and staff, and construction workers commenced in 2013. An online orientation is also available. A brief public / visitor orientation is complete and provided for scheduled group visits. See also CR-3 and EO-2
Ecosystem Protection, Enhancement & 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.	Ongoing	Botanical survey of UH managed lands is completed. Biodiversity, wēkiu bug, and erosion and surficial geology surveys are ongoing. A study and mapping of wēkiu bug habitat is completed. Surveys for birds and bats are ongoing.
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).	Ongoing	Assisted DLNR with fencing natural population of Silverswords. Other areas will be fenced when areas are identified and needed.
NR-9	Increase native plant density and diversity through an outplanting program.	Ongoing	Māmane seedlings germinated from seeds found in the Halepōhaku area were planted near the VIS Worked with DLNR and planted 200 Silversword seedlings in the Halepōhaku area. Collaborated with Kamehameha Schools to build plant propagation benches and start seedlings for eventual habitat restoration and enhancement at Halepōhaku. Germination of māmane seedlings continues. The construction of a small greenhouse at Halepōhaku for growing native plants was approved by BLNR as part of a project to improve the ingress/egress and parking at the VIS. Planning for construction is ongoing. Over 200 native plants were planted under the ingress/egress improvements permit.
NR-10	Incorporate mitigation plans into project planning and conduct mitigation following new development.	Ongoing	Mitigation and best management practices plans are required for projects as appropriate.
NR-11	Conduct habitat rehabilitation projects following unplanned disturbances.	Ongoing	Damage assessments and rehabilitation following unplanned disturbances are conducted on a case-by-case basis as needed. Generally, unplanned disturbances, such as vehicle oil leaks, occur on previously disturbed areas such as roadways, where humans frequent.
NR-12	Create restoration plans and conduct habitat restoration activities, as needed.	Ongoing	A study of wēkiu bug habitat restoration was initiated in 2015. A study and mapping of wēkiu bug habitat has been completed. Restoration plans and greenhouse for long-term program use are part of a project to improve the ingress/egress and parking at the VIS.

COMPONENT PLAN: UNDERSTANDING AND PROTECTING MAUNA KEA'S RESOURCES

Implementation Status

Comments

Program Management

NR-13	Increase communication, networking, and collaborative opportunities to support management and protection of natural resources.	Ongoing	OMKM has established and continues to establish working relationships with the community and DLNR through working groups such as the Maunakea Environment Committee and Big Island Invasive Species Committee, Maunakea Watershed Alliance, Hawaii Ant Lab, and OHA.
NR-14	Use the principles of adaptive management when developing programs and methodologies. Review programs annually and revise any component plan every five years, based on the results of the program review.	Ongoing	Potential CMP revisions are identified in annual program documentation. Program plans, such as the Maunakea Invasive Species Management Plan, are updated and communicated at MKMB meetings as issues are identified. Completion of Envision Maunakea project.

Inventory, Monitoring and Research

NR-15	Conduct baseline inventories of high-priority resources, as outlined in an inventory, monitoring, and research plan.	Ongoing	Baseline surveys of wēkiu bugs, other arthropods, including invasive species have been completed or are continuing. A botanical survey was completed in the Summer of 2011 and published in 2013. OMKM is funding a multi-year study on permafrost and working on designing a climate monitoring network. OMKM is also studying erosion to better understand surficial geology, cinder cone erosion, and characterize arthropod habitat. A bird and bat inventory commenced in 2017.
NR-16	Conduct regular long-term monitoring, as outlined in an inventory, monitoring, and research plan.	Ongoing	OMKM conducts annual wēkiu bug, alien and invasive species surveys. Botanical and arthropod surveys are conducted as part of the annual archaeological monitoring. Other monitoring plans to be developed following baseline surveys.
NR-17	Conduct research to fill knowledge gaps that cannot be addressed through inventory and monitoring.	Ongoing	OMKM funded a study to develop a long term model relating to climate change and potential impact to the summit ecosystem; a study of native arthropod habitats and vegetation association, arthropod food webs; analysis of historical weather climate conditions on the summit and meteorological and geological influences on insect and snowfall drops on the summit terrain to help inform wēkiu bug research; study to assess the presence and persistence of permafrost; surficial geology and erosion; and several studies related to the wēkiu bug including life history, genetics, habitat restoration, and habitat mapping. OMKM funded an international symposium on Tropical Alpine Ecosystems. Invited speakers are experts in research and management of alpine ecosystems. OMKM hopes to develop a network with other researchers and managers to gain knowledge to better manage Maunakea.
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.	Ongoing	Wēkiu bug and botanical data, infrastructure and signs have been mapped. A GIS database of resources surveyed utilizing ArcGIS and distributed as GoogleEarth layers has been developed; new data as available is added to this database.

COMPONENT PLAN: UNDERSTANDING AND PROTECTING MAUNA KEA'S RESOURCES

Implementation Status			
Comments			
EDUCATION AND OUTREACH			
Program Development			
EO-1	Develop and implement education and outreach program	Ongoing	Volunteer, Orientation, Brochures (Safety, Culture, Resources, What is OMKM) are available. In-school visits (Hilo Inter, Hawaii Academy of Arts and Sciences PCS, Ke Ana La'ahana, Waiakea High, Kealakehe Elementary) occur regularly. Community organizations and members help support OMKM's volunteer program. Work with Kealakehe Elementary School to support their annual Science Showcase at the school. Outreach activities by researchers are conducted at various schools; OMKM research affiliate also helps advise young scientists with their science fair projects. Updates on OMKM activities are given to various community organizations. OMKM also participates in community events. The MKMB approved an Education and Outreach plan in July 2020. This plan addresses EO-1, 3, 5, 6, 7, and 8.
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.	Ongoing	Resource orientation of those who work on the mountain including observatory personnel, VIS and MKSS staff, rangers, commercial tour operators and staff, and construction workers commenced in 2013. Orientation is available to all interested parties in-person or online. Proposed administrative rules include a provision for an orientation of visitors.
EO-3	Continue to develop, update, and distribute materials explaining important aspects of Mauna Kea.	Ongoing	Materials on the cultural and natural resources, visiting safely and responsibly and Mauna Kea hazards are distributed at the VIS.
EO-4	Develop and implement a signage plan to improve signage throughout the UH Management Areas (interpretive, safety, rules and regulations).	Completed/ Ongoing	A sign plan was approved by the MKMB in 2016 and implemented in 2017. An inventory of sign locations on UH's managed lands has been completed. Cultural and safety related signs have been installed.
EO-5	Develop interpretive features such as self-guided cultural walks and volunteer-maintained native plant gardens.	In Progress	Included as part of ongoing CIP funded project. The MKMB approved an Education and Outreach plan in July 2020. This plan addresses EO-1, 3, 5, 6, 7, and 8.
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.	Ongoing	See EO-1

