Change Over Time

E uhi ana ka wā i hala i na mea i hala.

Passing time obscures the past.
— Mary Kawena Pukui, *ʻŌlelo Noʻeau* 379

Change Over Time

Teacher's Introduction

When changes occur gradually over time it is difficult to conjure up the past and realize what has been lost. If we follow the path of the honu (Hawaiian green sea turtles) from the main Hawaiian Islands to French Frigate Shoals where most honu nest, we find a window to the past. In and around the clear waters where the honu feeds, the "kūpuna" islands reveal to us what a healthy coral reef and terrestrial ecosystem look like. By studying the ecosystem's complexity and abundance, and marveling at its beauty, we see what once was, and what we can work towards in restoring balance to the ecosystems of the main Hawaiian Islands. This unit is designed to help students peer through that window to the past and lay a foundation for positive change.

Monitoring and Protection

Most of the NWHI have undergone state or federally administered protection and management for more than 90 years. During the past 30 years, biologists have lived in remote camps or out of old abandoned government structures while surveying terrestrial life and measuring the health of the wildlife populations, including counting and banding thousands of land and seabirds. Their cumulative work is considered to be the longest standing sequential tropical seabird monitoring data available in the world today.

Green sea turtle monitoring at French Frigate Shoals, which began more than 30 years ago, provided the impetus for protection of this threatened species whose declining population was cause for serious alarm. Today, green sea turtles are protected as they forage and attempt to nest in the main Hawaiian Islands.

Hawaiian monk seal tagging, tracking and monitoring work has been on-going for many years as biologists and researchers try to stop the seal's critical population decline. The monk seal population is in a decline that has lasted 20 years and researchers predict the population will fall below 1,000 by 2013 (National Marine Fisheries Service 2007).

On a more positive note, since 1970 there has been much progress in island restoration; rats have been completely eliminated from the NWHI and entire invasive and aggressive plant species have been replaced with native plants. In 2003, Laysan ducks were translocated from Laysan Island to Midway Atoll National Wildlife Refuge where thy are thriving and reproducing near freshwater seeps in record numbers.

Research Expeditions

In early 2000, before the NWHI became a Marine National Monument, an expedition to the Northwestern Hawaiian Islands was launched to map and assess the terrestrial environment and the shallow reefs

of the islands for their biodiversity, status, and management needs. This expedition was a collaborative effort of 50 scientists participating in the Northwestern Hawaiian Islands Reef Assessment and Monitoring Program (NOWRAMP). The scientists studied emergent land habitats and participated in more than 1,000 dives to learn about the coral reefs of the NWHI. They collected hundreds of specimens, took photographs, recorded video, and concluded that the islands were much more pristine and diverse than anticipated.

Following are some general conclusions from the Executive Summary of the project:

- Jacks, sharks, and other top predators dominate fish populations; a situation not now encountered in any other large-scale coral reef ecosystem.
- Stony coral colonies are abundant, diverse, and often large (and likely very old in many areas), with total species variety exceeding that of the main Hawaiian Islands.
- One-fourth of the reef animals and plant species reported are unique to Hawai‘i with many new species of sponges, algae and coral discovered during the three expedition cruises.
- Marine debris continues to degrade reef habitat at many NOWRAMP sites, injuring and killing corals and other wildlife.
- Marine alien species do not appear to be a severe problem and are common only at Midway.
- Reef habitats are diverse, with some unique types not present in the main islands.
- Large pods of spinner dolphins are regular residents in several atoll lagoons, corroborating decades of similar observations by others.

Since 2000, many more research expeditions have been conducted to do a biological survey of the general health of the islands and to continue surveying this vast marine wilderness. Through the information gathered in these expeditions scientists are trying to determine a baseline for the region as a whole. This baseline will be used to evaluate the current health of the area and it will serve as a reference point to measure any changes in the region’s ecosystems over time. The baseline will also help to prioritize any management or restoration efforts that the region may need. In addition to this survey, monitoring stations are being set up throughout the shallow waters of the region so that accurate measures of changes in specific areas can be recorded. The information collected at these sample sites will be used to determine the health of the shallow water areas across the region. It can also be very useful in determining the extent of coral bleaching events, or the accumulation of marine debris.

The Northwestern Hawaiian Islands and the reefs that surround them provide us with a chance to see what ecosystems throughout the main Hawaiian Islands may have looked like before the arrival of human beings more than 1,500 years ago. Very diverse and numerous unique species of endangered plants, land birds, seabirds, insects, corals, marine invertebrates, algae and sea grasses, fishes, sea turtles, and marine mammals all make the NWHI their homes. Today, this vast marine world is afforded protection due to the newly designated Papahānaumokuākea Marine National Monument.

“With coral reefs around the world in decline, it is extremely rare to be able to examine a coral reef ecosystem that is relatively free of human influence. Because of their relative isolation, the shallow reefs of the Northwestern Hawaiian Islands represent a large no-take zone, providing us with a unique opportunity to assess how `natural’ coral reef ecosystems function in the absence of major human intervention.”

— Alan Friedlander, fisheries ecologist, Oceanic Institute and NOWRAMP expedition team member

Reference

National Marine Fisheries Service. (August, 2007). *Recovery Plan for the Hawaiian Monk Seal*. National Oceanic and Atmospheric Administration.

Change Over Time

Grades 4 - 5 Unit Map

Unit Essential Question: What do the "kūpuna" islands teach us about changes to our coral reefs and coastal areas over time?

Hawai'i DOE Standards, GLOs, & Nā Honua Mauli Ola	Focus Questions & Activities	Key Concepts	DOE Benchmarks
Science 1: The Scientific Process Scientific Inquiry **Language Arts 6: Oral Communication: Conventions and Skills** Discussion and Presentation	How are the land and marine life of the "kūpuna" islands (NWHI) different from those of the main Hawaiian Islands (MHI)? **ACTIVITY 1** **Learning from the "Kūpuna" Islands**	There are many differences between the "kūpuna" islands (NWHI) and the MHI. • Most of the NWHI land is submerged so there is not much dry land. • Thousands more seabirds nest in the NWHI than in the MHI. • Almost all the green sea turtles in the Hawaiian archipelago nest in the NWHI and they are home to almost all Hawaiian monk seals. There are many differences between the ocean life and coral reefs of the NWHI and the MHI. • There are more apex predators like sharks and ulua in the NWHI. • Corals are found in greater health, variety, and number in the NWHI. • Many species of corals, fish, and other sea animals that are abundant in the NWHI are rare in the MHI.	**SC.4.1.1** Describe a testable hypothesis and an experimental procedure. **SC.5.1.2** Formulate and defend conclusions based on evidence. **LA.4.6.1** Participate in grade-appropriate oral group activities. **LA.5.6.1** Use speaking and listening skills to fill a prescribed role in group activities.
Social Studies 7: Geography: World in Spatial Terms Environment and Society **Social Studies 1: Historical Understanding**: Change, Continuity, and Causality – Chronological Thinking **Math 9: Patterns and Functional Relationships** Functions	How have the coral reefs and coastal areas in our community changed over time? **ACTIVITY 2** **Looking Back**	• The coral reefs of the NWHI provide a baseline to see how reefs in the MHI have changed due to human activities. • Interviewing elder fishers and other resource people in the community is one way to learn about how the coral reefs and coastal offshore islands have changed over time. • The small islands of the Monument give us an opportunity to see predator-free habitats where native plants and seabirds thrive and turtles and seals make an every day appearance.	**SS.4.7.3** Analyze the consequences of human modification of the physical environment in Hawai'i using geographic representations. **SS.5.1.1** Use chronological order to explain causal relationships between and among people and events. **MA.4.9.2** Represent the relationship between quantities in a variety of forms. **MA.5.9.2** Describe situations in which the relationship between two quantities vary directly or inversely.

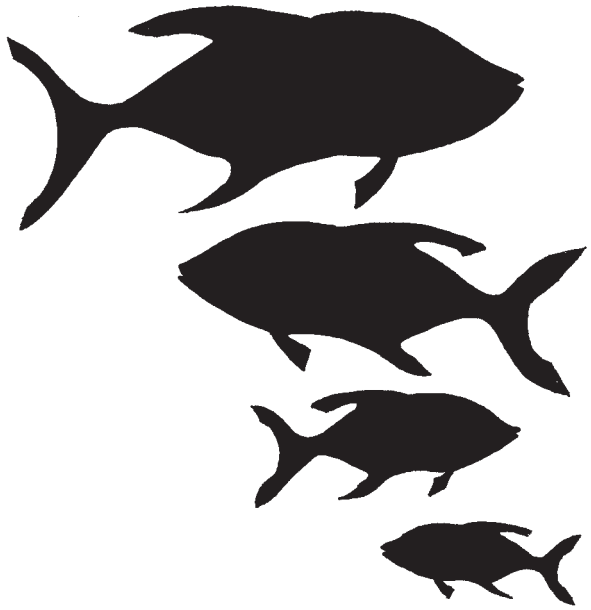
Change Over Time

Grades 4 - 5 Unit Map

Hawai'i DOE Standards, GLOs, & Nā Honua Mauli Ola	Focus Questions & Activities	Key Concepts	DOE Benchmarks
Nā Honua Mauli Ola 8 - 12 Pursue opportunities to observe and listen to expert resources within the community. GLO 5: Effective Communicator			
Math 10: Patterns, Functions, and Algebra: Symbolic Representation – Numeric and Algebraic Representations **Science 2: The Scientific Process**: Nature of Science - Unifying Concepts and Themes **Nā Honua Mauli Ola 8 - 4 & 5 - 1** Apply the cultural and traditional knowledge of the past to the present. Develop a sustainable food production system. GLO 2: Community Contributor GLO 5: Effective Communicator	How can we apply traditional Hawaiian practices to our management of fish populations today? **ACTIVITY 3** **Aunty Ulua**	• The Hawaiian kapu (taboo) system prevented fishing during the spawning period, which allowed the fish population to be replenished. • It is important to leave larger, older female fish in the ocean since they make many more eggs than smaller fish. • When fishing, we should observe fishing rules and regulations that are designed to ensure that there will be enough fish for the future.	**MA.4.10.1** Use symbols to represent unknown quantities in open sentences and determine the unknown quantities. **MA.5.10.2** Model problem situations with objects or manipulatives and use representations (e.g., graphs, tables, equations) to draw conclusions. **SC.4.2.1** Describe how the use of technology has influenced the economy, demography, and environment of Hawai'i. **SC.5.2.1** Use models and/or simulations to represent and investigate features of objects, events, and processes in the real world.

Student Journal

Unit 3 – Change Over Time



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Student's Name: _____

School: _____

Date started: _____

Date ended: _____

Student Assessment Overview

Unit 3 Essential Question: What do the "kūpuna" islands teach us about changes to our coral reefs and coastal areas over time?

Nā Honua Mauli Ola (Hawaiian Guidelines) in this unit
- Apply the cultural and traditional knowledge of the past to the present.
- Pursue opportunities to observe and listen to expert resources within the community.
- Develop a sustainable food production system.

General Learner Outcomes (GLOs) in this unit
- GLO 2: Cooperate with and help and encourage others in group situations.
- GLO 5: Listen to, interpret, and use information effectively

How you will be graded for this unit:

Individual Journal

It is your kuleana (responsibility) to complete a journal for this unit. Following is a checklist of the pages you will need to complete for your journal. Place this page in your journal and make a check next to each item when your complete it. You will be given more details during each lesson.

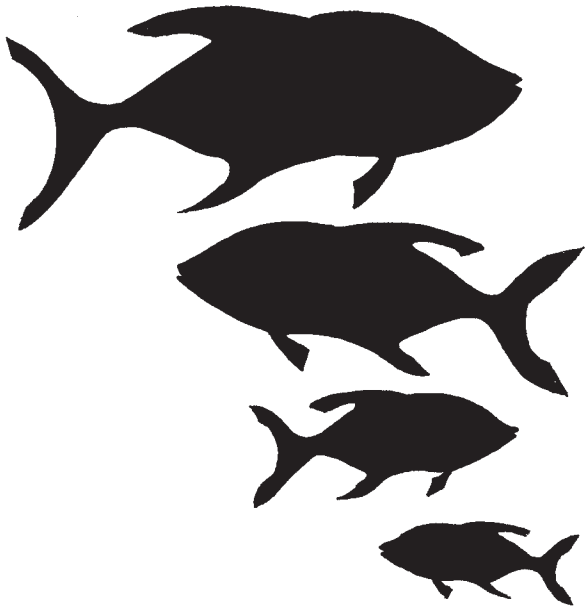
Standards and Journal Pages	✓ Completed
1. Learning from the "Kūpuna" Islands – Standards: Science 1 and Language Arts 6 **Journal 12:** New discoveries - vocabulary and expedition preparation **Journal 13**: Expedition team conclusions **Journal 14**: Summary of expedition team findings **Journal 15**: Venn diagram	
2. Looking Back – Standards: Gr. 4 Social Studies 7; Gr. 5 Social Studies 1; Gr. 4 - 5 Math 9 **Journal 16**: Circle graphs **Journal 17**: Interviews about reef changes	
3. Aunty Ulua – Standards: Gr. 4 - 5 Math 10 and Science 2 **Journal 18**: Learning from the past	

Unit Culminating Activity – Due Date:_____

Your challenge: Work in teams to present what you have learned about your coral reef to other classes in your school. You may use stories, songs, computer images, posters, photographs, models, or other methods. Your presentations should answer the unit essential question and include the following:

- Evidence that the reef has changed over time, including conclusions about how the reef compares to reefs in the NWHI
- Conclusions about how human activities such as new fishing technology, overfishing, pollution, the introduction of alien species, or development have affected the coral reef and coastal areas
- Diagrams or sketches to summarize changes to the reef
- What you have learned from kūpuna or others about how the reef has changed
- What people can do to mālama (care for) the reef and use more sustainable fishing practices

We will review a rubric to guide you as you develop your presentation.



