Alpine/Aeolian Unit 5

Observatories, Transmitters, & Sacred Places

Overview

Among other things that make Haleakalā special in Hawaiian tradition, this volcano is the house of the sun, a sacred place used sparingly by humans and held in reverence as a place of prayer. Haleakalā is the *piko*, the navel or spiritual center, of all of the islands that once were joined as *Maui Nui*: Maui, Molokaʻi, Lānaʻi, and Kahoʻolawe.

Today, Haleakalā attracts many other human uses, some of which come into conflict with each other. These conflicting perspectives must be resolved in order to ensure that Haleakalā will continue to be a special place for Maui residents and visitors alike.

In this unit, students learn more about the scientific research that takes place within the Haleakalā Observatories complex and what makes the summit a good place for that kind of research. Then they explore different ways that people think the summit area should be used, focusing on the unresolved issue of the location of broadcast facilities on the mountain.

Length of Entire Unit

Five 50-minute periods

Unit Focus Questions

1) What significance do different people place on the summit area of Haleakalā?

2) How do those perspectives influence views about how the summit area should be used?

3) What are students' opinions about a real-life proposal concerning the use of the summit area?

Unit at a Glance

Activity #1

Exploring the Importance of the Summit

Students explore the significance of the summit area of Haleakalā from as many perspectives as they can think of, including its traditional Hawaiian importance and its suitability as a place for observatories.

Length
One class period

Prerequisite Activity
None

Objectives
- Describe personal responses to a Hawaiian chant about the summit area.
- Identify different perspectives about the importance of the summit area.
- Discuss characteristics that make the summit suitable for observatories.

DOE Grades 9-12 Science Standards and Benchmarks
LIVING THE VALUES, ATTITUDES, AND COMMITMENTS OF THE INQUIRING MIND: Students apply the values, attitudes, and commitments characteristic of an inquiring mind.
- Objectivity: Evaluate various perspectives and their implications before drawing conclusions.

Activity #2

In-Class Public Forum

Students use existing points of view to develop testimony for an in-class "public forum" on an issue about the appropriate use of the summit area. Students also articulate their own perspectives on this issue.

Length
Four class periods preceded by a homework reading assignment

Prerequisite Activity
Activity #1 "Exploring the Importance of the Summit"

Objectives
- Examine and describe one perspective about the importance of the summit area.
- Formulate and express an opinion about the value of the summit area and which uses are appropriate there.

DOE Grades 9-12 Science Standards and Benchmarks
LIVING THE VALUES, ATTITUDES, AND COMMITMENTS OF THE INQUIRING MIND: Students apply the values, attitudes, and commitments characteristic of an inquiring mind.
- Objectivity: Evaluate various perspectives and their implications before drawing conclusions.

RELATING THE NATURE OF TECHNOLOGY TO SCIENCE: Students use the problem-solving process to address current issues involving human adaptations in the environment.
- Identify and explain current issues or problems based on evidence found in available information.
- Evaluate alternative solutions for effectiveness based on appropriate criteria.

Bonus Activity

What Goes On at the Observatories?

Students perform Internet research to learn about the work that is being done in the observatories on Haleakalā.

Length
Student research time plus one class period
This activity may also be given as homework only.

Prerequisite Activity
None

Objective

- Use the Internet to find information about the research or other work that takes place at one of the facilities in the Haleakalā Observatories complex.

DOE Grades 9-12 Science Standards and Benchmarks
LIVING THE VALUES, ATTITUDES, AND COMMITMENTS OF THE INQUIRING MIND: Students apply the values, attitudes, and commitments characteristic of an inquiring mind.

- Use research techniques and a variety of resources to complete a report on a project of one's choice.
- Ask questions, explain, and elaborate how science is a way of thinking and knowing the world around us.

Enrichment Ideas

- Begin the unit with an activity that gets students interested in what can be learned about the sun from earth. This is an important component of the research taking place at Haleakalā Observatories. Many activities can be found on websites in the "Resources for Reading and Research" listing below. A simple one entitled, "Reflections of a Star: How to Find the Angular Diameter of the Sun" can be found on the Exploratorium website at <www.exploratorium.edu/snacks/suns_angular_diameter/index.html>.

- Have students write "letters to the editor" based on their own views about how the summit of Haleakalā should be used.

- Have students read chapter 25, "The House of the Sun," in *Born in Paradise*, Armine von Tempski's autobiography about growing up on the flanks of Haleakalā (Ox Bow Press, Woodbridge, Connecticut, 1985). This chapter describes von Tempski's youthful adventures in the summit basin with her rancher father, Hawaiian *paniolos*, her sister, and Bishop Museum archaelogists. Several scenes from this chapter offer opportunities to compare present-day views about the summit area with views, attitudes, and uses prevalent in the past.

- During the in-class public forum, have students analyze the different viewpoints presented using the list of value systems included in the Activity #2 Student Page "Questions About the Viewpoints" (pp. 33-34).

- Give students several days to prepare for the in-class public forum by working more in-depth with the Draft Environmental Assessment (appended to this unit), interviewing

people who could shed light on the perspective they are researching, developing supporting materials or media presentations for their testimony, and so forth.

- Prior to holding the in-class public forum, have students brainstorm questions they have about the proposal to move the transmitter towers. Using the table of contents of the Draft Environmental Assessment (DEA), find out whether those questions seem to be covered in the DEA. Have students gather available information from the DEA on different topics and report to the class. You could do this prior to holding the in-class public forum.

- Have students research the Hawai‘i and federal environmental review processes. The Hawai‘i process is set forth in section 343 of the Hawai‘i code. The federal process is set forth in the National Environmental Policy Act.

Resources for Further Reading and Research

High Altitude Observatory, a National Science Foundation laboratory, maintains educational materials related to solar research. These materials include basic sun facts, questions and answers, slides and images, suggested reading, historical material, lecture notes, and tutorials at <www.hao.ucar.edu/public/education/education.html#basic>.

Stanford Solar Center maintains on-line information and educational resources including activities based on solar research data at <solarcenter.stanford.edu/>.

A Guide to the Hawai‘i State Environmental Review Process is available to download at <www.state.hi.us/health/oeqc/guidance/index.html>.

HRS 343, the section of the Hawai‘i code that sets up the environmental review process mandating environmental assessments and environmental impact statements for specific types of proposed projects is available on-line at <www.hawaii.gov/health/oeqc/eioeq343.htm>.

Office of Environmental Quality Control on-line guide to the Hawai‘i environmental review process is available at <www.state.hi.us/health/oeqc/eioeqc04.htm>.

Scudder, Richard J., *EIS Handbook for Hawai‘i,* Office of Environmental Quality Control, Honolulu.

“The Environmental Notice,” a semi-monthly publication of the Hawai‘i Office of Environmental Quality Control, lists current environmental assessments and environmental impact statements available for public comment. Current and back issues are available to download at <www.state.hi.us/health/oeqc/notice/index.html>.

Activity #1

Exploring the Importance of the Summit

● ● ● Class Period One *Exploring the Importance of the Summit*

Materials & Setup

- Acetate of *Nani Ke Ao i Haleakalā* chant (master, p. 9)
- Overhead projector and screen

Instructions

1) Display the chant and read it aloud, or have a student read it. Ask students to focus on the feelings the chant invokes.

2) After the chant has finished, ask students to write down the feelings the chant brought out, or what it made them think about. Then ask several students to share what they wrote.

3) Display the acetate on the overhead and read aloud the English version of the chant. Ask students to write down whether they have different thoughts and feelings now that they know what the chant means. Ask a few students to share their reactions.

4) Ask the class to brainstorm answers to this question: Why is the summit area of Haleakalā important to people? Encourage students to think about people in the past, present, and future. Write student responses on the board or overhead. Try to generate as complete a list as possible, making sure that something related to the research and other work done at the observatories gets on the list, as well as the location of television and radio transmitters.

5) Lead a lecture and discussion of the characteristics of the summit area that make it suitable for observatories. See the teacher background (pp. 6-8) for details.

Journal Ideas

- Think of a situation in which you felt very differently about something than another person did. Were you able to work out your differences? If so, how? If not, why not?
- Write a poem, short story, or Hawaiian *mele,* or draw pictures that illustrate what Haleakalā means to you.
- Think about all the reasons that the summit of Haleakalā is important to people. Which do you think are the most important?
- If a company or government agency wanted to build a new observatory at the summit, do you think they should be allowed to do so? Why or why not?

Assessment Tools

- Participation in class discussion
- In-class writing
- Journal entries

Teacher Background

What Makes the Summit Area of Haleakalā Suited to Observatories?

Near the summit of Haleakalā, which rises 3056 meters (10,023 feet) from sea level, the Haleakalā Observatories occupy a site that is considered to be among the top five percent in the world for locating ground-based astronomy research and monitoring facilities.

Since 1961, several facilities have been built on this site to study and track a variety of things having to do with the sun and moon, the earth's atmosphere, satellites, and other objects traveling through space. These facilities include:

The Air Force Maui Space Surveillance Complex (MSSC)

Space surveillance activities are conducted here for the U.S. Department of Defense. Find more information at <ulua.mhpcc.af.mil/>.

Cosmic Ray Neutron Monitor Station

A neutron monitor detects incoming energy from cosmic rays emanating from sources including solar flares. Find more information at <ulysses.sr.unh.edu/NeutronMonitor/neutron_mon.html>.

Lunar and Satellite Ranging (LURE) Observatory

Laser equipment is used to track satellites. Until 1990, this equipment was also used to track the distance between the earth and the moon, helping scientists measure phenomena such as tectonic plate shifts. Find more information at <koa.ifa.hawaii.edu.>.

