

Introduction

Vision for Navigating Change (Educational Objectives & Messages)

Community Outreach Ideas

Workshop Schedule

Lending Box Information

Acknowledgment of Participating Agencies & Personnel

Contact Information for the NWHI Educator's Workshop Committee:

The NWHI Educator's Workshop Committee offices are located at Bishop Museum, Education Department, Honolulu, Hawaii. Our office hours are weekdays from 8:00 a.m to 5:00 p.m. Hawaiian Standard Time. We can be reached at:

808-848-4149

808-847-8250 (fax)

e-mail education@bishopmuseum.org

Web Site: <http://bishopmuseum.org/nwhi>

Or

The NWHI Educator's Workshop Committee

Bishop Museum

1525 Bernice Street

Honolulu, HI 96817

Vision for Navigating Change

Why are we going?

The Northwestern Hawaiian Islands are one of the most precious ecosystems in the world. They are rich with birds, monk seals, sea turtles, reef life, endemic plants and insects as well as cultural history.

Visiting the Northwestern Hawaiian Islands allows us to envision a world of healthy ecosystems, sustainable natural resources, and diverse cultures living in harmony and taking responsibility for the future of our planet.

As we voyage to these islands, we hope to inspire our audience to understand and embrace our natural and cultural world so they can make informed decisions that impact our future.

Our hope is – Malama Hawai'i, to take care of Hawai'i, and Malama Ka Honua, to take care of the Earth.

We expect:

1. To appreciate the ecology of the Northwestern Hawaiian Islands and relate it to ecosystems close to home.
2. To understand man's impact on the Northwestern Hawaiian Islands and to understand man's impact on ecosystems.
3. To malama the Northwestern Hawaiian Islands, the Main Hawaiian Islands, and the Earth.
4. To take action for the future regarding Malama Hawai'i.
5. To take action for the future regarding our own communities (Malama Ka Honua).

Educational Messages:

Taking care of our environment and resources is everyone's responsibility and is essential for the future of the inhabitants of this planet.

- **ECOLOGY:** Life on small islands provides a microcosm for understanding how we can live in balance with our natural environment and each other.
- **HUMAN IMPACT:** Our actions impact the environment more than any other living thing. We can impact our environment as much positively as we do negatively.
- **MALAMA:** The fragile ecosystem of a coral reef illustrates the delicate balance of nature. Upsetting this balance can cause serious consequences.

ACTIONS FOR THE FUTURE: The cultural values of people who have survived long periods of time in the same region support the need to live in harmony with the environment. The cultures of today need to recognize the importance of making informed choices about the use of our natural resources and the impact we have on our environment.

Table of Contents

Introduction

- Vision for Navigating Change (Educational Objective & Messages)
- Community Outreach Ideas
- Workshop Schedule
- Lending Box Information
- Acknowledgment of Participating Agencies & Personnel

The Hawaiian Archipelago

- The Map of the Hawaiian Archipelago
- Geology: Life of the Islands
- Hotspots / The Hawaiian Hotspot / Thermal Plumes / Hot Hydrothermal Vents /
Types of Lava / Lava Tubes in Hawaii / The Youngest Volcano in Hawaii
– Lo’ihi / Hawai’i’s Changing Beaches
- Islands to Atolls
- Historical Timeline of the NWHI
- Descriptions of the NWHI
- Environmental Conditions – El Nino / Hurricanes / Tsunamis

Hawaiian Culture and Protocol

- Hawaiian Names for the NWHI
- Hawaiian Seasons, Weather Patterns and Months
- Hawaiian Language & Vocabulary
- The Kumulipo – Hawaiian Creation Chant
- Polynesian Migrations, Canoes, and Wayfinding
- Personal Stories of Nihoa & Necker Islands

Hokule’a

- The Hawaiian Canoe
- The Founding of the Polynesian Voyaging Society
- The Building of Hokule’a
- Voyaging Into the New Millennium

Marine and Terrestrial Ecology of the NWHI

- NWHI Reefs & Marine Ecosystems
- Underwater Apartment Building
- New Species Evolve by Adapting to New Environment
- Habitat Description
- Coral
- Glossary of Coral Technical Terms
- Algae
- Marine Invertebrates
- Invertebrate Habitat Descriptions & Community Integrity
- Fish
- Shallow Reef, Mid Reefs and Open Ocean Chart

Marine Turtles
Monk Seals
Terrestrial Environment
Terrestrial Studies
Seabirds of the NWHI
Names of the Sea and Land Birds of the NWHI
Bird Habitat Descriptions & Community Integrity
Insects
Plants
Terrestrial Plant Species
Scientific Classification System / Categories
Model for Making an Evolutionary Tree

Human Impact

Marine Debris & Pollution
Alien Seaweeds in Hawai'i
10 Things To Help Protect Hawai'i's Coral Reefs From Alien Seaweeds
Threats to Habitats & Species
Polynesian Culture
Panala'au: Living on an Atoll in 1935
How Military Powers Affected Atolls
Environmental Effects of Aquaculture
Research in the NWHI National Wildlife Refuge

Malama & Actions for the Future

Legal Status & Protection
Executive Order 1019 – President Theodore Roosevelt
Executive Order 13178 / 13196 – President Bill Clinton
Expedition Conservation Protocols
Research in the NWHI National Wildlife Refuge
13 Things You Can Do To Protect Hawaii's Coral Reefs

References and Additional Resources

Reference List
Online Website Resources
Relevant Newspaper Article Reference List
Additional Resources & Literature
Glossary of Terms

Community Outreach Ideas

Highlight the natural beauty and habitat of the surrounding environment

- Pristine environment -The NWHI is a 1,200-mile stretch of atolls, volcanic islands, seamounts, banks and shoals, creating the most extensive coral reefs in the United States;
- Contains approximately 3% of the world's coral reefs, of which 50-70% of U.S. coral reefs are in the NWHI; and
- Home to endemic Hawaiian Monk Seals, the Green Sea Turtle, millions of seabirds, countless reef fish, invertebrates, and other marine mammals.

Signify relevant connections between our culture and ancestors of the past

- Lifestyle
 - Fishing (techniques, tools, types of fishes)
 - Dwellings (materials, styles, location)
 - Food Grown & Eaten (sweet potato, coconut, ect...)
 - Means of transportation (canoe voyages)
 - Songs, Chants

Geographical Importance & Geological Relevance

- Connection to the Main Hawaiian Islands (MHI)
 - Part of the same archipelago
 - Inhabited by Native Hawaiians
- Compare & Contrast (MHI verses NWHI)
 - Fish biomass (i.e. Apex Predators, Herbivores & Low-level Carnivores)
 - Terrestrial inhabitants (i.e. mammals, birds, insects & plants)
 - Invertebrates (i.e. sponges, corals, worms, snails, lobsters, crabs, shrimp, clams, oysters, sea urchins & seastars)
 - Algal & Seaweed variations
- Reasons for implementing responsible change
 - To develop a more informed and educated community, who understand the importance of protecting and preserving the NWHI;
 - To increase awareness among Hawaiian citizens, regarding their personal role in shaping the future of Hawaii.

Showcasing individuals (past and present) who have conducted work, specific to the NWHI (i.e.: ecology, marine life), with the goal of building hope for the future

How do we create meaningful programs in the community

- Contact and educate the following user groups & audiences of all islands
 - Ocean users
 - Canoe clubs
 - Teachers
 - Higher education classes
 - Develop and implement curriculum in schools
 - Boys & Girls Club
 - Harbor masters
 - Neighborhood boards near coastal areas

The Overall Project, Strategy & Goals

1. **STRATEGY:** To develop Kaneohe Bay as an “ocean learning center” emphasizing the integrated elements of marine science and the Hawaiian culture.

GOAL: To use the natural resources of Kaneohe Bay as a tool to educate and inform students, adults, and the greater community, about their surrounding environment and the role they play in its preservation.

2. **STRATEGY:** To integrate and develop quality programs for teachers to implement in the classrooms (primary education and higher education institutions).

GOAL: To create awareness and educate students through an integrated ocean curriculum.

3. **STRATEGY:** To develop a program that directly involves members of the greater community, specifically those with leadership roles, for example, politicians and people holding a government office.

GOAL: To increase government participation through the involvement of community leaders, with the help of teachers, their students and the greater community.

Lending Boxes: Check it out... literally!

Take a variety of Museum replicas, teaching tips, teacher reference materials, student books, and artifacts into your classroom. The Education Department provides a number of interactive Lending Boxes to enhance your curriculum. Lending Boxes are appropriate for grades K- 12, unless otherwise specified. Bring the Museum to Your Class!

Lending Boxes may be borrowed for one-week period by any O‘ahu school for a fee of \$15, two-weeks for \$20.

- Reservations required
- Payment may be made by cash, check or purchase order
- \$5 fee per working day for late returns
- Call the Education Department Office @ 848 4168 to reserve a lending box

Lending Boxes

Fishhooks and Fishponds: Get hooked! Take a look at traditional Hawaiian fishhook replicas along with the tools that were used to make them. Included is a video containing excerpts from **two films, "Ke Kai: The Sea" and "Ka Hana No‘eau Hawai‘i."**

Kaho‘olawe (K-12): Experience Kaho'olawe and its rich history through hands-on interaction with more than thirty natural and cultural objects, contemporary and historic photographs, a map, an award-winning book, a CD-ROM, videotapes and more. A full-scale teacher packet with thirty lesson plans and teacher background materials are included.

Sharks: Take a bite of mystery out of this fascinating species and study small freeze-dried sharks, shark jaws and fossil shark teeth. You'll even examine a "mermaid's purse." Included is the video "Sharks: Fact and Fantasy."

Volcanic Rocks: You'll erupt and flow with knowledge after viewing the video "Inside Hawaiian Volcanoes," and examining 13 different volcanic rock specimens.

Northwestern Hawaiian Islands: A hands-on experience for kids to learn about the environment and ecology of the NWHI through replicas of ancient tools and objects found on the islands of Necker and Nihoa.

Northwestern Hawaiian Islands (NWHI) Educator's Workshop July 1st - 6th of 2002

ACKNOWLEDGMENTS

Mahalo to all the helpful people and the support of their agencies who dedicated their time and shared their expertise in developing this workshop and related teacher manual. Without their kokua this project would not have been possible.

Bishop Museum:

Thomas C. Cummings, Jr., Education
Brad Evans, Education
Cindy Hoddick, Education
Kealoha Kelekolio, Education
Lokelani Kenolio, Education
Susan Lebo, Hawaiian Pacific Studies
Betty Tatar, Hawaiian Pacific Studies
Larry Wiss, Education
Jacey Waterhouse, Education
Bob Moore, Hawai'i Maritime Center

Polynesian Voyaging Society:

Na'aleau Anthony
Shantelle Ching
Pat Duarte
Dennis Kawaharada
Liz Kilbey
Nainoa Thompson

Department of Education:

Hilary Apana-McKee

Department of Land and Natural Resources:

National Ocean Marine Sanctuary:
Division of Aquatic Resources (DAR):
Forestry & Wildlife:

'Aulani Wilhelm
Dave Gulko
David Smith

US Fish and Wildlife Services:

Beth Flint
Ann Hudgins
Rob Shallenberger
Alex Wegmann
Mike Richards

University of Hawaii:

Malia Chow
JoAnn Leong

Western Pacific Regional Fishery Management Council: Cindy Knapman

Wakiki Aquarium:

Cindy Hunter
Mark Heckman

The Hawaiian Archipelago

The Map of the Hawaiian Archipelago

Geology: Life of the Islands

Hotspots / The Hawaiian Hotspot / Thermal Plumes / Hot

Hydrothermal Vents / Types of Lava / Lava Tubes in Hawaii / The

Youngest Volcano in Hawaii – Lo’ihi / Hawai’i’s Changing Beaches

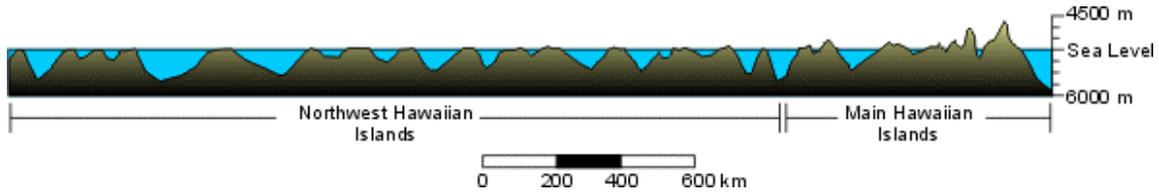
Islands to Atolls

Historical Timeline of the NWHI

Descriptions of the NWHI

Environmental Conditions – El Nino / Hurricanes / Tsunamis

Geology: Life of the Islands



The Northwestern Hawaiian Islands are part of a long line of volcanoes. A hotspot under the oceanic plate provides lava to build mountains from the bottom of the sea. As the Pacific Plate slowly moves northwest over the hotspot, a chain of volcanic mountains is created. The hotspot that has created the Hawaiian Islands has been erupting from underneath the Pacific Plate for more than 50 million years.