Unit 3 Culminating Activity Rubric - Grade 4

Team Names_____ **Date** _____ **Total Points** _____

Unit Essential Question: What do the "kūpuna" islands teach us about changes to our coral reefs and coastal areas over time?

DOE Benchmarks, GLOs, & Nā Honua Mauli Ola	Kūlia (Exceeds Standard)	Mākaukau (Meets Standard)	ʻAno Mākaukau (Almost at Standard)	Mākaukau ʻOle (Below Standard)
Social Studies 7: Geography Environment and Society Analyze the consequences of human modification of the physical environment in Hawaiʻi using geographic representations. **Points**___	Your presentation evaluated the ways that people have changed the environment and affected the coral reef. Your conclusions were relevant and insightful. Excellent use of diagrams or sketches to share information.	Your presentation analyzed the ways that people have changed the environment and affected the coral reef. Good use of diagrams or sketches to share information and relevant conclusions.	Your presentation described the ways that people have changed the environment and affected the coral reef. Your use of diagrams or sketches needed more work to share relevant conclusions.	Your presentation recognized that people have changed the environment and affected the coral reef. You need to use diagrams or sketches to share relevant conclusions.
GLO 5: Effective Communicator Communicates effectively and clearly through speaking, using appropriate forms, conventions, and styles to convey ideas and information for a variety of audiences and purposes. **Points** ___ **Nā Honua Mauli Ola 2 - 5**	The organization of your presentation was excellent. You understood the purpose and clearly presented information to your audience.	Your presentation was well organized. You understood the purpose and presented information so that the audience could understand it.	Your presentation was somewhat organized, but there is room for improvement. See notes on the other side of this page.	Your presentation was difficult to understand because it was not organized. See notes on the other side of this page.
Learners gather oral and written information from the local community and provide appropriate interpretation of its cultural meaning and significance. GLO 5: Effective Communicator Listens to, interprets, and uses information effectively. **Points** ___	Your interpretation of how the reef has changed showed excellent understanding of the oral and written information you gathered and the cultural significance of the changes to the reef.	Your interpretation of how the reef has changed showed good understanding of the oral and written information you gathered and the cultural significance of the changes to the reef.	Your interpretation of how the reef has changed showed you understand some of the oral and written information you gathered.	Your presentation did not interpret information that was, or should have been, gathered from the community.

Unit 3 Culminating Activity Rubric - Grade 5

Team Names_____ **Date**_____ **Total Points**_____

Unit Essential Question: What do the "kūpuna" islands teach us about changes to our coral reefs and coastal areas over time?

DOE Benchmarks, GLOs, & Nā Honua Mauli Ola	Kūlia (Exceeds Standard)	Mākaukau (Meets Standard)	ʻAno Mākaukau (Almost at Standard)	Mākaukau ʻOle (Below Standard)
Science 2: The Scientific Process: Unifying Concepts and Themes Use models and/or simulations to represent and investigate features of objects, events, and processes in the real world. **Points** ___	Your presentation made excellent use of diagrams or sketches to share information about how the reef has changed over time and how it compares to reefs in the NWHI.	Your presentation made good use of diagrams or sketches to share information about how the reef has changed over time and how it compares to reefs in the NWHI.	Your presentation used diagrams or sketches, with assistance, to share information about how the reef has changed over time and how it compares to reefs in the NWHI.	Your presentation recognized that the coral had changed. You need to use diagrams or sketches to share information you have gathered.
GLO 5: Effective Communicator Communicates effectively and clearly through speaking, using appropriate forms, conventions, and styles to convey ideas and information for a variety of audiences and purposes **Points** ___	The organization of your presentation was excellent. You understood the purpose and clearly presented information to your audience.	Your presentation was well organized. You understood the purpose and presented information so that the audience could understand it.	Your presentation was somewhat organized, but there is room for improvement. See notes on the other side of this page.	Your presentation was difficult to understand because it was not organized. See notes on the other side of this page.
Nā Honua Mauli Ola 2 - 5 Learners gather oral and written information from the local community and provide appropriate interpretation of its cultural meaning and significance. **GLO 5: Effective Communicator** Listens to, interprets, and uses information effectively. **Points** ___	Your interpretation of how the reef has changed shows excellent understanding of the oral and written information you gathered and the cultural significance of the changes to the reef.	Your interpretation of how the reef has changed shows good understanding of the oral and written information you gathered and the cultural significance of the changes to the reef.	Your interpretation of how the reef has changed shows you understand some of the oral and written information you gathered.	Your presentation did not interpret information that was, or should have been, gathered from the community.

Learning from the "Kūpuna" Islands

How is the land and marine life of the "kūpuna" islands (NWHI) different from those of the main Hawaiian Islands (MHI)?

Hawai'i DOE Standard Benchmarks

Grades 4 - 5
Science 1: The Scientific Process: Scientific Investigation - Scientific Inquiry
- **SC.4.1.1** Describe a testable hypothesis and an experimental procedure.
- **SC.5.1.2** Formulate and defend conclusions based on evidence.

Language Arts 6: Oral Communication: Conventions and Skills - Discussion and Presentation
- **LA.4.6.1** Participate in grade-appropriate oral group activities.
- **LA.5.6.1** Use speaking and listening skills to fill a prescribed role in group activities.

Key Concepts

- There are many differences between the "kūpuna" islands (NWHI) and the MHI.
  a) Most of the NWHI land is submerged so there is not much dry land.
  b) Thousands more seabirds nest in the NWHI than in the MHI.
  c) Almost all the green sea turtles in the Hawaiian archipelago nest in the NWHI and they are home to almost all Hawaiian monk seals.
- There are many differences between the ocean life and coral reefs of the NWHI and the MHI.
  a) There are more apex predators, like sharks and ulua in the NWHI.
  b) Corals are found in greater health, variety, and number in the NWHI.
  c) Many species of corals, fish, and other sea animals that are abundant in the NWHI are rare in the MHI.

Activity at a Glance

Students develop a hypothesis about how plants or animals in the NWHI are different from those in the MHI. They take an imaginary expedition to study the plants and animals of the NWHI to discover what we can learn from these elder, "kūpuna" islands. Five teams of students become the class specialists studying one group of organisms on the expedition. The teams then do a jigsaw activity to form new groups with a specialist from each group sharing what has been learned.

Time

2 - 3 class periods

Assessment

Students:

- Describe their testable hypothesis and the experimental procedure of the expedition and teach other students about their team's expedition. (Gr. 4).
- Formulate and defend conclusions based on evidence gathered in the expedition and teach other students about the conclusions (Gr. 5).
- Complete a Venn diagram that compares the land, fish, coral, other invertebrates, and limu of the NWHI and the MHI (Gr. 4 & 5).

Hawai'i DOE Rubric

Advanced	Proficient	Partially Proficient	Novice
Science Grade 4			
Create a testable hypothesis and an experimental procedure to test it.	Describe a testable hypothesis and an experimental procedure.	Identify, with assistance, a testable hypothesis and an experimental procedure.	Recognize, with assistance, a testable hypothesis or an experimental procedure.
Language Arts Grade 4			
Participate in grade-appropriate oral group activities, in a highly effective way	Participate in grade-appropriate oral group activities	Participate in grade-appropriate oral group activities, in a limited way or in a way that only partially facilitates the group's work	Participate very little in grade-appropriate oral group activities or participate in a way that does not facilitate the group's work
Science Grade 5			
Formulate and defend conclusions that are supported by detailed evidence and make connections to the real world.	Formulate and defend conclusions that are supported by evidence.	Make conclusions that are partially supported by evidence.	Make conclusions without evidence.
Language Arts Grade 5			
Use speaking and listening skills to fill a prescribed role in group activities, in a highly effective way	Use speaking and listening skills to fill a prescribed role in group activities	Use some speaking and listening skills that assist in filling a prescribed role in group activities, in a limited way	Use irrelevant speaking and listening skills that do not relate to a prescribed role in group activities

Vocabulary

acre – an area representing 4,840 square yards; there are 640 acres in one square mile
apex predators – animals at the top of the food chain, such as sharks
biodiversity – the abundance of native species in an area
biomass – total weight of living things in a defined area
emergent – above the surface of the water
endemic – unique to an area
invertebrates – animals without backbones
kūpuna - Hawaiian word for "elders." The NWHI have been recently referred to as the "kūpuna" islands.
land birds – birds that spend most of their lives on land where they obtain all of their habitat needs
limpet – mollusk with a conical shell that clings to rocks and corals; 'opihi
seabirds – birds that spend most of their life at sea and come on land to nest and rear their young
submerged – beneath the surface of the water
transect – a line along which one records data in the process of estimating populations in a study area

Materials

- student journal and assessment pages (provided in Unit Introduction)
- student expedition sheets (provided)

- student journals 12 - 15 (provided)
- Navigating Change video segment “Change Over Time” (provided on DVD)
- Reef monitoring video clips (provided on CD)
- Navigating Change photo CD (provided)

Advance Preparation

- Copy the student expedition sheets. (One copy of a team expedition sheet for each student in the five teams.)
- Copy student journal - 13 so that each student has the journal sheet for their team’s expedition.
- Make one copy of student journals - 12,14, and 15 for each student.
- Burn a copy of the Navigating Change photo CD and Video Clips CD for each of the five student expedition groups (or make copies of some of the color images to give to each group).
- Copy the student assessment overview pages from the Unit Introduction for each student.
- Preview the video clips provided on the Navigating Change CD to introduce this activity. (See the NOWRAMP clips that feature researchers during the 2002 expedition. See also TowDiver.mov clip to use in the activity introduction.)

Teacher Background Information

There are many differences between the NWHI and the MHI. Differences can be demonstrated by comparing the land, the corals, and the ocean fauna of the two island groups. One key difference is that despite the fact that the atolls and coral reefs of the northwestern part of the archipelago are called islands, they are not islands in the typical meaning of the word. In fact, most of their structure is submerged. Laysan Island is the largest natural dry land (Midway Atoll’s Sand Island is larger, but it was enlarged by humans). Laysan Island’s 1,015 land acres represent less than 2 square miles of land. In comparison, the smallest of the MHI is 166,425 land acres in size or 260 square miles.

Despite the fact that the NWHI have small land areas above sea level, these small areas are the homes of millions of birds, of 90% of nesting Hawaiian green sea turtles, and almost all of the endangered Hawaiian monk seals. The biomass of marine life (total weight of living things in a defined area) in the NWHI is three times that of the MHI. The coral reefs of the NWHI have many more apex predators, such as sharks and ulua, than the MHI. The presence of these animals in large numbers is generally indicative of a healthy ecosystem since there has to be sufficient numbers of species to support them. In contrast, the coral reefs of the MHI are mostly composed of small size, low-level carnivores and herbivores. The near absence of apex predators is attributed mostly to overfishing. Even though the fish biomass is much greater in the NWHI than in the MHI, there are actually fewer species in the NWHI. Scientists believe this can be partially explained by the colder water temperatures in the NWHI.

Teaching Suggestions

1. **Distribute the student journal and assessment pages to introduce students to the unit.**
- Introduce the essential question for the unit.
- Review the projects and assignments and discuss the journals that students will be producing. Set a deadline for the culminating project and review the sample rubric.

2. **Distribute student journal - 12 to introduce the new vocabulary words for this activity.**
- Explain that students will be taking an imaginary expedition to Papahānaumokuākea, the Marine National Monument to learn from these elder “kūpuna” islands.
- Review the vocabulary students will need to know for the expedition and help them with definitions.

3. Show the Navigating Change video segment "Change Over Time" to the class.

- Discuss students' reactions to the video.
  Discussion Questions:
  - What is one thing the "kūpuna" islands (NWHI) have to teach us about changes to our main islands over time?
  - What is the change that we need to make in ourselves to keep our islands healthy?

4. Show the video clips (provided with this guide) of researchers studying the reefs and island of the NWHI.

- Explain that scientists from the Northwestern Hawaiian Islands Reef Assessment and Monitoring Program (NOWRAMP) conducted expeditions to the NWHI to find out what we could learn from these older islands.
- The expeditions included scientists who surveyed the land and marine environment and they made some fascinating discoveries!
- Record students initial responses about the differences between the reefs in the NWHI compared to the MHI.
- Challenge students to try and count the numbers of different species of fish that swim by as the researchers swim above their transects or the amount of seabirds that they see in a given area. (This will give them an idea of how challenging this task is.)

5. Explain that students are going to take on the role of those scientists by taking an imaginary expedition to the NWHI.

- Divide the class into the following five teams:
  Land Team
  Fish Team
  Coral Team
  Ocean Invertebrate Team
  Limu (Algal) Team.

6. Distribute the team expedition sheets and accompanying journal - 13 sheets to students on each team.

- Before going on the expedition, read the incomplete hypotheses on the top of the expedition sheets to the teams.
- Ask each student on a team to generate a testable hypothesis by completing the statement (e.g., the population of seabirds on the beach will be larger, the populations of fish will be larger, the size of fish will be larger, the number of species will be fewer or greater, etc.) and why they think that will be true. Discuss what makes a hypothesis testable.
- Ask students to count off from 1 to 5 in their groups and write their own numbers on the top of individual sheets. (This will be their group number when they switch groups to do a jigsaw sharing.)
- Ask students to take turns reading the information on the expedition sheets out loud to others in their group. As they are reading, have them refer to the images of the organisms and the islands on the photo CD.

7. Have students work together to answer the questions on journal - 13.

- Instruct all students to write answers because each member will be responsible for sharing his/her new expertise when students switch groups.
- Visit each group to ensure that students' answers are accurate and that each student has recorded the answers.