Mees Solar Observatory

The main instrument used here is the imaging vector magnetograph, which enables researchers to measure the electric currents passing through selected regions of the sun's surface. Research topics include solar flares, magnetic fields on the sun, and solar oscillations. Find more information at <koa.ifa.hawaii.edu> and <www.ifa.hawaii.edu/research>.

For a listing of related websites, see Bonus Activity "What Goes On at the Observatories?" Student Page "Surf the Net to Research the Haleakalā Observatories" (pp. 36-38).

Summit Advantages

Why is the Haleakalā High Altitude Observatory Site such a good place for these types of research and other work?

- Astronomers prefer to work on high mountain tops in order to have the clearest view possible of objects in space. In general, high mountain tops are above most of the dust, clouds, and water vapor found in the lower atmosphere.

- The summit area of Haleakalā is above the trade wind inversion much of the time. (See Alpine/Aeolian Unit 2 "*Mauna Lei* Mystery" for background information about the tradewind inversion.) Because of this, there is a good proportion of days suitable for viewing. The trade wind inversion restricts the influx of air pollution, clouds, and water vapor from lower elevations.

- At night, a usual downslope flow of air enhances clarity by keeping moisture and particulates from reaching the summit or accumulating there.

- Because Haleakalā is in the middle of the ocean, the air is even cleaner and clearer than

it is at many landlocked sites. In addition, the fact that air currents travel over the ocean, rather than large land masses, before they reach Haleakalā means that there is less air turbulence. Air turbulence is caused by differences in air density caused by differential heating. Air flows traveling across land masses can pick up heat, causing turbulence when they mix with the cooler air at higher elevations. This causes blurriness in the image, reducing the quality of what astronomers call "seeing," or visibility through the atmosphere. The air flows coming directly from the ocean rather than over land are called "free atmosphere." They generally contain less turbulence and make for clearer viewing.

At Haleakalā, the wind usually blows across the summit basin, coming from the northeast. As it traverses the landscape, the air heats up. It also rises off the lip of the summit basin wall and forms a turbulent eddy, despite the fact that the density differences are minor. Because of this, the quality of "seeing" at Haleakalā is not as good as it is at Mauna Kea. But it is still better than most other observatory locations around the world. (When the winds are light and steady from the southeast, scientists at the Mees Solar Observatory report the best viewing conditions. The winds then are not traversing so much land before reaching the observtory.)

- Because Haleakalā is in the tropics, scientists can view some of the southern sky from there. Observatories on the continental United States are too far north for this.

Adaptive Optics: Advancing Technologies for Even Better "Seeing"

The seeing is already quite good at Haleakalā Observatories, but technological advances are making it even better. "Adaptive optics" are being used in the Advanced Electro-Optics System (AEOS) telescope, which is part of the Maui Space Surveillance Complex.

"Adaptive optics" (or AO) refers to optical equipment that compensates for the effect of turbulence in the lower atmosphere as well as high above the earth's surface. Small temperature variations in the atmosphere cause the light entering different parts of a telescope pupil to travel at slightly different speeds. That's what causes blurriness. The AO system used in the AEOS telescope senses these differences and corrects for them using a flexible mirror. (Modern telescopes use mirrors rather than lenses.) Since the atmosphere is constantly moving, the AO system adjusts rapidly, more than 100 times per second!

The following websites are starting points if you or your students would like to learn more about adaptive optics:

Adaptive Optics at the University of Hawai'i at <www.ifa.hawaii.edu/ao/>. Includes downloadable movies of the Hōkūpa'a ("immovable star") telescope correcting for turbulence.

Herzberg Institute of Astrophysics page on adaptive optics and air turbulence at <www.hia.nrc.ca/moffatt/eng/adaptive/adaptive.html>.

International Society for Optical Engineering overview of adaptive optics at <www.spie.org/web/oer/february/feb98/adapt.html>.

Lawrence Livermore National Laboratory page on adaptive optics at <www.llnl.gov/str>.

- Unlike the weather on high mountains in many other parts of the world, the weather on Haleakalā is only infrequently severe enough to hamper the use of observatory facilities. The weather is more reasonable on Haleakalā than it is even on nearby, but higher, Mauna Kea.

- Temperatures are moderate for the altitude.

- There is more oxygen per volume of air available on Haleakalā than on higher elevation mountains such as Mauna Kea. This makes it easier for researchers and maintenance personnel to work there.

- There is minimal light pollution from nearby urbanized areas.

- Access to the summit is relatively easy. The road is paved all the way to the top, and is seldom closed by bad conditions or weather.

One Significant Disadvantage

Discussing the advantages of Mauna Kea as an observatory site, Saul Price noted that "radio telescopes experience an almost complete absence of electrical interference from urban or other sources." On Mauna Kea, radio and television broadcasting transmitters are not allowed in the Mauna Kea Science Reserve. But on Haleakalā, the observatories are in close proximity to several powerful broadcast facilities, some of which are immediately adjacent to the observatories.

The radio frequency interference (RFI) caused by the proximity of the broadcast facilities to the observatories has a different effect depending upon the device receiving the interfering signals. Some types of equipment are particularly sensitive to the radio frequency signals, which interfere with their ability to amplify, process, and display weak electrical signals associated with astronomical measurements. In some cases, RFI has been so bad that screens that normally display data instead display fuzzy television pictures.

This is one example of a conflict between different uses of the summit area.

Sources

KC Environmental, Inc., *Draft Environmental Assessment and Anticipated Finding of No Significant Impact (FONSI) for a Coordinated Broadcast Facility at Haleakala, Maui, Hawaii,* University of Hawai'i Institute for Astronomy, Honolulu, 1998.

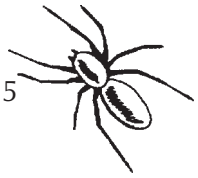
Price, Saul, "Hawai'i as a Site for Research in Astronomy and Climate Change," in *Prevailing Trade Winds: Weather and Climate in Hawai'i*, Marie Sanderson (ed.), University of Hawai'i Press, Honolulu, 1993.

Mickey, Donald. Personal interview, January 2000.

Nani ke Ao i Haleakalā

Nani ke Ao i Haleakalā
ʻOhuʻohu i ka noe o uka
ʻA ʻahu i ke kapa o ka hau
Anu e kai o Kahului
E hului pau mai kaua
I ua mea nei he aloha
E ko a paʻa ka manaʻo
I lua no kuʻu makemeke

Adorned with the mists of the upland
Dressed in a garment of snow
Whose cold reaches down to Kahului
Let us take all to ourselves
This thing that is called love
Grip and hold fast to the thought
That accompanies my desires



Activity #2

In-Class Public Forum

● ● ● In Advance *Student Reading*

- Assign Student Page "A Proposal to Relocate Broadcast Facilities on Haleakalā" (pp.13-17) as homework reading.

● ● ● Class Period One *Exploring the Relocation Proposal*

Materials & Setup

For each student

- Student Page "Different Points of View" (pp. 18-30)
- Student Page "Different Views in the News" (pp. 31-32)
- Student Page "Questions about the Viewpoints" (pp. 33-34)

Instructions

1) With the whole class, brainstorm answers to these questions: Who would care about this proposal to move the radio and television transmitter towers? Why would they be concerned?

2) Review key elements of the proposal with the class, using the information provided in the student background sheet.

3) Before you wrap up for the day, have students count off by sevens, writing down their number as they say it. Make reading and homework assignments based on students' numbers:
   a) Students should read the numbered viewpoint in the Student Page "Different Points of View" that corresponds to their number (one to seven).
   b) All students should also read the Student Page "Different Views in the News."
   c) All students answer the questions on the Student Page "Questions about the Viewpoints."

● ● ● Class Periods Two and Three *Preparing Testimony*

Materials & Setup

For each group of three to four students

- One photocopy of the "Summary and Anticipated Determination" section from the Draft Environmental Assessment (DEA) for the development of a coordinated broadcast facility on Haleakalā. (The DEA is included as an appendix to this unit.)

Instructions

1) Divide the students into small groups based on the views they read. There should be one group representing each viewpoint. Each group is to prepare for a "public hearing" on whether the transmitters should be moved to the proposed site at Kalepeamoa. You will hold this public meeting in class in two days.

During these class periods, each group will create a four to six minute testimony for that public hearing, as convincing as possible, based on the viewpoint they read. They may use visuals or other support for their presentation if they want to. They may come up with research tasks and divide these among group members as homework.

2) Each group should have a copy of the "Summary and Anticipated Determination" section of the Draft Environmental Assessment. This provides additional background about the project and the findings of the DEA. The table of contents for this section will help students find their way quickly to important information.

3) As an additional resource, you may wish to photocopy other parts of the draft environmental assessment for students, especially Chapter Four "The Affected Environment," and Chapter Five "Environmental Effects and Potential Mitigations."

● ● ● Class Period Four *In-Class Public Forum*

Instructions

1) Hold the "public forum" by having each team give its "testimony" to the entire class, allowing a few minutes for questions before moving on to the next one. If there is time left over at the end of class, hold a general discussion about what the most convincing presentations were and why, which perspectives students agree with, and what they think should be done about moving the transmitters. You may want to continue this summary discussion during the next class period.

Journal Ideas

- Do you agree or disagree with the perspective you were assigned in the public hearing? How did it feel to argue for that point of view?
- What is *your* perspective on whether the coordinated broadcast facility should be built at Kalepeamoa?
- What would you need to learn more about in order to make an informed decision about siting broadcast facilities at Kalepeamoa?
- Read the descriptions of value systems in the Student Page "Questions About the Viewpoints," and explain which value systems show up most strongly in your personal point of view.

