



LOOKING TO THE *KŪPUNA* (ELDERS)

What do older coral reefs in the Northwestern Hawaiian Islands (NWHI) reveal about changes to reefs in the Main Hawaiian Islands (MHI) over time?

HAWAI'Ī DOE STANDARD BENCHMARKS

Science 1: The Scientific Process: SCIENTIFIC INVESTIGATION

- **SC.7.1.3** Explain the need to revise conclusions and explanations based on new scientific evidence.

Science 2: The Scientific Process: NATURE OF SCIENCE

- **SC.7.2.1** Explain the use of reliable print and electronic sources to provide scientific information and evidence.

Language Arts 1: Reading: CONVENTIONS AND SKILLS

- **LA.7.1.2** Use a variety of grade-appropriate print and online sources to research an inquiry question.

ACTIVITY AT A GLANCE

Students work in ten teams, each researching one island in the Northwestern Hawaiian Islands (NWHI) to discover the major findings of research expeditions. They share their findings with the class and draw conclusions about what the “kūpuna” (elder) islands can teach us about the reefs of the Main Hawaiian Islands (MHI).

MATERIALS

Provided:

- ✓ student expedition sheets
- ✓ Learning Log – 5
- ✓ *Navigating Change* video segment “Change Over Time”

- ✓ Reef monitoring video clips (provided on *Navigating Change* Video Clips CD)
- ✓ Comparing Reefs PowerPoint presentation (provided on *Navigating Change* Photo and Resource CD)

ASSESSMENT

Students:

- Using scientific data from NOWRAMP expeditions, write a comparison of the reefs of the NWHI and the reefs of the MHI.
- Explain what a shifting baseline for the reefs of the MHI is and describe how scientific evidence from the NWHI causes us to revise conclusions about our MHI reefs.

KEY CONCEPTS

- Evidence from NOWRAMP excursions has revealed that apex predators are much more dominant in the reefs of the NWHI compared to the MHI.
- Scientific evidence reveals that the biomass of the coral reefs in the NWHI is much greater than the biomass of the reefs in the MHI.
- Over the years, there tends to be a shifting baseline for healthy, balanced reefs due to gradual human impacts over time. The reefs of the NWHI provide a baseline by which we can measure change in the MHI reefs brought on by human activities such as overfishing, pollution, and the introduction of invasive species.

TIME

3 - 4 class periods

**SKILLS**

analyzing, classifying, comparing and contrasting, writing

- Preview the Comparing Reefs PowerPoint presentation.

ADVANCE PREPARATION

- Make one copy of Learning Log 5 for each student.
- Make two or three copies of each expedition sheet (to distribute to student pairs or teams researching the island).
- Place the video clips from the *Navigating Change* Video Clips CD onto classroom computers or burn copies onto CDs for student teams to use.
- Preview the video clips provided on the *Navigating Change* CD to introduce this activity. (See *Nowramp02_Navigating_Change.mov* (4:25 minutes), and *Nowramp02_underwater.mov* (2:47 minutes), and *TowDiver.mov* (0:25 sec.)

VOCABULARY

- apex predators – animals at the top of the food chain, such as *manō* (sharks) and *ulua* (giant trevally)
- biodiversity – the abundance of native species in an area
- biomass – total weight of living things in a defined area
- 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.
- nautical mile – measure used in navigation based on length of one minute of arc of a great circle (about 6, 076 feet)
- NOWRAMP – Northwestern Hawaiian Islands Reef Assessment and Monitoring Program

HAWAI‘I DOE RUBRICS

Advanced	Proficient	Partially Proficient	Novice
Science			
Evaluate and revise conclusions and explanations using justifications based on new scientific evidence	Explain the need to revise conclusions and explanations based on new scientific evidence	Identify the need to revise conclusions and explanations based on new scientific evidence	Recognize the need to revise conclusions and explanations
Explain how print and electronic sources can be used to provide scientific information and evaluate the sources used for validity and reliability	Explain the use of reliable print and electronic sources to provide scientific information and evidence	Explain that print and electronic sources can be used to provide scientific information and evidence	Recognize that print and electronic sources can be used to provide scientific information and evidence



Language Arts

Use substantive information from an extensive variety of grade-appropriate print and online resources to thoroughly research an inquiry question	Use relevant information from a variety of grade-appropriate print and online resources to research an inquiry question	Use some relevant information from a selection of grade-appropriate print and online resources to research an inquiry question	Use very little relevant information from grade-appropriate print or online resources to research an inquiry question
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TEACHER BACKGROUND INFORMATION

The following information is reprinted with permission from a Teacher's Guide to Navigating Change:

The Northwestern Hawaiian Islands include three types of islands: Nihoa, Necker, and Gardner Pinnacles are volcanic basalt; Laysan and Lisianski are coral islands with fringing reefs; and French Frigate Shoals, Maro Reef, Pearl and Hermes Reef, Midway, and Kure are atolls.