8. Distribute journal - 14 to each student and conduct a jigsaw sharing activity.

- Ask students to switch groups by having all students with the number 1 gather in one area, number 2 in another area, and so on.
- Each group should be composed of five students representing each of the five teams on the expedition. If the number of students does not equally divide into groups of five, extra students should be

assigned to an existing group as a second expert. Incomplete groups should not be formed.

- Ask students to take turns sharing their hypotheses and the conclusions that the team has drawn from the expedition. In groups where there are two specialists for one area of expertise, students should be instructed to split the task in half.
- Students should take notes on **journal - 14** as each student presents information.
- Encourage students to share images from the photo CD as well.

9. Once every student has shared his/her expertise with the group, have a class discussion.

- Ask student teams to identify one major difference between the NWHI and the MHI.
- Ask them to also name one similarity between the two groups of islands. An answer could be elicited by asking students to complete the sentence: "Both the NWHI and the MHI are/have_____."

10. Distribute journal - 15 to each student.

- Challenge students to use their notes from student presentations to complete the Venn diagram with the similarities and differences between the NWHI to the MHI.

Extended Activities

Challenge groups of students to learn more about the land, coral reefs, or ocean life of a particular island. Have them research the island's history and add information about how the land, coral reefs, and ocean life have changed over time as a result of human presence. See the Appendix for a timeline of significant events in the NWHI. In addition, refer to the Navigating Change photo CD for images from Units 2 and 3 that students may want to use in their reports. Students may also want to check out the following web sites for more information.

- Navigatingchange.org
- Hawaiianatolls.org
- http://www.hawaiireef.noaa.gov/about/welcom.html

On O'ahu, take students to the Navigating Change exhibit at the Hawai'i Maritime Center where they can go on a simulated expedition to the NWHI. At the center, students will visit a life-sized model of an atoll and assume the role of scientists on an expedition. Call 523-6151 to schedule a field trip.

On Hawai'i island, visit NOAA's Mokupāpapa Discovery Center in Hilo where students can discover more about the NWHI through interactive displays, three-dimensional models, and immersive theater. The Center has a 2,500 gallon salt-water aquarium with marine life from the NWHI reefs. Also included is a mock-up of Hawai'i Undersea Research Laboratory's Pisces V submersible with robotic arms that visitors can manipulate. For more information: http://hawaiireef.noaa.gov; phone: (808) 933-8195.

New Discoveries

Name **Date**

Before you can participate in an “expedition” to Papahānaumokuākea, the Marine National Monument, you need to learn the language of a scientist. Write the definition of each word below. Be prepared to use these words as you discover the natural wonders of these “kūpuna” islands.

acre –

apex predators –

biodiversity –

biomass –

emergent –

endemic –

invertebrates –

kūpuna –

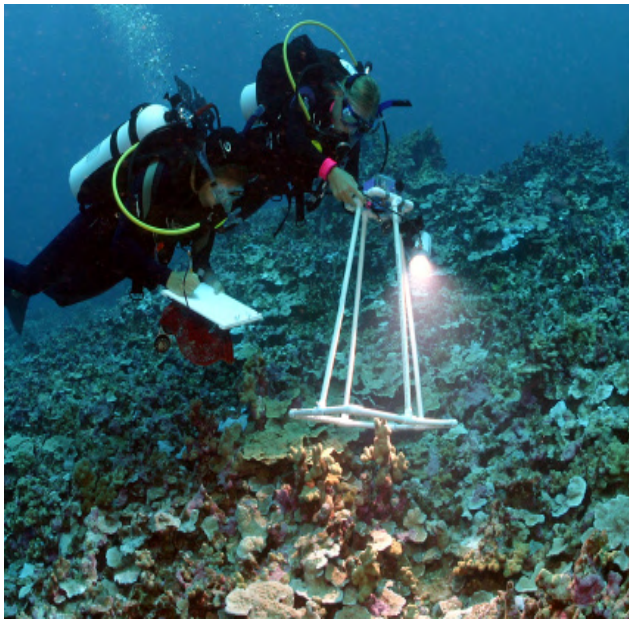
land birds –

limpet –

seabirds

submerged –

transect –



Scientists studying coral in NWHI - Photo by: James Watt
http://www.hawaiianatolls.org/images/wattphotos/LIS_coral_research.jpg

Student Expedition Sheet: Land Team

Name_____ **No.**_____

Geographic Area: Northwestern Hawaiian Islands (NWHI)

Complete this hypothesis: Compared to the main Hawaiian Islands, the populations of seabirds, native plants, and turtles on the beaches of the NWHI will be…_____

_____because_____

Imagine that you are one of the 50 scientists departing for an expedition to the "kūpuna" islands. Your mission is to study the plants and animals on land in these NWHI. The data you collect will guide how these islands will be managed in the future. These "kūpuna" islands are the older islands; they have much to teach us. So, let's go!

Our expedition will include the following teams: Land Team, Fish Team, Coral Team, Invertebrate Team, and Limu (Algal) Team. As a member of the land team, you are working together with scientists who study both plants and animals. Your team conducts surveys on all of the emergent (above sea level) areas of the NWHI. **Check your map of the islands. Which islands have emergent areas that you'll be landing on?**

_____

_____

How to Count What You See

You are going to be tasked with counting the different kinds of plants you see, seabird eggs and chicks, rare land birds, and the green sea turtles and monk seals basking on the beaches. To do a complete job of counting you must figure out how your team of scientists is going to walk the entire area of the island. One way this can be accomplished is by teaming up with a partner and walking next to each other down the middle of the island. Your partner can cover all the land on his right and you can cover all the land area on your left. You will need to count all the eggs and chicks whether they are nesting underneath the ground in a burrow, right on top of ground, or up in a bush.

Don't forget you will be noting the different kinds of plants you see while you are counting all those seabird nests. You can easily put a check mark on a photo plant identification list you carry with you. It is important to take a sketch pad of paper along with you to draw plants that are not on your list. You can use the drawings to identify the plants later. And you should also note any alien insects that you might see.

Learning from the Count

Scientists compare their count numbers from year to year so they know whether populations are increasing or decreasing. If the numbers increase year after year that is good sign of a healthy ocean that can provide food for millions of seabirds, and hundreds of green sea turtles and monk seals.

Climbing the Cliffs

Making it through the surf and up the steep cliffs of Nihoa is very challenging! But the effort is worth it! As soon as you land on shore you will be surrounded by thousands of seabirds and upon a closer look you see very rare land birds flitting by. You must complete your counts as quickly as possible so as not to scare away nesting adult birds that are protecting their eggs and baby chicks from the hot burning sun. At the same time you must walk carefully and watch where you step. The weight of your body can trap a baby chick in a nesting underground burrow.

Finding Rare Native Species

Your team finds native plants and animals on every square foot of this deserted island. There are three endangered plant species, including the Nihoa fan palm. In addition to the thousands of seabird nests you also count the number of individual rare land bird species you see. The endangered Nihoa finch population is about 1,000 birds. And there are about 200 Nihoa millerbirds. These rare birds are endemic to this island.

Smallest Duck Range in the World

On Laysan, the Laysan duck relies on the invertebrates that hatch from the salty lake in the middle of the island for habitat. It was the smallest range of any duck in the world until biologists moved some ducklings to Midway. Midway provides this rare bird with more food and habitat , which increases its chances for survival. From fossil studies, you know that this endangered bird had a much larger range in the past. It was once found on many mountain locations in the Main Hawaiian Islands (MHI). In general, land birds are rare on the NWHI. There is very little fresh water and habitats for land birds are limited.

Largest Tropical Seabird Rookery in U.S.

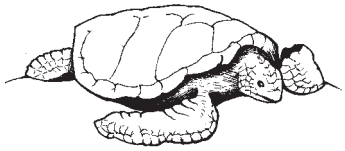
Seabirds are the most abundant birds on the islands. The “kūpuna” islands are the largest tropical seabird rookery in the U.S., and perhaps the world. Millions of resident seabirds belonging to more than 20 species nest on the islands. Thousands of migratory shorebirds also spend the winter here. It is so different from the MHI where seabirds are never seen in such large numbers.

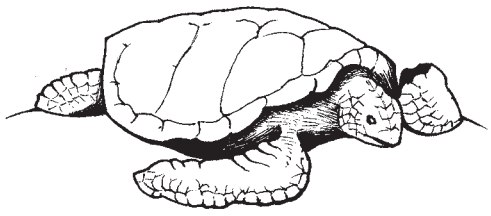
Native Hawaiian monk seals and green sea turtles rely on these island beaches for habitat as well. The monk seal is critically endangered with a population of only about 1,400. They are one of the most critically endangered marine mammals in the entire U.S. When you survey Native French Frigate Shoals, you see the beaches where more than 90% of all Hawaiian green sea turtles are born! They range throughout the state, but this is where most come to nest. At home it is a rare treat to spot either of these animals resting on a beach.

Big-Headed Ant Invaders

Your team discovers alien (non-native) insects on all islands. You find that alien insects are a big problem on Kure and Midway where big-headed ant populations are huge. At Kure Atoll you find that there are 26,500 alien ants per square meter! There are no predators for these ants. These alien insects are efficient predators with very few limits on their diet. They can prey on native insects that have no defenses against them. They also disturb ground-nesting seabirds in their burrows, and can invade the eyes of vulnerable, newly hatched seabirds. One of your team calls these ants “ecosystem-busters.”

A few alien plants are found on all islands except Gardner Pinnacles. To prevent these plants from taking over the native plants, you carefully pick them. It is important to pick only the plants *without* dried seeds on them. If you pick alien plants with dried seeds on them, the seeds can fly away in the wind and reseed somewhere else on the island.





Name_____**Date**_____

Land Team Conclusions

1. Was your hypothesis validated by the expeditions's findings? Explain.

2. Which animal species are more common on island beaches in the NWHI than the main Hawaiian Islands (MHI)?

3. Which endangered and threatened species are found on French Frigate Shoals? Why is this an important habitat?

4. What are some of the rare land species you find in the NWHI? Why do you think they are rare?

5. Most of the NWHI you visit are not typical islands. Some islands are just submerged banks; others are atolls or low coral islands. Many do not have a natural fresh water supply. This makes it difficult for even researchers to live there. From notes of earlier expeditions, you realize that these atolls and low coral islands are constantly changed by coral growth, erosion, and tides. Review the data in the table on the following page and find:

- the island with the largest natural land area_____
- the island with smallest land area_____
- the island with the largest submerged coral reefs_____

The "Kūpuna" Islands - Land Area and Submerged Coral Reefs

Island	Land Acres	Submerged Coral Reef (acres)	Characteristics
Maro Reef	Less than 1	458,540	• Totally submerged most of the time • Less than an acre of coral emerges from the water at low tide.
Nihoa Island	171	142,000	• Has two peaks and steep sea cliffs • 88 known cultural sites from Hawaiians who inhabited the island between 1000 and 1700 AD
Necker Island	46	380,000	• Geologists believe it was once as large as Oʻahu. • At its highest point, it rises 365 feet above the sea.
French Frigate Shoals	67	230,000	• Small sandy islets are continually submerged and uncovered as waves and currents shift the sand.
Gardner Pinnacles	5	600,000	• The exposed part of the island appears as two rocks jutting from the surface of the sea. The largest one is 180 feet high and 590 feet in diameter. • Most of the coral reefs are in waters deeper than 60 feet.
Laysan Island	1,015	145,334	• A small portion of the reef is in shallow water but most of it is in deep water. • A hypersaline (very salty) lake is in the interior of the island.
Lisianski Island	395	241,916	• Its highest point stands 40 feet above water.
Pearl & Hermes Atoll	89	300,000	• The land is divided among many small islets piercing the water surface.
Kure Atoll	200	80,000	• Green Island is found on the edge of the lagoon.
Midway Atoll	1,535	85,929	• Two islands – Sand and Eastern – and a small island called Spit Island are above the surface of the water.

Adapted from Coral Reef Ecosystems of the Northwestern Hawaiian Islands, NOAA. Northwestern Hawaiian Islands: A Resource Guide, and NODC Unit Conversion Guide, NOAA at http://www.nodc.noaa.gov/dsdt/ucg/

Student Expedition Sheet: Fish Team

Name_____ **No.**_____

Geographic Area: Northwestern Hawaiian Islands (NWHI)

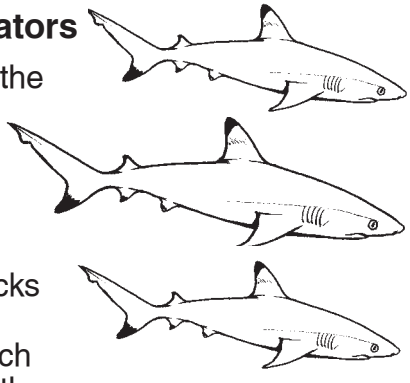
Complete this hypothesis: Compared to the main Hawaiian Islands, the fish in NWHI will be…
_____because _____

_____

Imagine that you are one of the 50 scientists departing for an expedition to the Northwestern Hawaiian Islands. Your mission is to study the plants and animals on land and in the waters surrounding the NWHI. The data you collect will guide how these islands will be managed in the future. These "kūpuna" islands are the older islands; they have much to teach us. So, let's go!

Our expedition will include the following teams: Land Team, Fish Team, Coral Team, Invertebrate Team, and Limu (Algal) Team. As a member of the fish team, you are working together with a few teams. The first team to go out when you reach the NWHI is the towboard team. Two trained divers are towed behind a boat with video cameras to record the ocean habitat. The towboard team helps the rest of you figure out the best areas to study. Then teams of three divers swim along a line (called a transect) to study the fish. They count different species of large fish within 2 meters of each side of the line. On the swim back along the line, they count the small fish.