Assessment Tools

- Participation in class discussions
- Student Page "Questions About the Viewpoints"
- Participation with group in putting together testimony
- Testimony given in class: Evaluate on the basis of thoroughness, reasoning, and presentation.
- Journal entries

A Proposal to Relocate Broadcast Facilities on Haleakalā

High up near the summit of Haleakalā, a conflict has been brewing for years. At the center of this conflict are researchers who use sensitive electronic equipment in their work at Haleakalā Observatories, and broadcasters, whose radio and television communication facilities produce high-powered signals. The signals from the broadcast facilities can interfere with the electronic equipment at the observatories. Imagine sitting down at a computer screen expecting to review data from your most recent solar observations and instead seeing a blurry image of the local weather report!

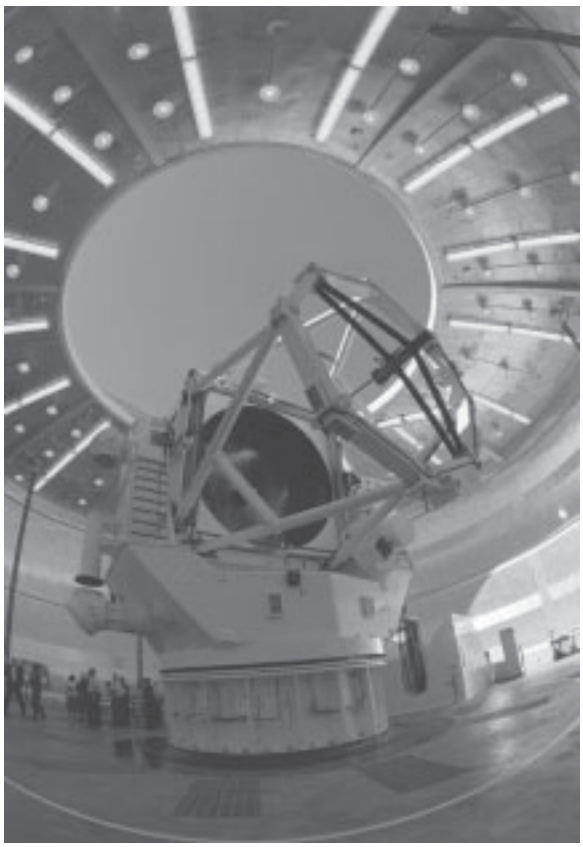
LURE observatory (Photo: Michael Maberry)

The "observatories" (buildings equipped for observing natural phenomena, as in astronomy) and broadcast facilities have grown up side-by-side near the summit. The summit offers atmospheric and space researchers an accessible high-elevation vantage point for their research. The summit provides radio and television broadcasters coverage of Maui, the windward side of O'ahu, and the Kona coast of Hawai'i. From the summit of Haleakalā, there are also clear microwave paths to receive transmissions from studios on O'ahu that can in turn be transmitted to other areas.

There are not too many options for resolving this situation. Commercial broadcasters now occupy six sites on Haleakalā, most of which are next to or even within the 18-acre Haleakalā High Altitude Observatory site. New technological developments mean that researchers at the observatories are using electronic equipment that is increasingly sensitive to radio frequency interference (RFI) from the transmitters. There have been some efforts to shield the research equipment, but shielding is expensive and only partially effective.

The situation is bound to get worse, not better, if the broadcast facilities are left where they are. Applications for construction permits for several new stations have been submitted, and some have been approved. In addition, the federal government has

Transmitter facilities in the saddle area (Photo: Michael Maberry)



Air Force AEOS telescope (Photo: U.S. Air Force)

mandated a transition to digital television. During this transition period, broadcasters will be constructing new digital transmitters to accompany the existing analog facilities. After a number of years, the analog transmitters will be phased out. In the meantime, however, there will be more transmitters and more RFI for the observatories.

A Proposed Solution

In 1998, the University of Hawai'i Institute for Astronomy formally proposed moving all of the broadcast facilities in the summit area to a single site about a mile away from Haleakalā Observatories. Its aim was to reduce the proliferation of transmitter facilities at the summit and to protect the observatories from radio frequency interference. The Institute commissioned a site selection study and prepared an "environmental assessment" (this term is defined in the sidebar on the environmental review process).

Four alternative sites were examined to see:

1) Whether they would reduce RFI to an acceptable level at the observatories, and
2) If they would provide adequate coverage for broadcast facilities.

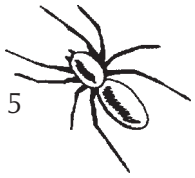
Based on that analysis, a site along the southwest rift zone near Kalepeamoa Pu'u was chosen as the best option. Therefore, the likely impacts of developing a coordinated broadcast facility at the Kalepeamoa site were studied. The results of that analysis were published in the Draft Environmental Assessment.

The Kalepeamoa Site Plan

The proposed facility would be built on land owned by the state of Hawai'i and managed as conservation land. It would be at an elevation of 2900 meters (9250 feet) on the southwest rift zone of Haleakalā. Access to the site is along Skyline Drive, an unimproved, gated road that is sometimes used as a trail by hikers, hunters, and mountain bikers.

Antennae with Pu'u'ula'ula *(Red Hill) in the background (Photo: Michael Maberry)*

A utility corridor already exists along Skyline Drive, making it easy to extend electricity and telephone service to the site. A diesel generator would provide backup power, requiring an above-ground fuel storage tank. Non-potable water would be collected from a roof catchment system. Maintenance workers at the facilities would carry in their own drinking water. A septic system would be installed for sewage disposal.



The proposed coordinated broadcast facility would include as many as four antenna towers, each of which would be no taller than 61 meters (199 feet). Transmitters and other equipment would be housed in individual shelters or in a single building with separate rooms. Other rooms (or separate buildings) would house the power distribution center, the standby generator, and toilet facilities.

The broadcast facility would be operated by remote control from Honolulu. Normally, the only people coming to the facility would be performing routine maintenance two to four times a month for each station. Fuel tanks for the generator would need to be topped off between one and four times per year.

Potential Impacts Considered In the Environmental Assessment

The environmental assessment explored a number of possible impacts of the construction and operation of the proposed facility. They included:

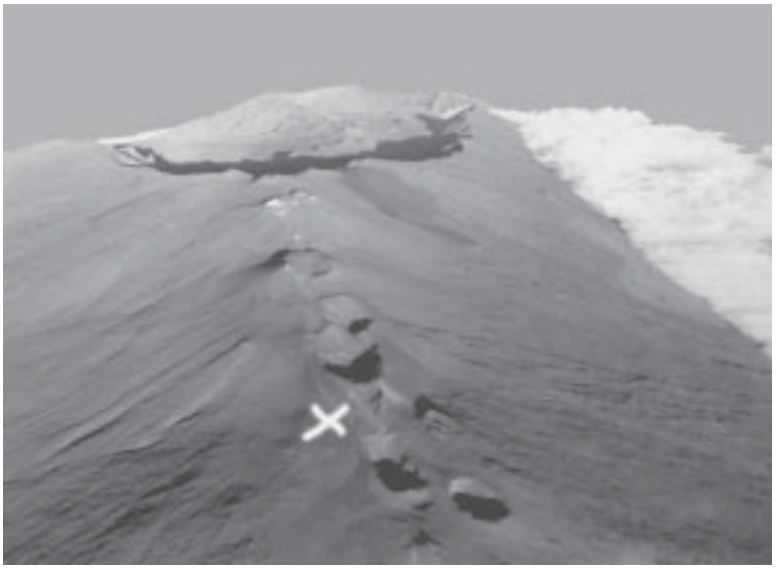
Air Quality, Traffic, Noise

Construction activities would generate dust, especially along the unpaved access road, and intermittent high noise levels. During construction, a small increase in traffic on the road to the summit would be expected. A small number of large, oversize loads would be timed during off-peak traffic hours in the park.

Once the facility became operational, there would be an estimated five to ten vehicle trips per week for maintenance and deliveries. This would cause no increase in traffic on the main Haleakalā road, since most of the tenants in the new facility would be broadcasters that already have facilities in the summit area.

Vegetation

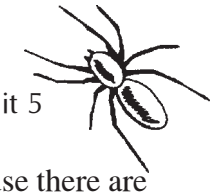
The site is sparsely vegetated with no threatened, endangered, rare, or vulnerable plants found there or in the surrounding areas. The biggest concern is the unwitting introduction of nonnative plants on construction equipment or supplies. To address this concern, the project plan proposed all incoming equipment, supplies, and construction materials be inspected by a park biologist.



The proposed site is marked on this photo. Observatories and existing transmitter sites are uphill from this site, along the rift zone. (Photo: Frank Rozzo)

Birds

The endangered *ʻuaʻu* or Hawaiian dark-rumped petrel fly over the proposed site during breeding season, especially at night. *ʻUaʻu* are prone to colliding with objects such as power lines, utility poles, and barbed wire fences. To minimize impacts on the *ʻuaʻu*, the fencing around the facility would be designed based on advice from the U.S. Fish and Wildlife Service. In addition, utility cables would be buried wherever possible. During construction, work would be done during the daytime to avoid disturbing the birds with



lights at night. Nearby *ʻuaʻu* nests would be monitored to assure that vibrations from the construction do not disturb the birds or their burrows.

Invertebrates

A cursory site survey turned up no insect species unique to the area. Construction would disturb and destroy some insect habitat, but the larger concern is the potential to introduce non-native insects on equipment, supplies, and construction materials. Proposed inspections by a qualified biologist would guard against introducing alien species.

Archaeological Sites

Five sites had been recorded in a 1995 survey of the area. The State Historic Preservation Division found that neither of the two sites directly affected by project construction were prehistoric or otherwise especially significant. Also, the proposed project would not impede worship or access to previously accessible sites for Native Hawaiians. There could be temporary closures during construction.