As undersea volcanoes grow they eventually are exposed on the surface. They continue to grow as long as new lava is extruded. Eventually, when an island has moved off of the hotspot, it no longer increases in size.

Subsidence and erosion gradually wear away volcanic islands. Eventually, all that is left of the island is a ring of coral, an atoll. Given enough time, this too will sink under the waves, eventually sinking so low that corals cannot grow and maintain the atoll. These underwater mountains are called guyots.

For most coral to grow, water must be relatively warm and shallow, since energy from the sun is used in photosynthesis. Deep water blocks all sunlight and only very specialized corals can survive.

Hotspots – Blow Torches from the Deep Earth

The Hawaiian Islands to the Aleutians. These islands, and many others on Earth, form when molten rock (magma) spews out at a hotspot. Hotspots are the surface expression of mantle plumes, hot columns of rock formed in the deep mantle of the Earth. Hotspots burn through the moving tectonic plates like a blowtorch and produce linear volcanic chains. The hotspot that has created the Hawaiian Islands has been erupting for more than 70 million years. Islands are part of a long chain of volcanoes that stretches from Hawai'i (Bishop Museum, *Xtreme Science*).

The Long Trail of the Hawaiian Hotspot

Over the past 70 million years, the combined processes of magma formation, volcano eruption and growth, and continued movement of the Pacific Plate over the stationary Hawaiian "hot-spot" have left a long trail of volcanoes across the Pacific Ocean floor. The Hawaiian Ridge-Emperor Seamounts chain extends some 6,000 km from the "Big Island" of Hawaii to the Aleutian Trench off Alaska. The Hawaiian Islands themselves are a very small part of the chain and are the youngest islands in the immense, mostly submarine mountain chain composed of more than 80 volcanoes. The length of the Hawaiian Ridge segment alone, from the Big Island northwest to Midway Island, is about equal to the distance from Washington, D.C. to Denver, Colorado (2,600 km). The amount of lava erupted to form the Hawaiian-Emperor chain is calculated to be at least 750,000 cubic kilometers-more than enough to blanket the entire State of California with a layer of lava roughly 1.5 km thick.

A sharp bend in the chain indicates that the motion of the Pacific Plate abruptly changed about 43 million years ago, as it took a more westerly turn from its earlier northerly direction. Why the Pacific Plate changed direction is not known, but the change may be related in some way to the collision of India into the Asian continent, which began about the same time.

As the Pacific Plate continues to move west-northwest, the Island of Hawaii will be carried beyond the hotspot by plate motion, setting the stage for the formation of a new volcanic island in its place. In fact, this process may be under way. Loihi Seamount, an active submarine volcano, is forming about 35 km off the southern coast of Hawaii. Loihi already has risen about 3 km above the ocean floor to within 1 km of the ocean surface. According to the hotspot theory, assuming Loihi continues to grow, it will become the next island in the Hawaiian chain. In the geologic future, Loihi may eventually become fused with the Island of Hawaii, which itself is composed of five volcanoes knitted together-Kohala, Mauna Kea, Hualalai, Mauna Loa, and Kilauea (United States Geological Survey, *The Long Trail of the Hawaiian Hotspot*).

Bishop Museum (2001, December). *Xtreme Science: Exploring Oceans, Volcanoes and Outer Space*. Honolulu, HI: Bishop Museum, as a part of the "Explores Program" an educational partnership with NASA.

United States Geological Survey. (1999). *The Long Trail of the Hawaiian Hotspot*. Retrieved on May 22, 2002, from <http://pubs.usgs.gov/publications/text/Hawaiian.html>.

Hotspots- Mantle of Thermal Plumes

In 1963, J. Tuzo Wilson, the Canadian geophysicist who discovered transform faults, came up with an ingenious idea that became known as the "hotspot" theory. Wilson noted that in certain locations around the world, such as Hawaii, volcanism has been active for very long periods of time. This could only happen, he reasoned, if relatively small, long-lasting, and exceptionally hot regions -- called *hotspots* -- existed below the plates that would provide localized sources of high heat energy (*thermal plumes*) to sustain volcanism. Specifically, Wilson hypothesized that the distinctive linear shape of the Hawaiian Island-Emperor Seamounts chain resulted from the Pacific Plate moving over a deep, stationary hotspot in the mantle, located beneath the present-day position of the Island of Hawaii. Heat from this hotspot produced a persistent source of magma by partly melting the overriding Pacific Plate. The magma, which is lighter than the surrounding solid rock, then rises through the mantle and crust to erupt onto the seafloor, forming an active seamount. Over time, countless eruptions cause the seamount to grow until it finally emerges above sea level to form an island volcano. Wilson suggested that continuing plate movement eventually carries the island beyond the hotspot, cutting it off from the magma source, and volcanism ceases. As one island volcano becomes extinct, another develops over the hotspot, and the cycle is repeated. This process of volcano growth and death, over many millions of years, has left a long trail of volcanic islands and seamounts across the Pacific Ocean floor. According to Wilson's hotspot theory, the volcanoes of the Hawaiian chain should get progressively older and become more eroded the farther they travel beyond the hotspot. The oldest volcanic rocks on Kauai, the northwesternmost inhabited Hawaiian island, are about 5.5 million years old and are deeply eroded. By comparison, on the "Big Island" of Hawaii -- southeasternmost in the chain and presumably still positioned over the hotspot -- the oldest exposed rocks are less than 0.7 million years old and new volcanic rock is continually being formed.

The possibility that the Hawaiian Islands become younger to the southeast was suspected by the ancient Hawaiians, long before any scientific studies were done. During their voyages, sea-faring Hawaiians noticed the differences in erosion, soil formation, and vegetation and recognized that the islands to the northwest (Niihau and Kauai) were older than those to the southeast (Maui and Hawaii). This idea was handed down from generation to generation in the legends of Pele, the fiery Goddess of Volcanoes. Pele originally lived on Kauai. When her older sister Namakaokahai, the Goddess of the Sea, attacked her, Pele fled to the Island of Oahu. When she was forced by Namakaokahai to flee again, Pele moved southeast to Maui and finally to Hawaii, where she now lives in the Halemaumau Crater at the summit of Kilauea Volcano. The mythical flight of Pele from Kauai to Hawaii, which alludes to the eternal struggle between the growth of volcanic islands from eruptions and their later erosion by ocean waves, is consistent with geologic evidence obtained centuries later that clearly shows the islands becoming younger from northwest to southeast (United States Geological Survey, *Hotspots – Mantle of Thermal Plumes*).

Bishop Museum (2001, December). *Xtreme Science: Exploring Oceans, Volcanoes and Outer Space*. Honolulu, HI: Bishop Museum, as a part of the "Explores Program" an educational partnership with NASA.

United States Geological Survey. (1999). *Hotspots- Mantle of Thermal Plumes*. Retrieved on May 22, 2002, from <http://pubs.usgs.gov/publications/text/hotspots.html#anchor19596916>

Hot Hydrothermal Vent

Hydrothermal vents are geysers, much like Old Faithful in Yellowstone National Park, except that they occur at the bottom of the ocean. Superheated water blasts out of these cracks in the ocean floor and mixes with the cold water of the ocean itself. Hydrothermal vents are among the hottest, but at the same time coldest, regions on Earth. They are home to some of the most unusual, and most recently discovered, living things on our planet (Bishop Museum, *Xtreme Science*).

Types of Lava and their characteristics

‘A’a is the rough, jumbled type of lava in Hawai’i and other volcanoes. It is less fluid than pahoehoe.

Pahoehoe is the smoother looking lava. It flows more easily than ‘a’a and its surface often looks like a crumpled sheet.

Lava before it erupts is called magma and it contains many dissolved gases, including water. When magma reaches the surface, the water comes out as steam. Some gases, like sulfur dioxide, make the fumes harmful to breathe. Then, if the lava hits the sea it fragments into glass particles that are carried up in the steam cloud, making the mixture even worse.

The direct method of measuring lava temperatures is with a device called a “thermocouple probe.” The probe is inserted into the flow, and the temperature is read from a hand-held device. It’s hard to get an accurate measurement because the lava is too hot to stand near for long.

The “runny-ness” of lava is its viscosity. Cooler lava is viscous and slow-flowing and hot lava is less viscous and faster-flowing (Bishop Museum, *Xtreme Science*).

Lava Tubes in Hawaii

Lava tubes can form near or away from eruptive volcanic vents. Lava generally flows from eruptive vents in lava rivers called channels. Over time the channel’s edge can build up and over the lava stream and form a roof, this creating a lava tube. Lava tubes form away from the eruptive vent when pahoehoe lava flows cool on the sides and top forming strong walls that contain and direct the lava flow. After the lava flow has stopped, the hot liquid empties out of the tube, leaving a hollow cave.

Lava tubes generally persist for about 1000 years, and at first people did not think that life could exist in such a remote place. However, in 1971 Francis Howarth started working in Hawaiian lava tubes and found they often support a whole community of specialized cave animals!

Bishop Museum (2001, December). *Xtreme Science: Exploring Oceans, Volcanoes and Outer Space*. Honolulu, HI: Bishop Museum, as a part of the “Explores Program” an educational partnership with NASA.

Physical Features:

- The lava tubes that are now carrying lava from Pu'u 'O'o vent 8 miles to the ocean are typically 10 – 15 feet in diameter and 5 – 20 feet beneath the surface.
- The tubes are generally wider and deeper near the vent and smaller and shallower near the coast.
- The lava flowing through the tube is rarely more than 5 to 6 feet deep flowing at speeds of less than two miles per hour.
- The fastest lava stream measured during the current eruption of Kilauea was travelling at a speed of nearly 16 miles per hour.
- Both Nahuku (the lava tube formerly known as Thurston) in Hawaii Volcanoes National Park and Kaumana lava tube along the Kaumana Drive in Hilo are open to the public and contain a variety of lava stream features.

Life:

- Many cave-adapted invertebrates (insects and spiders) exist in young lava tubes on at least five of the Main Hawaiian Islands; about 45 species of obligate cave-dwelling, evolved in most instances from known surface relatives (e.g. lycosid spiders and various crickets)
- These organisms are adapted to extremely constant conditions of temperature and humidity and the roots of surface plants, which provide a food supply.
- Cave ecosystems are destroyed when the overlying forest that provides the cave their life-giving root is lost.
- Crickets that are found in the lava tubes on Maui are pale colored and blind.

Web Sites: http://www.hvo.wr.usgs.gov/volcanowatch/1996/96_08_30.html
Lava tubes in Hawaii

The Bishop Museum. (2001, December). *X-Treme Science: Exploring Oceans, Volcanoes and Outer Space*. Honolulu, HI: Bishop Museum, as part of the “Explores Program” an educational partnership with NASA.

The Youngest Volcano in Hawai'i – Lo'ihi

Loihi is the most recent expression of the hotspot that produces the Main Hawaiian Island (MHI) chain. About 20 miles southeast of the Big Island and 3,200 feet deep, our youngest volcano, Lo'ihi, simmers. Although it's a respectable mountain in it's own right, about 13,000 feet tall and 17 miles long, it is dwarfed by Manua Loa, the world's largest volcano.

Physical Features:

- The summit of Loihi is 1000 meters below the ocean surface and it arises from the submarine slopes of Mauna Loa.
- Active hydrothermal vents exist surrounding Loihi and resemble those found at mid-ocean ridge spreading centers.
- Low temperature (30` C) and high temperature (over 200`C) vents have been discovered at Loihi.
- In September 1997, the Forbidden Vents were examined and submersible divers measured exit temperatures of over 200`C. These vents had, within the course of a year, spawned new hydrothermal chimneys comprised mostly of pyrite and barite.

Life:

- On a National Science Foundation sampling expedition to Loihi in 1999 scientists found microbial mats and a never before seen jelly-like bacterial mat surrounding the 160`C vents. These organisms are being studied at the Marine Bioproducts Engineering Center (MarBEC) here in Hawaii.
- Scientists will be cultivating the bacteria and archea extremophiles in order to explore their unique biochemistries in an effort to discover new product to help humankind,

Web Site:

- <http://www.soest.hawaii.edu/GG/HCV/loihi.html>
- http://oar.noaa.gov/spotlite/spot_loihi.html
- <http://www.marbec.net>

The Bishop Museum. (2001, December). *X-Treme Science: Exploring Oceans, Volcanoes and Outer Space*. Honolulu, HI: Bishop Museum, as part of the "Explores Program" an educational partnership with NASA.