Diving with Predators



When you dive into the water, the first thing that you notice is the number of large fish such as sharks (manō), jacks (ulua), and amberjacks (kahala). These are apex predators, which means they feed at the apex (top) of the food chain.

When you dive at Pearl and Hermes Atoll, you and your team are surrounded by over 300 jacks (ulua)! A "big daddy" ulua, a giant trevally, bites at some of the divers' hands. In one of the dives at Kure Atoll, 30 Galapagos sharks are counted in a single pass! When you dive off the MHI you do not often find large numbers of big predators, and if you do, they usually swim away. Here there are lots of large predators and they seem to be attracted to your team.

Big Fish That Don't Swim Away

Other big fish that you observe are Hawaiian hogfish (ʻaʻawa), bigeye emperor (mū), and spectacled parrotfish (uhu uliuli). You find these fish in large numbers and you notice that they are easily approached. When you dive in the MHI, you see much fewer of these fish and they aren't as large! These species also swim away when you find them in the waters at home. The spectacled parrotfish (uhu uliuli), which is a favorite food fish of many, has really suffered from overfishing. From your surveys, you discover that the abundance of uhu is more than 700% greater in the NWHI than in the MHI. This means that for every parrotfish seen in the MHI, more than 7 are seen in the NWHI!

Giant Groupers, Table Corals, and More

Other interesting finds include the cardinal fish, which is common here but rarely seen in the MHI. You also observe the chevron butterflyfish feeding on table corals. This fish is rare in the MHI since its food source is rare there. Another discovery are the giant groupers (hāpuʻupuʻu) swimming in shallow water off Midway and Kure atolls. These endemic fish approach and follow right behind you in the water. At home, due to overfishing, it's rare to see a giant grouper. And when you do see a grouper, they are usually at depths of about 300 feet.

Name_____**Date**_____

Fish Team Conclusions

1. Was your hypothesis validated by the expedition's findings? Explain.

2. When you summarize your data, you find that the average fish biomass (total weight of living things in a defined area) in the NWHI is nearly three times greater than in the MHI. Why do you think there is such a difference?

3. What is different about the apex predators you observe in the NWHI compared to these predators in the MHI? Why do you think there is this difference?

4. What do you notice about the behavior of some of the fish that is different from the fish at home? Why do you think it is different?

5. What lessons we can learn from the "kūpuna" islands to help us manage our coral reefs at home?

Student Expedition Sheet: Invertebrate Team

Name_____ **No.**_____

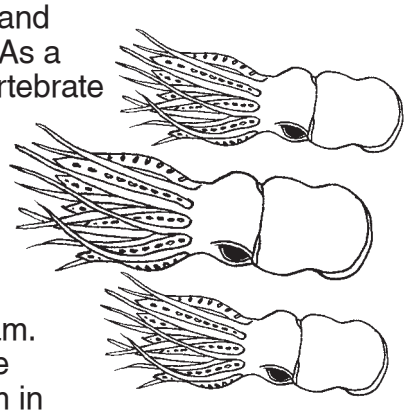
Geographic Area: Northwestern Hawaiian Islands (NWHI)

Complete this hypothesis: Compared to the main Hawaiian Islands, the invertebrates in the NWHI will be…_____because_____

_____

Imagine that you are one of the 50 scientists departing for an expedition to the Northwestern Hawaiian Islands. Your mission is to study the plants and animals on land in these NWHI. The data you collect will guide how these islands will be managed in the future. These "kūpuna" islands are the older islands; they have much to teach us. So, let's go!

Our expedition will include the following teams: Land Team, Fish Team, Coral Team, Invertebrate Team, and Limu (Algal) Team. As a member of the invertebrate team, you are working together with a few other teams. Corals are invertebrates, too, so you are working closely with that team. When you reach the NWHI, the first team in the water is the fish team. They count different species of fish within 2 meters of each side of a transect line. After the fish team completes its dive, your invertebrate team dives in to study the invertebrates. You swim along the same transect line as the fish team and record what you find. You collect specimens, take photographs, and record video.



Diving at Nihoa and Necker

You are excited when you dive in the NWHI because there are so many invertebrates (animals without backbones, such as sponges, lobsters, crabs, and snails) that you have never seen before in your dives at home! When you dive around Nihoa and Necker you find groups of invertebrates that are different from the species you find at the atolls. In Shark Bay at Necker Island, you find lots of different species of sea cucumbers and sea urchins, and lobsters are common.

New Discoveries at Pearl and Hermes Reef and French Frigate Shoals

The atoll lagoons at Pearl and Hermes Reef and French Frigate Shoals provide a unique habitat for new species to evolve. At French Frigate Shoals you discover lots of clams that you have never seen in the MHI. You and your team also collect snails, crustaceans, and sponges that have never been seen before in the MHI. Of the 75 sponge species you collect, 60 are new records for the Hawaiian Islands! On one dive at Pearl and Hermes Reef, one of your team collected a variety of sponges. Seven of those were thought to be new species. It was quite a discovery for a single dive!

You observe more crown-of-thorns seastars feeding on corals than you see in the MHI.

Giant 'Opihi

You also observe giant 'opihi around Gardner Pinnacles! These endemic giant limpets have just about disappeared from the MHI. It is also rare to find concentrations of smaller 'opihi in the MHI since they are valued as a delicious food.

Name_____**Date**_____

Invertebrate Team Conclusions

1. Was your hypothesis validated by the expedition's findings? Explain.

2. What do you discover about the 'opihi (limpets) in the NWHI that is different from the MHI? Why do you think there is such a difference?

3. Why do you think there are different invertebrates around Nihoa and Necker compared to the lagoons in the atolls?

4. What did you find in the lagoons in the atolls that does not occur in the MHI?

5. What have we learned from studying invertebrates in the "kūpuna" islands that could help us manage coral reefs in the MHI?

Student Expedition Sheet: Coral Team

Name_____ **No.**_____

Geographic Area: Northwestern Hawaiian Islands (NWHI)

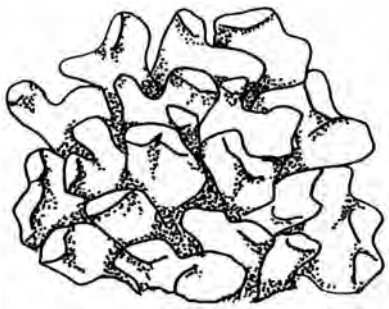
Complete this hypothesis: Compared to the main Hawaiian Islands, the coral in the NWHI will be…_____because_____

_____

Imagine that you are one of the 50 scientists departing for an expedition to the Northwestern Hawaiian Islands. Your mission is to study the plants and animals on land and in the water surrounding the NWHI. The data you collect will guide how these islands will be managed in the future. These "kūpuna" islands are the older islands; they have much to teach us. So, let's go!

Our expedition will include the following teams: Land Team, Fish Team, Coral Team, Invertebrate Team, and Limu (Algal) Team.

As a member of the coral team, you are working together with a few other teams. Since corals are also invertebrates, you work closely with that team. When you reach the NWHI, the first team in the water is fish team. They count different species of fish within 2 meters of each side of a transect line. After the fish team completes its dive, your coral team dives in to study the corals. You swim along the same transect line as the fish team and record what you find. You collect specimens, take photographs, and record video.



Amazing Discoveries

As soon as you enter the water, you are amazed by how many different kinds of corals you see. There are many large stony coral colonies—55 species in all! At least three, and possibly as many as six, of the stony coral species may be new discoveries for Hawai'i.

Diving at Kure and Maro

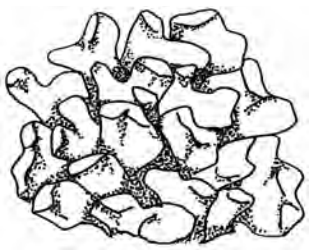
In the waters of Kure and Maro you see many large disk corals, table corals, and finger corals. The atoll lagoons are where you find most corals. These lagoons are protected from wave action and they have lots of habitats. The colorful corals and fish in these peaceful waters are beautiful.

Finds at French Frigate Shoals

At French Frigate Shoals you find the greatest number of coral species in the NWHI, including two new species of Acropora table corals.

Never Seen Before

Later, when you study the pictures you took, you realize that 10 of the 55 species you found have never been seen in the NWHI before. Also, 12 of the species you found have never been seen in the MHI. It's amazing that there are more species of corals in the NWHI than there are in the MHI. Corals grow best in warm waters, and as you head north, the water temperature is cooler. So it is strange to see more coral species in the cooler water at the NWHI than in the warmer water at the MHI.



Name_____**Date**_____

Coral Team Conclusions

1. Was your hypothesis validated by the expedition's findings? Explain.

2. What do you discover about the corals in the NWHI that is different from the MHI? Why do you think there is such a difference?

3. Why do you think the lagoons in the atolls are where you found most coral species?

4. What did you find in the lagoons in the atolls that does not occur in the MHI?

5. What have we learned from studying corals in the "kūpuna" islands that could help us manage coral reefs in the MHI?

Student Expedition Sheet: Limu Team

Name_____ **No.**_____

Geographic Area: Northwestern Hawaiian Islands (NWHI)

Complete this hypothesis: Compared to the main Hawaiian Islands, the limu in the NWHI will be_____because_____

_____

Imagine that you are one of the 50 scientists departing for an expedition to the Northwestern Hawaiian Islands. Your mission is to study the plants and animals on land in these NWHI. The data you collect will guide how these islands will be managed in the future. These "kūpuna" islands are the older islands; they have much to teach us. So, let's go!

Our expedition will include the following teams: Land Team, Fish Team, Coral Team, Invertebrate Team, and Limu (Algal) Team.

As a member of the limu team, you are working together with a few other teams. When you reach the NWHI, the first team in the water is the fish team. They count different species of fish within 2 meters of each side of a transect line. After the fish team completes its dive, your limu team dives in to study the limu. You swim along the same transect line as the fish team and record what you find. You collect specimens, take photographs, and record video.

New Discoveries at French Frigate Shoals

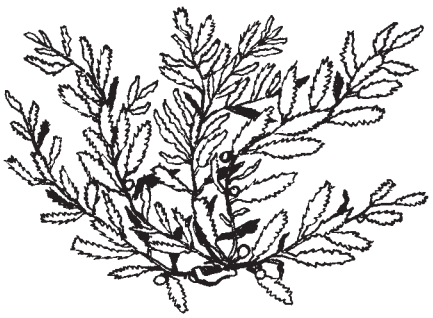
As you enter the lagoon at French Frigate Shoals, the first thing you notice is that there are so many different types of limu! On dives in the MHI, you have seen more and more alien limu taking over the reefs, crowding out the native species. These reefs in the NWHI are healthy and diverse. At French Frigate Shoals, you find many limu species that you know have not been recorded there before. Most species are red algae, which is typical for tropical waters. You carefully collect specimens of each species that you will examine under the microscope later on. This lab work is necessary to positively identify the different limu species.

Crunching Green Chips

As you walk along the sand at the edge of the lagoon on French Frigate Shoals, there is a crunching sound. You stop to check out the dried green algal chips under your feet. The sand here is made up of large patches of green algae. The algae encase themselves in calcium carbonate, which is the same substance that shells are made of. There are many more of these algal chips in the sand here than what you have seen in the MHI.

New to Science!

After you return from the expedition you study your specimens in the lab. From the specimens you brought back from French Frigate Shoals you discover four species of red algae that are totally new to science! Two limu species are new to Hawai'i and 70 are new to French Frigate Shoals. Additionally, you have also uncovered 28 new species of green algae and 10 new species of brown algae. Your dive at French Frigate Shoals increased the known limu species for that location by almost ten times, or 1000%.



Name_____ **Date**_____

Limu Team Conclusions

1. Was your hypothesis validated by the expedition's findings? Explain.

2. What do you discover about limu in the NWHI that is different from the MHI? Why do you think there is such a difference?

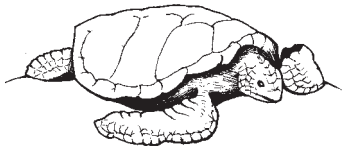
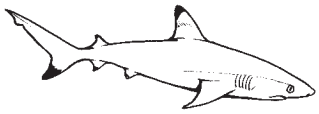
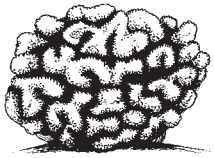
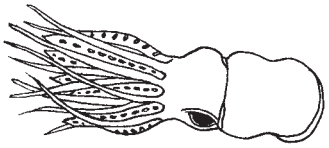
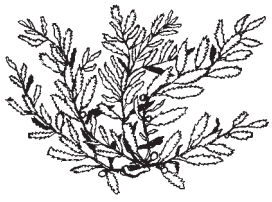
3. Why do you think the lagoons in the atolls are where you found most limu species?