COMPONENT PLAN: UNDERSTANDING AND PROTECTING MAUNA KEA'S RESOURCES

**Implementation
Status**

Comments

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.	Ongoing	OMKM through the MKMB, Kahu Kū Mauna, and Environment Committee provide opportunity for members of the community and other organizations to participate in the management activities of the mountain. Bi-monthly volunteer activities provide an opportunity for the community to participate and share knowledge. Meetings with community groups and open houses were conducted to give the public an opportunity to provide input and feedback on administrative rules being developed by OMKM. Public hearings seeking public comments on a proposed draft were held in 2018.
EO-8	Provide opportunities for community members to participate in stewardship activities.	Ongoing	OMKM through the MKMB, Kahu Kū Mauna, and Environment provide opportunity for members of the community to participate in the management activities of the mountain. Bi-monthly volunteer activities provide an opportunity for the community to participate and share knowledge. Student projects and mentoring provides opportunities (science fair, legacy, etc.) for one-on-one interaction and more in-depth efforts.

ASTRONOMICAL RESOURCES

AR-1	Operate the UH Management Areas to prohibit activities resulting in negative impacts to astronomical resources.	Ongoing	Administrative rules, effective beginning January 2020, for UH's managed lands incorporate policies approved by the University President while ensuring protections afforded to Native Hawaiian traditional and customary practices.
AR-2	Prevent light pollution, radio frequency interference (RFI) and dust.	Ongoing	Project proposals requesting the use of radio signals are reviewed by the Institute for Astronomy for potential interference with astronomical research activities. At the State level, the Starlight Reserve Advisory Committee was active from 2010 to 2015. Efforts by UH and DBEDT .to make the committee permanent were unsuccessful at the 2015 and 2016 Legislature were unsuccessful. They will try again in 2107. UH has been working closely with Hawaii County officials on outdoor lighting issues. This has resulted in the adoption of public-health, wildlife, and astronomy-friendly LED lights to replace the previous low-pressure sodium lights. UH and the County are now requesting the State to use similar lights at Hawaii Island airports and harbors. UH continues to provide advice on amendments to the Hawaii County lighting ordinance

COMPONENT PLAN: MANAGING ACCESS AND USES

Implementation
Status

Comments

ACTIVITIES AND USES

General Management

ACT-1	Continue and update managed access policy of 1995 Management Plan.	Completed Ongoing	The BLNR approved the Public Access Plan for UH Management Areas on Mauna Kea. This plan contains principals and policies regarding public access. Administrative rules will help define UH's public access policy. Public hearings seeking public comments on a proposed draft were held in 2018 and the rules implemented in January 2020. UH is in the process of updating the Master Plan and CMP that will address access policy
ACT-2	Develop parking and visitor traffic plan.	Ongoing	Capital improvement funds are being used to implement an Ingress/egress, and parking plan to address concerns of traffic flow and pedestrian safety. A CDUP was issued to implement the ingress/egress project commenced in late 2018. OMKM Rangers assist staff at the VIS with the implementation of their interim parking plan to maintain order, accommodate as many vehicles as possible and to ensure the safety of visitors to the VIS. An automated vehicle counter counts the number of vehicles (differentiating: public, commercial, tour, observatory, etc.) that drive above Halepōhaku.
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.	Completed Ongoing	Mauna Kea Rangers are present year round from 7:15 am to 10:15 pm daily; DOCARE officers and Hawaii County Police are called for assistance on an as needed basis.
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.	Ongoing	OMKM prohibits the use of off-road vehicles on UH's managed lands. Vehicle access to the top of Pu'upoli'ahu has been blocked since 2001 at the request of Kahu Kū Mauna. Commercial operators and film crews are required to stay on the road or within the footprint of existing facilities, unless granted permission by OMKM. Administrative rules, effective beginning January 2020, for UH's managed lands incorporate policies approved by the University President while ensuring protections afforded to Native Hawaiian traditional and customary practices.

Recreational

ACT-5	Implement policies to reduce impacts of recreational hiking	Completed Ongoing	Administrative rules, effective beginning January 2020, for UH's managed lands incorporate policies approved by the University President while ensuring protections afforded to Native Hawaiian traditional and customary practices..
ACT-6	Define and maintain areas where snow-related activities can occur and confine activities to slopes that have a protective layer of snow.	Completed Ongoing	Generally, this is a self-regulated activity. People usually do not venture to areas where there is no snow. A map of areas where snow play generally occurs has been developed, but areas change depending on the weather and snow deposition. Administrative rules, effective beginning January 2020, for UH's managed lands incorporate policies approved by the University President while ensuring protections afforded to Native Hawaiian traditional and customary practices.
ACT-7	Confine University or other sponsored tours and stargazing activities to previously disturbed ground surfaces and established parking areas.	Completed Ongoing	Star gazing activities on UH's lands are limited to parking lots, or in areas in close proximity to the VIS

