Activity #3

Design a Monitoring Study

● ● ● In Advance *Student Assignment*

- As homework, assign the Student Page "Design Your Own Monitoring Study" (pp. 48-52). You may want to give students several days to complete this assignment, allowing students ample time to complete their study designs. If you want students to research and footnote any parts of their design proposals (such as the project background), let them know this in advance.

● ● ● Class Period One *Discussing Study Designs*

Materials & Setup

For each student

- Student Page "Design Your Own Monitoring Study" (pp. 48-52)

Instructions

1) Divide the class into four or five small groups. Have students describe their study designs to other students in their group. Each group should select the best study design from the ones presented.

2) Bring the whole class back together and have the students whose study designs were selected by the groups present them to the whole class. Lead a discussion about the similarities and differences in the designs and how this kind of monitoring information could affect how natural areas are managed.

3) Have the class vote on the best study design of those selected by the groups. The class will present that study design to the Department of Land and Natural Resources (DLNR) on Maui. Select a small committee of students to write a cover letter describing what the class has learned during this unit and offering the study design as a suggested way for DLNR to monitor ʻĀhihi-Kīnaʻu Natural Area Reserve.

Journal Ideas

- Describe one point of similarity and one point of difference between your study design and the one Brian Tissot and Leon Hallacher did on the Big Island.
- How important do you think scientific research should be to government policy makers deciding how to protect Hawaiian marine areas and marine life? What else should they consider in making these decisions?

Assessment Tools

- Design for monitoring study: Evaluate these on the basis of completeness using the list of elements in the Student Page "Design Your Own Monitoring Study," scientific rigor, logic, and clarity of presentation.
- Journal entries

Design Your Own Monitoring Study

Natural Area Reserves (NARs) are among the most highly protected lands managed by the State of Hawai‘i. They protect the best of what is left of the unique biological and geological resources of Hawai‘i. The ‘Āhihi-Kīna‘u Natural Area Reserve is situated near the end of the road at Mākena on Maui, and is the only reserve in the Department of Land and Natural Resources (DLNR) system that includes a marine section as well as a land section. It is one of only two areas on Maui where fishing is restricted.

Within the reserve are the only three miles (4.8 kilometers) out of 120 total miles (193 kilometers) of Maui coastline that are totally protected, where no type of fishing, collecting of any marine life, or motorized vessel is allowed.

‘Āhihi-Kīna‘u Natural Area Reserve is an example of what is often called a “marine protected area” or MPA. MPAs are parts of the ocean that have legal restrictions on fishing, collecting, and other human activities that directly affect populations of fish and other marine life. There are many ways to manage marine protected areas. Some are closed to fishing or collecting altogether. Others have restrictions about the kind of gear that can be used. Still others limit fishing to certain species.

The basic ideas behind MPAs are that:

- MPAs may provide a refuge for fish, a protected area where they can exist in natural abundance without direct pressure from humans collecting or fishing for them.
- MPAs may provide a “source” area for fish and other marine life. Population levels may be higher inside MPAs than outside them. MPA supporters believe that populations in fishing grounds and other areas outside the MPAs will grow as larvae and fish “spill over” from the MPA.
- MPAs provide places to study recovery from prior fishing and/or collecting pressure.
- MPAs, like wilderness areas, may provide places to study intact natural communities, relatively undisturbed by human activities.

How Well Protected is ‘Āhihi-Kīna‘u?

The reserve is designed to be a marine protected area. The following activities are prohibited by law in the reserve:

a) To remove, injure, or kill any form of plant or animal,
b) To introduce any form of plant or animal life, or
c) To operate, anchor, or moor any motorized vessel.

However, reality is different than the law envisions. Although fishing and motorized vessels are prohibited in the reserve, illegal fishing still happens. The area is flanked on one side by La Pérouse Bay, where fishing is allowed, but the reserve is a prime spot for poachers anyway, many of whom enter the reserve in motorized vessels.

So, for researchers and natural resource managers, it is difficult to know just how well ‘Āhihi-Kīna‘u is working as a marine protected area. It is a challenge to interpret the results of monitoring and observations such as the following:

Image: Maui Recreation Map*, State of Hawai'i*

1) According to 1998 surveys, populations of some reef fish in the reserve have declined in variety and abundance, in comparison to surveys done in 1972, many years before the reserve was formed, and

2) '*Opihi* (limpets) are scarce along much of the coastline.

It is difficult to trace the causes of problems such as these because, although 'Āhihi-Kīna'u is supposed to be a protected area, people and illegal activities could be contributing. And that kind of illegal activity is not easy to monitor, especially along the reserve's rugged and remote lava coastline.