Hawai'i's Changing Beaches

Beaches in Hawai'i are subject to erosion because of the number of homes and hotels built along its shores. This is not the only problem facing our beaches though. Pollution also damages beaches.

The beaches in Hawai'i obtain most of their sand from the surrounding reefs. When pollution or storms affect the health of the reef, that can affect how much sand the reefs are able to supply.

We can not blame humans for everything though! Large tropical storms also carry sediment away from the coastlines.

Beach Sand

Beaches in Hawai'i may be made of 'black sand' derived from the erosion of volcanic rocks, of 'white sand' made by marine organisms, or a mixture of both.

- On the windward side of the Big Island, black sand beaches are very common;
- The beach at South Point, Hawai'i is almost entirely green sand composed of olivine, a common mineral found in the volcanic rocks here in Hawai'i;
- On the Kona coast and on the other islands, the beaches have mixed compositions, some with a high volcanic component; some dominated by calcareous (reef-derived) sediment; and
- Beach and submarine sands in Kailua Bay on Windward O'ahu are almost entirely composed of reef-derived material.

Every beach is unique and has its own source and type of sediments.

Islands to Atolls

Current geological theory holds that a stationary “hot spot” beneath the Pacific tectonic plate is responsible for the origin of the volcanic Hawaiian islands and the adjacent Emperor seamount chain, which extend more than 2,000 miles across the north-central Pacific. Islands formed at the hot spot (where Hawaii Island is now located) are slowly carried to the northwest as the tectonic plate moves. Erosion and island subsidence gradually transformed the high islands to small basalt pinnacles as they moved to the northwest.

As these basaltic islands submerged, fringing coral reefs became atoll reefs. At a point in the archipelago between 27° to 31° N (the “Darwin Point”), coral growth fails to keep up with the continued submergence/erosion of volcanic islands, and the atolls “drown” to form seamounts.

French Frigate Shoals provides an interesting example of transitional phase in this geological process, since it is an atoll with well developed coral reefs, but it also has a small, basaltic pinnacle (La Perouse Rock) sticking up in the center of the lagoon.

The Hawaiian Islands National Wildlife Refuge is a geologically unique area and includes three different land forms: small islands with little beach area formed from volcanic basalt (Nihoa, Necker, and Gardner Pinnacles), coral islands with fringing reef (Laysan and Lisianski), and atolls formed on top of submerged volcanic remnants (French Frigate Shoals, Maro Reef, and Pearl and Hermosa Reef). These islands represent various stages in the volcano erosion and subsidence process, and the subsequent formation of atolls.

Historical Timeline of the NWHI

- 2000** – The Northwestern Hawaiian Islands Reef Assessment and Monitoring Program (NOWRAMP) expedition was launched as a multi-agency and institutional partnership that brought together the best field resources (people, equipment and funding) of both the resources trustees (State and Federal) and the academic community.
- President Bill Clinton calls for recommendations on the conservation of the NWHI and issues the Executive Order 13178 that creates the NWHI Coral Reef Ecosystem Reserve and protects Hawaiian cultural and religious uses.
- 1997** – Hui Malama I Ka Kupuna O Hawai'i Nei re-inters the remains of seven ancient Hawaiians at Nihoa and Necker
- 1995 – 2000** – Council contractors complete Review of Coral Reefs around American Flag Pacific Islands and assessment of need and feasibility of establishing a coral reef fishery management plan for the Western Pacific Region
- 1992** - LORAN (a marine navigation system station on Kure Atoll is closed)
- 1987 – 1991** – The Council establishes the Pelagic FMP (1987), MWHI Hoomalu Zone bottomfish limited entry program (1989), and Protected species Zone, 50 nm around NWHI, within which longline fishing is prohibited (1991)
- 1984** – A Bishop Museum Expedition finds 25 additional archeological sites on Nihoa and Necker
- 1980 – 1986** – The council establishes the Precious Coral Fishery Management Plan (1980), Crustaceans FMP (1983), and Bottomfish and Seamount Groundfish FMP (1986)
- 1978** – Following a Governor's Advisory Committee recommendation, NMFS, USFWS, the State of Hawaii, and the University of Hawaii begin a five-year cooperative research program to identify NWHI marine resources
- 1965 – 1959** – Japanese longliners annually expend up to 2,170 vessel days in the NWHI
- 1964** – Wilderness Act is passed, prohibiting commercial enterprise within a National Wilderness Preservation System

- 1946 – 1959** – Nine large commercial vessels fish in the waters of the NWHI
- 1942** – World War II leads to the development of a US Navy base at Midway Atoll
- Japanese fleet is defeated at the Battle of Midway, June 3-6
- 1941** - Midway is bombed by the Japanese on the same day as Pearl Harbor, marking the beginning World War II.
- 1925** - Tanager Expedition records travels to a number of islands studying plants, animals and geology. They also find 115 archeological sites that include ancient houses, agriculture and religious sites. Kenneth Emory is a part of this expedition. While on Laysan, they witness the extinction of the Laysan Apapane
- 1917** – Public officials deny requests to establish a fishing station and cannery at French Frigate Shoals
- 1909** - President Theodore Roosevelt creates the Hawaiian National Wildlife Refuge, a preserve and breeding ground for native birds, which extends from Pearl and Hermes to Nihoa, and includes Kure.
- 1908** – The rights to remove “products of whatever nature from the islands” of Laysan and Lisianski are given to Genkichi Yamanouchi, who exports tons of feathers and bird wings
- 1898** – The U.S. annexes “the Hawaiian Islands and their dependencies” through a joint Resolution of Annexation. Most of the NWHI are incorporated into the U.S.
- 1894** – Necker Island annexed by the Republic of Hawai’i
- 1893** – The Hawaiian Kingdom is overthrown
- 1890** – The Hawaiian Kingdom allows Captain George D. Freeth and Captain Charles N. Spencer to mine guano on Laysan and other Northwestern Hawaiian Islands for 20 years, for a royalty of 50 cents per ton
- 1886** – Kure is formally annexed o the Hawaiian Kingdom by King Kalaukaua
- 1885** – Lili’uokalani’s travel party arrive on Nihoa
- 1872** – Captain Dowsett of the whale ship *Kamehameha* discovers Dowsett Reef, just north of Maro Reef, which was discovered in 1820 by Captain Allen

- 1859** – The Midway Islands are discovered by Captain N.C. Brooks sailing under the Hawaiian flag. He named it Middlebrooks Islands (after himself), and claims it for the U.S. under the Guano Act of 1856; a law that authorizes Americans to temporarily occupy unclaimed Pacific islands to obtain guano
- 1857** – Kamehameha IV visits Nihoa and annexes this island as well as the rest of the Northwestern Hawaiian Islands to the Hawaiian Kingdom
- 1854** – Kamehameha III claims Pearl and Hermes
- 1828** – Laysan Island “discovered” by Captain Stanikowitch of the Russian ship *Moller*
- 1823** – Kure Atoll discovered by Captain Benjamin Morrell, Jr. of the schooner *Tartar*, who claims Kure to have an abundance of sea turtles and sea elephants
- 1822** – Ka’ahumanu annexes Nihoa to the Kingdom of Hawai’i
- Pearl and Hermes Atoll are accidentally found when the ships *Pearl and Hermes* run aground there
- 1820** – Gardner Pinnacles and Maro Reef discovered by Captain Joseph Allen of the brig *Maro*.
- 1805** – Captain Yurii Lisianski runs aground on what becomes known as Lisianski Island
- 1800** – Western sailing ships begin to exploit the area for seals, whales, reef fish, turtles, sharks, birds, pearl oysters, and sea cucumbers
- 1789** – Nihoa found by Western explorers. Captain Douglas was the first European to see the island, and named it Bird Island, referring to the multitude of its inhabitants.
- 1786** – Captain La Perouse, the first European to sail past Necker and names it in honor of the French Minister of Finance, Jacques Necker. The French Frigate Shoals are discovered
- 1779** – Captain Cook’s men are accompanied by a chief’s canoe headed to Ka’ula Island, off the coast of Kaua’i

- 1700** – Hawaiians from Kaua’i and Ni’ihau make regular canoe trips to Mokuapapa, an island west of Kaula, for turtles and seabirds
- 1500** – Habitation of Necker and Nihoa ends;
- 1200** – Pele, the Hawaiian Fire-Goddess, and her family arrive in Nihoa
- 1000** – Hawaiians settle on Nihoa
- 0 A.D.** – The first Hawaiian Voyagers arrive in the Hawaiian Archipelago

Bishop Museum. (2002). *Life on Islands*. Join a Research Expedition to the Northwestern Hawaiian Islands. Retrieved May 22, 2002, from <http://www.bishopmuseum.org/research/nwhi/timeline.shtml>

Gulko, D. & J. Maragos. (eds.). (2002). *Coral Reef Ecosystem 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: 46 pp.

Kearns, C., H. Sonoda, J. Norris. (2002, May). *The Ancestral Beginnings*. The Office of Hawaiian Affairs. Ka Wai Ola [Newsletter], p. 12.

Rauzon, M.J. *Isles of Refuge: Wildlife and history of the Northwestern Hawaiian Islands*. (2001). Honolulu, HI: University of Hawai’i Press.

Western Pacific Regional Fishery Management Council. (2002). *History of the Fisheries in the Northwestern Hawaiian Islands*. Retrieved May 15, 2002, from <http://www.wpcouncil.org/history.html>

Habitat Description

The Northwestern Hawaiian Islands contain more reef acreage than all of the main Hawaiian Islands, as well as greater diversity in habitat (e.g., lagoon complexes and barrier reefs). The islands comprise only 1% of land for the entire Hawaiian archipelago, but about 65% of the shallow water marine habitat. Fringing reefs and atoll reefs surrounding shallow lagoons are extensive in the area.

Corals are the most conspicuous members of the reef community, although other organisms such as coralline algae, mollusks, echinoderms, and foraminiferans aid in the reef building process. Coral reefs of the Hawaiian Islands National Wildlife Refuge provide habitat, shelter, and food for most [of the] hundreds of marine species. The species composition of corals on all reefs in the archipelago is remarkably uniform.

The geological and biological characteristics of the nearshore marine community in the Hawaiian Islands National Wildlife Refuge are intimately tied to the volcanic origin of the Hawaiian Islands, coral reef formation, and the northwestward movement of the Pacific plate. The emergent portion of all islands north of Gardner consists entirely of calcium carbonate, deposited by coral reefs and associated marine organisms. Were it not for coral growth, these islands would have sunk at the latitude of Gardner Pinnacles millions of years ago. Instead, corals and other calcifying organisms have built reefs, which have kept pace with sinking and erosion of the volcanic islands.

Recent studies have clearly demonstrated a pattern of reduced coral growth rates as a function of latitude, yet no large differences in coral community structure have been documented with the archipelago. Variations in coral species dominance do occur and some types of coral, such as the genus *Acropora*, are restricted to the center of the chain. The coral reefs of Hawaiian Islands National Wildlife Refuge offer a variety of habitat types, including seaward and leeward reefs, lagoons, coral flats, banks, and shoals.

Environmental Conditions

What is El Nino?

Normally, strong winds blow warm water in the Pacific Ocean towards Australia. The movement of warm water towards the west causes cold, nutrient rich water to rise to the surface off the coast of South America. Fish and sea life use these nutrients to keep them healthy. During El Nino seasons, the winds that normally bring warm water to the west weaken. That leaves no room for the cold nutrient rich water to rise, and makes the entire Pacific Ocean warmer.

Impact of El Nino

El Nino can alter weather patterns all over the Earth. Slight changes in weather can sometimes have drastic impacts on people's lives. Drought on the Big Island cost farmers their crops. Warmer Pacific waters increase the likelihood of hurricanes. Sea alge concentrations in the Pacific shrink, affecting the fishing industry. Corals all around the Pacific can bleach and die. Dry conditions create fire hazards in Volcanoes National Park.

By forecasting when El Nino seasons are likely to occur, people in affected countries can prepare. Farmers can plant crops that are more drought resistant, governments can act to conserve water, and fisheries can prepared for fewer catches.

Hurricanes

Hurricanes are the most destructive storms on Earth. They bring strong winds, high surf, and heavy rains. Most hurricanes that threaten the islands originate off the coast of Central America. Fortunately, most of them weaken while crossing the Pacific Ocean.