ACT-8	Coordinate with DLNR in the development of a policy regarding hunting in the UH Management Areas.	Completed Ongoing	DLNR's hunting rules apply to UH's managed lands. UH administrative rules confirms application of DLNR's hunting rules to UH managed lands. Administrative rules, effective beginning January 2020, for UH's managed lands incorporate policies approved by the University President while ensuring protections afforded to Native Hawaiian traditional and customary practices.
Commercial			
ACT-9	Maintain commercial tour permitting process; evaluate and issue permits annually.	Ongoing	UH oversees commercial tour permits, a responsibility transferred to UH from BLNR. Administrative rules, effective beginning January 2020, for UH's managed lands incorporate policies approved by the University President while ensuring protections afforded to Native Hawaiian traditional and customary practices..
ACT-10	Ensure OMKM input on permits for filming activities	Completed Ongoing	Film permits are issued by the Hawaii Film Office of Department of Business Economic Development of Tourism. All film permits require OMKM's approval before they are issued. Administrative rules, effective beginning January 2020, for UH's managed lands incorporate policies approved by the University President while ensuring protections afforded to Native Hawaiian traditional and customary practices.
ACT-11	Seek statutory authority for the University to regulate commercial activities in the UH Management Areas.	Completed Ongoing	The function of commercial tour permitting was transferred by BLNR to UH. OMKM oversees commercial tour operations and film activities. Statutory authority to promulgate administrative rules was granted by the Legislature in 2009. Administrative rules, effective beginning January 2020, for UH's managed lands incorporate policies approved by the University President while ensuring protections afforded to Native Hawaiian traditional and customary practices.
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.	Ongoing	All research proposals must be approved by OMKM. Proposals requiring ground disturbing activities or potential impact to the cultural and/or natural landscape are reviewed by Kahu Kū Mauna and MKMB. Permit by DLNR as appropriate.
PERMITTING AND ENFORCEMENT			
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.	Ongoing	This is a condition of UH's leases with DLNR. Rangers monitor activities. Regular communication with DLNR's Division of Conservation and Resources Enforcement, County of Hawaii police, and Sheriff's department continues as demonstrated during TMT protests. Since 2006, OMKM rangers have been conducting biannual inspections of all facilities on UH's managed lands for compliance with their CDUPs.
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.	Ongoing	Relevant CMP management actions were incorporated into the CDUA for the Thirty Meter Telescope project. The MKMB requires proposals for projects for Maunakea include a review and comments on how the proposer will comply with CMP action items relevant to the project.

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.	Completed	The Legislature granted UH authority to promulgate administrative rules in 2009. Act 132.
P-4	Educate management staff and users of the mountain about all applicable rules and permit requirements.	Ongoing	Included as part of the orientation and with new project start-up meetings. Administrative rules, effective beginning January 2020, for UH's managed lands incorporate policies approved by the University President while ensuring protections afforded to Native Hawaiian traditional and customary practices.

COMPONENT PLAN: MANAGING ACCESS AND USES

Implementation Status				Comments
Enforcement				
P-5	Continue coordinating with other agencies on enforcement needs.	Ongoing		OMKM coordinates with DOCARE on enforcement activities. Ranger observations are sent to DLNR, NAR, DOFAW, and US Fish & Wildlife Service.
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.	Completed		
P-7	Develop and implement protocol for oversight and compliance with Conservation District Use Permits.	Ongoing		Since 2006, OMKM rangers have been conducting biannual inspections of all facilities on UH's managed lands for compliance with their CDUPs
P-8	Enforce conditions contained in commercial and Special Use permits.	Ongoing		Rangers' responsibilities includes oversight of commercial tour activities and special use permits issued by OMKM.

**COMPONENT PLAN: MANAGING THE BUILT ENVIRONMENT
INFRASTRUCTURE AND MAINTENANCE**

Routine Maintenance

IM-1	Develop and implement an OMMP.	Completed/ Ongoing	An Operations Monitoring and Maintenance Plan (OMMP) was reviewed by Kahu Kū Mauna and approved by the MKMB. At the request of Kahu Kū Mauna, beginning in 2016 OMKM initiated a project review process that requires all observatories to submit annual 5-year outlook plans, that include projects the facilities plan on executing in the upcoming 5-years. Implementation is ongoing.
IM-2	Reduce impacts from operations and maintenance activities by educating personnel about Mauna Kea's unique resources.	Ongoing	A cultural and natural resources orientation program has been developed and is implemented. Orientation sessions on resources and safety are conducted for OMKM and Maunakea Observatory Support Staff. Administrative rules, effective beginning January 2020, for UH's managed lands incorporate policies approved by the University President while ensuring protections afforded to Native Hawaiian traditional and customary practices.
IM-3	Conduct historic preservation review for maintenance activities that will have an adverse effect on historic properties.	Ongoing	OMKM submits detailed proposals to DLNR for activities conducted infrequently. DLNR reviews and approves these as appropriate based on review by appropriate divisions. OMKM is also currently developing a Programmatic Agreement/MOU relating to maintenance activities that will be submitted to State Historic Preservation Division. A programmatic agreement may not be necessary being that activity that involves major ground disturbance involves a permit from DLNR and SHPD review. Routine activities do not involve major ground disturbance or occur on already disturbed land.
IM-4	Evaluate need for and feasibility of a vehicle wash station near Hale Pōhaku, and requiring that vehicles be cleaned.	Completed/ Ongoing	OMKM funded a study to evaluate the efficacy current measures to prevent the introduction of invasive species, including vehicle and equipment wash practices.
IM-5	Develop and implement a Debris Removal, Monitoring and Prevention Plan.	Ongoing	Trash from the HP facilities and VIS are removed daily. Each observatory removes trash from their respective facilities. Rangers routinely check for and pick up trash and debris while on their daily patrols. Rangers pick up and map the location of trash at the parking lot near the trail head to Lake Waiau (NAR). The amount of trash decreased following the installation of a portable toilet. A draft plan is under review.
IM-6	Develop and implement an erosion inventory and assessment plan.	In Progress	OMKM partnered with UH Hilo geography department to study surficial geology and cinder cone erosion issues. It is anticipated the inventory will be completed in 2020
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.	Ongoing	An inventory of all known aircraft and military wreckage was submitted to the Department of Defense for review and updating. OMKM is working with DOD, OCCL, and SHPD to determine appropriate plans for removal or preservation in place.