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.

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).

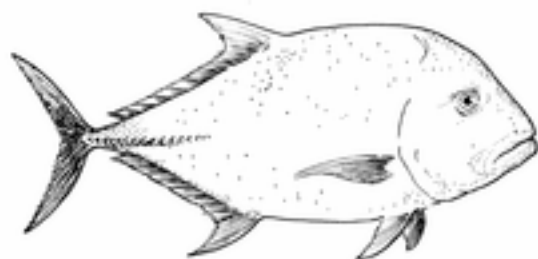


On a more positive note, since 1970 there has been much progress in island restoration; rats have been completely eliminated from the NWHI and entire invasive and aggressive plant species have been replaced with native plants. In 2003, Laysan ducks were translocated from Laysan Island to Midway Atoll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



ulua; giant trevally
(*Caranx ignobilis*)

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 2000 NOWRAMP expedition:

- 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.

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 coral 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

“Kūpuna” Islands in the Papahānaumokuākea Marine National Monument

ISLAND NAME (ENGLISH)	ISLAND NAME (HAWAIIAN)	DESCRIPTION
Nihoa	Nihoa	A small basaltic islet with many archaeological sites
Necker Island	Mokumanamana	A small basaltic islet with numerous <i>heiau</i> (temple)
French Frigate Shoals	Kānemiloha'i	An atoll of reefs, low sand islets, and the 120-foot-high La Pérouse Pinnacle



Gardner Pinnacle	Pūhāhonu	Pūhāhonu means “surfacing of a turtle for air.” These two isolated islands and various rock outcroppings seem to appear unexpectedly to voyagers at sea, like a turtle coming up for air, its back and head emerging above the surface. Turtles can often be seen resting on crevices and rock ledges at Pūhāhonu.
Maro Reef	Ko'anako'a	Breakers generally cover this atoll.
Laysan Island	Kauō	This flat island surrounded by sand and surf and harboring a pond resembles a bird's egg, cracked open, with the yolk surrounded by egg white. “Kauō” is used to identify the yolk of an egg or the egg white. Kauō is the habitat of thousands of birds.
Lisianski Island	Papa'āpoho	The literal translation describes the physical appearance of Papa'āpoho, a flat island with a depression.
Pearl and Hermes Atoll	Holoikauaua	This atoll is named for the endangered Hawaiian monk seal, which frequents local waters and hauls out on the beaches. Holoikauaua means “dog-like animal that swims in the rough waters.”
Midway Atoll	Pihemanu	Along with many of the “kūpuna” islands, Pihemanu is a refuge for birds. Its name means “the loud din of birds.”
Kure Atoll	Mokupāpapa	It is the northwestern-most island in the Hawaiian archipelago. It is thought to have been the place where one of Pele's brothers was left as a guard during Pele's voyage to Hawai'i from Kahiki.

Source: Adapted from Kimura, L.L. (1998). *Hawaiian Names for the Northwestern Hawaiian Islands*. In J.O. Juvik & S.P. Juvik (3rd ed.). *Atlas of Hawai'i* (p.27). Honolulu, HI: University of Hawaii Press and from the Hawaiian Lexicon Committee. Reprinted from a Teacher's Guide to Navigating Change.

Note: In numerous instances traditional place names either were replaced with foreign ones or the Hawaiian names were misspelled to the degree that their meanings were changed. The island names of Nihoa and Mokumanamana are the old names that have been passed down through genealogy, stories, and chants. Kānemiloha'i and Mokupāpapa are old Hawaiian names found in chants that have a new association here. These names and other Hawaiian names were assigned to the islands recently by the Hawaiian Lexicon Committee.



TEACHING SUGGESTIONS

1. Write the focus question for this lesson on the board and show the Navigating Change video segment “Change Over Time” to the class.

1. 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 does it mean to say that the NWHI provide a baseline for us to compare reefs of NWHI to the MHI?
- After watching the video, what is the most significant difference you see between the NWHI and MHI?
- How do we know what we know about these “kūpuna” islands?