Although few hurricanes have hit the Hawaiian Islands, several storms have been very destructive. Hurricane Iniki, which struck Kaua'i in 1992, was a very powerful and destructive storm. It caused over \$2.3 billion in property damage.

What is a tsunami?

A tsunami is a series of ocean waves that appear when the shape of the bottom of the ocean moves. Large earthquakes located near the ocean floor most commonly cause these waves. However, large underwater landslides, underwater volcanoes, or massive meteorite impacts can also make them! Tsunamis move very fast over deep water, but slow and become higher as they approach the shore.

Tsunamis in Hawai'i

Being located in the middle of the Pacific means that the islands of Hawai'i get their fair share of tsunamis. While the most destructive ones have arisen from earthquakes around the Pacific Rim, our own islands have also produced some deadly ones.

On April 1, 1946, a strong earthquake with a magnitude of 7.1 occurred in the Aleutian Islands off Alaska. The waves generated from that earthquake took less than 5 hours to reach Hawai'i. In all, 159 people lost their lives, including many school children. The next major tsunami to reach Hawai'i occurred in 1960, and originated off the coast of Chile. Hilo was the hardest hit, where waves reached speeds of 30 mph, and 61 people died.

Tsunami Travel Times

How long would it take for a tsunami to hit Hawai'i?

Tsunami waves travel as fast as a jet plane when in deep ocean water, leaving only a few hours for people to prepare. Scientists use seismometers to warn them of large earthquakes as soon as they occur. They can predict if a tsunami will hit, by using information on when and where the earthquake occurred.

Hawaiian Culture and Protocol

Hawaiian Names for the NWHI

Hawaiian Seasons, Weather Patterns and Months

Hawaiian Language & Vocabulary

The Kumulipo – Hawaiian Creation Chant

Polynesian Migrations, Canoes, and Wayfinding

Personal Stories of Nihoa and Necker Islands

Hawaiian Names for the Northwestern Hawaiian Islands

An important aspect of the Hawaiian cultural rebound is the awareness that 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 Hawaiian Lexicon Committee has identified the following names for some places in the Northwestern Hawaiian Islands:

Mokumanamana (Necker Island) – The original name. A small basaltic islet with numerous heiau.

Mokupapapa (French Frigate Shoals) – An atoll of reefs, low sand islets, and the 120-foot-high La Perouse Pinnacle. Moku ‘islet’ combined with papapa ‘low, flat, expansive reef’ means ‘islet with low-lying reefs’. Recorded in chants, the name Mokupapapa refers to an island, or islands. Of the name’s description located northwest of Ni’ihau. The nearest shoal-like place is the French Frigate Shoals.

Puhahonu (Gardner Pinnacles) – 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. Although turtles are rarely sighted on land in the main islands, often they can be seen resting on crevices and rock ledges at Puhahonu.

Nalukakala (Maro Reef) – Because this atoll is generally covered by breakers, it is given a Hawaiian name that translates as ‘surf that arrives in combers’.

Kauo (Laysan Island) – This flat island, bordered by sand and surf and harboring a pond, resembles a bird’s egg, cracked open, with the yolk surrounded by egg white. Kauo can be either the yolk or the egg white, its meaning specified with the modifier melemele ‘yellow’ or ke’oke’o ‘white’. Denoting the contents of an egg, the name Kauo also signifies the thousands of birds that inhabit the island.

Papa’apoho (Lisianski Island) – The literal translation describes the physical appearance of Papa’apoho, a flat (island) with a depression.

Holoilauaua (Pearl and Hermes Atoll) – This atoll is named for the endangered Hawaiian monk seal – described in Hawaiian as a ‘do-like animal that swims in the rough’ – which frequents local waters and hauls out on the beach of several of the northwestern islands of Hawai’i.

Pihemanu (Midway Atoll) – Along with many of the Northwestern Islands, Pihemanu is a refuge for birds. Its name means ‘the loud din of birds’.

Kanemiloha’i (Kure Atoll) – The northwesternmost island in the Hawaiian archipelago is thought to have been the place where one of Pele’s brother was left as a guard during the voyage to Hawai’i from Kahiki. And so its name commemorates Kanemiloha’i. Now that the Hawaiian names of the northwestern islands have been identified, Hawaiian speakers may be tempted to amend the traditional saying, “From where the sun rises at Ha’eha’e [Kumukahi, Hawai’i Island] to its setting at Lehua [a small island north of Ni’ihau], to Mai ka pi’ina a ka la I Ha’eha’e a I ka la welowelo I Kanemiloha’i: “From where the sun rises at Ha’eha’e to its setting at Kanemiloha’i.”

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.

Hawaiian Seasons, Weather Patterns & Stars

Ho'oulo (Cooler, Wetter Season)

Welehu (Oct. – Nov.) – Makali'i (Pleiades) appears in the ENE sky after sunset. Rainy season. Makahiki, a four-month long harvest festival, dedicated to Lono, god of rain and agriculture, began towards the end of Kau and continued into the new year. 'opelu & akule fishing took place.

Makali'i (Nov. – Dec.) – Sun rises and sets at its southern limit (winter solstice). Land was prepared for planting, 'opule and akule fishing took place; 'ama'ama (mullet) spawning and kapu through February. Kohala (humpback whales) feed and breed in island waters through April.

Ka'elo (Dec. – Jan.) – 'A'a (Sirius) and Orion in the eastern evening sky. Planting season. 'Uala (sweet potato) planting to take advantage of winter rains. Reef and inshore fishing.

Kaulua (Jan. – Feb.) – Ke Ali'i o Kona i ka Lewa (Canopus) in the SE by S evening sky. Planting season. In traditional times, the aku kapu was lifted at the end of the Makahiki; 'opule kapu through July during its spawning season; reef and inshore fishing.

Nana (Feb. – Mar.) – Sun rises due east and sets due west (spring equinox). Mulch and weed gardens; vigorous plant growth begins. 'Ama'ama fishing season opens; malolo (flying fish) spawning.

Welo (Mar. – April) – Leo in the eastern evening sky. All things grow; crops maturing. 'Ama'ama and malolo fishing. Deep-sea fishing through summer. 'Ilio-holo-i-ka-uaua (monk seal) pups are born, spring through summer.

Kau (Hotter, Drier Season)

Ikiiki (April – May) – Makali’i in the WNW evening sky; Hokule’a (Arcturus) in the ENE evening sky. ‘Uala planting with summer rains. Great schools of malolo and moi (threadfish). Honu (green sea turtles) come ashore to lay their eggs in the sand through summer.

Ka’aona (May – June) – Sun rises and sets at its northern limit (summer solstice). Breadfruit ripens. Aku and ‘ahi (tuna) season; Ula (lobster) and moi kapu through August during their spawning seasons.

Hinaia’ele’ele (June – July) – Manaiakalani (Maui’s fishhook, or Scorpio) in the SE evening sky. Humid weather sudden storms. ‘Ohi’a’ai (mountain apple) ripens; groups and melons ripens. In traditional times, ‘opelu kapu lifted; aku kapu through Jan. during its spawning season; akule spawning.

Hilinaehu (July – Aug) – Leo in the western evening sky. ‘Ohi’a’ai abundant. He’e (octopus) fishing with lures.

Hilinama (Aug. – Sept.) – Sun rises due east and sets due west (fall equinox). Tubers ripen for harvest; sugar cane blossoms; vines dying off. Ula and moi season; ‘opelu fishing.

Ikuwa (Sept. – Oct.) – Iwakeli’i (Cassiopeia) in the NNE evening sky. Thunder and rain. Plant growth slows. Kalo and ‘uala harvest. Preparation for the Makahiki Harvest Festival. ‘Opelu and akule plentiful.

Ua (Rain)

The Hawaiian gods Lono and Kane were associated with rain clouds and rain. Lono is addressed as “ke-ao-loa” (the long cloud) and “ke-ao-poko” (the short cloud) and Kane is called Kane-i-ka-‘opua (Kane, the horizon clouds) and Kane i-ka-ao (Kane, the floating cloud). Kane was the god of water – ka waiola a Kane, “the life-giving waters of Kane,” were found in rain clouds.

Trade Wind Showers – Warm, humid air and clouds brought from the east by trade winds rise over mountains and condense into windward and mauka showers. Clouds above islands have distinctive shapes and can help a deep-sea voyager locate land.

Winter Rains – Cold fronts sweeping over the islands from the west push warm, humid air high into the atmosphere; towering cumulonimbus clouds form, bringing heavy rains preceded by strong southwesterly winds.

Makani (Wind)

Ka Moa’e, the trade Winds (predominately ENE; average speed 13.5 mph), are generated by the North Pacific anticyclone situated northwest of Hawai’i. This northern hemisphere high-pressure system, with winds turning clockwise, moves with the seasons. It is farther north in the summer, when the tradewinds prevail about 90% of the time; it moves closer to the islands in the winter, when the winds are, on average, lighter, more variable, and more easterly, with the trade winds prevailing about 40 – 60 % of the time. Strong, gusty trade occurs in both seasons. The winds veer around headlands, funnel through channels, mountain gaps, and valley, picking up speed; they slow up against high cliffs. Wind shadows occur on the leeward side of high mountains.

In summer, hurricanes spawned in the warmer ocean waters to the south and southeast may reach the islands. In winter, Kona storms bring southerly winds and rain; cold fronts moving across the islands from the west bring southwesterly winds and rain, followed by cool, dry northerly winds. On calm days, sea breezes blow onshore during the day, and land breezes blow offshore at night.

In ancient times the wind of Hawai’i were thought to blow from holes in the dome of heaven near the horizon. The wind deity La’amaomao called forth the winds of Hawai’i by chanting their names, Kanaloa, god of the ocean, controlled the sea winds; his sea form is the he’e (octopus); his landform is the banana.

Au (Currents)

Surface Currents are produced by wind blowing on the ocean surface and by temperatures and pressure variations in the ocean; surface currents around Hawai'i generally flow westward at .3 - .5 knots. Eddies form south of the islands due to the mixing of warm lee waters and upwellings of cool water along wind shear lines between the lee calm and trade wind flow.

Tidal Currents are caused by the rising and falling of the tide, which is caused by the gravitational pull of the sun and moon; the highest tides occur when the sun and moon are aligned (new moon and full moon). Near-shore tidal currents tend to flow parallel to shorelines. They may counteract or enhance surface currents and change direction when the tide changes. Ocean currents are difficult to detect or predict. "Ike i ke au nui me ke au iki –Knows the big current and the little current- is said of someone who is well versed or knowledgeable.

'Ale (Swells)

Swells are produced by winds and travel beyond the area where they were formed. On the Hawaiian star compass, swells move in a straight line from one directional house, through the center of the horizon circle, to a directional house of the same name on the opposite side of the circle. For example, a swell coming from Na Leo of the SW quadrant (SSW) will travel toward Na Leo of the NE quadrant (NNE). Swells from the same direction can persist for several days or longer and thus, can be used to orient a vessel at sea in particular direction. Swells reflecting off of or refracting around an unseen island are clues to its presence and bearing.

Hokupa'a (Stationary Star)

Stars like Holopuni (Kochab, lit. "To go around"), located less than 18.5 – 22.5° from the North Celestial Pole (NCP), are circumpolar in Hawai'i. They neither rise nor set, but circle the NCP in a counterclockwise path. This circular movement is due to the earth's rotation. One circle takes 24 hours to complete, so the movement of stars like Holopuni can be used to estimate the passage of time.

At the center of the circumpolar stars is Hokupa'a, the North Star, located very close to the North Celestial Pole. Hokupa'a appears to remain stationary in the sky, due north. In the Northern Hemisphere, the altitude of Hokupa'a is approximately equal to the latitude of the observer – in Hawaii, between 18.5° and 22.5° above the horizon.

Hanaiakamalama (Southern Cross)

Stars in the southern sky in Hawai'i appear to travel in low arcs above the horizon. The center of their arcs, the South Celestial Pole (SCP), is below the horizon.

Hanaiakamalama (Southern Cross) stands upright and points south as it crosses the meridian, which divides east and west. At the latitudes of Hawai'i, Ka Mole Honua (Acrux), the bottom star in the cross, transits the meridian about 6° above the horizon; Kaulia (Gacrux), the top star, is about 6° above Acrux.

Hoku ho'okelewa'a (Canoe –Guiding Stars)

Ancient Hawaiian voyagers such as Mo'ikeha, Kila, La'amaikahiki, Kaha'i and Pa'ao traveled between Hawai'i and Kahiki using stars and other celestial bodies as their guides.

A star rises, like the sun, in a particular directional "house" on the eastern horizon, travels across the sky, and sets in a corresponding house on the western horizon.