What's Really Going On Here?

Imagine that you are a scientist—perhaps Leon Hallacher or Brian Tissot—and the Department of Land and Natural Resources has asked you to help them monitor populations of fish in the reserve and determine the cause of the decrease in abundance of many fish species between a 1972 fish survey and one performed in 1998.

Some scientists believe that the decline in fish abundance and variety in the reserve is linked to the destruction of much of the finger coral habitat in powerful storms such as Hurricane 'Iniki (1992) and Iwa (1982). Others believe that illegal fishing has played an important role in decreasing fish abundance in the area.

Your job is to design a study to provide more information about:

1) Why the changes in abundance of many fish species has happened, and
2) Whether fish diversity and abundance seem to be recovering or declining since 1998.

As background, read the article from the DLNR-Division of Aquatic Resources newsletter, *Current Line* (April 1999) that follows. Then design a study that will provide information about the two goals listed above. As you design your study, don't forget you have access to a pool of willing and able university students who would love the chance to be part of this project. As in the Tissot and Hallacher study, they can help you collect data in the field.

Assignment

Write a study proposal including these seven elements:

1) **Title**

2) **Name of investigator(s)**

3) **Brief project background**

4) **Purpose and objectives**
   Questions to ask yourself:
   - Why are you doing this study?
   - What do you plan to accomplish?

5) **Hypothesis (or hypotheses)**
   - What results do you anticipate?
   - What do you think caused changes in fish abundance?

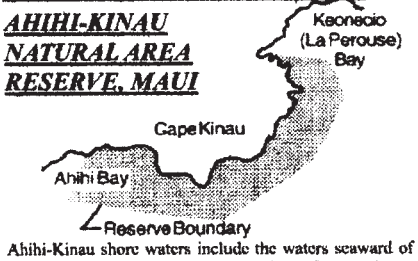
6) **Approach and methods**
   Questions to ask yourself:
   - What is your basic experimental design?
   - What kinds of areas do you want to study? (The Tissot/Hallacher study, for example, looked at "impact" areas and "control" areas, and defined what was meant by those terms and why they were included in the study.)
   - How long should the study be?
   - What is the geographic scope of the study?
   - Will you look at particular species of fish or other marine life? Will you look at adults, juveniles, and/or larvae? Why?
   - What assumptions are made in your research design? Do you need to add or do anything differently to gather evidence about the validity of these assumptions?

7) **Dissemination of findings**
   Questions to ask yourself:
   - Who should receive the information generated by this study? Why?
   - In what form should this information be disseminated?

From Hawai'i Division of Aquatic Resources, "Current Line" newsletter, April 1999.

INSHORE PROJECTS

AHIHI-KINAU NATURAL AREA RESERVE, MAUI



Ahihi-Kinau shore waters include the waters seaward of Cape Kinau a distance of 2000 to 3000 feet as shown above

The Ahihi-Kinau Natural Area Reserve (NAR), set on the last historic lava flow on Maui, was established in 1973. Ahihi-Kinau contains five natural communites including anchialine pools with a high diversity of rare Hawaiian shrimps (i.e. 'Ōpae'ula), a unique coastal lava tube community that provides habitat for native Hawaiian cave animals, and 900 acres of nearshore waters off Cape Kinau. NARs are different from Marine Life Conservation Districts (MLCDs) in that these areas are prime examples of relatively unmodified/unaltered native ecosystems which are set aside to protect "the best of what's left" of Hawaii's unique native environments. Therefore, fishing or taking of marine life is NOT ALLOWED.

Surveys done in 1972 by the Division of Fish and Game (now known as Division of Aquatic Resources) staff revealed dense growths of finger corals (Porites compressa) at 4 out of 6 survey sites along with a good diversity of fish species. In 1998 (26 years later), these same areas were again surveyed with some notable results. Fish populations in the remonitored areas appear to have decreased from 1364 fish per acre in 1972 to 962 fish per acre in 1998. The following tables give some examples on the differences between the numbers of specific fish seen in 1972 and 1998 at Ahihi-Kinau:

Fish that have increased or barely changed (<5%) in numbers per acre

Fish	*1972 Survey Numbers*	*1998 Survey Numbers*	*Diet*
C. strigosus (kole)	185	177	algae
C. vanderbilti (black-fin damsel)	72	98	zooplankton, copepods
A. nigofuscus (lavendar tang)	18	180	filamentous algae
P. multifasciatus (moana)	29	60	small crabs, fish, shrimp