4. What did you find in the lagoons in the atolls that does not occur in the MHI?

5. What have we learned from studying limu in the "kūpuna" islands that could help us manage coral reefs in the MHI?

Name_____**Date**_____

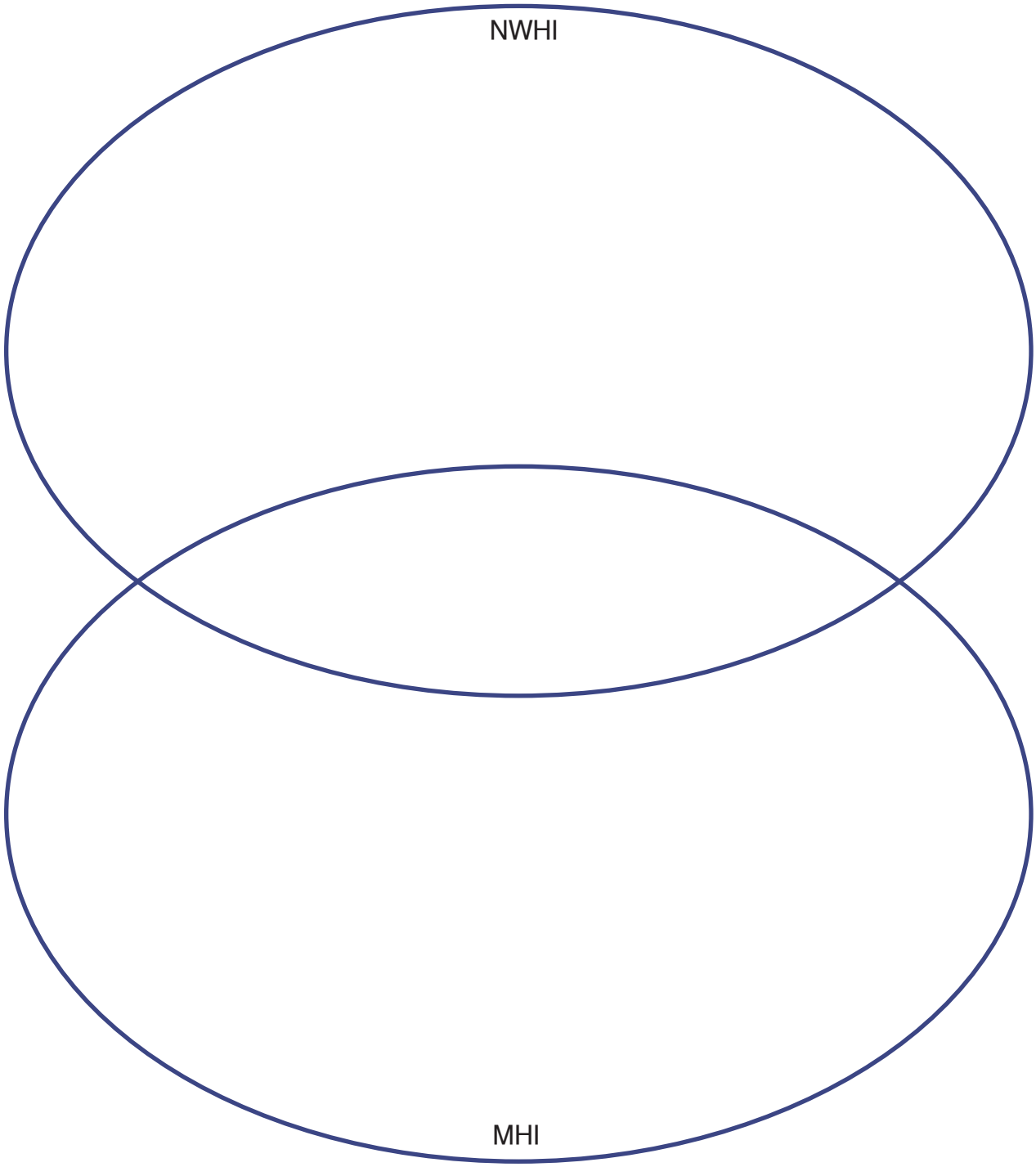
Summarize what you have learned from the expedition about the differences between the NWHI and MHI for each of the areas the five teams investigated.

	NWHI	MHI
Land 		
Fish 		
Coral 		
Other Invertebrates 		
Limu 		

Name_____**Date**_____

Venn Diagram

Compare the similarities and differences between the NWHI to the MHI. List the differences in the large spaces in the ovals below. List the similarities in the space where the two ovals overlap.



How have the coral reefs and coastal areas in our community changed over time?

Hawai‘i DOE Standard Benchmarks

Grade 4
Social Studies 7: Geography: World in Spatial Terms – Environment and Society
- **SS.4.7.3** Analyze the consequences of human modification of the physical environment in Hawai‘i using geographic representations (including lo‘i kalo and loko i‘a)

Grade 5
Social Studies 1: Historical Understanding: Change, Continuity, and Causality – Chronological Thinking
- **SS.5.1.1** Use chronological order to explain causal relationships between and among people and events.

Grades 4 - 5
Math 9: Patterns, Functions and Algebra: Patterns and Functional Relationships – Function
- **MA.4.9.2** Represent the relationship between quantities in a variety of forms (e.g., manipulatives, tables, pictures, symbols)
- **MA.5.9.2** Describe situations in which the relationship between two quantities vary directly or inversely.

General Learner Outcome 5: Effective Communicator: The ability to communicate effectively
- **GLO 5** Listens to, interprets, and uses information effectively

Nā Honua Mauli Ola 8 - 12

Engage in activities independently or collaboratively with community members to perpetuate traditional ways of knowing, learning, teaching, and leading to sustain cultural knowledge and resources within the learning community.
- Learners are able to pursue opportunities to observe and listen to expert resources within the community.

Key Concepts

- The coral reefs of the NWHI provide a baseline to see how reefs in the MHI have changed due to human activities.
- Interviewing elder fishers and other resource people in the community is one way to learn about how the coral reefs have changed over time.
- The small islands of the Monument give us an opportunity to see predator-free habitats where native plants and seabirds thrive and turtles and seals make an every day appearance.

Activity at a Glance

Students develop interview questions and practice interviewing skills before talking to elder fishers, kūpuna, and other resource people to learn more about how the coral reefs and coastal areas in their community have changed over time. Students use circle graphs to represent the different amount of herbivores, low level carnivores, and apex predators in the NWHI compared to the MHI.

Time

3 - 4 class periods

Assessment

Students:

- Add information to their Venn diagram comparing the NWHI and the MHI.
- Summarize their conclusions about how human activities have affected coral reefs and coastal around the main Hawaiian Islands (Gr. 4 & 5), and place events in chronological order in their summaries (Gr. 5).
- Create circle graphs and bar graphs to represent the relationship between quantities of herbivores, low level carnivores, and apex predators in the NWHI and MHI.
- Describe how the relationships among quantities of herbivores, low level carnivores, and apex predators varies as one population is overfished.

Hawai'i DOE Rubric

Advanced	Proficient	Partially Proficient	Novice
Social Studies Grade 4			
Evaluate the consequences of human modification of the physical environment in Hawai`i using geographic representations, drawing relevant and insightful conclusions	Analyze the consequences of human modification of the physical environment in Hawai`i using geographic representations, drawing relevant conclusions	Describe the consequences of human modification of the physical environment in Hawai`i using geographic representations	Recognize, with assistance, the consequences of human modification of the physical environment in Hawai`i using geographic representations
Math Grade 4			
Represent the relationship between quantities in a variety of forms and describe the effectiveness of the representations	Represent the relationship between quantities in a variety of forms	Represent the relationship between quantities in one or two forms	Have difficulty representing the relationship between quantities

Social Studies Grade 5			
Use chronological order to analyze causal relationships between and among people and events, with accuracy	Use chronological order to explain causal relationships between and among people and events, with no significant errors	Use chronological order to identify causal relationships between and among people and events, with a few significant errors	Use chronological order to identify causal relationships between and among people and events, with many significant errors
Math Grade 5			
Describe situations in which the relationship between two quantities vary directly or inversely, with accuracy	Describe situations in which the relationship between two quantities vary directly or inversely, with no significant errors	Describe situations in which the relationship between two quantities vary directly or inversely, with a few significant errors	Describe situations in which the relationship between two quantities vary directly or inversely, with many significant errors

Vocabulary

apex predators – carnivorous animals at the top of the food chain, like sharks and ulua
baseline – information collected about an ecosystem at a known point of time that creates a "picture" for measuring change in the future
biomass – total weight of living things in a defined area
ecosystem – a system of interactions between living organisms and their physical environment
herbivores – animals that feed on plants
low-level carnivores – animals, smaller than apex predators, that feed on organisms lower in the food chain
reproductive maturity – age or size at which an organism is able to reproduce
shifting baseline – using information recorded at a different time as a baseline by which to measure change

Materials

- Comparing Reefs PowerPoint presentation (provided on photo CD)
- acetate sheets (to make overheads if computer projection is not an option)
- student journals - 16 and 17 (provided)
- Navigating Change video segment "Change Over Time" (provided on DVD)

Advance Preparation

- Copy student journal - 16 and 17 for each student.
- Preview the PowerPoint presentation and note that Teaching Suggestion 3 calls for showing only the first 8 slides.
- If you do not have the technology that enables you to project the PowerPoint presentation provided on the photo CD, print each slide and make overhead transparencies. (Note: A copy of the Power Point slide show is included after this lesson.)

Teacher Background Information

If we dive into the water to study the reefs around our main islands today, how do we know how much the reefs have changed over time? What is the point of reference we can use to determine how much change has taken place? We all hear stories from community elders about how plentiful the reefs used to be, and from time to time there are articles in the news about declining commercial fish catch. One way that we can assess change is to use a baseline as a reference point for measuring change in ecosystems over time or for measuring the effects of a particular impact, like fishing, or pollution. If the change being assured is in response to something in particular, like human activities, a baseline from before these activities took place is needed to form a true picture of the change.

Two baselines can be used to assess the health of the MHI ecosystems. First, the MHI of today can be compared to the baseline from previous decades. Second, as students learned in the previous activity, the NWHI offer a baseline that probably resembles what ecosystems of the MHI looked like before humans inhabited the islands.

From generation to generation, there is a tendency to shift baselines. If the new generation is unaware of a previous baseline, it can end up perceiving a degraded ecosystem as normal or even as an improvement. Awareness of the original baseline is essential to understanding the impact humans have on the environment and to taking restorative actions before it is too late. By comparing baselines of the MHI 100 years ago with information collected today, we know that the current fish stocks are at most 20-25% of what they were 100 years ago! Most alarming is the fact that this reduction in numbers and size of the fish has been documented in oceans worldwide. In this lesson, students reach out to elders in their community to collect information on how our coral reefs have changed.

Teaching Suggestions

1. Introduce the activity with a discussion about coral reefs and coastal areas on your island.

Discussion Questions

- Do you think the coral reefs and coastal areas around our island have changed since the time when your parents were children? How about when your grandparents were children?
- How do you know?
- What would be the evidence of change?
- How could we find out how much change has taken place over time?
    - Compare data – fishing records of amount of fish caught
    - Talk to older fishers to hear their accounts of how their fish catch has changed
    - Ask scientists who study reefs to share information they have collected
    - Compare the NWHI reefs with our MHI reefs to get an idea of what reefs in areas of less human impact are like.
    - Ask elders to show you old photos of coastal areas and compare them with how these areas look today.

2. Conduct a demonstration to introduce the concept of a baseline.

- Have students imagine that the class is a coral reef ecosystem and that each member of the class represents a fish in the ecosystem 100 years ago.
- What is the total population of fish? Use that population as the baseline—the reference point.
- Now imagine that 50 years have gone by and that the fish population is decreasing due to more and more fishing. Have 10 students step to the side of the class. What is the population now?
- Allow 50 more years to go by and remove 12 more "fish." Take a count of the fish population again. How much has the fish population changed?

3. Discuss the demonstration.

Discussion Questions

- If we didn't have our original baseline, would we know how much change there had been in our coral reef? (No, we might only have a general idea that there weren't as many fish as there used to be.)
- If we only had the population of fish from 50 years ago, would that be enough of a baseline to measure change? (It only gives a partial picture. This is what we call a shifting baseline.)
- How do you think the reefs and islands in the NWHI provide us with a baseline to measure change? (They offer a baseline that probably resembles what ecosystems of the MHI looked like before humans inhabited the islands.)

4. **Show the first 8 slides of the PowerPoint presentation about comparing coral reef ecosystems and discuss the information with students.**
- Before projecting the slide with the pie charts showing the differences in biomass and composition of the reefs in the NWHI and MHI, challenge students to graph this information on **student journal - 16**.
- Define terms and ask students to use the data tables to create the graphs and answer the questions.
- If percentages are new to your students, use a dollar bill and some coins to help them understand the concept. The dollar bill = 100%; a quarter = 25%; a dime = 10% and a nickel = 5%.

5. **Show the remainder of the slides in the PowerPoint presentation and have students compare their circle graphs to the ones presented.**
- Explain that the larger circle graph for the NWHI represents larger biomass. The average fish biomass in the NWHI is more than 260% greater than in the MHI!
- Discuss how overfishing in the MHI has decreased the food supply for apex predators. Help students to understand that the high percentage of apex predators in the NWHI is a reflection of long periods of time without fishing pressure.
- Use the ʻōmilu slides in the PowerPoint presentation to discuss the impact of overfishing.

6. **If you have not already done so, show students the Navigating Change video segment, "Change Over Time."**
- Discuss differences and similarities between the NWHI and the main Hawaiian Islands.

7. **Distribute student journal - 17 and challenge each student to interview a community member to learn more about how the nearest coral reef has changed over time.**
- Ask students to decide on whom they will approach for an interview and what kinds of questions they will ask during the interview.
- Discuss what makes good interview questions, i.e., questions that are open-ended, requiring more than a "yes" or "no" response, and questions that focus on the information students wish to learn.

8. **Prepare students for interviews.**
- Have students submit their questions for peer review by their classmates.
- Have students edit their work and refine their questions as needed.
- Discuss ways to approach people to request an interview and key points to remember when conducting an interview.

    Conducting Interviews – Key Points:
    - Arrive at the scheduled time.
    - Be polite and show hōʻihi (respect).
    - Take notes and repeat key points to clarify information heard.
    - Thank the interviewee at the end of the interview, and also with a follow-up note.

9. **Once students have conducted their interviews, ask them to share what they have learned, including any photographs they have taken.**
- Help students to distinguish between information that is factual and that which is opinion.
- Summarize what the class has learned about the changes in the community over time.
- Ask students to add new information to their Venn diagrams from the previous activity (journal - 15).