On the Hawaiian star compass, the house in which a star rises has the same name as the house in which it sets (eg., a star rising in 'aina of the NW quadrant (ENE), sets in 'aina of the NW quadrant (WNW). The house that a star sets in is at the same angular distance and in the same direction (i.e., north or south) from west as the house in which it rose is from east. Thus, the rising and setting points of stars are clues to directions.

Recognizing a rising or setting star and knowing the house it rises and sets in gives the observer a directional point by which to orient himself.

The rising points of the 21 brightest stars, on the compass to the left, are for stars rising at the Equator. As the observer moves away from the Equator, rising and setting points shift north for stars rising north of east; and south for stars rising south of east. At the north and south poles, stars travel in circles at fixed altitudes around the sky, without rising or setting.

Honolulu, HI: Polynesian Voyaging Society & The Bishop Museum.

Hawaiian Language & Vocabulary

Concepts & Terms

huaka'i:	Journey
imi'ike:	To seek knowledge
kuleana:	Rights, privileges, responsibility
kupa'a:	Steadfast, loyal
lokahi:	Harmony, unity, agreement
lokomaiika'i:	To share with each other
malama:	To care for, preserve, protect & maintain
na'ua pono:	To nurture a deep sense of justice
olakino maika'i:	To live healthy
'opala:	Trash
pono:	Goodness, well being, harmony with ourselves and with others

Animals

holoholona:	Animal
-------------	--------

Terrestrial Animals:

'ilio:	Dog
'io:	Hawaiian hawk
kao:	Goat
lio:	Horse
manu:	Bird
moa:	Chicken
mo'o:	Lizard
'ope'ape'a:	Hoary bat
pipi:	Cow
pueo:	Owl
pua'a:	Pig

Birds:

`a:	Masked booby
`a:	Red-footed booby
`a:	Brown booby
`ake`ake:	Band-rumped storm-petrel
'alae `ula:	Common moorhen
`ewa`ewa:	Sooty tern
'iwa:	Great frigate bird
ka'upu:	Albatross
koa`e kea:	White-tailed tropicbird
koa`e `ula:	Red-tailed tropicbird
manu-o-Ku:	White tern

moli:	Laysan albatross
noio:	Black noddy
noio koha:	Brown noddy
`ou:	Bulwer's petrel
pakalakala:	Gray-backed tern
`ua`u:	Dark-rumped petrel
`ua`u kani:	Wedge-tailed shearwater

Weather

anu:	Cold
hekili:	Thunder
ho'oilo:	Wet season
hu'ihu'i:	Cool
ikiiki:	Humid
'ino:	Storm
ka moa'e:	Trade-wind
kau wela:	Dry season
makani:	Wind
malie:	Calm
malo'o:	Dry
mehana:	Warm
'ohu:	Mist
'olu'olu:	Pleasant
'omalumalu:	Cloudy
pa ka makani:	Windy
pulu:	Wet
ua:	Rain
uila:	Lightning
wela:	Hot

Environment

'aina:	Land
aloha 'aina:	Respect and love for the land
honua:	World
kaiapuni:	Environment
ka puka 'an o ka la:	Sunrise- the emerging of the sun
ka napo'o 'ana o ka la:	Sunset- the setting of the sun
mokupuni:	Island

Plants:

kalo:	Taro
kumula'au:	Tree
kumu nui:	Coconut tree
meakanu:	Plant
'ohi'a'ai:	Mountain apple
pua:	Flower
'uala:	Sweet potato
'ulu:	Breadfruit

The Mountains:

ahi:	Fire
ahua:	Low rising hill areas
'alu ha'aha'a:	Deep ravines
apa'a:	Grasslands
awawa:	Valley
ho'oku'u:	Gradual sloping of ridges downward
kaha kua:	Flanks behind the mountain
kuahiwi:	Below the summit of a mountain, where a forest grows
lepo:	Dirt, earth, or soil
lua pele:	Volcano
malu:	Shade
ma uka:	Towards the mountains
mauna:	Mountain
mau'u:	Grass
nahele:	Forests
pali:	Cliff
pohaku:	Rock
punawai:	Pond
pu'u:	Hill or mound
wai:	Water
welau:	The peak or pinnacle

The Sea:

'ae kai:	The water's edge
'apapa 'aina:	Many islands
awa:	Harbor
hapapa:	Shoal
hapuna:	Where puddles of water remain standing
hono / hana:	Bay
hono:	Bay or island(s) that are close together
kai 'elemihi:	Land side of the reef
kai hohonu:	Deep dark blue seas
kai kahekaheka:	Makai side of the reef
kai ka'ili:	Sea for fishing with hook and line
kai kaka uhu:	Sea for netting uhu
kai kea:	White wave areas
kai ki'oki'o:	Salt collecting tide pools
kai kohola:	Shallows within the reef
kai lawai'a:	Sea for deep sea fishing
kai lipo:	Deep dark blue seas
kai lu'u:	Sea for diving
kai 'ohua:	Feeding grounds for small fishes
kai o leho:	Sea for octopus fishing
kai paeaea:	Sea for pole fishing
kai po'ina nalu:	Where the waves break
limu:	Seaweed
ma kai:	Towards the ocean
makawalu:	Islands that are scattered here and there also called 'aluka
moku kele:	A single island standing alone
pae'aina:	Archipelago
papa:	Reef
papa he'e:	Squidding grounds
pupu:	Shell

Marine Environment

kahakai:	Beach
kahaone:	Sandy beach
kai:	Sea
moana:	Ocean
nalu:	Wave
one:	Sand

Ocean Creatures:

‘ahi:	Yellow-fin-tuna
aku:	Bonito
akule:	Big-eyed scad
‘ama’ama:	Mullet
ea:	Hawksbill Turtle
hahalua:	Manta ray
he’e:	Octopus
hinalea:	Wrasse
honu:	Green Sea Turtle
humuhumunukunukuapua’a:	Trigger fish (Hawaii’s state fish)
i’a:	Fish
‘ilo holo i ka uaua:	Monk Seal
kohola:	Humpback whale
lupe:	Spotted ray
malolo:	Flying fish
manini:	Convict tang fish
mano:	Shark
moi:	Treadfish
nai’a:	Porpoise /Dolphin
‘opelu:	Mackerel scad
papa’i:	Crab
po’imalau:	Portuguese man-o-war
puhi:	Eel
ula:	Lobster
‘ula’ula:	Red snapper
wana:	Sea urchin

Ocean Objects:

‘iako:	Cross beams of a canoe or wa’a
pola:	Decking of a canoe, or wa’a
papa he’e nalu:	Surfboard
wa’a:	Outrigger canoe

Celestial

ao:	Clouds
anuenue:	Rainbow
hoku:	Star
hoku ae'a:	Wandering stars
la:	Sun
lani:	Heavens, sky, royal
mahina:	Moon
nani:	Beautiful

Directions:

'akau:	North
hema:	South
hikina:	East
ho'olua:	NW Horizon
komohana:	West
kona:	SW Horizon
ko'olau:	NE Horizon
malani:	SE Horizon

Stars and Planets:

'A'a:	Sirius
aohoku:	Jupiter
kamole honua:	Acrux
hanaiakamalama:	Southern Cross / Crux
hokule'a:	Arcturus / Star of Happiness
hoku lele:	Traveling stars
hokuloa:	Venus
hokupa'a:	The North Star / Polaris / Stationary Star
hoku'ula:	Mars
iwakeli'i:	Cassiopeia
kaulia:	Canopus
Ke Ali'i o Kona i ka Lewa:	Canopus
keoe:	Lyra
lehua-kona:	Antares / Souther Lehua Blossom
makali'i:	Pleiades
makulu:	Saturn
manaiakalani:	Scorpio
me'e:	Corus / Voice of Joy
na hiku:	Ursa Major / The Seven
ukaliali'i:	Mercury

Family & Friends

hanalima:	Worker. Literally means working hands
hoaloha:	Friend
ho'olaule'a:	Celebration
kama'aina:	Native born, or long time resident of a place, district, or country
kanaka:	Person
kanaka maoli:	People of Hawaii
kane:	Man
kokua:	To help or assist; to support or cooperate
kupuna:	An elder looked to for knowledge and guidance in traditional ways and teachings
laulima:	Cooperation; a group of people working together; literally means "many hands."
makua:	Parent
na honua I ho'ea'ia:	Land settlers
na ho'o kele:	Navigators
'ohana:	Immediate or extended family group
panala'au:	A colonist or a colony
wahine:	Woman

Spiritual Side

akua:	God
ali'i:	Chief
'aumakua:	Family, ancestral, or personal god
halua:	Place of learning
hau'oil:	Happy
heiau:	Temple, shrine, Pre-Christian place of worship
himeni:	To sing
ho'okupu:	Refers to ceremonial gift-giving to a god or a chief as a sign of honor, respect & thanks
ipu:	Gourd
kahu:	Honored attendant, guardian, or keeper
kahuna:	Expert or priest
Kanaloa:	God of the Ocean
kapu:	Forbidden or taboo
ko'i:	A stone adze
Ku:	God of war
kumu:	Teacher or master
La'amaomao:	Wind deity
lei hulu:	A feather garland for wearing around the head, neck, or as a hat band
Lono:	God of agriculture

mana:	Authority or divine power
mana'o:	Thought or feeling
mele:	Song
ola:	Life
'olelo:	Language
oli:	Chant
pahu:	Drum
Papa:	Our Earth mother
pono:	Just, rightness, or proper
pule:	To pray, a prayer
pu'uhonua:	Place of refuge, place of peace & safety
wahi pana:	Storied and sacred places, honored in legends and chants. These places are associated with the gods, temples & shrines; places having historical significance or special function
Wakea:	Our sky father

The Hawai'i Millennium Commission. (2000-2001). *Malama Hawai'i*. [Brochure].
Honolulu, HI: Polynesian Voyaging Society & The Bishop Museum.

Lake, J. K. (2000). *Hawaiian Land Divisions, Terminology's and Locations*. [Brochure]
Honolulu, HI: Bishop Museum.

Pukui, M. K. & Elbert, S. H. (1986). *Hawaiian Dictionary* (5th ed.) Honolulu, HI:
University of Hawaii Press.

“Language map” Series. (2001). *Hawaiian: A language map*. [Brochure]. Bilingual
Books, Inc. Seattle, WA: Kristine K. Kershul.

The Kumulipo – Hawaiian Creation Chant

According to historian Kekuni Blaisdell, the Kanaka Maoli of old were one with everything in their cosmos. And this is clear from the opening lines of the *Kumulipo*.

So literally those words refer to the turning of the fiery earth against the changing sky.

But the metaphor, of course, is the mating of Wakea, our sky father, with Papa, our earth mother. And out of that mating came and continues to come everything in our cosmos. And we as Kanaka Maoli (people of Hawaii) are just one of the many components of this cosmos.

So we Kanaka Maoli consider everything in our cosmos to be living, communicating, conscious. And so we communicate with everything and that is why we listen to the wind and the ocean and we observe the clouds and the rainbows, as well as the fish and birds.

And we can communicate with these forces and they guide us in our thinking and in our acts, And our chants simulate, our chants take on the great forces of our cosmos.

So we Kanaka Maoli are one, we are lokahi with everything in our cosmos, inherently, because we have the same parents and therefore we are all siblings and therefore we must respect, revere, everything in our environment.

And that is why we cannot destroy and pollute, contaminate, because to do this is to hurt ourselves. So that is the essence of being Kanaka Maoli.

And in our thinking and action, the greatest virtue is to maintain proper *pono*.

That is proper relationships, harmony within ourselves, between ourselves and others and with everything in the cosmos.

Classification and Relationships of the Hawaiian Biota: Evolution and the Order of Appearance on Earth: The Hawaiian *Kumulipo* and Scientific Taxonomy

In addition to naming and grouping the animals and plants of our world, many cultures seek to define where things came from and which came first.

In Hawai'i there is a long and intricate chant of creation called the *Kumulipo*. It is over 2000 lines long, and describes the beginning of the world, the appearance of the plants and animals, the appearance of people, and genealogy of a very important chiefly lineage of Ka-'i-i-mamao.

It was composed sometime in the 1700s, but is based in traditional Hawaiian beliefs that date far back into the past. The chant is composed of sixteen *Wa* (ages or sections). During the first eight *Wa* most of the plants, animals, and the people appear.

The text of the *Kumulipo* was apparently noticed by European scientists in the 1800s as it has some elements in common with evolutionary theories that were developing at that time. In 1981 and 2000, Rubellite Kawena Johnson published books exploring the comparisons between parts of the *Kumulipo* and concepts of classification and evolution in the classic scientific sense. She notes that there is some resemblance between the some parts of the *Kumulipo* and Scientific Taxonomy and Evolution.