Visibility

Construction equipment would be visible only in the immediate vicinity of the project. The broadcast facility itself would stand out among the rugged and barren cinder cones and craters. Few people would see the project up close, and those that do are likely to have many different opinions about it. The antennae would be visible from much of Upcountry Maui but not from most of the main visitor areas in the park.

Infrastructure, Utilities, & Services

Maui Electric Company would extend existing power lines to the site. Power use would not affect other electric company customers. A catchment system would provide the small amount of water used at the facility. The septic system for treating waste water would have no adverse effect on ground water because there are no springs nearby and the ground water is thousands of feet below the surface. All other waste would be taken off-site for disposal.

Radio Frequency Interference

The facility and the observatories would be one mile apart, with shielding provided by the hilly terrain. This should make it easy for broadcasters to adjust the shape of their antenna beam to minimize RFI at Haleakalā Observatories.

Human Health and Safety

Analyses of the risk of human exposure to radio frequency radiation found levels to be well below the maximum limits.

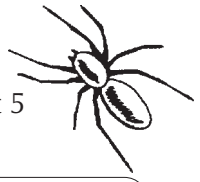
What Happened to the Proposal

After the environmental assessment was written, the University of Hawaiʻi released it for public comment. Based on their analysis, University staff and consultants believed that a "finding of no significant impact" (FONSI) was appropriate.

However, the overwhelming majority of public comments expressed concern about the potential effects of the project. In the end, the University received so many negative public comments that it could not issue a FONSI.

In Hawaiʻi, the environmental review process allows two options in cases such as this one. The first option is to prepare a more detailed analysis of the project and submit this "environmental impact statement" for additional public comment. The other option is to drop the project.

The University of Hawaiʻi decided not to prepare an environmental impact statement because it did not have enough money in its budget to cover the more detailed analysis required. What that means for the observatory researchers and the broadcasters is not clear. The issue of radio frequency interference has not been resolved and promises to come up again in the future.



The Hawai'i Environmental Review Process at a Glance

Has anyone ever said to you, "Think before you act"? Have you ever found yourself wishing someone else would think before they do something that seems stupid? Getting government decision makers to think before approving a project that might harm the environment is one of the main reasons behind the Hawai'i "environmental review" process (a formal process that examines potential project affects on the environment). Many projects proposed by Hawai'i state government agencies must go through this process. There are similar review processes set up under the National Environmental Policy Act, and some counties even have similar ordinances.

Federal, state, county, and private projects can all be required to go through an environmental review process. Among other types of projects, any proposed use of state land designated as a conservation district must go through this review. The proposed site of the coordinated broadcast facility is in a state conservation district. So the environmental review was required. Here's how it works:

Step #1: **Environmental Assessment (EA)**
A written evaluation to determine whether an action may have a significant effect

Step #2: **Public Comment** on the EA

Step #3: **Finding of No Significant Impact** (FONSI)
If the project will not significantly harm the environment, a FONSI is issued. There is a period of time during which people or organizations may challenge this finding in court.

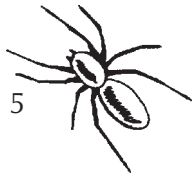
Step #4: **Environmental Impact Statement (EIS)** If the project *may* have significant environmental impact or if the FONSI is struck down in court, an EIS is written to examine a proposed project's:

- environmental effects,
- effects on the community and state social and economic welfare,
- effects on economic activities,
- attempts to minimize adverse effects, and
- alternatives and their environmental effects.

Step #5: **Public Comment** on a Draft Environmental Impact Statement

Step #6: **Final EIS**
The final statement includes public comments and the agency's response to them.

Step #7: **Governor's Approval**
The final EIS is evaluated for acceptability by the governor. If accepted, the project may go forward.



Different Points of View

The proposal to move the radio transmitters to another location on Haleakalā, away from the Haleakalā Observatories, sparked much controversy on Maui. People have many different points of view about whether the transmitters should be moved and if so, where the best location for them would be. Here are seven different viewpoints. READ THE ONE THAT CORRESPONDS TO THE NUMBER YOU WERE GIVEN IN CLASS. You may read the other viewpoints as well, but be sure to read your assigned viewpoint carefully.

Viewpoint #1

Mike Maberry, Assistant Director
Institute for Astronomy, Haleakalā Observatories

(These comments on the Draft Environmental Assessment were submitted on behalf of the Institute for Astronomy at the University of Hawai'i.)

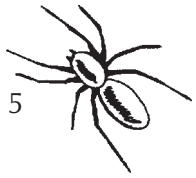
On behalf of the University of Hawai'i Institute for Astronomy (IfA), I would like to address our interest in the development of a coordinated broadcast facility for Haleakalā.

It has been incorrectly stated that commercial broadcasting preceded astronomy on Haleakalā and that our astronomers and space scientists should have avoided building telescopes near transmitters. The truth is that professional astronomical research came first. In the spring of 1951, Dr. Grote Reber, the father of radio astronomy, chose Haleakalā as one of the best sites in the world to undertake his experiments. Unfortunately, since radio astronomy cannot tolerate any level of "Radio Frequency Interference" (RFI), he soon had to abandon the site when commercial broadcasters began transmitting from the summit. In the ensuing four decades, the level of RFI has increased considerably.

What is Radio Frequency Interference? Have you ever tried to watch television when someone has turned on a vacuum cleaner in the same room? Did you notice what happened to the picture quality? You probably saw distortion, perhaps bands of light and dark or a fuzzy image, caused by competing electrical signals. If so, then you may have also noticed that when the vacuum was moved to the far side of the room the interference diminished and the picture improved. What you witnessed was a form of RFI. Moving the source (vacuum motor) away from the television reduced the interference. The same would be true for Haleakalā. Moving the source of RFI (the broadcast antennas) away from the sensitive astronomical and space surveillance equipment would have a similar beneficial effect.

The commercial broadcasters have transmitters, buildings and antennae at some six different sites on Haleakalā. Most of these sites are leased from the Department of Land and Natural Resources on month-to-month revocable permits. The University of Hawai'i owns the 18-acre scientific reserve officially known as the Haleakalā High Altitude Observatory site, or HO. The commercial broadcasters on Haleakalā are currently located right next to and even within HO.

Beginning in the 1970s the RFI generated by the commercial broadcasters on Haleakalā began to seriously impact IfA's ability to utilize the latest developments in sensor technology. After enduring growing frustration from the effects of RFI, we commissioned a study in 1989 to see exactly what levels of interference exist within HO. According to the International Astronomical Union, an acceptable level of RFI, measured



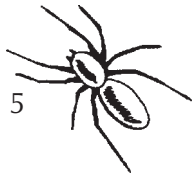
outside an observatory doing optical or infrared observations, is two microwatts per square meter. We have measured in excess of 184,000 microwatts per square meter.

At 10,000 ft., Haleakalā is obviously an excellent site from which to relay broadcast signals to windward O‘ahu, Moloka‘i, Maui and parts of the Big Island. The Federal Communications Commission (FCC) has received requests for licenses for more than 70 additional transmitters and antennas to be located on Haleakalā. Some of these are essential so that the existing broadcasters can meet the FCC’s mandate for simultaneous digital and analog transmission by the year 2004. If the state granted the requested permits without regard to where the transmitters are placed on the summit, the addition of so many more antennas would constitute both a visual blight and an additional RFI nightmare for IfA. It is therefore only logical for the State and County of Maui to work toward development of a coordinated broadcast facility on Haleakalā.

Technology has progressed such that in a coordinated facility, all commercial broadcasters and their individual antennas currently accommodated at the summit of Haleakalā can be located on two towers. Two additional antenna towers were recommended in the recent Environmental Assessment to allow for future growth well into the next century.

The IfA is preparing a Research Development Plan (RDP) that will identify what types of research can be undertaken at HO. Once the RDP is complete we can develop a Master Plan for our 18 acres (not the whole summit, as some mistakenly believe). However, we can not complete the RDP until we know how much RFI we will have to contend with.

The IfA has been working hard to resolve the problems associated with the cohabitation of astronomy and commercial broadcasters for many years and we support the concept of a coordinated, consolidated broadcast facility.



Viewpoint #2

Kahu (Reverend) Charles Kauluwehi Maxwell, Senior

(These comments reflect Rev. Maxwell's point of view and do not reflect the position of any organization.)

Why do we native Hawaiians get angry whenever something is put on the top of Haleakalā? From ancient times the mariners used Haleakalā as a point of reference. When they looked up and saw the star called Hōkūpa'a, they knew they were in Hawaiian waters. They continued in a northerly direction and the first thing they saw was Haleakalā if they were coming down the Keala i Kahiki channel. "Keala i Kahiki" means the road to Tahiti.

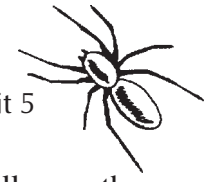
Maui, Moloka'i, Lāna'i, Kaho'olawe were all one island thousands of year ago. This was called Maui Nui a Kama, the Greater Maui. Papa, the earth mother and Wakea, the sky father, created the islands, and Haleakalā is the *piko*, the navel, the center of Maui Nui a Kama. It is the cultural center point of all these islands that were once joined.

Pele, the Goddess of Volcanoes, was born in Tahiti. She tried to find a permanent home by digging craters with her magic *'ō'ō* (digging stick) throughout the Pacific. Reaching the Hawaiian Islands, she tried to make a home on each island from the northern islands of Nihoa and Necker to the Big Island of Hawai'i. She dug the crater of Pu'umōiwi on Kaho'olawe and created eruptions at Kanaio. She continued up the south rift of Haleakalā and left a chain of cinder cones which led directly into the crater of Haleakalā. For a while, she resided in Haleakalā but was not satisfied, so she ventured to Hāna by way of Kaupō, causing a great eruption that ran down to the sea. A great battle ensued between Pele and her sister Nā-maka-o-ka-ha'i, the goddess of the sea. Pele was killed and her bones were scattered on a cinder hill called Ka-iwi-o-Pele in Hāna. Being a goddess, Pele manifested herself and went to the island of Hawai'i, where she presently resides at Hale-ma'u-ma'u crater on Kīlauea.