Extended Activity

In groups of four, have students research one organism that is present in both the NWHI and the MHI and create a short PowerPoint presentation to share with the class. Provide them with the Navigating Change photo CD as a resource. Students may want to check out the following web sites for more information.

- Navigatingchange.org
- Hawaiianatolls.org
- www.shiftingbaselines.org

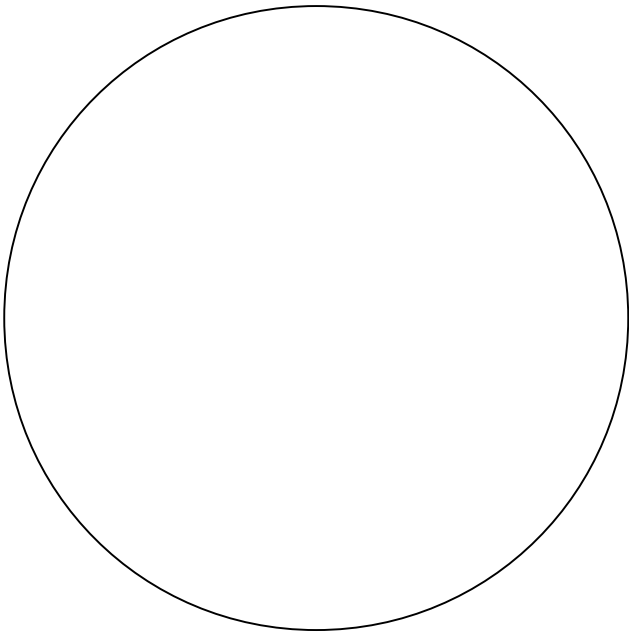
Name_____**Date**_____

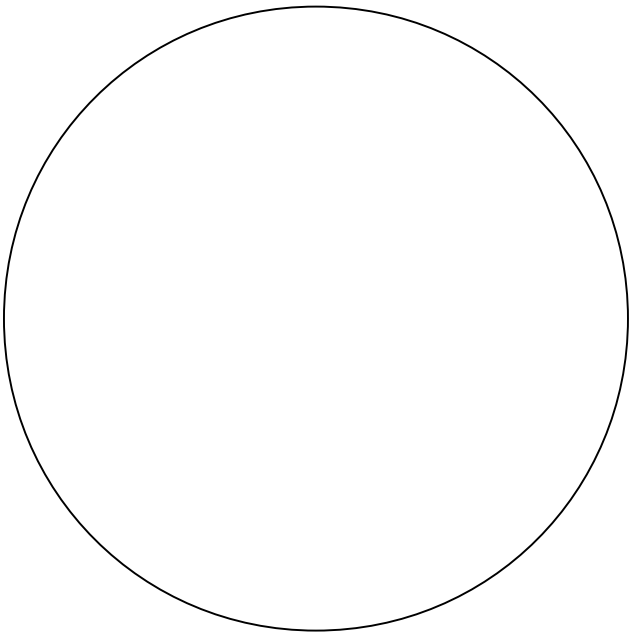
Looking Back - Comparing Differences

1. Make a circle graph (pie chart) of the fish data for each of the island groups.
- Use a ruler to draw lines from the center of the circle for each section of your circle graph.
- Color the herbivore segment of the circle graph green.
- Color the low-level carnivore segment blue.
- Color the apex predator segment of the circle graph red.
- Be sure to label the name of each graph and complete the legend at the bottom of this page showing the colors used for each section of the graph.

Fish	Main Hawaiian Islands (MHI)	Northwestern Hawaiian Islands (NWHI)
Apex Predators	3%	54%
Low-Level Carnivores	49%	18%
Herbivores	48%	27%

_____ _____





Name_____**Date**_____

2. How are the relationships among herbivores, low level carnivores, and apex predators different in the two island groups?

_____

_____

3. How do you think overfishing of herbivores and low-level carnivores in the MHI has affected the number of apex predators?

_____

_____

_____

_____

4. Summarize your conclusions about the differences between the percentages of apex predators, low-level carnivores, and herbivores in the MHI and NWHI.

_____

_____

_____

_____

_____

_____

_____

Name_____**Date**_____

Looking Back - Talk Story

The way we live, the things we do, and the place where we live have changed. We need to know what the past was like to understand what kinds of changes are happening today. When we look at our reefs in the main Hawaiian Islands, we only see the way they are now. But how have they changed over time? Our studies of the "kūpuna" islands have given us an idea of what our reefs and coastal areas may have been like. Let's conduct some research and see what we can find out about changes over time.

Your challenge: Talk story with someone who has lived on our island for more than 20 years. Find out how the land and sea have changed since they have been alive. Visit the place that they tell you about and record what you see.

1. Select a person who has lived on our island for more than 20 years. It can be a parent, grandparent, relative, friend or teacher. Try to find someone who has fished, surfed, or been connected to the ocean for a long time. **Name of Interviewee**:_____

2. Conduct an interview! Talk story with this person about what a local reef or coastal area, was like 20 or more years ago. Write at least 4 interview questions using the guidelines we discuss in class.

My interview questions:

a._____

_____

b._____

_____

c._____

_____

d._____

_____

3. Record the answers to your interview questions on a separate sheet.

4. Visit the area that you learn about in your talk story session. If possible, take a picture of it.

5. Write a reflection about your interview and share what you have learned with the class.

6. Grade 5 students: Make a list of events that may have contributed to the change in your island's reefs. Put the events in chronological order from past to present.

Adapted from *Home Project - Talk Story Time*. Mahalo to Kalama Intermediate Hui Lōkahi Team.


How do we know what our coral reefs in the MHI used to looked like?
•Talk to people who have observed changes over time (e.g. kūpuna, grandparents).
•Read books that were written in the past (e.g. Captain Cook's journal entries).
•Compare the MHI with a similar environment that has not been heavily changed by humans (NWHI).
•Learn from Hawaiian oral history and chants, and from scientific records and research.

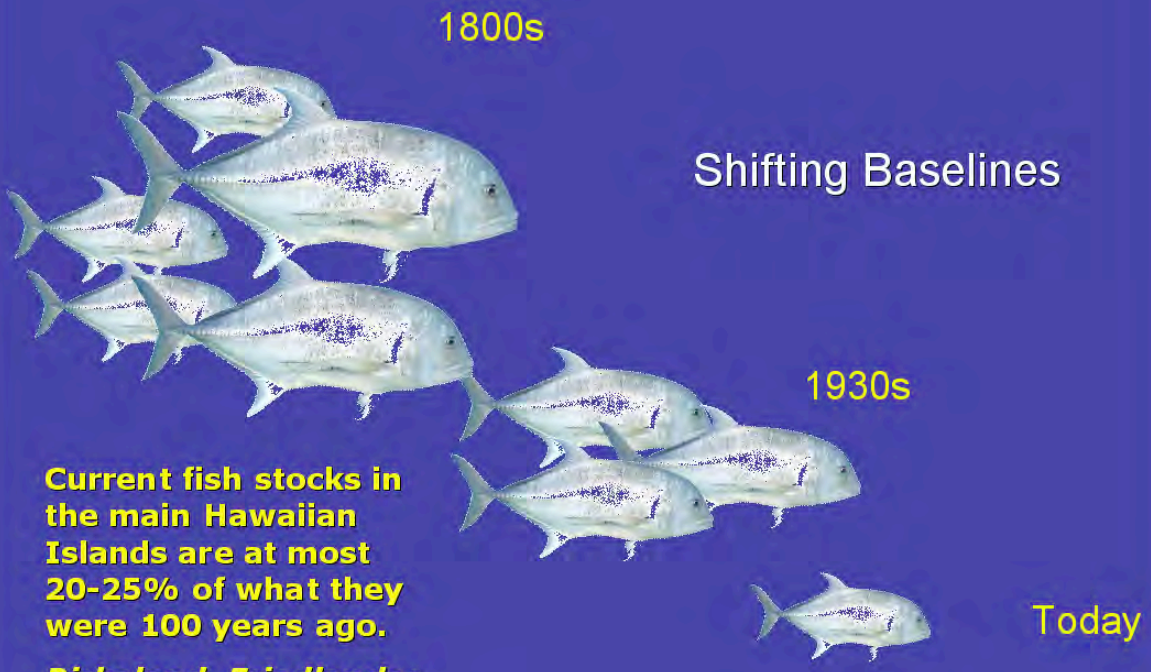
What is a baseline?

A baseline is information collected about an ecosystem, like a coral reef, at a known point in time. It creates a "picture" for measuring change in the future.

Baselines...

- provide information to understand changes in our reefs over time.
- help us to understand how we can work toward restoring damaged reefs.

Using baselines from different times gives us different "pictures" when we compare reefs.

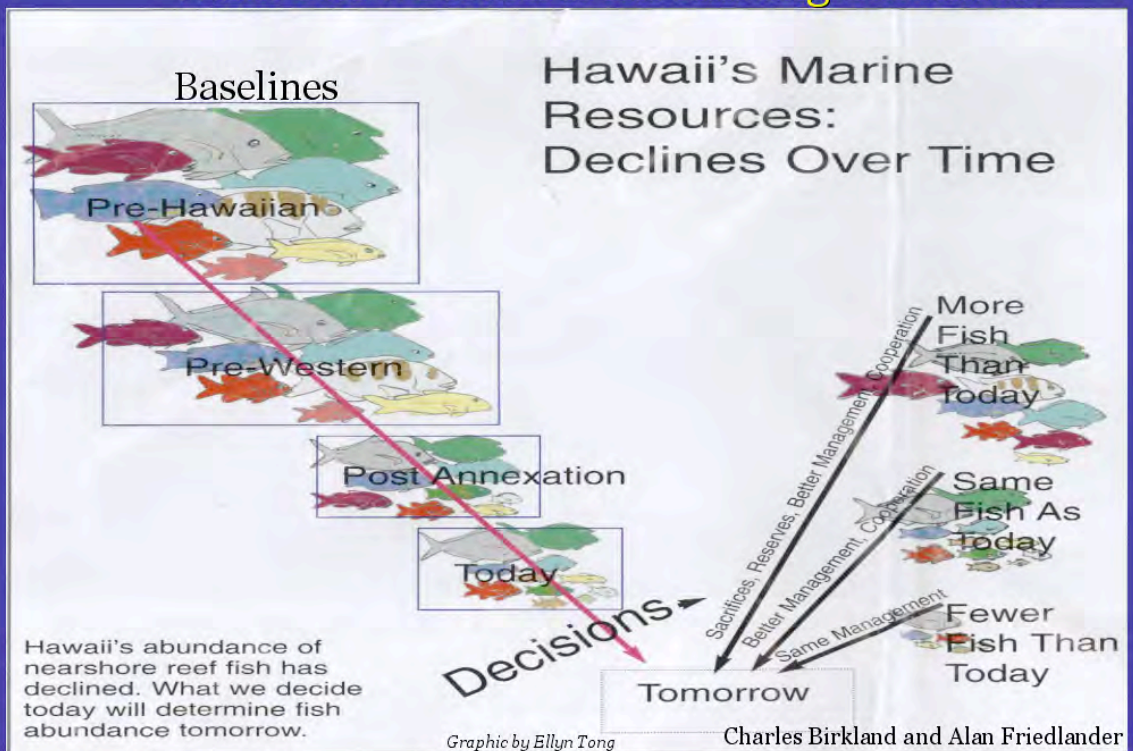


Current fish stocks in the main Hawaiian Islands are at most 20-25% of what they were 100 years ago.

Birkeland, Friedlander

Fish stock decline of the MHI

What can we learn from shifting baselines?



How can we compare ecosystems?

Marine Ecosystem of NWHI vs **Marine Ecosystem of MHI**

- Number and size of fish?
- Coral cover and health of coral reefs?
- Number of native vs. alien species?
- Populations of monk seals, turtles, birds?

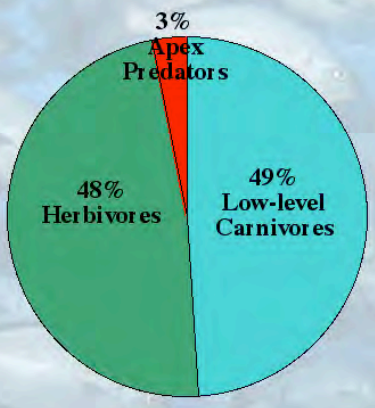
What is Biomass?

Biomass is the total weight of living things in a defined area.

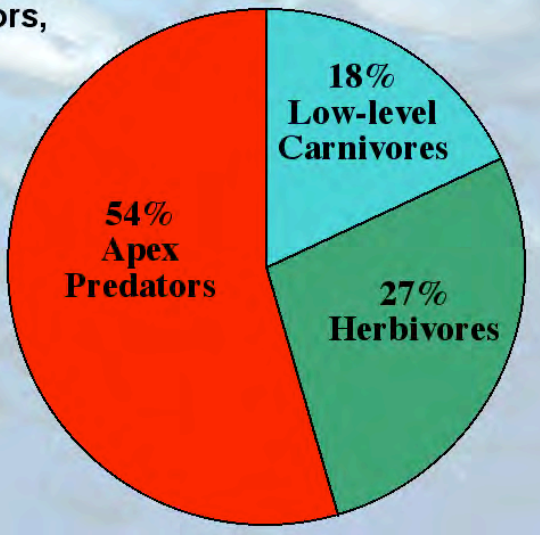
- *The biomass of fish in the waters of the NWHI = the total weight of all the fish that swim in a measured area of the waters of the NWHI.*

How are they different?

The size of the circles represent biomass. The colors show differences in apex predators, herbivores and low-level carnivores.