COMPONENT PLAN: MANAGING THE BUILT ENVIRONMENT

Implementation

Status

Comments

Infrastructure

IM-8	Assess feasibility of paving the Summit Access Road.	Completed/ Ongoing	An engineering study related to the paving of the access road from Halepōhaku to the summit was completed in 1984. This study was the basis for paving the road from the summit to about the boundary of the Science Reserve. Another study was prepared in 2017 of the damage caused by large storms over the past 10 years. The report assessed repairs needed and potential cost. .
IM-9	Evaluate need for additional parking lots and vehicle pullouts and install if necessary.	Ongoing	As part of the CIP ingress/egress project at the VIS, additional parking was assessed and parking added. With TMT a recreational parking plan for Batch Plant (Park 3) was submitted to DLNR and approved. A visitor study initiated in 2019 by UH Mānoa will further inform any future efforts.
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.	Ongoing	Initial consideration of converting the presentation room building into a rest and eating stop for commercial tours as a means of reducing congestion at the VIS and providing greater access by the independent travelers, has been put on hold until completion of the ingress/egress project is completed, or if another solution presents itself. MKSS is considering options for handling overcrowding at the VIS. Additional portable toilets are available at the summit to address restroom facilities needs at the summit. Waterless urinals were installed in the VIS men's restroom.

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.	Ongoing	The proposed Thirty Meter Telescope is incorporating energy efficiency in its design. Maunakea Observatory Support Services installed a photovoltaic system at Halepōhaku; Gemini observatory installed, and Keck observatory is planning to install photovoltaic systems on their respective summit facilities.
IM-12	Conduct energy audits to identify energy use and system inefficiencies, and develop solutions to reduce energy usage.	Ongoing	Energy audits are part of the photovoltaic system design process, completed or in progress at Gemini, Keck, and Halepōhaku.
IM-13	Conduct feasibility assessment, in consultation with Hawaii Electric Light Company, on developing locally-based alternative energy sources.	Ongoing	MKSS installed a photovoltaic system at Halepōhaku. Additional energy conservation and sustainable generation possibilities are discussed by UHH, MKSS, and Observatories as opportunities arise.
IM-14	Encourage observatories to investigate options to reduce the use of hazardous materials in telescope operations.	Ongoing	With the development of new technology, observatories are beginning to reduce their need to use hazardous materials. An example, is the TMT observatory, which will not be using mercury.

COMPONENT PLAN: MANAGING THE BUILT ENVIRONMENT

Implementation Status

Comments

CONSTRUCTION GUIDELINES

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.	Ongoing	Included as part of the proposed TMT Management Plan in its CDUA.
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Best Management Practices

C-2	Require use of Best Management Practices Plan for Construction Practices.	Ongoing	Included as part of the proposed TMT Management Plan in its CDUA. A template for adaptation and use by others is also available.
C-3	Develop, prior to construction, a rock movement plan.	Ongoing	Included as part of the proposed TMT Management Plan in its CDUA.
C-4	Require contractors to provide information from construction activities to OMKM for input into OMKM information databases.	Ongoing	Included as part of the proposed TMT Management Plan in its CDUA.
C-5	Require on-site monitors (e.g., archaeologist, cultural resources specialist, entomologist) during construction, as determined by the appropriate agency.	Ongoing	Included as part of the proposed TMT Management Plan in its CDUA.
C-6	Conduct required archaeological monitoring during construction projects per SHPD approved plan	Ongoing	Included as part of the proposed TMT Management Plan in its CDUA.
C-7	Education regarding historical and cultural significance	Ongoing	Included as part of the proposed TMT Management Plan in its CDUA.
C-8	Education regarding environment, ecology and natural resources	Ongoing	Included as part of the proposed TMT Management Plan in its CDUA.
C-9	Inspection of construction materials	Ongoing	Included as part of the proposed TMT Management Plan in its CDUA.

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.	Ongoing	This will be part of the TMT decommissioning plan, with the TMT decommissioning funding plan approved by the MKMB in 2014.
SR-2	Require observatories to develop a restoration plan in association with decommissioning, to include an environmental cost-benefit analysis and a cultural assessment.	Ongoing	Included as part of the proposed TMT Management Plan in its CDUA.
SR-3	Require any future observatories to consider site restoration during project planning and include provisions in subleases for funding of full restoration.	Ongoing	Included as part of the proposed TMT Management Plan in its CDUA.

COMPONENT PLAN: MANAGING THE BUILT ENVIRONMENT

Implementation

Status

Comments

CONSIDERING FUTURE LAND USE

Facility Planning Guidelines

FLU-1	Follow design guidelines presented in the 2000 Master Plan.	Ongoing	The Design Review Process, which incorporated the 2000 Master Plan's design guidelines, were used in the review of the Thirty Meter Telescope project
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.	Ongoing	Areas previously mapped as off-limits for future land use through plans such as the Master Plan or CMP are used to limit any proposed activity. UH President Lassner confirmed that TMT was the last telescope to be built on undisturbed land. Resource data must be part of any proposal for major land use requests. HAR 13-5 allows for different types of land uses with each having its own requirements for preparing a land use application. Thus a single pre-prepared map cannot possibly address all potential scenarios.
FLU-3	Require cataloguing of initial site conditions for use when conducting site restoration.	Ongoing	TMT project completed a photo documentation of its site.
FLU-4	Require project specific visual rendering of both pre- and post-project settings to facilitate analysis of potential impacts to view planes.	Ongoing	TMT project completed a photo documentation.
FLU-5	Require an airflow analysis on the design of proposed structures to assess potential impacts to aeolian ecosystems.	Ongoing	Incorporated into the TMT project.
FLU-6	Incorporate habitat mitigation plans into project planning process.	Ongoing	Incorporated into the TMT project
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.	Ongoing	Incorporated into the TMT project