There are shelter sites in Haleakalā crater with carbon dates that show human habitation from the third century. Haleakalā has so many ancient burials. I was privileged to have discovered an *akua kā'ai*, which are remains of ancient kings that were wrapped in sennit (Hawaiian rope made from coconut husk fibers) and placed in a *heiau* (Hawaiian temple). It had spears next to it, and carved carrying sticks. It is considered as one of the most sacred religious items for our people. Everyone that was buried in Haleakalā was considered royalty. No commoner would be buried up there.

For our people it is considered the "pathway to call the sun" and that is where the sun lives. The placing of a telescope on top of the mountain ruins the spirituality of the entire mountain. There is a *heiau* on one of the ridges in the crater where the demigod Maui prepared his sennit to lasso the sun so his mother's tapa could dry. After the telescope was built, the Air Force wanted to put several sensors on the ridges of the crater. I told them that they could not because of the sacred *heiau* that were there. They did not believe me, so they flew me up in a helicopter, and on the three-thousand-foot precipice, there stood the *heiau*. When I was 18 years old, I had climbed up the cliff to see it. My *kupuna* told me about the *heiau*. I also showed them several others. They did not place any sensors on the crater ridges.

Poli'ahu is the goddess of the snow and when Hawaiians see the snow on Haleakalā, they say that Poli'ahu is in residence and is covering the bones of our kupuna. That's why when you build a telescope that can be seen from all over, it is an actual blight on the sanctity of Haleakalā. For us it is not just a mountain, it's a sacrilege to desecrate it—like moving the antennas one mile and bringing them down to Kalepeamoa. Kalepeamoa

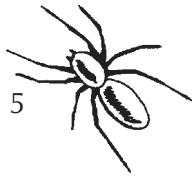


is named for a chicken demigod that lived in that area, so the whole mountain is for us a very spiritual place. It is a sacrilege to plow it, to take out rock as they did when building the Air Force telescope.

Why step on our culture for the betterment of science? We are the only group of people that can spiritually link to Haleakalā. Every island is named, every river, every gulch is named after Hawaiian gods and goddesses, but people don't respect that. Can you imagine that thousands of years before our people came here in the third century these names existed? It was told to our ancestors by our prophets and spoken about in chants. We did not "stumble" on Hawai'i like Captain Cook did. Our ancestors knew it existed. When they came here in their double-hull canoes, they came equipped with their families, animals, plants, gods and goddess. They lived here thirteen hundred years before being discovered by Western man. They were strong robust people and the world's greatest ecologists.

When Captain Cook arrived, it actually was the end of our race, as we died by the thousands from the common cold and other Western diseases. Now we are fighting this new disease called "progress" that wants to eliminate us and our Hawaiian spirituality and values. We all must bend to ideas of the West and science that threaten our existence in these islands as we know it. Our lands were taken against our will, and we are doggedly trying to hold on to our culture. They want to change it to be like wherever they're from.

Why can't we work together? Why aren't we consulted? As our late King Kalakaua said in his book, *Myth and Legends*: "Soon we will be only footprints in the sand and our song will not be heard."



Viewpoint #3

Mary M. Evanson, President
Friends of Haleakalā National Park

(These comments on the Draft Environmental Assessment were submitted on behalf of Friends of Haleakalā National Park.)

We have reviewed the subject document and offer the following comments:

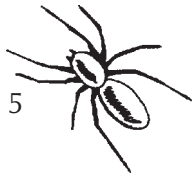
It is stated in the Draft Environmental Assessment (DEA) that both Kalepeamoa and Keonehunehune [a lower elevation site located on Ulupalakua Ranch] are viable sites for this project from the technical standpoint. We feel that there will be significant adverse environmental impacts if Kalepeamoa is developed, while at the lower site of Keonehunehune adverse impacts would be negligible. Therefore, we strongly urge that Keonehunehune or some other site lower on the southwest rift zone be used for this project instead of Kalepeamoa.

The only development now on the summit area of Haleakalā outside the national park has been within lands set aside for Haleakalā Observatories and lands down to and including the FAA low site. This proposed tower project is well outside this developed area, one mile down the mountain and could very well spark demand for other projects in the area. This southwest rift zone is remote wilderness that is little known but worthy of protection either under the state's Natural Area Reserve System or the National Park Service.

The entire mountain of Haleakalā is a visual, cultural and geological resource that must continue to be recognized as being of great significance and vital to our visitors and our local residents. The northeast side of Haleakalā supports dense native forests with heavy rainfall. The southwest rift zone has sparse vegetation and little rainfall but spectacular views and volcanic eruptions up and down the rift zone created a line of colorful cinder cones and pit craters. This alpine rockland provides visual enjoyment of geological features found nowhere else. The scenic beauty and interpretive possibilities of this area are unlimited and should be preserved. The proposed 199-foot towers would be the highest structures on the mountain; they would be visible from Kula and all of central Maui from Kihei to Haʻikū. They will greatly impact the values and the environment of Haleakalā and especially the southwest rift zone.

There are concerns about the endangered dark-rumped petrel that must be addressed more fully. The four 199-foot towers would be in the vicinity of petrel nesting burrows and in the flight paths of the birds. Petrels will die, and since the facility will not be manned, any downed injured birds cannot be saved. We should be doing all we can to save what few native birds are left; erecting four 199-foot towers in their path is not the way to go. Only a cursory survey was done for invertebrates and plants; this is not adequate. The DEA states that the road to the site will not be improved, and yet heavy construction equipment of all kinds will be needed. There needs to be more detailed information regarding public health and safety relative to radiation in the area.

In addition, we have serious concerns about the impacts of alien species—such as the Argentine ant, which threatens numerous native insect species, as well as such rare plants as the federally-protected Haleakalā silversword, with extinction—which may be introduced to the national park and surrounding areas by use of the Kalepeamoa site. The unique and fragile biotic character of the Kalepeamoa area is underscored by Haleakalā National Park's designation as a globally important "Man and the Biosphere"

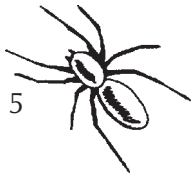


Reserve. Because it is impossible to guarantee that harmful alien species will not be introduced by construction and other human-related activities with respect to this project—and such introductions are potentially permanent and have irreversible consequences—we propose that an alternative site be used, one which is less unique and biotically sensitive.

Alien species issues (introductions, impacts, and control/eradication if introduced) are not adequately addressed in the DEA. Alien species which may be inadvertently introduced could affect invertebrates, plants, birds, and other organisms, some of which are federally protected species. Adequate measures for prevention of alien species introduction must be detailed and these measures included in contractors' specifications for all aspects of the proposed project. Also, contingency plans should be devised to ensure funded eradication measures in perpetuity in the event of any breach of preventive measures (i.e., in the event of an alien species introduction). These issues must be acknowledged and adequately addressed by formal, legal documentation and prior to any decisions being made about the selection of any site for this proposed project.

If Kalepeamoa continues to be the site of choice a full analysis of the project through an Environmental Impact Statement must be done. In addition to the aforementioned concerns, questions which must be addressed include:

- How will construction be arranged without destroying the existing loose cinder Skyline Drive?
- How big an area might be affected by the project?
- Will radiation impact the petrels?
- Skyline Drive is an official *Na Ala Hele* trail and is used by hikers, mountain bikers, and hunters; how might they be affected by radiation?
- The area is now one of absolute silence except for an occasional helicopter; will there be noise from the facility (such as humming)?



Viewpoint #4

Virginia Parsons, Broadcast Consultant

(These comments are based on those submitted by Ms. Parsons on the Draft Environmental Assessment. They do not reflect the position of any organization.)

I am in full support of the proposed antenna farm project on the summit of Haleakalā and have personally visited the site. The proposed project will help broadcasters become more efficient.

In addition to the transmitters that can be relocated so they no longer interfere with operations at the Haleakalā Observatories, there are transmitters located at lower elevations that could be moved to the new site. All of the FM transmitters could be moved out of the local communities where they are now housed. From the new site, they would require less electricity to operate and have better "line of sight" to carry their signals to the public. Up top, there would be less reception interference than there is at the lower elevations where the towers are currently located. The proposed site will be built away from local housing communities in an area unlikely to be inhabited by development. This avoids future conflicts between development and the transmitters.

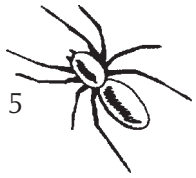
More importantly, the reach of the broadcast signal from the proposed summit site will be an enhancement to our civil defense program as it will allow broadcasters to reach almost all points throughout the state in an emergency. No other site offers such coverage. Unfortunately, disasters happen, and we must be prepared to protect the public the best we can. Not looking beyond the moment would be a crime, as lives would surely be lost without effective broadcast coverage.

There are no alternatives to the proposed summit site that would provide adequate coverage to the population at large. It appears the only reason that there is any conflict regarding this proposed summit site deals with a "bad" business decision made by a Lahaina broadcaster to pour $400,000 of concrete onto Ulupalakua Ranch, apparently to construct an antenna farm on private property so as to avoid the normal state bid process for a landlord at the top of Haleakalā.