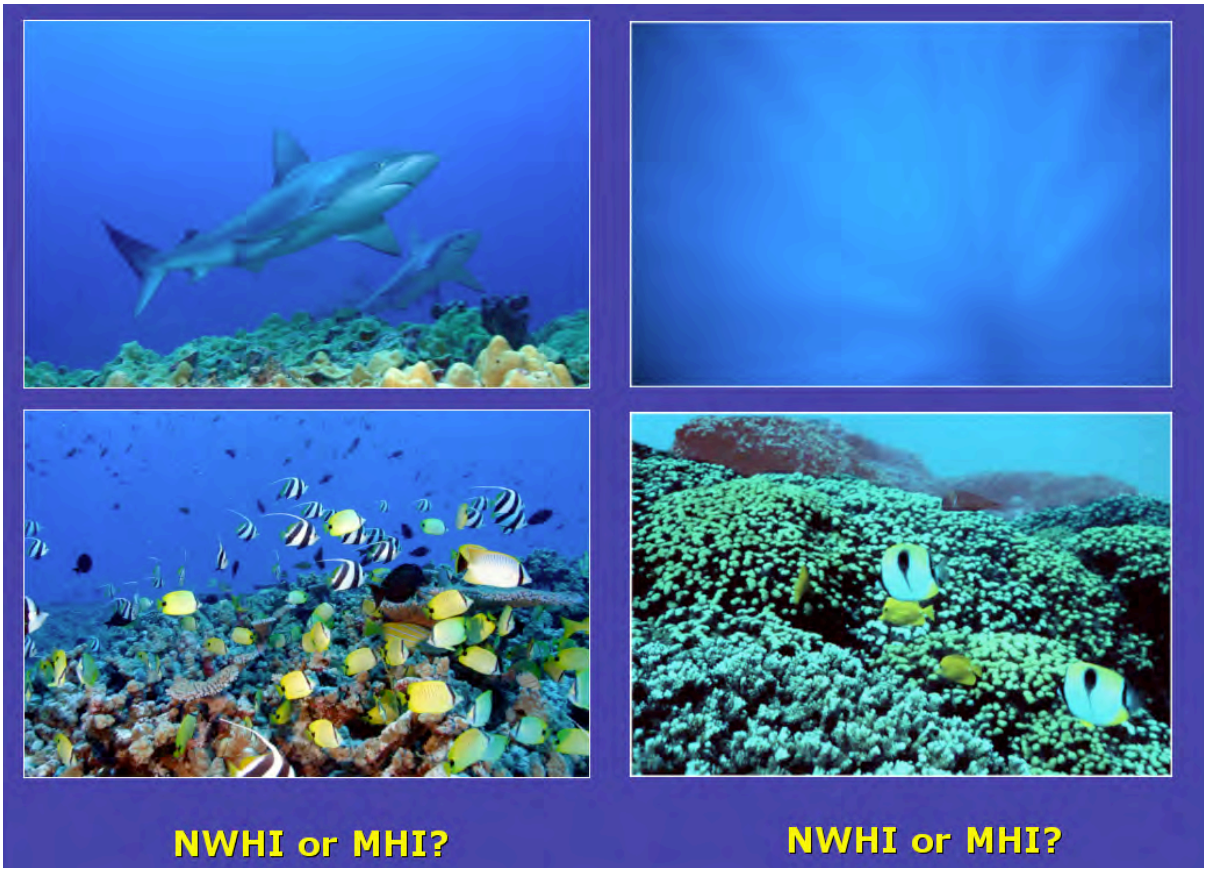
Main Hawaiian Islands (MHI)



Northwestern Hawaiian Islands (NWHI)

Maragos and Gulko 2000

MHI or NWHI?



Why such a big difference?

We can get one clue by looking at the number of babies that the ʻŌmilu has at different ages.

ʻŌmilu

How many eggs?

- The 13-inch ʻŌmilu produces about 50,000 eggs.

13 inch ʻŌmilu

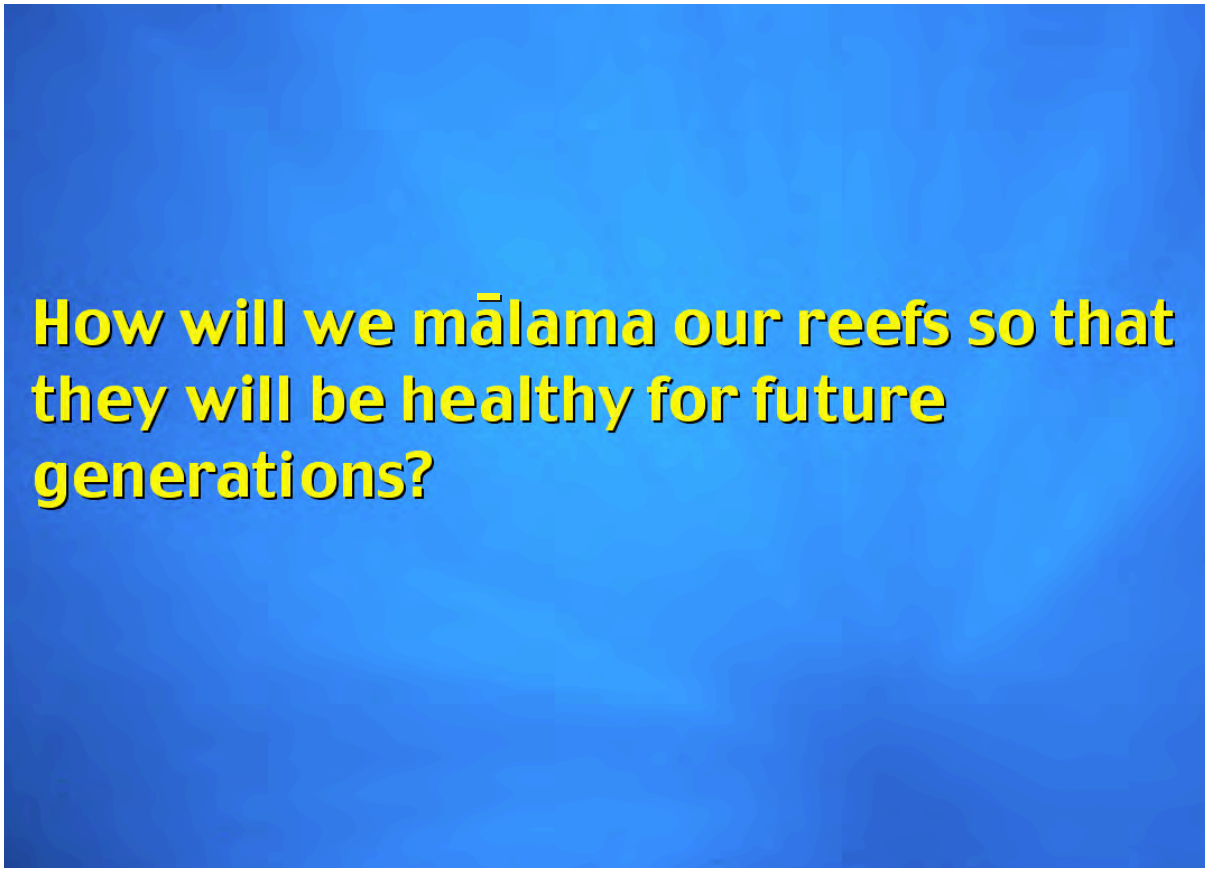
- Produces ~ 4 million eggs or 84 times more eggs than a 13" ʻŌmilu!

27 inch ʻŌmilu

Therefore...

27 inch ʻŌmilu

Taking **ONE** 27 inch ʻŌmilu is the equivalent of...


How will we mālama our reefs so that they will be healthy for future generations?

Aunty Ulua

How can we apply traditional Hawaiian practices to our management of fish populations today?

Hawai'i DOE Standard Benchmarks

Grades 4 - 5

Math 10: Patterns, Functions, and Algebra: Symbolic Representation – Numeric and Algebraic Representations

- **MA.4.10.1** Use symbols to represent unknown quantities in open sentences and determine the unknown quantities.
- **MA.5.10.2** Model problem situations with objects or manipulatives and use representations (e.g., graphs, tables, equations) to draw conclusions.

Science 2: The Scientific Process: Nature of Science - Unifying Concepts and Themes

- **SC.4.2.1** Describe how the use of technology has influenced the economy, demography, and environment of Hawai'i.
- **SC.5.2.1** Use models and/or simulations to represent and investigate features of objects, events, and processes in the real world.

General Learner Outcomes

Community Contributor: The understanding that it is essential for human beings to work together

- **GLO 2** Cooperates with and helps and encourages others in group situations.

Effective Communicator: The ability to communicate effectively

- **GLO 5** Listens to, interprets, and uses information effectively.

Nā Honua Mauli Ola 15 - 1; 8 - 4

Engage in experiences which mālama the entire learning community and the environment to support learning and good practices of stewardship, resource sustainability, and spirituality. Learners:

- Develop a sustainable food production system.
- Apply the cultural and traditional knowledge of the past to the present.

Key Concepts

- The Hawaiian kapu (taboo) system prevented fishing during the spawning period, which allowed the fish population to be replenished.
- It is important to leave larger, older female fish in the ocean since they make many more eggs than smaller fish.
- When fishing, we should observe fishing rules and regulations that are designed to ensure that there will be enough fish for the future.

Activity at a Glance

Students conduct a fishing demonstration in the classroom that shows what happens when a fish population is overfished. They read about traditional Hawaiian fishing practices and a story about wanting too much fish. They apply what they've learned to propose sustainable fishing practices.

Time

2 - 3 class periods

Assessment

Students:

- Complete a project (poster, web page, song, poem, computer presentation, etc.) that communicates

sustainable fishing practices.

- Write a summary of how changes in fishing practices, including new technology have affected fish populations. Make recommendations for harvesting fish sustainably and include graphs, sketches, or diagrams to support conclusions (Gr. 4).
- Create a model or simulation to demonstrate how a population of fish could be harvested sustainably and use representations (e.g., graphs, tables, equations) to draw conclusions. (Gr. 5)

Hawai‘i DOE Rubric

Advanced	Proficient	Partially Proficient	Novice
Grade 4 Math			
Use symbols to represent unknown quantities in open sentences and determine the unknown quantities, with accuracy	Use symbols to represent unknown quantities in open sentences and determine the unknown quantities, with no significant errors	Use symbols to represent unknown quantities in open sentences and determine the unknown quantities, with a few significant errors	Use symbols to represent unknown quantities in open sentences and determine the unknown quantities, with many significant errors
Grade 4 Science			
Explain how the use of technology has influenced the economy, demography, and environment of Hawai‘i and suggest ways to conserve the environment	Describe how the use of technology has influenced the economy, demography, and environment of Hawai‘i	Give examples of how the use of technology has influenced the economy, demography, and environment of Hawai‘i	Recognize that the use of technology has influenced the economy, demography, and environment of Hawai‘i
Grade 5 Math			
Model problem situations with objects or manipulatives and use representations to draw conclusions, with accuracy.	Model problem situations with objects or manipulatives and use representations to draw conclusions, with no significant errors.	Model problem situations with objects or manipulatives and use representations to draw conclusions, with a few significant errors.	Model problem situations with objects or manipulatives and use representations to draw conclusions, with many significant errors.
Grade 5 Science			
Consistently select and use models and simulations to effectively represent and investigate features of objects, events, and processes in the real world.	Use models and/or simulations to represent and investigate features of objects, events, and processes in the real world.	With assistance, use models or simulations to represent features of objects, events, or processes in the real world.	Recognize examples of models or simulations that can be used to represent features of objects, events, or processes.

Lanikai Public Charter School students install signs they created to help mālama the Mokulua Islands

Vocabulary

kapu – taboo
kuleana – responsibility
reproductive size – the size of an organism when it is sexually mature
L_{50} – the length (L) of a fish species at the time when approximately 50% are reproductively mature (only half will be able to spawn at that size)
sustainable use – use of a resource in a way that allows future generations to meet their needs

Materials

- Actual Reproductive Size fish poster (provided)
- Photo CD (provided)
- student reading (provided)
- student journal - 18 (provided)
- rubric for culminating projects (provided in Unit Introduction)
- rulers
- large sheets of drawing paper
- scissors
- color markers
- craft materials (paints, poster paper)

Advance Preparation

- Locate the ulua photos in the fish file on the Navigating Change photo CD.
- Copy the student reading and journal - 18 for each student.
- Copy a rubric for the culminating project (provided in the Unit Introduction) for each student or prepare to project it and review it with students.

Teacher Background Information

"The very high biomass of apex predator reef fish in the NWHI is perhaps unique in the world and a reflection of long periods without fishing pressure."

—Alan Friedlander, Oceanic Institute (Maragos & Gulko, 2002)

The biomass of marine life (total weight of living things in a defined area) in the NWHI is three times that of the MHI. The coral reefs of the NWHI have many more apex predators, such as sharks and ulua, than the MHI. The presence of these animals in large numbers is generally indicative of a healthy ecosystem since there has to be sufficient numbers of species to support them. In contrast, the coral reefs of the MHI are mostly composed of small size, low-level carnivores and herbivores. The near absence of apex predators is attributed mostly to overfishing (Maragos & Gulko, 2002).

Overfishing or fishing pressure has reduced many nearshore fish populations in the MHI to levels below the capacity of the fish resources to replenish themselves (Birkeland & Friedlander, 2001). The loss of traditional controls on fishing in the last 200 years, combined with a growing human population, coastal development, habitat loss, sedimentation, invasive species, and the use of modern technology, has contributed to decreased fish populations. Technology such as high-powered boats, scuba-diving gear, underwater lights, and large monofilament nets has increased fish harvests. When the relatively inexpensive gill nets are abandoned, they can float through the ocean and "ghost-fish" for years, further depleting our coral reefs.