Bishop Museum. (2002). *Kumulipo*. Retrieved June 6, 2002, from <http://explorers.bishopmuseum.org/sciencegarden/dClassification/taxonomy.html>

KUMULIPO –THE FIRST AGE– ENGLISH VERSION

1. At the time when the earth became hot
At the time when the heavens turned about
At the time when the sun was darkened
To cause the moon to shine
5. The time of the rise of the Pleiades
The slime, this was the source of the earth
The source of the darkness that made darkness
The source of the night that made night
The intense darkness, the deep darkness
10. Darkness of the sun, darkness of the night
Nothing but night.
The night gave birth
Born was Kumulipo in the night, a male
Born was Po'ele in the night, a female
15. Born was the coral polyp, born was the coral, came forth
Born was the grub that digs and heaps up the earth, came forth
Born was his [child] an earthworm, came forth
Born was the starfish, his child the small starfish came forth
Born was the sea cucumber, his child the small sea cucumber came forth
20. Born was the sea urchin, the sea urchin [tribe]
Born was the short-spiked sea urchin, came forth
Born was the smooth sea urchin, his child the long-spiked came forth
Born was the ring-shaped sea urchin, his child the thin-spiked came forth
Born was the barnacle, his child the pearl oyster came forth
25. Born was the mother-of-pearl, his child the oyster came forth
Born was the mussel, his child the hermit crab came forth
Born was the big limpet, his child the small limpet came forth
Born was the cowry, his child the small cowry came forth
Born was the naka shellfish, the rock oyster his child came forth
30. Born was the drupa shellfish, his child the bitter white shell fish came forth
Born was the conch shell, his child the small conch shell came forth
{p. 59}
Born was the nerita shellfish, the sand-burrowing shellfish his child came forth
Born was the fresh water shellfish, his child the small fresh water shellfish came forth
Born was man for the narrow stream, the woman for the broad stream
35. Born was the Ekaha moss living in the sea
Guarded by the Ekahakaha fern living on land
Darkness slips into light
Earth and water are the food of the plant
The god enters, man can not enter
40. Man for the narrow stream, woman for the broad stream
Born was the touch seagrass living in the sea
Guarded by the tough landgrass living on land

Refrain

46. Man for the narrow stream, woman for the broad stream
Born was the 'Ala'ala moss living in the sea
Guarded by the 'Ala'ala mint living on land

Refrain

52. Man for the narrow stream, woman for the broad stream
Born was the Manauea moss living in the sea
Guarded by the Manauea taro plant living on land

Refrain

58. Man for the narrow stream, woman for the broad stream
Born was the Ko'ele seaweed living in the sea
Guarded by the long-jointed sugarcane, the *ko 'ele'ele*, living on land

Refrain

64. Man for the narrow stream, woman for the broad stream
Born was the Puaki seaweed living in the sea
Guarded by the Akiaki rush living on land

Refrain

70. Man for the narrow stream, woman for the broad stream
Born was the Kakalamoa living in the sea
Guarded by the moamoa plant living on land

Refrain

{p. 60}

76. Man for the narrow stream, woman for the broad stream
Born was the Kele seaweed living in the sea
Guarded by the Ekele plant living on land

Refrain

82. Man for the narrow stream, woman for the broad stream
Born was the Kala seaweed living in the sea
Guarded by the 'Akala vine living on land

Refrain

88. Man for the narrow stream, woman for the broad stream
Born was the Lipu'upu'u living in the sea
Guarded by the Lipu'u living on land

Refrain

94. Man for the narrow stream, woman for the broad stream
Born was the Long-one living at sea
Guarded by the Long-torch living on land

Refrain

100. Man for the narrow stream, woman for the broad stream
Born was the Ne seaweed living in the sea
Guarded by the Neneleau [sumach] living on land

Refrain

106. Man for the narrow stream, woman for the broad stream
Born was the hairy seaweed living in the sea
Guarded by the hairy pandanus vine living on land
Darkness slips into light

Earth and water are the food of the plant
The god enters, man can not enter
112. The man with the water gourd, he is a god
Water that causes the withered vine to flourish
Causes the plant top to develop freely
115. Multiplying in the passing time
The long night slips along
Fruitful, very fruitful
Spreading here, spreading there
Spreading this way, spreading that way
120. Propping up earth, holding up the sky
The time passes, this night of Kumulipo
Still it is night.
{p. 61}

KUMULIPO - KA WA AKAHI – HAWAIIAN VERSION

1. O ke au i kahuli wela ka honua
2. O ke au i kahuli lole ka lani
3. O ke au i kuka'iaka ka la.
4. E ho'omalalama i ka malama
5. O ke au o Makali'i ka po
6. O ka walewale ho'okumu honua ia
7. O ke kumu o ka lipo, i lipo ai
8. O ke kumu o ka Po, i po ai
9. O ka lipolipo, o ka lipolipo
10. O ka lipo o ka la, o ka lipo o ka po
11. Po wale ho--'i
12. Hanau ka po
13. Hanau Kumulipo i ka po, he kane
14. Hanau Po'ele i ka po, he wahine
15. Hanau ka 'Uku-ko'ako'a, hanau kana, he 'Ako'ako'a, puka
16. Hanau ke Ko'e-enuhe 'eli ho'opu'u honua
17. Hanau kana, he Ko'e, puka
18. Hanau ka Pe'a, ka Pe'ape'a kana keiki puka
19. Hanau ka Weli, he Weliweli kana keiki, puka
20. Hanau ka 'Ina, ka 'Ina
21. Hanau kana, he Halula, puka

{p. 187}

22. Hanau ka Hawa'e, o ka Wana-ku kana keiki, puka
23. Hanau ka Ha'uke'uke, o ka 'Uhalula kana keiki, puka
24. Hanau ka Pi'oe, o ka Pipi kana keiki, puka
25. Hanau ka Papaua, o ka 'Olepe kana keiki, puka
26. Hanau ka Nahaweale, o ka Unauna kana keiki, puka
27. Hanau ka Makaiauli, o ka 'Opihi kana keiki, puka

28. Hanau ka Leho, o ka Puleholeho kana keiki, puka
29. Hanau ka Naka, o ke Kupekala kana keiki, puka
30. Hanau ka Makaloa, o ka Pupu'awa kana keiki, puka
31. Hanau ka 'Ole, o ka 'Ole'ole kana keiki, puka
32. Hanau ka Pipipi, o ke Kupe'e kana keiki, puka
33. Hanau ka Wi, o ke Kiki kana keiki, puka

34. Hanau kane ia Wai'ololi, o ka wahine ia Wai'olola
35. Hanau ka Ekaha noho i kai
36. Kia'i ia e ka Ekahakaha noho i uka
37. He po uhe'e i ka wawa
38. He nuku, he wai ka 'ai a ka la'au
39. O ke Akua ke komo, 'a'oe komo kanaka

40. O kane ia Wai'ololi, o ka wahine ia Wai'olola
41. Hanau ka 'Aki'aki noho i kai
42. Kia'i ia e ka Manienie-'aki'aki noho i uka
43. He po uhe'e i ka wawa
44. He nuku, he wai ka 'ai a ka la'au
45. O ke Akua ke komo, 'a'oe komo kanaka

46. O kane ia Wai'ololi, o ka wahine ia Wai'olola
47. Hanau ka 'A'ala'ula noho i kai
48. Kia'i ia e ka 'Ala'ala-wai-nui noho i uka
49. He po uhe'e i ka wawa
50. He nuku, he wai ka 'ai a ka la'au
51. O ke Akua ke komo, 'a'oe komo kanaka

52. O kane ia Wai'ololi, o ka wahine ia Wai'olola
53. Hanau ka Manaea noho i kai
54. Kia'i ia e ke Kalo-manaea noho i uka
55. He po uhe'e i ka wawa
56. He nuku, he wai ka 'ai a ka la'au
57. O ke Akua ke komo, 'a'oe komo kanaka

58. O kane, ia Wai'ololi, o ka wahine ia Wai'olola
59. Hanau ke Ko'ele'ele noho i kai
60. Kia'i ia e ke ko Punapuna, ko 'ele'ele, noho i uka

{p. 189}

61. He po uhe'e i ka wawa
62. He nuku, he wai ka 'ai a ka la'au
63. O ke Akua ke komo, 'a'oe komo kanaka

64. O kane ia Wai'ololi, o ka wahine ia Wai'olola
65. Hanau ka Puaki noho i kai
66. Kia'i ia e ka Lauaki noho i uka
67. He po uhe'e i ka wawa

68. He nuku, he wai ka 'ai a ka la'au
69. O ke Akua ke komo, 'a'oe komo kanaka
70. O kane ia Wai'ololi, o ka wahine ia Wai'olola
71. Hanau ka Kakalamoa noho i kai
72. Kia'i ia e ka Moamoa noho i uka
73. He po uhe'e i ka wawa
74. He nuku, he wai ka 'ai a ka la'au
75. O ke Akua ke komo, 'a'oe komo kanaka
76. O kane ia Wai'ololi, o ka wahine ia Wai'olola
77. Hanau ka limu Kele noho i kai
78. Kia'i ia e ka Ekele noho i uka
79. He po uhe'e i ka wawa
80. He nuku, he wai ka 'ai a ka la'au
81. O ke Akua ke komo, 'a'oe komo kanaka
82. O kane ia Wai'ololi, o ka wahine ia Wai'olola
83. Hanau ka limu Kala noho i kai
84. Kia'i ia e ka 'Akala noho i uka
85. He po uhe'e i ka wawa
86. He nuku, he wai ka 'ai a ka la'au
87. O ke Akua ke komo, 'a'oe komo kanaka
88. O kane ia Wai'ololi, o ka wahine ia Wai'olola
89. Hanau ka Lipu'upu'u noho i kai
90. Kia'i ia e ka Lipu'u, noho i uka
91. He po uhe'e i ka wawa
92. He nuku, he wai ka 'ai a ka la'au
93. O ke Akua ke komo, 'a'oe komo kanaka
94. O kane ia Wai'ololi, o ka wahine ia Wai'olola
95. Hanau ka Loloa, noho i kai
96. Kia'i ia e ka Kalamaloloa, noho i uka
97. He po uhe'e i ka wawa
98. He nuku, he wai ka 'ai a ka la'au
99. O ke Akua ke komo, 'a'oe komo kanaka
- {p. 190}
100. O kane ia Wai'ololi, o ka wahine ia Wai'olola
101. Hanau ka Ne, noho i kai
102. Kia'i ia e ka Neneleau noho i uka
103. He po uhe'e i ka wawa
104. He nuku, he wai ka 'ai a ka la'au
105. O ke Akua ke komo, 'a'oe komo kanaka
106. O kane ia Wai'ololi, o ka wahine ia Wai'olola
107. Hanau ka Huluwaena, noho i kai

108. Kia'i ia e ka Huluhulu-'ie'ie noho i uka
109. He po uhe'e i ka wawa
110. He nuku, he wai ka 'ai a ka la'au
111. O ke Akua ke komo, 'a'oe komo kanaka
112. O ke kane huawai, Akua kena
113. O kalina a ka wai i ho'oulu ai
114. O ka huli ho'okawowo honua
115. O paia ['a] i ke auau ka manawa
116. O he'e au loloa ka po
117. O piha, o pihapiha
118. O piha-u, o piha-a
119. O piha-e, o piha-o
120. O ke ko'o honua pa'a ka lani
121. O lewa ke au, ia Kumulipo ka po
122. Po--no

The Hawaiian Kumulipo and Scientific Taxonomy

In the *Wa Akahi* (The First Age) many Marine Invertebrates first appear:

Corals (Phylum Coelenterata)
Worms (Phylum Annelida)
Starfish, Sea Cucumbers, Sea Urchins (Phylum Echinodermata)
Barnacles (Phylum Arthropoda)
Oysters, Mussels, Clams, Limpets, Cowries, Conches, Snails (Phylum Mollusca)

In *Ka Wa Elua* (The Second Age) come Marine Vertebrates (Phylum Chordata):

Rays and Sharks (Class Chondrichthyes)
Bony Fishes (Class Osteichthyes)
Porpoise (Class Mammalia)

In *Ka Wa Ekolu* The "Winged Creatures" appear:

Birds (Phylum Chordata, Class Aves)

In *Ka Wa Eha* come "The Crawlers":

Turtles (Phylum Chordata, Class Reptilia)
Geckos (Phylum Chordata, Class Reptilia)
Lobsters (Phylum Crustacea, Class Malacostraca)

In *Ka Wa Elima* "The Night Diggers" come forth:

Pigs (Phylum Chordata, Class Mammalia, Order Artiodactyla)
Certain classes of people (Phylum Chordata, Class Mammalia, Order Primates)

In *Ka Wa Eono* "The Nibblers" appear:

Rats (Phylum Chordata, Class Mammalia, Order Rodentia)

In *Ka Wa Ehiku* comes "The Dog Child"

Dog (Phylum Chordata, Class Mammalia, Order Carnivora)

In *Ka Wa Ewalu* "The Dawn of the Day"

In this *Wa* large numbers of people (Phylum Chordata, Class Mammalia, Order Primates)

The final lines of this *Wa* state:

O kanaka lele wale, o kanaka nei la, Ua a--o--

"Adults, human beings, people, here now, it was Day" Here they are [side-by-side](#).