Even if this concrete disaster were remotely viable, television broadcast would work only with towers 750 feet high. Even with such high towers, engineers believe they would still lose coverage at this lower-elevation site. And we have not yet determined what kind of coverage these facilities would offer as broadcasters transition from the current analog technology to new digital broadcast technologies. Some radio stations would be able to reach the city in which they are licensed to broadcast from the Ulupalakua site. Others, such as those serving or slated to serve Makawao and Haʻikū, would not.

Given the choice between 750-foot towers equipped with flashing strobe lights, and the shorter, less obtrusive towers that would be needed at the higher elevation, I think I'll take four short (199-foot) sticks. These will have underground wiring. (The proposed summit site area has already been dug and lined with fiber optics.) I doubt that the facility on top of Haleakalā will be the eyesore that was built on Erdman's ranch.

Realistically, if the nay sayers were to truly evaluate the good from the evil, the facts abound that in an emergency, broadcast transmission is a Godsend, a life-saving warning, a comfort, as well as necessary survival information, which would surely outweigh any opportunistic protest. We need to reach beyond the current reflection and see the real reason for the rivalry—and it has nothing to do with the good of the land or the people … only rental incomes.



Viewpoint #5

Dr. Donald Mickey, Solar Astronomer, University of Hawai'i Institute for Astronomy

(These comments reflect Dr. Mickey's point of view and do not reflect the position of any organization.)

Astronomers work on high mountain tops in order to have the clearest view possible of objects in the sky. The quality of "seeing" at Haleakalā is not quite as good as it is on Mauna Kea because the prevailing northeast winds heat up as they blow across the crater, causing a small amount of air turbulence around the lip of the crater. But Haleakalā has some advantages over Mauna Kea. The weather is more reasonable on Haleakalā, the road access is better, and because of its lower elevation there is more oxygen available in the atmosphere. An elevation of 10,000 feet is manageable for most people, while 14,000 feet is uncomfortable for most.

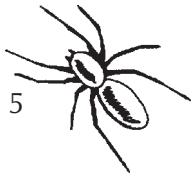
Mauna Kea is one of the three best astronomy sites in the world. But Haleakalā is not far behind in the ranking. Astronomers consider it to be among the top five percent of sites for ground-based astronomy.

High up on the slopes of Haleakalā is also a good place to locate television and radio transmitters. From there, the transmitters can cover most of Maui, windward O'ahu, and the Kohala coast of Hawai'i. And, as is true for the observatories, the transmitters are easy to reach by road for the people who need to maintain and repair them.

The problem is that increasingly powerful radio and TV transmitters placed on top of Haleakalā cause interference in the electronic cameras systems in the telescopes and degrade the quality of observations. Both the number and the radiated power of the transmitters has increased over time, so that they now are not only unsightly but could represent a health hazard for people walking the nearby roads. At the same time as the radio frequency interference (RFI) from the transmitters has increased, astronomers have also become dependent on very sophisticated electronic equipment to do their work. In the past, electronics at the observatories was limited to motors that moved equipment. Now, most equipment relies on high speed computers and sensitive electronic detectors. The more sensitive the instrument the more it is affected by the transmitters.

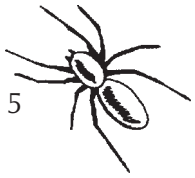
The conflict between the broadcast facilities and the observatories has been growing for many years. Now there is an opportunity to move the transmitters to another location that will work well for them and reduce RFI at the observatories. In 1996, the U.S. Congress passed the Telecommunications Act, mandating a nationwide transition from analog to digital broadcasting. During the next several years, television broadcasters will be putting digital transmission in place while continuing to transmit conventional analog television programming. Eventually, analog will be phased out.

Since the broadcasters will have to replace their transmitters to accommodate digital transmission, this is a good opportunity to relocate the transmitters from their scattered locations around the observatory complex to a different, well-designed location. This move could benefit everyone concerned: The broadcasters would benefit from a modern facility with comparable broadcast coverage to the present site but better separated from people. Astronomers would benefit from dramatically decreased RFI due to a greater distance between the observatory and the transmitters. The mountain itself would shield the observatories from some of the signal put out by the transmitters. Visitors to Haleakalā National Park would also benefit because there would be less visual impact in the summit area.



The International Astronomical Union has set standards for the acceptable level of radio frequency interference measured outside an observatory doing optical or infrared observations. The total allowable interference, summed over all frequencies, is two microwatts per square meter. At Haleakalā Observatories, we have measured in excess of 184,000 microwatts per square meter.

When local broadcasters comply with the Federal Communication Commission requirement to simultaneously transmit in both digital and analog for several years, we expect the RFI levels to more than double at the observatories. This is obviously a problem we need to solve, and moving the transmitters is a good solution.



Viewpoint #6

Iokepa Nae'ole

(These comments reflect the viewpoint of Mr. Nae'ole and do not reflect the position of any organization.)

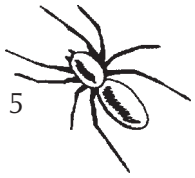
Through my ancestral connection to these islands, I am bound to its stewardship. By nature as well as by trade, I am a conservationist and stand opposed to any form of *commercial* development, large or small. Periodically throughout my lifelong residency here on Maui, I would ask, "When will it stop?" When will there be enough hotels to satisfy the supposed demands of the visitor industry? When will we finally have enough retail outlets to supply our population with the modern amenities that fill our homes? How many television and radio stations will be sufficient to entertain the masses? How much of our precious land and natural resources will we *all* ultimately sacrifice in the name of technology and progress?

As a native Hawaiian I have always questioned, and will always question, the reasoning and the logic used by developers when they seek government approval for their ventures. I am forever skeptical of their motivations. I detest the reality of development and refuse to accept the lack of control that native Hawaiians have in regulating land use. Rationalization has become my way of dealing with it. Okay, maybe a new resort will provide much need employment for the island. And a new Home Depot will not only provide jobs, but may also stir up some competitive prices. I may need a new recliner so that I can thoroughly enjoy all 200 channels of commercial advertisement, interrupted occasionally by an episode of Gilligan's Island. So there you have my stance on development in general: too much already.

So what about the Haleakalā Observatories and the radio frequency interference caused by transmitters located nearby? We know that the two facilities are technically incompatible neighbors and one of them has to move. So the proposal is to relocate and consolidate existing broadcast facilities to an area where RFI will no longer affect the mission of the observatories. I partially agree with this proposal. I feel that the scientific activities conducted at the summit should continue and that all efforts be made to eliminate the source of RFI from the summit area. Does this belief come into conflict with my own cultural values? How, you may ask, do I feel about the existence of such a facility that many Hawaiians view as a desecration of sacred land? While I do agree that the summit is a culturally and ecologically sacred place and that the construction of the structures there has no doubt caused extensive environmental change, I also value knowledge and learning.

Hawaiians have always been a race of stargazers. The *kilohōkū* of ancient days would spend many nights perched upon the highest summits gazing, searching, pondering, and prophesying. Without physically departing our *honua* they would take journeys of the mind into the depths of space, seeking answers to questions still asked, and yet to be answered, by modern science and technology. While I regret the loss of habitat for native species, and while I resent the restricted access to the sacred summit area, I know that Hawaiians themselves were explorers whose culture was dynamic and innovative, and accepting of progress in the name of exploration.

Exploitation, on the other hand, is a subject less open to compromise. Commercial exploitation of land for financial gain is a foreign concept to the Hawaiian culture. Whether it is a resort built on beachfront property or a snorkel tour mooring drilled into the ocean floor, it is considered an affront to nature and culture. As far as I'm concerned, there are only two transmitters that should exist on the mountain: Hawai'i Public Television and National Public Radio. The rest are just *'ōpala*. We waste entirely too much time



inside, insulated from the real world, while watching "The Real World." I wouldn't even blink if all of a sudden there were only one station to look at or listen to. Channel surfing would become a thing of the past. Call it a radical point of view; I don't care. So why don't we tear down the existing transmitters from the summit area and build two new ones in the Kalepeamoa area?

Getting back to reality, we know this idea won't fly. We all know money speaks louder than logic. The project will proceed as planned, and transmitters will proliferate at an even more rapid pace. The mountain will suffer another lesion that many of us will witness every day, quickly to be forgotten with the opening jingle of the KGMB News at Six. In my life I have learned to understand progress. Building more stuff doesn't mean progress. It just means we'll have more stuff. Do we need all of this junk? One day my TV will be put to its best use as I throw it over the side of my canoe as an anchor over my best fishing spot.

Viewpoint #7

Donald W. Reeser, Superintendent Haleakalā National Park

(These comments on the Draft Environmental Assessment are a summary of those submitted on behalf of Haleakalā National Park.)

Perhaps the greatest factor protecting the unique cultural and natural resources of Haleakalā National Park is the large extent to which the park is surrounded by conservation lands. The conservation land base comprised of the park, State Forest and Natural Area Reserves and private reserves provides an effective unfragmented area for perpetuating Hawaiian ecosystems. It also buffers the serious threat of invasions of alien plants and animals. The proposed project site is on State Forest Reserve/ conservation land, and will increase the footprint of development on the summit ridgeline.

The Draft Environmental Assessment (DEA) is based on speculation in a number of areas that call into question the viability of the proposed site and raise a number of environmental concerns. Any development in the buffer of conservation lands around the park poses a potential threat of new alien invasions to park ecosystems.