COMPONENT PLAN: MANAGING OPERATIONS			
		Implementation Status	Comments
OPERATION AND IMPLEMENTATION			
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.	Completed	The MKMB meets regularly, holding numerous public meetings; which includes consultation with Kahu Kū Mauna Council. OMKM continues to submit CMP management actions (such as the OMMP) to MKMB. MKSS continues to maintain the road and public services, financially supported by the Maunakea Observatories. Part of the role and responsibilities of OMKM, Kahu Kū Mauna Council and MKMB is the review of projects proposed for UH's managed lands, in particular for compliance with DLNR conservation district rules and since 2009, the CMP. To date over 300 projects have been reviewed by OMKM/Kahu Kū Mauna Council/MKMB. See Appendix H: Board & Committee Composition.
OI-2	Develop training plan for staff and volunteers.	Completed	OMKM requires all staff and volunteers to attend the Maunakea orientation. A training plan was submitted and approved by the MKMB; bi-monthly trainings of all staff is being conducted.
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.	Ongoing	OMKM has frequent contact in particularly with its neighbor, DLNR on resource management issues. OMKM rangers report unusual or suspicious behavior observed on DLNR lands to DLNR including DOCARE.
OI-4	Establish grievance procedures for OMKM, to address issues as they arise.	Completed Ongoing	The public has the opportunity to address grievances at the MKMB publicly held meetings. Administrative rules, effective beginning January 2020, for UH's managed lands incorporate policies approved by the University President while ensuring protections afforded to Native Hawaiian traditional and customary practices.
OI-5	Update and implement emergency response plan.	Ongoing	Emergency response plan is reviewed annually.
MONITORING, EVALUATION AND UPDATES			
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.	Ongoing	Reports are provided at the publicly held MKMB Meetings.
MEU-2	Conduct regular updates of the CMP that reflect outcomes of the evaluation process, and that incorporate new information about the resources.	Ongoing	Five-year CMP revision interval was initiated in 2014. EnVision Maunakea and administrative rules will play a role in the updating the CMP.
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.	Ongoing	UH is preparing an EIS for a new land authorization for UH's lands on Maunakea. A Prep Notice was prepared and published in February 2018. UH is reviewing comments and is considering them in the development of the draft. The 2000 Master Plan is being replaced by a new version, with preparation ongoing. The 2009 CMP is being updated, with preparation of progress report and DLNR review ongoing.

Appendix G: Cumulative Progression

Cumulative Annual Progression of CMP Implementation Status.

Management		CMP	Annual Implementation Status										
Action	Description	Implementation Timeframe	2010	2011	2012*	2013	2014	2015	2016	2017	2018	2019	2020
Native Hawaiian Cultural Resources					.	.	.	.	.	.	.	.	.
Management					.	.	.	.	.	.	.	.	.
CR-1	Kahu Kū Mauna shall work with families with lineal and historical connections to Maunakea, cultural practitioners, and other Native Hawaiian groups, including the Maunakea Management Board’s Hawaiian Culture Committee, toward the development of appropriate procedures and protocols regarding cultural issues.	Immediate		Ongoing	In Progress		Ongoing						
CR-2	Support application for designation of the summit region of Maunakea 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.	Short-term							Ongoing				
CR-3	Conduct educational efforts to generate public awareness about the importance of preserving the cultural landscape.	Immediate		Ongoing	In Progress		Ongoing						
Cultural Practices													
CR-4	Establish a process for ongoing collection of information on traditional, contemporary, and customary cultural practices.	Short-term									Ongoing		
CR-5	Develop and adopt guidelines for the culturally appropriate placement and removal of offerings.	Immediate			In Progress*						Completed		
CR-6	Develop and adopt guidelines for the visitation and use of ancient shrines.	Immediate			In Progress			Ongoing			Completed		
CR-7	Kahu Kū Mauna shall take the lead in determining the appropriateness of constructing new Hawaiian cultural features.	Immediate			In Progress*						Completed		
CR-8	Develop and adopt a management policy for the UH Management Areas on the scattering of cremated human remains.	Immediate		Ongoing	In Progress*						Completed		
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.	Immediate		Ongoing	In Progress*						Completed		
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.	Immediate		Ongoing	In Progress		Completed						
CR-11	Complete an archaeological survey of the portions of the Summit Access Road corridor that are under UH management	Completed											

Management		CMP Implementation Timeframe	Annual Implementation Status										
Action	Description		2010	2011	2012*	2013	2014	2015	2016	2017	2018	2019	2020
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	Immediate		As needed	As needed	As needed	Ongoing				Completed		
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, recognized lineal or cultural descendants, and SHPD.	Immediate		Ongoing	In Progress	A burial treatment plan was approved by SHPD in July 2014. This was incorrectly reported as 'In Progress' in the previously submitted 2014 and 2015 narrative reports.	Completed						
CR-14	Immediately report any disturbance of a shrine or burial site to the rangers, DOCARE, Kahu Kū Mauna Council, and SHPD	Ongoing											
Natural Resources													
Threat Prevention and Control													
NR-1	Limit threats to natural resources through management of permitted activities and uses	Short-term			In Progress				Ongoing		Completed / Ongoing		
NR-2	Limit damage caused by invasive species through creation of an invasive species prevention and control program	Immediate		Ongoing	In Progress		Ongoing				Completed / Ongoing		
NR-3	Maintain native plant and animal populations and biological diversity	Mid and Long-term								Ongoing			
NR-4	Minimize barriers to species migration, to help maintain populations and protect ecosystem processes and development.	Mid and Long-term								Ongoing			
NR-5	Manage ecosystems to allow for response to climate change	Long-term								Ongoing			
NR-6	Reduce threats to natural resources by educating stakeholders and the public about Maunakea's unique natural resources.	Immediate		Ongoing									
Ecosystem Protection, Enhancement & Restoration													
NR-7	Delineate areas of high native diversity, unique communities, or unique geological features within the Astronomy Precinct and at Halepōhaku and consider protection from development.	Short and Mid-term					In Progress		Ongoing				