Fish that have decreased (6% to 900%)) in numbers per acre

Fish	*1972 Survey Numbers*	*1998 Survey Numbers*	*Diet*
C. ovalis (blue damsel)	100	6	wide variety (shrimps, crustacean larvae, worms, fish eggs, etc.)
M. flavolineatus (white weke)	92	10	wide variety
A. abdominalis (mamo)	91	22	algae, zooplankton, crustaceans
D. albisella (aloiloi)	67	10	wide variety
M. vanicolensis (red weke)	67	22	echinoderms, worms, crustaceans
C. hanui (chocolate dip damsel)	64	24	"
T. duperrey (saddleback wrasse)	64	48	echinoderms, worms, crustaceans
Z. flavescens (yellow tang)	57	38	algae

As you can see, most of the fish appear to have decreased in numbers from 1972. DAR staff conducting the re-monitor surveys in 1998 did not observe the dense growths of finger corals as it was noted on 4 out of the 6 original survey sites in 1972. Instead of lush coral beds, the habitat in these areas now consist mostly of coral rubble. Since finger corals are very fragile, it is speculated that powerful storms like Hurricane Iniki (1992) and Hurricane Iwa (1982) caused the destruction of these vast coral beds within the last 26 years. The apparent loss of this finger coral habitat may explain the observed changes in fish populations.

Since the habitat now consists of coral rubble, this provides a lot of surface area for fine algal growth and other organic matter, which is an excellent food source for fishes such as the kole and lavendar tang. As a result, you can see from the previous tables that the numbers for these fish have either increased or remained relatively stable. This kind of coral rubble habitat may not have a wide variety of the larger invertebrates, but animals such as small shrimp, crabs, copepods, and other zooplankton can thrive providing a food source for fish like the black-fin damsel and moana, whose numbers have also increased. Most of the other fish whose numbers have decreased require a wider variety in diet than what can be found in coral rubble habitat. These fish probably moved into areas that are able to provide the right kind of diet for them, such as areas with richer coral growth. In addition to food, the more branching type corals provide shelter for juvenile fishes such as the yellow tang and aloiloi.

The mystery of Mother Nature is in Her continuing evolutionary ways, finding balance for all of Earth's natural resources. We can only monitor and observe these forever changing situations, as in the case of Ahihi-Kinau NAR. However, all is not lost in Ahihi-Kinau as wherever Mother Nature takes away, She always provides for someplace else. Additional surveys in 1998 along the shoreline of Ahihi-Kinau NAR revealed fish populations in quantities and diversity similar to many of the State's Marine Life Conservation Districts (MLCDs):

Comparison of Fish Counts in Ahihi-Kinau (inshore) to Other MLCDs in Terms of Numbers per Acre and Species Diversity

MLCD Location	*Date of Survey*	*Number of Fish per Acre*	*Number of Species Seen*
Honolua Bay, Maui	10/97	3764	76
Hanauma Bay, Oahu	5/97	3257	67
Ahihi-Kinau (inshore), Maui	**2/98**	**2839**	**83**
Manele-Hulopoe, Lanai	10/97	2686	86
Molokini Shoals, Maui	10/97	2034	92

Top Ten Most Abundant Species Observed Along Shoreline Surveys of the Ahihi-Kinau NAR in 1998

Rank	*Fish Species*	*Number of Fish Per Acre*
1	C. strigosus (kole)	684
2	A. nigrofuscus (lavendar tang)	478
3	Z. flavescens (yellow tang)	282
4	C. vanderbilti (blackfin damsel)	194
5	A. achilles (achilles tang)	185
6	M. niger (humu ele ele)	121
7	T. duperrey (saddle-back wrasse)	41
8	Family Scaridae (Uhu)	34
9	N. lituratus (clown tang)	30
10	A. sordidus (kupipi)	25

Although the resources are not what they were once described in the remonitored areas in Ahihi-Kinau, the shoreline fishery resources appear to have "weathered the storm". This is excellent news which means that areas like Ahihi-Kinau NAR can serve to provide the fishery stocks needed to spawn and restock other nearby areas.

Since fishing is not allowed within the boundaries of the Ahihi-Kinau NAR, you can clearly see that overfishing is not always the only factor that can contribute to declines in fish populations. Changes in habitat, such as those caused by natural disasters like hurricanes or man-made influences such as non-point source pollution and urban runoff, can also change the habitat causing fish populations to fluctuate. In the case of natural disasters, Mother Nature can always take care of Herself. The rest of us have to do our part to conserve and take care of our ocean resources by taking only what we need and limiting what we put into our ocean environment. You never know what may cause a fish or any other marine animal species to decline or increase.