A series of issues raised by the proposal follows:

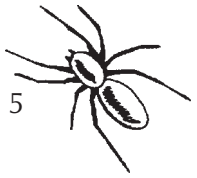
1) The need for the project is to provide broadcast service antenna facilities which will not cause unacceptable levels of radio frequency interference at Haleakalā Observatories (HO). The DEA states: "Relocation of the broadcast facilities to Kalepeamoa *should* decrease RF energy at the observatories to an acceptable level." It appears that the outcome of the preferred alternative is uncertain, yet the DEA fails to consider the Keonehunehune site as a viable alternative even though it states with certainty of the Keonehunehune site: "No special beam shaping of the transmitting antennas would be required since the terrain shielding and path loss *would* reduce signal at the observatories to levels will below the International Astronomical Union recommended limits." In contrast, the Kalepeamoa site would require special directional antenna patterns to reduce RFI at the observatories.

2) Page S-9 states, "The antenna facilities will cover less than one acre, and consequently their construction will have minimal impact on natural resources." Figure III-1 illustrates the footprint at more than four acres. Thinking more broadly, the visual impact of the proposed site will be many thousands of acres.

3) The DEA fails to consider the unique high-elevation Haleakalā aeolian environment as a sensitive area. Construction in the area of the Haleakalā Observatories Complex has degraded the fragile environment, reducing the diversity of plants and insects there. This should be considered a prediction of impacts of the proposed project.

4) The DEA makes no definite provision for moving the existing antennae towers and other structures if a new facility is built. In V-21, 5.2.1.4 the DEA notes: "It is *anticipated* that the manmade structures in the saddle facility would *eventually* be removed."

5) The proposed site is a known *ʻuaʻu* flyway. This Endangered Species is vulnerable to flying into foreign objects such as towers, fences, and buildings. The entire broadcast facility would be a "foreign object" into which the *ʻuaʻu* may fly.



Also, the DEA states in section 5.2.6.1, "There would be *no* unshielded lights to disorient birds in flight." But in S-5, the section on avifauna, the DEA states, "It is *assumed* that the Federal Aviation Administration (FAA) will not *require* lights on antenna towers." It appears that antennas on the proposed site would present an aircraft hazard. If lights are required on the antennas by the FAA, navigational and collision hazards to *ʻuaʻu* would be increased. Visual impacts would be extended to the night sky.

6) Based on previous construction projects in the summit area, we know that shipments of construction materials and equipment need to be inspected by a qualified biologist prior to shipment, as well as before access is permitted through the park. Portions of the hydraulic systems of the Air Force Advanced Electro-Optical System telescope were manufactured in killer-bee-infested areas of Texas, for example. Once on Maui, accidental alien importation could cause environmental havoc before being detected. The DEA's recommendations for monitoring access and the construction site for at least a year as are important mitigation measures, as inspections will not detect 100 percent of alien organisms. Any construction project in a Hawaiian conservation area poses potential impact to native ecosystems from alien invasions.

If this DEA were to pass public review, inspections both prior to shipping and before transit through the park would be required to attempt to mitigate threats from alien introductions. Increasing the footprint of development on the Haleakalā summit ridgeline sets a precedent for future development of public conservation lands adjacent to Haleakalā National Park. The National Park Service strongly urges that an alternative site to Kalepeamoa be selected for the facility. The potential impacts to the park are too great.

Different Views in the News

The Honolulu Advertiser
HAWAII B
Friday, November 27, 1998
City Desk: 525-8090

Adv. 11/27/98

Haleakala antennas debated

TV, astronomy among issues

By Edwin Tanji
Advertiser Maui County Bureau

HALEAKALA, Maui — The chilly, bleak summit of Haleakala just doesn't have enough room for everyone who wants to be there.

Air Force and University of Hawaii observatories track the sun, satellites, asteroids and stars. Television and radio antennas broadcast signals across the state. Hikers and tourists admire panoramic views and austere geologic features. Native Hawaiians see a spiritual center of their culture.

The competing values are turning the 10,023-foot-high summit into a battleground over what use should prevail.

An environmental assessment by the University of Hawaii's Institute for Astronomy to move the antennas just below the summit is now the focal point of the debate. It is a decision that could affect the future of astronomy and telecommunications on Maui, and could cut off television viewers in isolated areas of the state.

Since 1958, Haleakala has been home to UH and Air Force observatories measuring distances in space, observing activity on the sun and tracking satellites in Earth orbit.

Even before the observatories were built, Haleakala also was home to a cluster of broadcast antennas that send television and radio signals to homes on Maui, the Big Island and Windward Oahu.

For FM transmitters, Haleakala's summit is an ideal antenna site, capable of sending line-of-sight signals 200 miles away to Kauai. But radio waves that powerful — as much as 22,000 watts — also overpower astronomical instruments just a few hundred yards away.

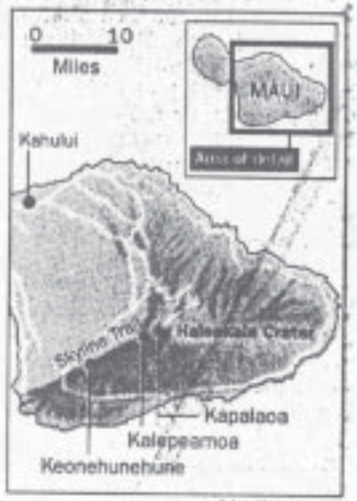
Researchers studying data on computer screens are finding television programs popping up instead, consultant Charles Fein said.

"The radio waves can overwhelm everything else," he said.

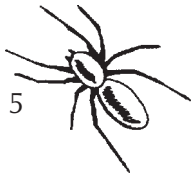
"It's like when you turn on a vacuum cleaner and your television is on. The electronic discharge from that electric motor causes interference with the television," he said.

The potential addition of antennas is an issue for UH scientists, because research has grown more sophisticated. The scientists must measure radio waves from distant stars and satellites, as well as opti-

See Antennas, Page B4



Advertiser graphic



Antennas: Plans debated for future of Haleakala summit

A 11/27/98

FROM PAGE B1

cal images.

"The real problem is that there are 80 applications for transmitters on top of Haleakala, in addition to the seven or eight that are there now," said Mike Maberry, Maui manager for the Institute for Astronomy.

Maberry said a coordinated broadcast facility is needed that could accommodate the demand for new transmitters, but would not interfere with the work of astronomers. But Kalepeamoa, a potential broadcast site at 9,400 feet identified in the environmental assessment, intrudes on a pristine natural area and has brought objections from hikers and Hawaiians.

"To me, it's just one of the most beautiful places on Maui," said Mary Evanson, a Sierra Club supporter and a founder of the Friends of Haleakala National Park.

Panoramic views

Kalepeamoa is a ridge line where the Haleakala "Skyline Trail" runs down the southwest slope, offering hikers panoramic views of the Big Island, Lanai, Molokai and Maui, with closeup looks at craters and cinder cones that illustrate Maui's geologic history.

"It's just super special," Evanson said. It would be marred by 190-foot-tall antennas clustered over a five-acre site, with fences and sheds to protect transmitters and generators, she said.

Evanson conceded that she doesn't understand the broadcast technology. But her resolve is firm.

"It's very complicated and it's very difficult for us to understand. All I know is that Kalepeamoa is much too precious. We cannot let anyone develop it," she said.

'Spirituality of Haleakala'

Charles Maxwell, the Pukalani Hawaiian cultural specialist, said he would prefer the antennas stay where they are, and the Institute for Astronomy forego further development at the summit.

"Every building, every structure they put up there, to me, is ruining the spirituality of Haleakala from what it was 1,000 years ago," Maxwell said.

He said he has seen evidence of traditional burials around the summit, probably of high-ranking ali'i. Volcanic formations are seen as indicators of the presence of the Hawaiian goddess Pele, who legend says made her home on Haleakala before moving to Kilauea on the Big island.

There are remains of an ancient heiau on the ridge above Kapalaoa that Maxwell said is associated with the demigod Maui, who is said by legend to have forced the sun to slow down by netting it from Haleakala.

Moving the antennas to Kalepeamoa would intrude on yet another sacred area, while allowing the Institute for Astronomy to plan more observatories on the summit, he said. He said he doesn't oppose the antennas, just the proposed site.

Evanson said she would support moving the antennas to a site at Keonehunehune, at 4,400 feet of elevation. An antenna farm for radio transmitters already has been located there.

But television engineers said the lower site would cut off a large number of television viewers. From Kalepeamoa, television and radio transmissions can reach half of the Big Island, central Maui to Huelo and Windward Oahu from Makapuu to Laie. From Keonehunehune, the signal would be cut off to parts of Kona, would reach only to Pauwela on Maui and would be lost to all but Makapuu on Oahu.

Dave Moore, director of engineering for KHON-TV, said any site below 8,000 feet "doesn't work." Television signals are sent from Honolulu to Haleakala to be rebroadcast back to the areas blocked from the Honolulu transmitters, he said.

Matter of cost

At lower elevations, he said, the West Maui mountains would block the signal from Honolulu. Stations would have to install additional transmitters at an extra cost that might not be justified for a relatively small part of a station's audience, he said.

Keith Aotaki, director of engineering for KHNL-TV, said the Haleakala antennas also relay their television signal to the Big Island to transmitters that cover East Hawaii. Moving the Haleakala antenna to a lower elevation could mean moving transmitters on the Big Island, which could prove too costly, he said.

But not moving the antennas would affect Haleakala's role in scientific research. UH officials say without the interference from broadcast antennas, the Haleakala summit could attract three to five new scientific facilities over the next 20 years.

Economic benefit

New observatories would put millions of dollars in construction spending into Maui's economy, while operating expenditures would run at $1 million to $5 million a year.

None of it can happen until a decision is made on the antennas, Maberry said. He said the Institute for Astronomy committed itself to preparing a master plan for its 18-acre "Science City" parcel at the summit.

But the institute cannot prepare a master plan until it knows what is possible, he said. If the antennas stay in place, they will affect the plans, he said.

"It will determine what type of equipment we may be able to put up there. With some facilities, we still will be able to do certain types of science," Maberry said.