2. Set the stage for students’ team research by showing video clips and discussing how researchers collect data.

- Show some of the video clips: Nowramp02_Navigating_Change.mov (4:25 minutes) and Nowramp02_underwater.mov (2:47 minutes) and explain that the scientists were part of the Northwestern Hawaiian Islands Reef Assessment and Monitoring Program (NOWRAMP) expeditions to the NWHI to find out what we could learn from these elder islands.
- Show the TowDiver.mov (0:25 seconds) and explain that this is the first team into the water. Two divers are towed along by a boat to allow for a fast survey over a large area as they record video of the habitat. Explain that other teams including fish, invertebrates, coral, *limu* and land teams use transects (lines) to swim along or walk along and collect data. Let students know they will learn to use transects to conduct their own research in the lessons that follow.

3. Divide the class into ten teams to research the major findings from the NOWRAMP expeditions (one team for each of the 10 NWHI).

- Have each team select one of the islands to research:

Nihoa	Laysan Island
Necker Island	Lisianski Island
French Frigate Shoals	Pearl and Hermes Atoll
Gardner Pinnacle	Midway Atoll
Maro Reef	Kure Atoll
- (Note: Students could draw island names out of a box or be assigned names to make sure all islands are covered. Students could also conduct individual research about an island and then pool their findings as they prepare team presentations.)



4. Distribute the expedition sheets for the appropriate island to each team and review tasks for students to complete.

- Review the tasks listed for student research.
- Explain to students that video clips from the expedition depicting each island are on classroom computers (or CDs) for student teams to use.
- Review expectations for team presentations and stress the need for each student to participate. Note that some teams are asked to present general findings about fish or corals to the rest of the class.

5. Give teams time to conduct some of their research in class and then schedule team presentations.

- Review effective ways to take notes of major findings as students listen to each team's presentation.
- Encourage teams to share the video clips of their island during their presentations.

6. Show the Comparing Reefs PowerPoint presentation and discuss it with students.

Discussion Questions

- What is a shifting baseline?
- How do the reefs of the "kūpuna" islands provide a baseline for comparing changes to our reefs in the MHI over time?
- How does this information cause us to revise our understanding of the reefs in the MHI today?
- Should we limit fishing since current fish stocks in the MHI are 20 – 25% of what they were 100 years ago? Why or why not?

7. Distribute Learning Log – 5 and have students complete the assessment.

- Ask students to share their conclusions and summarize the major findings from the expedition.

ADAPTATIONS / EXTENSIONS

Encourage students to learn more about the new Papahānuamokuākea Marine National Monument. Go to: <http://www.hawaiiireef.noaa.gov/> and download the Citizen's Guide from the center of the home page.

On the island of Hawai'i, have students visit NOAA's Mokuapāpapa Discovery Center in Hilo where they 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://hawaiiireef.noaa.gov>; phone: (808) 933-8195.



REFERENCES

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

A Teacher's Guide to Navigating Change. 2nd Edition. 2008. Bishop Museum, The Co-Trustees of the Papahānaumokuākea Marine National Monument, and Polynesian Voyaging Society. Honolulu, HI.

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

LOOKING TO THE *KŪPUNA*

TEACHER ANSWER SHEET

ISLAND	DESCRIPTION & LOCATION	NOTES FROM THE NOWRAMP EXPEDITIONS
Nihoa	A small basaltic islet; 240 nautical miles northwest of O'ahu	<ul style="list-style-type: none"> Inhabited between 1000 and 1700 A.D. Archaeological features - house and religious sites and sweet potato terraces Hawaiian coastal scrub community found here – only remaining example in world. Development and human impact led to loss in MHI. Native <i>loulu</i> fan palm - fed on by introduced grasshoppers; transplanting palms to other NWHI that don't have the grasshoppers.
Necker Island Mokumanamana	A small basaltic islet; 90 nautical miles east of French Frigate Shoals	<ul style="list-style-type: none"> The island has many stone shrines, which may have been used for navigation purposes. The placement of these upright stones is similar to shrines found in the Marquesas Islands. Sea cucumbers, sea urchins and lobsters found here; also giant <i>opihī</i>, which are no longer found in MHI 16 species; table coral (<i>Acropora</i> spp.) Table corals probably dispersed from Johnston Atoll; corals are habitat for diversity of fish, such as the chevron butterflyfish that feed on it.
French Frigate Shoals Kānemiloha'i	Atoll of reefs, low sand islets, and the 120-foot-high La Pérouse Pinnacle; 500 nautical miles northwest of Honolulu	<ul style="list-style-type: none"> Monk seals (endangered) – largest population in NWHI found here, and green sea turtles (threatened) over 90% of their population nest here. As many as 600 species of invertebrates found; at least 3 new to HI. 41 species of stony coral (more than any other NWHI); Clams that have never been recorded before; 75 different sponge species of which 60 are new records for HI. Islets provide nesting grounds for hundreds of thousands of seabirds. Their guano on La Perouse Pinnacle enriches the water, providing nutrients for algae.
Gardner Pinnacle Pūhāhonu	Two isolated islands and various rock outcroppings; 150 nautical miles east southeast of Maro	<ul style="list-style-type: none"> Second highest fish biomass observed in the NWHI Only island in NWHI where no alien plants were found Giant <i>opihī</i> found in intertidal areas; no longer found in MHI Land team found 9 species of seabirds including terns, noddies, boobies, and frigate birds; also found what may be 2 new spider species