Management		CMP	Annual Implementation Status										
Action	Description	Implementation Timeframe	2010	2011	2012*	2013	2014	2015	2016	2017	2018	2019	2020
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).	Mid-term					Ongoing	Ongoing	Ongoing	Ongoing			
NR-9	Increase native plant density and diversity through an outplanting program.	Long-term							Ongoing				
NR-10	Incorporate mitigation plans into project planning and conduct mitigation following new development.	As needed					Ongoing						
NR-11	Conduct habitat rehabilitation projects following unplanned disturbances.	As needed					Ongoing						
NR-12	Create restoration plans and conduct habitat restoration activities, as needed.	As needed							In Progress	Ongoing			
Program Management													
NR-13	Increase communication, networking, and collaborative opportunities, to support management and protection of natural resources.	Immediate		Ongoing	In Progress	Ongoing							
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.	Short-term / As needed					In Progress				Ongoing		
Inventory, Monitoring and Research													
NR-15	Conduct baseline inventories of high-priority resources, as outlined in an inventory, monitoring, and research plan.	Immediate		Ongoing									
NR-16	Conduct regular long-term monitoring, as outlined in an inventory, monitoring, and research plan	Ongoing			In Progress	Ongoing							
NR-17	Conduct research to fill knowledge gaps that cannot be addressed through inventory and monitoring.	Immediate		Ongoing									
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.	Ongoing				In Progress	Ongoing						
Education and Outreach													
Program Development													
EO-1	Develop and implement education and outreach program	Immediate and Short-term				Ongoing							Completed
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.	Long-term			In Progress	Ongoing							

Management		CMP Implementation Timeframe	Annual Implementation Status										
Action	Description		2010	2011	2012*	2013	2014	2015	2016	2017	2018	2019	2020
EO-3	Continue to develop, update, and distribute materials explaining important aspects of Maunakea.	Ongoing	Ongoing	Ongoing	In Progress	Ongoing							
EO-4	Develop and implement a signage plan to improve signage throughout the UH Management Areas (interpretive, safety, rules and regulations).	Immediate							In Progress	Ongoing	Completed / Ongoing		
EO-5	Develop interpretive features such as self-guided cultural walks and volunteer-maintained native plant gardens.	Mid-term							In Progress				
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.	Mid-term					Ongoing						
Outreach													
EO-7	Continue and increase opportunities for community members to provide input to cultural and natural resources management activities on Maunakea, 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.	Ongoing											
EO-8	Provide opportunities for community members to participate in stewardship activities.	Ongoing											
Astronomy Resources													
Protection of Astronomical Resources													
AR-1	Operate the UH Management Areas to prohibit activities resulting in negative impacts to astronomical resources.	Ongoing			In Progress								Ongoing
AR-2	Prevent light pollution, radio frequency interference (RFI) and dust.	Ongoing											
Activities and Uses													
General Management													
ACT-1	Continue and update managed access policy of 1995 Management Plan.	Short-term			Completed Ongoing								
ACT-2	Develop parking and visitor traffic plan.	Immediate		Ongoing	In Progress						Ongoing		CDUP issued, construction completed in 2019
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.	Completed Ongoing											
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.	Ongoing											

Management			CMP Implementation		Annual Implementation Status								
Action	Description	Timeframe	2010	2011	2012*	2013	2014	2015	2016	2017	2018	2019	2020
Recreational													
ACT-5	Implement policies to reduce impacts of recreational hiking	Short-term			In Progress								Completed Ongoing
ACT-6	Define and maintain areas where snow-related activities can occur and confine activities to slopes that have a protective layer of snow	Ongoing											Completed Ongoing
ACT-7	Confine University or other sponsored tours and star-gazing activities to previously disturbed ground surfaces and established parking areas.	Ongoing											Completed Ongoing
ACT-8	Coordinate with DLNR in the development of a policy regarding hunting in the UH Management Areas.	Immediate		Ongoing	Completed Ongoing								
Commercial													
ACT-9	Maintain commercial tour permitting process; evaluate and issue permits annually.	Ongoing											
ACT-10	Ensure OMKM input on permits for filming activities	Ongoing										Completed Ongoing	
ACT-11	Seek statutory authority for the University to regulate commercial activities in the UH Management Areas.	Completed Ongoing											
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.	Ongoing											
Permitting and Enforcement													
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.	Ongoing											
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.	As needed			Ongoing								
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.	Completed											
P-4	Educate management staff and users of the mountain about all applicable rules and permit requirements.	Immediate		Ongoing									
Enforcement													
P-5	Continue coordinating with other agencies on enforcement needs.	Ongoing											

Management		CMP	Annual Implementation Status										
Action	Description	Implementation Timeframe	2010	2011	2012*	2013	2014	2015	2016	2017	2018	2019	2020
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 Maunakea.	Completed / As needed		Completed									
P-7	Develop and implement protocol for oversight and compliance with Conservation District Use Permits.	Ongoing											
P-8	Enforce conditions contained in commercial and Special Use permits.	Ongoing											
Infrastructure and Maintenance													
Routine Maintenance													
IM-1	Develop and implement an OMMP.	Ongoing			In Progress	In Progress	In Progress	In Progress	Completed/Ongoing				
IM-2	Reduce impacts from operations and maintenance activities by educating personnel about Maunakea’s unique resources.	Immediate		Ongoing	In Progress								
IM-3	Conduct historic preservation review for maintenance activities that will have an adverse effect on historic properties.	Short-term			In Progress								Ongoing
IM-4	Evaluate need for and feasibility of a vehicle wash station near Halepōhaku, and requiring that vehicles be cleaned.	Short-term					In Progress				Completed/ Ongoing		
IM-5	Develop and implement a Debris Removal, Monitoring and Prevention Plan.	Immediate		Ongoing									
IM-6	Develop and implement an erosion inventory and assessment plan.	Long-term					In Progress						Estimated completion in 2020
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.	Mid-term							Ongoing				
Infrastructure													
IM-8	Assess feasibility of paving the Summit Access Road.	Long-term			In Progress				Completed/Ongoing				
IM-9	Evaluate need for additional parking lots and vehicle pullouts and install if necessary.	Mid-term								In Progress		Ongoing	
IM-10	Evaluate need for additional public restroom facilities in the summit region and at Halepōhaku, and install close-contained zero waste systems if necessary.	Immediate			In Progress				Ongoing				
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.	As needed					Ongoing						