How do we work to replenish our overfished stocks in nearshore waters around the MHI? Fishing rules and regulations, including minimum catch size, bag limits, and closed seasons are one way to address the issue. The minimum catch size (for most species) allows the fish to grow to a size where they are reproductively mature. The poster that

accompanies this activity, beautifully illustrated by Ellyn Tong, shows the fish at their actual reproductive size. This is referred to as L_{50}—the length (L) of a fish species at the time when approximately 50% are reproductively mature (only half will be able to spawn at that size). The larger, older females at their reproductive peak are able to produce many more eggs than smaller fish. Their larger body size allows them to produce and hold more eggs. Allowing the big "aunty" fish to survive helps to increase the fish population. The bigger females are also capable of making eggs with bigger yolks, which helps the fish larvae to survive during that crucial first few weeks of life (Tong, 2003). Once the fish are past their reproductive peak, their production of eggs decline.

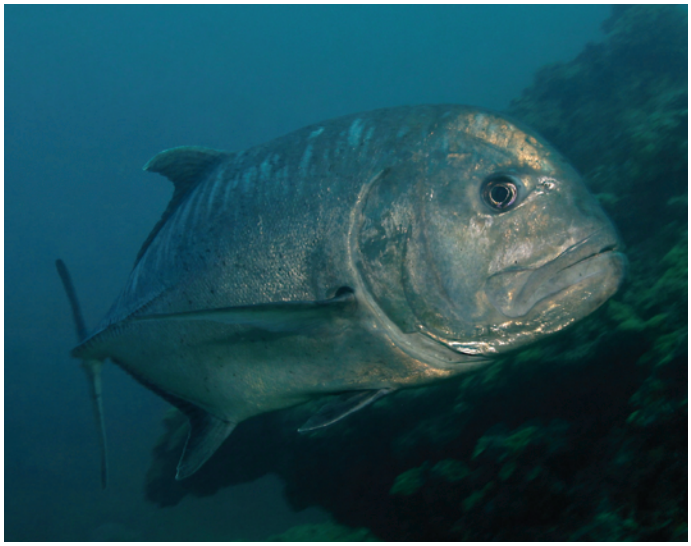
The Hawai'i Department of Land and Natural Resources, Division of Aquatic Resources is charged with developing and enforcing minimum catch size and other fishing regulations. However, securing adequate funding for enforcement and enforcement officers has been difficult, and enforcement of fishing regulations and rules often poses serious challenges. It takes commitment on the part of caring and informed individuals to conserve our fisheries for today and for future generations.

With the serious decline in our nearshore fisheries, it may be that establishing more marine refuges as a management tool is the answer for fish to recover. These refuges are areas where fishing is prohibited so that fish populations can be restored. According to Birkeland and Friedlander (2001), there is overwhelming evidence that fully protected marine refuges will rapidly enhance resident fish populations, while other management strategies such as quotas, size limits, gear restrictions, or temporary closures of fishing grounds have consistently failed over the years.

Teaching Suggestions

1. Summarize what students learned in the previous lesson about the differences between the reefs in the NWHI and the MHI.

- Ask students what the presence of many large apex predators, such as ulua (giant trevally) and manō (sharks), on reefs in the NWHI indicates about the health of those reefs compared to the MHI.
- Discuss the fact that the NWHI reefs are healthy enough to support large populations of apex predators. When reefs are overfished or damaged by sedimentation and pollution, or invasion by invasive species, the large apex predators don't have enough food to survive.



2. Show photos of the huge ulua provided on the photo CD.

- Ask students why they think we don't see many large ulua around the MHI today.

3. Show students the color poster of fish that are drawn to their actual reproductive size.

- Discuss what the L_{50} for fish means and why it is important for fishers to understand this concept. Point out the ulua (giant trevally) on the poster and ask a student to read the data provided about its reproductive size and the legal size for fishing.

4. Distribute large sheets of drawing paper, color markers, and rulers and ask students to help create a fishing demonstration.

- The class should make at least 24 large and 24 smaller fish.
  Have each student:

- Create a cut-out of the ulua at its L_{50} size (21 – 32 inches.)
- Make a second cut-out of the fish at half the L_{50} size.

5. Conduct a fishing demonstration.

Set-up

- Place 24 large ulua fish cut-outs in the center of a cleared area of the classroom to represent the ocean fishing grounds.
- Have half of the students sit in a circle around the fish. Give each of them 2 small ulua fish to hold on their laps.
- Have the remaining students form 4 fishing teams and stand with their teammates in a circle around the fishing area. These are the fishers who will harvest fish from the "ocean."

Fishing

- When a signal is given, fishing groups may begin "fishing." They may harvest as many fish as they want during each fishing trial.
- Call "Time" after 15 seconds. Collect all of the fish that were taken from the "ocean." Count the number of ulua remaining. For every 2 ulua remaining, students may replenish the fishing grounds with 1 baby ulua (L_{50}).
- If all fish are removed during the first trial, that provides an opportunity to discuss what would happen for future generations!
- There will be four 15-second fishing trials. At the fourth trial, half of the baby ulua remaining in the ocean will have grown into adults (switch small fish for large fish that were caught previously.) The other half will be eaten by predators (remove from the demonstration).

6. Discuss the fishing demonstration.

Discussion Questions

- Why weren't more ulua added to the ocean when only small ulua remained in the fishing grounds? (The baby ulua were not large enough to reproduce.)
- How could we change our fish harvest so that the ulua population would not be depleted? (Develop fishing regulations and follow them.)
- How could we fish sustainably—that is, take some now and leave enough for future generations—while maintaining the dynamics of a healthy fish population?

7. Distribute the student reading and journal - 18.

- Ask student to read the story and review the information about Hawaiian kapu.
- Discuss the student reading.

Discussion Questions

- What is the moral of the story of Hala'ea?
- Do you think the other fishermen were justified in their actions toward Hala'ea? Explain.
- How did the Hawaiian kapu system helped to maintain healthy fish populations?

8. Challenge students to complete journal - 18 with a proposal for fishing sustainably.

- Give students time to think about how we could learn from Hawaiian traditions and challenge them to come up with proposals for the fishing demonstration that would model fishing sustainably.

9. Have students share their proposals for sustainable fishing and conduct the demonstration again.

- Have students switch roles and conduct the demonstration again.
- Note: If fishers take no more than four of the adults in each trial and harvest no babies, the results are displayed below.

Trial 1 **24 a (adults)**	Fishers take - 4 a (adults)	20 a remain 10 b (babies) added	Total 20 a 10 b
Trial 2 **20 a** **10 b** **30 fish**	Fishers take - 4 a	16 a remain 10 b remain + 8 b added	16 a 18 b
Trial 3 **16 a** **18 b** **34 fish**	Fishers take - 4 a	12 a remain 18 b + 6 b added	12 a 24 b
Trial 4 **12 a** **24 b** **36 fish**	Fishers take - 4 a	8 a remain 24 b - ½ grow up +12 a - 12 b lost to predators + 10 b added	20 a 10 b 30 fish

10. Discuss the demonstration after implementing students' proposals.

Discussion Questions

- What happens to the fish population if we had a closed season or kapu during the time the fish were spawning?
- What are the consequences if we all just take what we want?
- What would happen to our fish population if we added mortality (death) of one quarter of the fish after each trial as young ulua became prey, or old fish died due to natural causes or marine debris (getting caught in net or swallowing plastics)?

11. Review the "Comparing Reefs" PowerPoint presentation (provided on the photo CD).

- Discuss what happens if we let ʻōmilu grow to larger size and produce more eggs.

12. Review the culminating project rubric and the Student Assessment Overview (provided in the Unit Introduction).

- Check students' progress with their culminating projects and remind them of the due date for their presentations.

Unit Culminating Activity: Students work in teams to present what they have learned in this unit to other classes in your school. They may use stories, songs, computer images, posters, photographs, models, or other methods. Their presentations should answer the unit essential question and include the following:

- Evidence that the reef has changed over time, including conclusions about how the reef compares to reefs in the NWHI
- Conclusions about how human activities such as new fishing technology, overfishing, pollution, alien species, or development have affected a coral reef or coastal area
- Diagrams or sketches to summarize changes to the reef
- What they have learned from kūpuna or others about how the reef has changed
- What people can do to mālama (care for) the reef and use more sustainable fishing practices

Extended Activities

Have each student select one fish from the actual reproductive size fish poster and complete these tasks:

- Create a project (poster, web page, song, poem, computer presentation, etc.) that communicates sustainable fishing practices.
- Research current fishing regulations developed by the Hawai'i Department of Land and Natural Resources, Division of Aquatic Resources, and add that information to their projects. See www.hawaii.gov/dlnr/dar.

Conduct a mock town meeting in class around the issue of establishing a marine refuge that would close a popular fishing area to fishing. Ask a few students to serve as the town council. Ask others to form teams that play the role of commercial fishers, recreational fishers, and marine biologists. Give teams a class period to prepare their arguments for or against the marine refuge and ask the town council to research the issue and come up with criteria for making their decision. Have students discuss the council's decision and how difficult it can be to respect the diverse views of others. For information on the process of developing a national marine sanctuary, see http://www.hawaiireef.noaa.gov/designation/welcome.html.

Visit the Pacific Fisheries Coalition web site for educational materials and information on fisheries. The Pacific Fisheries Coalition is a collaboration between conservationists and fishers to promote the protection and responsible use of marine resources through education and advocacy in Hawai`i and the Pacific. http://www.pacfish.org/education/.

Explore with students why predators, such as large ulua, are an important and necessary part of all ecosystems. The predators regulate all the species below them and help to promote healthy and diverse populations within their prey species. For additional background information on this important topic, see the University of Michigan's web site on global change at: http://www.globalchange.umich.edu/globalchange1/current/lectures/predation/predation.html.

Provide students with extra credit for responding with one-page journal entries to one of the following journal prompts:

- If I wrote fishing regulations, I would propose…
- In order to have enough fish for future generations it is our kuleana to…

References

Birkeland, C. & Friedlander, A. (2001). The Importance of Refuges for Reef Fish Replenishment in Hawai'i. Honolulu, HI: The Hawai'i Audubon Society, Pacific Fisheries Coalition.

Maragos, J. & Gulko, D. (Eds). (2002). Coral Reef Ecosystems of the Northwestern Hawaiian Islands: Interim Results Emphasizing the 2000 Surveys. Honolulu, HI: U.S. Fish and Wildlife Service and the Hawai'i Department of Land and Natural Resources.

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Hala‘ea

A greedy chief was Hala‘ea. Every day he visited the fleet of fishing canoes and took for himself and his retainers all the fish he could find. Then he held a feast, carousing and often wantonly wasting the food that remained. As for the fishermen, they were obliged to catch the fish without ever having any to take home to their families. Day after day, they ate herbs for food.

This conduct of the chief greatly vexed the people, and they sought means to rid themselves of his oppression. Never did they go out upon the ocean without hearing the voice of their chief crying, “the fish is mine! Give me the fish!”

At last came the season for ‘ahi, the tuna, and a proclamation was made, summoning the head fishermen to accompany their chief to the fishing grounds. So they gathered together and prepared their canoes, looking after the nets, the bait, and whatever else was required for the expedition. Also, they held a council at which it was agreed to deposit all their fish in the chief’s canoe and themselves return to the shore without even a backward glance. At the day appointed, everything was in readiness from Wai‘ahukini to Keauhou.

When the first canoe-load was conveyed to the chief’s canoe, even the voice of the chief could be heard protesting, “Bring me the fish! Bring me the fish!” But when the second, third, fourth, fifth, and succeeding canoes had deposited their loads into the chief’s canoe and he saw there was danger of swamping the canoe with their weight, he called out, “the chief has enough!”

“Not so!” cried the men. “Here is all the fish that the chief desires!” They piled in the last load, and the canoe began to sink rapidly. The chief looked about for help, but there was no canoe at hand and no man to show compassion; all had gone back to land.

So perished Hala‘ea in the sea, surrounded by objects of his greed.

Reprinted from: Pukui, M.K. (1995) *Folktales of Hawai‘i. He Mau Ka‘ao Hawai‘i.* Honolulu, HI: Bishop Museum Press.

1. What is the moral of this story?

2. Were the people justified in their treatment of the chief? Why or why not?

Name_____**Date**_____

Learning from the Past

In old Hawai‘i, when the constellation Makali‘i (Pleiades) appeared in the east-northeast sky at sunset, the Makahiki season began. Makahiki is a four-month long harvest festival, dedicated to the Hawaiian god Lono. At this time, ali‘i (chiefs) issued a kapu for aku (skipjack tuna) to allow the fish to reproduce and their populations to grow.

At the end of Makahiki, the kapu for aku was lifted, and the kapu began for ‘ōpelu (mackerel scad). The kapu were issued during the spawning cycle of these fish. The kapu were lifted when the spawning cycle ended. For ‘ōpelu, the kapu was lifted in July. ‘Ōpelu swim swiftly near the ocean surface in large schools. The traditional way of catching ‘ōpelu is to use a preparation of kalo or other vegetables to lure the school of fish into a funnel-shaped net.

Today, many fishers use large nets to catch vast quantities of fish for commercial use. The use of modern technology has contributed to decreased fish populations. Technology such as high-powered boats, scuba-diving gear, underwater lights, and large monofilament nets has increased fish harvests.

1. Think about the fish demonstration that was conducted in class. Propose a way to conduct the demonstration again that would not decrease the fish population over time.
Start with 24 fish. Allow fishers to take some fish during 4 fishing “trials.”

2. How many fish can be harvested during each trial?

3. What kapu would you establish to prevent overfishing of the fish population?

4. How did Hawaiian kapu help to sustain fish populations?

5. Go to the State of Hawai‘i Division of Aquatic Resources Web site at www.hawaii.gov/dlnr/dar and review their fishing regulations. Describe the fishing regulations for at least one fish.