Polynesian Migrations, Canoes, and Wayfinding

Before the birth of Christ, voyagers from islands east of New Guinea began to explore and settle islands upwind, toward the rising sun. This migration into the central Pacific Ocean was one of the most remarkable achievements of human history. It took over a thousand years to complete and involved finding and fixing in mind the positions of dozens of islands (some just coral rings on which the highest landmarks are coconut trees) scattered over 10 million square miles of water. By the time European explorers entered the Pacific in the 15th century almost all of the habitable islands had been settled for hundreds of years and oral traditions told of explorations, migrations, and travel across this immense watery world.

The voyaging was all the more remarkable in that it was done in canoes carved with tools of stone, bone, and coral; lashed with hand-made fiber; and navigated without instruments by expert seafarers who depended on their observations and knowledge of the ocean, sky, and birds for clues to the direction and location of islands.

The canoe hulls were carved from tree trunks with adzes or made from planks sewn together with fiber of coconut or other plants twisted into strands and braided for strength. Cracks and seams in the hull were caulked with plant fibers and sap from breadfruit and other trees. An outrigger was lashed to a single hull for greater stability on the open ocean; or two hulls were joined to crossbeams with a deck added between the hulls to increase carrying capacity for long-distance voyaging. The sails were made of mats woven from pandanus leaves.

These vessels were seaworthy enough to make voyages of over 2,000 miles along the longest sea roads of Polynesia, like the one between Hawai'i and Tahiti. And though these double-hulled canoes had less carrying capacity than the broad-beamed ships of the European explorers, the Polynesian canoes were faster: one of Captain Cook's crew estimated a Tongan canoe could sail "three miles to our two." After a visit to Society Islands in 1774, Andia y Varela marveled at the amount of sail the canoes carried and their speed and maneuverability: "These canoes are as fine forward as the edge of a knife, so that they travel faster than the swiftest of our vessels; and they are marvelous, not only in this respect, but for their smartness in shifting from one tack to the other" (Corney, 282).

The dangers of voyaging were many. The canoes could swamp or capsize in heavy seas; sails could be ripped apart, and masts and booms could snap in strong winds; the hulls could be break apart in heavy seas or smashed against unseen rocks or reefs. And while there might be grass shelters on the decks of canoes, the voyagers were often exposed to the wind, rain, and sun, with only capes of leaves or bark-cloth wrappings for protection. A person could die of exposure during a stormy night at sea. If supplies ran short during a long voyage, starvation was a possibility.

The art of weather prediction without instruments or satellites was essential to voyaging, to anticipate the changing direction and strength of the wind, which seemed to blow

through holes in the dome of heaven along the horizon, shifting clockwise or counterclockwise. A knowledge of seasonal patterns was the basis of prediction. Daily, the navigator watched the condition of the sea and the direction of the swells, the color of the sky and the shape, colors, and movements of clouds overhead to anticipate approaching weather.

For the navigator, the voyage was a mental challenge. To navigate hundreds of miles without instruments required an extensive, detailed knowledge of the ocean and sky. And without charts and plotting devices, the navigator had to memorize his course, sometimes over a period of weeks. Some scholars have expressed disbelief that such navigation could be done with any accuracy, especially on long voyages of over several hundred miles. However, modern voyages by Micronesians who still practice a form of traditional navigation and by Hawaiians and other Polynesians who have recovered this lost ancestral art have shown that navigation relies on natural signs for direction and on memorization of one's course was accurate enough to guide canoes between the farthest reaches of Polynesia.

In the 18th century, Andia y Varela recorded how Tahitian navigators held their courses by using the winds and swells, and the sun and stars, which seemed to rise from fixed pits along the eastern horizon, pass overhead across the dome of the heaven, then set into fixed pits along the western horizon:

[The Tahitians] have no mariner's compass, but divide the horizon into sixteen parts, taking for the cardinal points those at which the sun rises and sets...

When setting out from port, the helmsman reckons with the horizon, counting from the point where the sun rises; he knows the direction in which his destination bears: he sees, also, whether he has the wind aft, or on one or other beam, or on the quarter, or is close-hauled: he knows, further, whether there is a following sea, a head sea, a beam sea, or if it is on the bow or the quarter. He proceeds out of port with a knowledge of these conditions, heads his vessel according to his calculation, and aided by the signs the sea and wind afford him, does his best to keep steadily on his course.

This task becomes more difficult if the day is cloudy, because of having no mark to count from for dividing out the horizon. Should the night be cloudy as well, they regulate their course by the same signals, and since the wind is apt to vary in direction more than the swell does, they have their pennants, made of feathers and palmetto bark, to watch its changes by and trim sail, always taking their cue for a knowledge of the course from the indication the sea affords them.

When the night is a clear one, they steer by the stars; and this is the easiest navigation for them because, there being many stars not only do they note them by the bearings on which the several islands with which they are in touch lie, but also the harbors in them, so that they make straight for the entrance by following the rhumb of the particular star that rises or sets over it; and they hit it off with as much precision as the most expert navigator of civilized nations could achieve.

Finding islands before they could actually be seen was also part of the art of navigation. The name “Maui” seems to have been an honorific name given to numerous explorers who were capable of “fishing up” (i.e., discovering) islands. The first sign of an unseen island might be land-based birds like the fairy tern and noddy tern, or nesting seabirds, which fly out to fish in the daytime and return to their home islands at night to feed their young. Swell patterns also provide clues to the directions of islands. Swells from the direction of an island are partially blocked by it and wrap around the island, creating a distinctive pattern. Swells in the direction of an island reflect off the island back toward the observer on a canoe. The navigator was able to feel these swell patterns in the pitch and roll of his canoe. If the island is upwind, human, animal, or plant smells and drifting land vegetation might reach the canoe. Other clues to landfall include special cloud shapes over islands; a green blush on the bottom of clouds above the islands in the daytime; or a glow above an island created by sunlight or moonlight reflecting up from the white sand and smooth water of a lagoon. Underwater lighting may also point the way to land (Lewis, 153-215).

The Pacific Ocean mariners also use various seamarks to find their way. “As European use landmarks, so the Gilbertese [navigators] use seamarks to check their daily position. These signposts in mid-ocean consist of swarms of fish, flocks of birds, groups of driftwood, or conditions of wave and sky...peculiar to certain zones of the sea. Hundred of such traditional betia [seamarks] were stored up in the race memory as a result of cumulative experience of generations” (A. Grimble, 48). The seamarks were found along routes between islands and indicated to the navigator that he was at a certain point along the way to his destination. For example, a seamark called “the swarming of beasts” consisted of an extraordinary number of sharks and might indicate the canoe was “a day’s sail downwind of land.” Other fauna marks included a region where flying fish leaped in pairs, a zone of innumerable jellyfish, an area of numerous terns, an area of sharks and red-tailed tropic birds, a place marked by a school of porpoises, a place where pairs of porpoises point their heads “in the direction of the passage into Tarawa lagoon” (A. Grimble, 49 –50).

Before the 1992 voyage of the modern Hawaiian voyaging canoe *Hokule’a* from Hawai’i to Tahiti, Satawalese navigator Mau Piailug told Hawaiian navigator Shorty Bertelmann to look for a seamark he remembered from previous voyages along the route: a school of porpoises at the northern edge of the doldrums (around 9 degrees north latitude). Bertelmann sighted the porpoises at the right place, confirming for him that he was on course and solidifying his faith in Mau’s traditional navigation.

Along with their extensive natural knowledge of ocean and sky, Polynesian voyagers depended on help from their gods and spirits. The gods were essential to canoe-building. The builders performed rituals and prayers to ask permission of the forest gods to cut down a tree, so as not to offend them; they called on the gods to guide the work. (In the tradition of Rata, the forest god To’a-hiti and his canoe carver Ta-va’a built Rata’s canoe). The builders also called on the forest gods to protect the canoe at sea. The naming of canoe and parts were important, for it was part of the mana, or power of the

canoe: in the tradition of Te Erui Ariki, the canoe had to be renamed after it was almost destroyed in a hurricane. The two masts were renamed for the gods Tanaroa and Rongo.

The gods were also called upon for help at sea. Ru, who led a migration from Ra'iatea (Society Islands) to Aitutaki (Cook Islands), prayed to Tangaroa, the god of the ocean, to calm the stormy seas. Ancestral spirits accompanied Rata on his voyage to avenge his father's murder, guiding his canoe and helping his defeat various sea demons. Aku (bonito) and 'opelu (mackerel) came to rescue Pa'ao from storms sent by his angry brother Lonopele. The two fish were thereafter placed under a kapu (i.e., protected) during their spawning season by Pa'ao priestly family.

The most celebrated center of Polynesian voyaging and navigation was the district of Opoa on the island of Ra'iatea, anciently called Havai'i, one days sail downwind from Tahiti in the direction of the setting summer sun. The island was apparently named after a distance homeland, which some have suggested was the island of Java (Havai'i = Java 'iti, or "Little Java"). This name was given to new islands discovered as exploration and settlement spread east across the Pacific: Savai'i is the name of the largest island of Samoa; and Hawai'i, the largest island in the Hawaiian chain. (In Maori, "Havai'i is pronounced "Hawaiki"; in Rarotongan, "Avaiki").

Buck describes the development of central Polynesian culture in the fertile high islands of the Tahitian archipelago: "An exuberant new life opened up in central Polynesia and new adjustments and progress took place, not only in the arts and crafts but in social and religious matters. The senior families and the most intelligent priests seem to have settled down in the Opoa district of Havai'i, which became the cultural center of the group" (71-71). The main gods of the priests of Opoa were Ta'aroa (Kanaloa in Hawaiian, Tangaroa in Rarotongan), a god of fishing and the sea, represented by the octopus; and later his son 'Oro, a war god who required the first fruits of battle (human sacrifice) for his favor.

From this district, the chiefly culture spread throughout the Pacific to inhabited and uninhabited islands.

The story of these voyagers from Havai'i are told in the oral traditions of Polynesia. These oral traditions range from factual accounts of migration voyages (Ru, Te Erui Ariki, and Ruatapu) to stories in which the human and the divine, the natural and supernatural intermingle.

The motivations of the voyagers varied. Some left to explore the world or to seek adventure. Others departed to find new land or new resources because of growing populations or prolonged droughts and other ecological disasters in their homelands. Within the sphere of known persecution or unhappy love affairs, to find a wife or visit relatives, or to obtain prized objects, like red feathers, basalt rock or pearl shells, not available at home.

Whatever the motivation for voyaging, the challenge was always the same- the huge, trackless expanses of sun-heated saltwater capable of generating fierce winds and battering waves. The challenge was met again and again by daring Pacific Island voyagers, long before sailors in other parts of the world ventured beyond the coasts of continents or inland seas.

Kawaharada, D. (1995). Polynesian Migrations, Canoes, and Wayfinding. In T. Henry & others in *Voyaging Chiefs of Havai'i*. Honolulu, HI: Kalamakua Press, (pp. vii-xv).

Other Sources Cited in Text:

Buck, P. H. (1959). *Vikings of the Pacific* (Originally published as *Vikings of the Sunrise* in 1938). Chicago, IL: UC Press.

Corney, B.G. (1919). *The Quest and Occupation of Tahiti by Emissaries of Spain during the Years 1772- 1776* (ed). London: Hakluty Society.

Grimble, A. (1989). *Tungaru Traditions: Writing on the Atoll Culture of the Gilbert Islands*. Honolulu, HI: Univerity of Hawaii Press.

Kirch, P. (1987). *Feathered Gods and Fishhooks: An Introduction to Hawaiian Archaeology and Prehistory*. Honolulu, HI: University of Hawaii Press.

Lewis, D. (1972). *We, the Navigators*. Honolulu, HI: University of Hawaii Press.