Management		CMP	Annual Implementation Status										
Action	Description	Implementation Timeframe	2010	2011	2012*	2013	2014	2015	2016	2017	2018	2019	2020
IM-12	Conduct energy audits to identify energy use and system inefficiencies, and develop solutions to reduce energy usage.	Immediate							Ongoing				
IM-13	Conduct feasibility assessment, in consultation with Hawaii Electric Light Company, on developing locally-based alternative energy sources.	Mid-term							In Progress	Ongoing			
IM-14	Encourage observatories to investigate options to reduce the use of hazardous materials in telescope operations.	Short-term							Ongoing				
Construction Guidelines													
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.	As needed					Ongoing						
Best Management Practices													
C-2	Require use of Best Management Practices Plan for Construction Practices.	As needed					Ongoing						
C-3	Develop, prior to construction, a rock movement plan.	As needed					Ongoing						
C-4	Require contractors to provide information from construction activities to OMKM for input into OMKM information databases.	As needed					Ongoing						
C-5	Require on-site monitors (e.g., archaeologist, cultural resources specialist, entomologist) during construction, as determined by the appropriate agency.	As needed					Ongoing						
C-6	Conduct required archaeological monitoring during construction projects per SHPD approved plan.	As needed					Ongoing						
C-7	Education regarding historical and cultural significance.	As needed					Ongoing						
C-8	Education regarding environment, ecology and natural resources.	As needed					Ongoing						
C-9	Inspection of construction materials.	As needed					Ongoing						
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.	As needed					Ongoing						
SR-2	Require observatories to develop a restoration plan in association with decommissioning, to include an environmental cost-benefit analysis and a cultural assessment.	As needed					Ongoing						

Management		CMP	Annual Implementation Status										
Action	Description	Implementation Timeframe	2010	2011	2012*	2013	2014	2015	2016	2017	2018	2019	2020
SR-3	Require any future observatories to consider site restoration during project planning and include provisions in subleases for funding of full restoration.	As needed					Ongoing						
Considering Future Land Use													
Facility Planning Guidelines													
FLU-1	Follow design guidelines presented in the 2000 Master Plan	As needed			Ongoing								
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	Short-term								Ongoing			
FLU-3	Require cataloguing of initial site conditions for use when conducting site restoration.	As needed					Ongoing						
FLU-4	Require project specific visual rendering of both pre- and post-project settings to facilitate analysis of potential impacts to view planes.	As needed					Ongoing						
FLU-5	Require an airflow analysis on the design of proposed structures to assess potential impacts to aeolian ecosystems.	As needed					Ongoing						
FLU-6	Incorporate habitat mitigation plans into project planning process.	As needed					Ongoing						
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	As needed					Ongoing						
Operations and Implementation													
Management													
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.	Ongoing									Completed		
OI-2	Develop training plan for staff and volunteers	Ongoing			In Progress			Completed					
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.	Ongoing											
OI-4	Establish grievance procedures for OMKM, to address issues as they arise.	Short-term			Ongoing								Completed Ongoing
OI-5	Update and implement emergency response plan.	Ongoing											
Monitoring, Evaluation, and Updates													

Management		CMP Implementation	Annual Implementation Status										
Action	Description	Timeframe	2010	2011	2012*	2013	2014	2015	2016	2017	2018	2019	2020
Management													
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.	Immediate		Ongoing									
MEU-2	Conduct regular updates of the CMP that reflect outcomes of the evaluation process, and that incorporate new information about the resources.	Short-term / As needed					In Progress		In Progress		Ongoing		Designation reflects completion of Envision Maunakea process.
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 Maunakea and reflect stewardship matters resolved with DLNR.	As needed					In Progress						Ongoing

*In 2012 the **Ongoing** category was divided into two groups, **Ongoing** and **In Progress**.

+ A lawsuit was filed in federal court which was dismissed without prejudice; the plaintiff may still seek further judicial relief

Appendix H: Board & Committee Composition

Management board and committee composition, including the Maunakea Management Board, Kahu Kū Mauna Council, and Maunakea Environment Committee.

The following tables show the history of each Board, Council, or Committee by year. “X” indicates that an individual of the entity for at least some portion of the calendar year. “C” indicates that an individual was formally recognized as the Chair of the entity for at least some portion of the calendar year, shown only for the Maunakea Management Board. Kahu Kū Mauna Council members are all considered ex officio after their formal participation concludes.