The final environmental assessment found no significant impact for an antenna facility at Kalepeamoa.

But the public has until Monday to comment on the finding and on whether a full environmental impact statement should be prepared.

Questions About the Viewpoints

1) Which viewpoint were you assigned to read?

2) Do you think the person whose viewpoint you read would be in favor of:

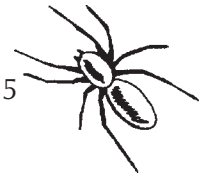
- moving the transmitters to Kalepeamoa?
- moving the transmitters somewhere, but not to Kalepeamoa?
- not moving the transmitters at all?
- studying the alternative further?
- another course of action? (If so, what?)
- allowing other types of development in the summit area? (For example, in the past there have been proposals to build a tram to take visitors up the mountain to the summit. Do you think this person would support this kind of proposal?)

3) What are the person's main arguments for their position?

4) Look at the following list of value systems. Which of these systems do you think are the most influential to this person's point of view? (There may be more than one.) Explain your answer.

Aesthetic	focus on appreciation of intrinsic and subjective qualities, such as the beauty of an area
Cultural	related to maintaining the practices and attitudes of a culture
Ecological	concerned with living things and the function of ecological systems
Economic	related to the exchange of goods and services
Educational	concerned with benefits derived from learning
Egocentric	focus on self-satisfaction and personal fulfillment
Legal	concerned with the law and its enforcement or application
Recreational	related to the use of leisure time

From ʻŌʻhia Project, Grades 7-8, *Bernice Pauahi Bishop Museum and Moanalua Gardens Foundation, Honolulu, 1992, p. 284. Adapted from Ramsey, J.M., H.R. Hungerford, and T. Volk, "A Technique for Analyzing Environmental Issues,"* The Journal of Environmental Education, *Vol. 21 No. 1, 1989.*



Bonus Activity

What Goes On at the Observatories?

● ● ● In Advance *Student Internet Research Assignment*

- Assign Student Page "Surf the Net to Research the Haleakalā Observatories" (pp. 36-38) and Student Page "Research Instructions and Questions" (pp. 39-40) as homework.

● ● ● Class Period One *Learning From Each Other's Research*

Instructions

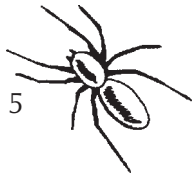
1) Ask one student to give a brief report on his or her research, then invite other students who researched the same facility to add details. Continue until you have covered all of the facilities. If there is time left at the end of class, begin a class discussion using the journal ideas listed below.

Journal Ideas

- Does knowing more about the research and work that is performed at the Haleakalā Observatories change your opinion about the proposal to relocate the broadcast facility to another location where radio frequency interference will not be a problem? Explain your response.
- Think of other ways that people might have understood or explained the phenomena being studied at the Haleakalā Observatories without the benefit of scientific inquiry and the instrumentation housed in the observatories. Describe one or more of these different ways of understanding the world.
- Describe at least one way in which you think the work being done at the Haleakalā Observatories will (or does) benefit people.

Assessment Tools

- Student Page "Research Instructions and Questions"
- Participation in class discussion
- Journal entries



Surf the Net to Research the Haleakalā Observatories

You've heard of "Science City," haven't you? It's the collection of observatories and other research facilities that sit clustered together near the summit of Haleakalā. Many people call it "Science City," but the scientists who work there prefer to use another name: "Haleakalā Observatories." This more official and respectable name is also an accurate reflection of what goes on in this group of white and metallic domes and a scattering of other buildings.

"What DOES happen up there?" you might ask. You are going to find out by doing your own research on the Internet. Most of the research facilities have excellent websites that can help you learn about what goes on behind the sign that says, "Authorized Access Only."

The Haleakalā High Altitude Observatory Site is—you guessed it—home of the Haleakalā Observatories. It is just downhill from the *Puʻuʻulaʻula* (Red Hill) Overlook near the mountain's summit. The 18-acre site was given to the University of Hawaiʻi by the State in 1961. This land must be used for observatory purposes only or it must be given back to the State.

Since 1961, several facilities have been built on this site to study and track all kinds of things having to do with the sun and moon, the earth's atmosphere, satellites, and other objects traveling through space.

Your Assignment

From the following listing of the observatories on Haleakalā, you will select one or more to research on the Internet. In addition to the observatories listed, there are other facilities proposed or being built at Haleakalā Observatories, some of which are mentioned on the Haleakalā Observatories website at <www.ifa.hawaii.edu/haleakala>. (These include the Faulkes telescope, Solar C telescope, and MAGNUM project.) As progress continues toward making these facilities operational, there is likely to be more information available about them on line and they could make interesting Internet research projects as well.

Other Internet Resources

- Personal web pages of researchers. Some of the observatory websites have links to researchers' web pages that describe the research they are doing.

- Glossary of terms related to the sun and solar research at <solar-center.stanford.edu/gloss.html> or <www.hao.ucar.edu/public/education/glossary.html>.

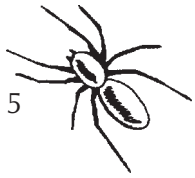
- "Ask a Solar Physicist," where students can direct solar questions to the staff of the Stanford University Solar Center, <solar-center.stanford.edu/ask-solar/asksolar.html>.

- Educational materials on solar physics, National Solar Observatory, <www.sunspot.noao.edu/>.

- Government departments that collect and archive data from heliopsheric projects. Each has a website: National Space Science Data Center (NSSDC), National Oceanic and Atmospheric Administration (NOAA), and World Data Center (WDC).

Facility name and website	Brief description of research	Related websites	Keywords for searches
Air Force Maui Space Surveillance Complex (MSSC) at <ulua.mhpcc.af.mil>	Space surveillance activities are conducted here for the U.S. Department of Defense.	Air Force Research Laboratory home page, which provides more information about the Maui Space Surveillance Complex at <ulua.mhpcc.af.mil/amos.html> Overview of space surveillance at <www.spacecom.af.mil/usspace/space.htm>	-Adaptive optics -Air turbulence -Space surveillance
Cosmic Ray Neutron Monitor Station at <ulysses.uchicago.edu/NeutronMonitor/neutron_mon.html>	A neutron monitor detects incoming energy from cosmic rays emanating from sources including solar flares.	"Listening for Cosmic Rays," an overview of cosmic rays, their significance, and how they are detected at <www.bartol.udel.edu/~neutronm/listen/main.html> Overview of cosmic rays and how they are monitored at <www.ngdc.noaa.gov/stp/SOLAR/COSMIC_RAYS/cosmic.html> Neutron monitor information, links, and general solar weather information, Solar-Terrestrial Division of the Izmiran Institute (Russia) at <helios.izmiran.rssi.ru/cosray/main.htm>	About the kinds of observations done at the monitor station: -Cosmic rays -Particle astrophysics -Air showers -Space weather Why scientists measure cosmic rays: -Stellar nucleosynthesis -Diffuse gamma-ray emission -Anti-particles Techniques for studying cosmic rays from the ground: -Neutron monitors -CASA/MIA -Fly's eye Spacecraft with instruments that measure cosmic ray intensity and related conditions in space. Each has a website: -Ulysses -Voyager -ACE -IMP-8 -SMAPEX -WIND -POLAR -GEOTAIL

Facility name and website	Brief description of research	Related websites	Keywords for searches
Lunar and Satellite Ranging (LURE) Observatory at <koa.ifa.hawaii.edu/Lure/>	Laser equipment is used to track the distance between the earth and the moon and to track satellites.	A brief history of laser (lunar) ranging at <almagest.as.utexas.edu/~rlr/history.html> An introduction to lunar laser ranging at <wwwrc.obs-azur.fr/cerga/laser/laslune/englishintro.htm> Article on lunar laser ranging written to commemorate the 30th anniversary of the Apollo 11 mission at <www.xs4all.nl/~carlkop/ap11.html>	-Satellite laser ranging -Lunar laser ranging
Mees Solar Observatory at <koa.ifa.hawaii.edu> and <www.ifa.hawaii.edu/research>	Optical instrumentation housed here is used to observe the sun. Research topics include solar flares, magnetic fields on the sun, and solar oscillations.	*A Primer on the Space Environment*, with basic information about solar phenomena and their relationship to earth at <sec.noaa.gov/primer/primer.html> SpaceWeather.com, a Nasa site with daily updates of sunspots, solar flares, near Earth asteroids, aurora, meteor showers; streaming video, text, at <http://spaceweather.com/> *Space Weather Today*, with information about the earth/sun relationship and how solar phenomena affect earth at <windows.engin.umich.edu/spaceweather/> Overview of "helioseismology," the study of wave oscillations in the sun at <soi.stanford.edu/results/heliowhat.html> or <helios.tuc.noao.edu/helioseismology.html>	-Solar flares -Solar oscillations (or low frequency solar oscillations) -Solar cycle -Solar physics -Helioseismology -Precision solar photometry (or PSPT)



Research Instructions and Questions

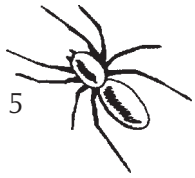
Student Instructions

- Choose an observatory to research from the list on the "Haleakalā Observatories" background sheet.
- Based on your research, write your answers to the following questions.

Questions

1) What is the name of the observatory? What organization or company runs it? How long has it existed?

2. What is the purpose of the facility? If there is more than one type of research or work that happens there, describe each one.



3. Pick one kind of research or work that happens at this observatory. What do scientists hope to learn? How do they apply, or hope to apply, what they learn?

4. List one interesting fact that you learned about this observatory or the research that is done there.

5. List two questions you have about this research.

Draft Environmental Assessment

Make this document available in your classroom or put it on reserve in the library.