<p>Maro Reef Ko'anako'a</p>	<p>Largest coral reef in NWHI; 60 nautical miles east of Laysan</p>	<ul style="list-style-type: none"> • Lots of gray reef sharks SE of Maro and Galapagos sharks NW of Maro <p>For NWHI in general:</p> <ul style="list-style-type: none"> • Divers frequently found large apex predators (<i>ulua</i>, sharks, and amberjacks); much more than in MHI. • Large <i>ulua aukea</i> (giant trevally) were bold and curious and sometimes bit divers' hands. • Hard pink encrusting algae acts like cement to hold reefs together. Provides food for herbivores like parrot fish and mollusks. • Many reef habitats – steep slopes, overhangs, holes and caves, patch reefs, shallow lagoon and sand flats may account for lots of fish and coral species.
<p>Laysan Island Kauō</p>	<p>Coral island 120 nautical miles east of Lisianski</p>	<ul style="list-style-type: none"> • Island has large interior salty lake that Laysan duck relies on for habitat. • Laysan finch and duck (endangered) found here; fossil bones of duck found at Mokapu mean duck had wider range. • Past human impact – guano mining, feather poaching, and alien rabbits – caused Laysan albatross population to drop and other land birds to go extinct. • Island recovery – removal of alien plants and restoration of native vegetation
<p>Lisianski Island Papa'āpoho</p>	<p>Atoll located 150 nautical miles southeast of Pearl and Hermes Atoll</p>	<ul style="list-style-type: none"> • Monk seals and green sea turtles frequent visitors • Tow divers describe "coral gardens" and reefs as among most scenic they observed. • Fish Biomass NWHI compared to MHI in general: • Apex predators in NWHI much higher biomass than in MHI • Lack of human population is main cause of difference • Herbivores make up more of the reef community in the MHI.
<p>Pearl and Hermes Atoll</p>	<p>Atoll located 90 nautical miles east southeast of Midway</p>	<ul style="list-style-type: none"> • Number of coral species is 3rd highest in NWHI after French Frigate Shoals and Maro Reef. These atolls all have protected shallow reefs and lagoons that are protected from wave action and have many different habitats for different types of coral and marine life. • Rare sponges – 7 new species on a single dive found in unique lagoon habitats • Habitat for nesting seabirds, endangered Hawaiian monk seal pups, spinner dolphins, and green sea turtles



Midway Atoll	Along with many of the “kūpuna” islands, Pihemanu is a refuge for birds.	<ul style="list-style-type: none"> • Divers frequently followed by endemic <i>hapu'upu'u</i> (grouper); found at depths greater than 300 ft. in MHI, but in shallow water here • Big spectacled parrotfish, Hawaiian hogfish, and bigeye emperor are abundant and grow to large size in NWHI; overfishing probably accounts for loss of these fish in MHI • Lagoon is habitat for many juvenile fish, including large number of cleaner wrasses and pods of dolphins • Reefs impacted by U.S. Navy – fishing pressure reduced numbers; alien <i>limu</i> found here was only concentration found during expedition – probably from ship's hulls. Water in lagoon is also polluted from human activity
Kure Atoll Mokupāpapa	Atoll; 1,240 nautical miles northwest of Honolulu	<ul style="list-style-type: none"> • Alien big-headed ants are “ecosystem-busters” here; they prey on native species and have no natural predators; recorded at 26,500 ants/sq. meter. • <i>Verbasina</i> plants also take away seabird nesting habitat. • Giant groupers (<i>hapu'upu'u</i>), which are rare in MHI, are common here; they followed divers like giant curious puppy dogs • Scientists surprised to find abundance and diversity of corals, echinoderms, crustaceans, and mollusks in these cooler northern waters.