Maunakea Management Board Composition

Name	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Armandroff, Taft															X	X					
Bergin, Patricia						X	X	X	X	X	X	X	X	X	X						
Bergin, William																					X
Chu, Roberta																			X	C	C
Chun, Gregory															X	X	X	C	C	C	X
Cole, Heather	X	X	X	X	X																
Cross, John								X	X	X	X	X									
Hadway, Lisa								X	X	X	X	X	X	X	X						
Higaki, Wayne																					
Hoke, Arthur	C	C	C	C	C	X	X														
Imoto, Roger																X	X	X	X	X	
Kalua, Herring							X	X	X	X	X	X	X	X	X	X	X	X	X		
Kennedy, Jim	X	X	X	X	X	X	X														
Leialoha, Julie																			X	X	X
Maly, Kepa																			X	X	
Mooers, Gregory												X	X	C	C	C	X	X	X		
Nahale'a, Alapaki																			X		
Pacheco, Rob	X	X	X	X	C	C	C	C													
Robertson, Barbara	X	X	X	X	X	X															
Schinckel, Antony							X														
Simons, Douglas																X	X	X	X	X	X
Springer, Hannah K															X	X	X	X	X		
Taniguchi, Barry	X	X	X	X	X	X	X	X	C	C	C	C	C							X	X
Terry, Ron					X	X	X	X	X	X	X	X	X								
Van De Car, Diana																					X
Veillet, Christian								X	X	X	X	X	X								
Veincent, Lehua M.															X	X	X	X	X		
Yada, Harry	X	X	X	X	X	X	X	X													

Kahu Kū Mauna Council Composition

Name	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Chad Kālepa Baybayan							X	X	X	X	X	X	X	X	X			X	X	X	X
Thomas Chun														X	X	X	X	X	X		
Leningrad Elarionoff																X	X	X	X	X	X
Dale Fergerstrom														X	X	X	X	X			
Celeste Hao													X	X	X	X	X				
Arthur Hoke Jr.							X	X	X	X	X	X									
Wallace Ishibashi													X								
Tiffnie Kakalia							X	X	X	X	X	X	X	X	X						
Reynolds Kamakawiwo'ole	X	X	X	X	X	X	X	X													
Pualani Kanahele	X	X	X	X	X	X	X	X													
Niniau Kanahele	X	X	X	X	X	X	X														
Larry Kimura	X	X	X	X	X	X	X	X	X												
Kaleo Kualii'i	X	X	X	X	X	X	X	X													
Wally Lau																				X	X
Kimo Lee																				X	X
Antoinette Mallow							X	X	X	X	X	X	X	X	X						
U'ilani Naipo																X	X	X	X	X	
Sean Naleimaile							X	X	X	X	X	X	X	X							
Shane Palacat-Nelsen													X	X	X	X	X	X	X	X	X
Leilehua Omphroy							X	X	X												
Mikahala Roy	X	X	X	X	X	X	X														
Ululani Sherlock	X	X	X	X	X	X	X	X	X	X											
Hannah Kihilani Springer	X	X	X	X	X	X	X	X	X												
Edward Stevens	X	X	X	X	X	X	X	X	X	X											
Keahi Tajon															X						

Maunakea Environment Committee Composition

The Maunakea Environment Committee primarily consists of current or former (including retired): adjacent land-owners or managers, non-profit cooperative partners for these same lands, management board/committee members, along with University, State and Federal agency scientists. Yet meeting attendance is less formal than either the Maunakea Management Board or Kahu Kū Mauna. While there is a standing list of individuals notified of meetings, those receiving the announcements may bring along or send (as a substitute) co-workers, colleagues, or friends depending upon the topic of interest. As such, only the current (early 2020) distribution list is included below.

Andrea Buskirk, Anya Tagawa, Casper Vanderwoude, Cheyenne Perry, David A. Phillips, Debbie Ward, Donald Thomas, Fritz Klasner, Grant Gerrish, Hannah Kihalani Springer, Ian Cole, Jackson Bauer, Jay Hatayama, Jesse Eiben, Jessica Kirkpatrick, Jim Kauahikaua, Joan Yoshioka, Joseph K Camara, Jordan Lee-Loy, Joy Yoshina, Kalā Asing, Nick Agorastos, Roger Imoto, Ron Terry, Springer Kaye, Stewart Hunter, Susan Cordell.

Appendix B. Summary of Outreach and Consultation

CMS sought and benefitted greatly from the input of many stakeholders in the preparation of preliminary and final draft versions of sections of the Draft Outcome Analysis Report that was published on April 30, 2021. Their participation typically included such things as: (i) reviewing and commenting on preliminary draft versions of portions or all the document and/or (ii) meeting with UH representatives to discuss elements of the report. Those that were contacted and/or participated are summarized in Table B-1.

Table B-1: Stakeholder Outreach for Draft OAR

UH System	Meeting Occurred and/or Comments Received
Regent Alapaki Nahale-a	
David Lassner, President	
Michael Bruno, Provost	
Vassilis Syrmos, VP	
Hawai‘inuiākea School of Hawaiian Knowledge, Dr. Jonathan Osorio	
UH School of Ocean & Earth Science & Technology, Dr. Donald Thomas	
UH School of Travel Industry Management, Dr. Daniel Spencer	
UHH Chancellor	
UHH Chancellor’s Maunakea Advisory Committee	
Hanakahi Council	
Member of UHH Physics & Astronomy Dept.	
Native Hawaiian Affairs Program Officer	
Pūko‘a Council	
‘Imiloa	
CMS Team	•
MKMB	•
KKM	•
Environment Committee	•
Astronomy Organizations	
IfA	
UHH Hōkū Ke‘a	
CFHT	•
Keck	
UKIRT	
IRTF	
Subaru	
Gemini	
VLBA	
JCMT	

SMA	
TMT	
AURA	
Federal Agencies	
Army PTA	
Hakalau Forest, USFWS	
US Forest Service, Dept. of Agriculture	
State Agencies	
DLNR/BLNR	•
Hawai‘i Tourism Authority	
DHHL	
Office of Hawaiian Affairs	
Mauna Kea Forest Restoration Project	
Mauna Kea Watershed Alliance	
Community Members/Organizations	
PUEO	
Kui‘walu	
Gerald DeMello	
Commercial Tour Operators	
Super Vacation Hawai‘i	
Arnott’s Lodge & Hiking Adventures	
Taikobo Hawai‘i	
Mauna Kea Summit Adventures	
Hawaii Forest & Trail	
Visitor, Commerce & Economic Development	
Island of Hawaii Visitors Bureau	
Japanese Chamber of Commerce	