_____ (1978). *The Voyaging Stars: Secrets of the Pacific Island Navigators*. New York, New York: W.W. Norton.

Kirch, P. (1987). *Feathered Gods & Fishhooks: An Introduction to Hawaiian Archaeology and Prehistory*. Honolulu, HI: University of Hawaii Press, p. 23.

Personal Stories of Nihoa and Necker Islands By Dennis Kawaharada

In 1822, Ka'ahumanu and a royal party including Kaumuali'i, Liholiho, Keopuokalani and Kahekili Ke'eaumoku, visited Ni'ihau and heard chants and stories about an island called Nihoa, to the west of Kaua'i, the direction from which the winter rains came:

*'Ea mai ana ke ao ua o Kona,
'Ea mai ana ma Nihoa
Ma ka mole mai o Lehua
Ua iho a pulu ke kahakai*

The rain clouds of Kona come,
Approaching from Nihoa,
From the base of Lehua,
Pouring down, drenching the coast.

Intrigued, Ka'ahumanu organized an expedition and sailed in two or three boats under Captain William Sumner to visit the island. They landed on the once inhabited, but long deserted island 150 miles WNW of Kaua'i and annexed it to the Hawaiian kingdom. The waterfront area around Ka'ahumanu Street in Honolulu was named Nihoa in honor of the visit. The island was annexed to the Hawaiian Kingdom again by Kamehameha IV, who landed on the island in 1857. In 1885, Queen Lili'uokalani, with 200 excursionists, visited Nihoa on the steamer *'Iwalani*, and brought back artifacts—a stone bowl, a stone dish, a coral rubbing stone, and a coral file (Emory 8-11).

Nihoa, jutting up from the sea beyond sight of Kaua'i and Ni'ihau, is the westernmost place in this tradition of Kaua'i geography. It has come to stand for "one who bravely faces misfortune": "*Ku paku ka pali o Nihoa i ka makani*"—"The cliffs of Nihoa stand strongly against the wind" (Pukui, 'Olelo, No. 1924). "Nihoa" means "firmly set," or "toothed," "serrated," possibly a reference to its jagged profile; from one side, it looks like a molar, standing isolated at sea. (In Micronesia, an island seen from a departing canoe, just before the island disappears from sight is called a "tooth," and serves as a final landmark to orient the canoe on its voyage.)

Nihoa is a mile long, a quarter mile wide, and 900 feet high on its east end. It was designated a wildlife refuge by Theodore Roosevelt in 1906. It is inhabited by insects, monk seals, two species of land birds, a finch and a millerbird, found nowhere else, and numerous seabirds (terns, boobies, petrels, shearwaters, albatrosses, tropic birds, and frigate birds). Today, access is controlled by the U.S. Fish and Wildlife Service and landing, except for scientific study and cultural purposes, is prohibited.

Nihoa was once inhabited by the kanaka maoli, sometime between 1000 and 1500 A.D. About 35 house sites, 15 bluff shelters, 15 *heiau*, and 28 agricultural terraces have been identified on the island (Emory 12; Cleghorn 21-22). Various artifacts have also been collected, including fishhooks, sinkers, cowry shell lures, hammerstones, grindstones, adzes, and coral rubbing stone (Emory 38-50). The evidence seems to indicate permanent or semi-permanent settlement.

Living on the island would have been difficult. Surveys have discovered only three seeps of water, all contaminated with guano (Emory 12). Tava and Keale report a tradition of Ni'ihau that a spring called Waiakanohoaka provided good, sweet water (102), but this spring has not been located. The freshwater on the island comes from the estimated 20-30 inches of rain that falls annually from passing squalls (Cleghorn 26).

Archaeologists surmise that the terraces were planted with sweet potatoes, a crop requiring less water than thirsty taro. They estimate that the 12-16 acres under cultivation might have supported about 100 people (Cleghorn 25). Fish, shellfish, crabs, lobsters, turtles, and seals, as well as seabirds and their eggs, are abundant sources of food. Cleghorn speculates that the food and water supply was sufficient for subsistence, but that the lack of firewood would have created a hardship (26). The only tree on the island is the *loulu* palm. Archaeologist Kenneth Emory of the Bishop Museum counted 515 palms when he landed in 1923. Its fan-like leaves were used for plaiting, and its trunk could have been used for building shelters or for firewood. But if the trees were cut down for firewood, the supply would have eventually been depleted.

Without the numerous kinds of plants in the forest of the larger islands (e.g., *koa*, *'ohi'a*, *hau*, *hala*, *olona*, *wauke*), the settlers could not have provided themselves with canoes, wood containers, nets, fishing line, clothing and blankets, mats, and medicines. The colony was probably supplied with these products from Kaua'i or Ni'ihau. Several gourd fragments have been found; other bowls and containers were carved from stone.

Landing on the island is difficult. High, sheer cliffs prevent landing on the east, north, and west sides; the island slopes down to the south, but the shoreline is rocky and unprotected from the surge of southerly swells. Large vessels anchor offshore, and those who wish to land have to go in on a smaller boat or swim ashore. In ancient times, small canoes could have been carried up onto the rocky coast on calm days. If the canoes used to reach the island were somehow damaged in the rough surf, the settlers would not have been able to repair their canoes with resources from the island. They would have been trapped until other canoes arrived from Ni'ihau or Kaua'i. Partial skeletons of men, women, and children have been found on the island, and two burial sites located. The journey of spirits to the afterworld (in the west, toward the setting sun) would have been shorter from this western outpost than from the islands to the east. The name of a place on the island where spirits of the dead departed for the afterworld is still remembered: it was called Mau-loku ("Continuous falling"; Pukui et al Place Names).

How the island was discovered is not known-possibly by fisherman working the seas west of Kaua'i, or following seabirds to gather their feathers or eggs. Red feathers were coveted for making sacred objects, and the red-tailed tropic bird is one of the seabirds that nests on Nihoa. Polynesians traveled great distances to obtain such feathers: one Marquesan tradition tells of a 1200-mile voyage, from Hiva Oa to Rarotonga, to obtain the red feathers of a kura bird; and the voyaging chief Hema is said to have sailed back to Kahiki to obtain a girdle of red feathers for his son Kaha'i.

Once discovered, the island became a part of the economy of Ni'ihau, an island relatively limited in resources. The traditions of Ni'ihau say that the people of that island were frequent and

perhaps long-term visitors to collect *loulou* palm wood for spears and a grass called Makiukiu, which could be used for cordage and stuffing (Tava and Keale 102).

Another motive for visiting the island is suggested by the chant of Ni'ihau describing the Kona rain clouds coming from Nihoa and soaking the west coasts of Kaua'i and Ni'ihau. Small, low islands like Ni'ihau and also the leeward coasts of high islands like Kaua'i depend on the heavy rains of annual Kona storms to bring life to their crops. But if the storms stay west or pass to the north without reaching Hawai'i, as they sometimes do, droughts and, in ancient times, famine, could occur. Could the people of Ni'ihau or leeward Kaua'i have sailed west to get closer to the source of these rain clouds or the deities who controlled them in order to pray for rain and make offerings? Water represented life and wealth in ancient Hawai'i, and such a voyage might have been worth the effort and the risk.

One hundred and fifty miles west of Nihoa is an island called Necker. This island is smaller and has even fewer resources than Nihoa. There are no trees and no soil. Yet the island is covered with some 33 heiau (Emory 59). Several stone images, the largest around 16 inches high, were found by visitors in historical times. The images look like gingerbread men-flat, neckless, with round faces, from which eyes, noses, mouths, and ears protrude (Emory 125, Illustrations XX-XXII). Who or what these images represent is unknown.

The Hawaiian name for Necker has been lost. But Teva reports that there are four names remembered on Ni'ihau of islands beyond Nihoa: Mokuakamohoali'i, Hanakaieie, Hanakeaumoe, and Ununui (103). Mokuakamohoali'i, "Island of the Shark God Kamohoali'i," is a possible name for Necker, as the largest geographical feature on this island is a bay called "Shark Bay." Kamohoali'i was the king of sharks and brother of the volcano goddess Pele. The Pele migration is said to have come from the west, with Kamohoali'i serving as the navigator.

Cleghorn suggests that in addition to going to Necker for gathering resources such as bird feathers and eggs, the visits may have had a ritualistic purpose: the heiau could have belonged to a bird cult, similar to the one on Rapa Nui (Easter Island) (61). But the heiau and statues could also have been used in rain-god worship. And as in the kachina rituals of the American Southwest, the rain deities might have been associated with ancestral spirits who return each year in the form rain clouds from their homes in the west. (The winter rains of the American Southwest come from the west, as they do in Hawai'i.) In either case, birds and rain clouds are metaphorically connected with each other in Hawaiian chant. Beckwith notes, "The cloud hanging over Ka'ula is a bird which flies before the wind:

The blackbird begged,
The bird of Ka'ula begged,
Floating up there above Wa'ahila"
(The Hawaiian Romance of Laieikawai, p. 323).

Nihoa would have been a stop on the way to or from Necker. Annual visits to Necker during the spring and summer trade wind season could have been made, when food would have been abundant on and around Nihoa and Necker. A Ni'ihau tradition suggests such was the case: "The Ni'ihauans sailed to Nihoa in the spring, returning to Ni'ihau in the fall on the Kona winds" (Tava

and Keale 102). The same sailing strategy could have taken them to Necker. After landing on Necker, prayers and offerings could have been presented to the deities. Then the pilgrims could have fished, hunted birds, collected eggs, and built or maintained heiau. When a cold front approached, the canoes could head back to Ni'ihau or Kaua'i on the southwesterly winds that precede the front or the northerly winds that follow.

Any downwind sail with the prevailing winds is a risky undertaking, because unless the wind shifts, the sail home involves tacking into the wind, something which the keel-less Polynesian canoes would have great difficulty doing. The risk is weighed against the importance of the potential benefits of going to the downwind destination. For a community dependent on farming, drought could be disastrous. If one of the sources of the life-giving waters of Kane was westward, was it worthwhile to sail west to present offerings and prayers to a god who brought life-giving waters? For a time in Hawaiian prehistory, the answer was apparently yes; then, perhaps after dry-land taro and sweet potato cultivation in areas with limited rainfall had improved enough so that famine was no longer a seasonal threat, such voyages became unnecessary.

Kawaharada, D. (n.d). *Personal Stories of Nihoa and Necker Islands*. Honolulu, HI: Bishop Museum.

Works Cited

Beckwith, M. W. (1919). *The Hawaiian Romance of Laieikawai*. Translation of Laieikawai by S.N. Hale`ole. Washington D.C.: Government Printing Office, 1919. pp. 285-666.

Cleghorn, P. (1987). *Prehistoric Cultural Resources and Management Plan for Nihoa and Necker Island, Hawai'i*. Honolulu, HI: Bishop Museum.

Emerson, N.B. (1965). *Unwritten Literature of Hawaii: The Sacred Songs of the Hula*. (First published in 1909 by Bureau of American Ethnology) Rutland, Vermont: Charles E. Tuttle Co., Inc.

Emory, K. P. (1928). *Archaeology of Nihoa and Necker Islands*. Honolulu, HI: Bishop Museum.

Tava, R. & Keale, M.K. *Ni'ihau: The Traditions of an Hawaiian Island*. Honolulu, HI: Mutual Publishing.

Kirch, P. (1987). *Feathered Gods & Fishhooks: An Introduction to Hawaiian Archaeology and Prehistory*. Honolulu, HI: University of Hawaii Press, p. 61.

Hokule'a

The Hawaiian Canoe

The Founding of the Polynesian Voyaging Society

The Building of Hokule'a

Voyaging Into the New Millennium

The Hawaiian Canoe

Historically, the movement of man from place to place over the surface of the earth in his struggles to survive and in his quest for suitable areas of settlement have been, for the greater part, a land-oriented achievement. By the time most of the more desirable lands had been discovered, settled or otherwise encumbered, there was not much productive land readily available or easily accessible for smaller groups of yet unsettled humans. Among the latter was a group now more widely known as Polynesians, the origin of whom is still a matter of some conjecture among scholars, researchers and even Polynesians themselves.

Craftsmen of a stone-age culture, the Polynesians were a homogeneous people who successfully carried out what may be considered the last organized, systematic migration and settlement trek in the history of mankind to unknown parts of the earth's surface. This was a dramatic human achievement, for it included an unprecedented migration over an awesome expanse of the great Pacific Ocean, a migration that begun about a thousand years before the Christian era and continued until the accidental discovery and subsequent settlement of the Hawaiian Islands in the north Pacific about fifteen hundred years later. The most important artifact was the canoe, from its simplest form to its most sophisticated design in the creation of the ocean-going canoe.

It was not until the settlement of the Hawaiian Islands that the Hawaiian canoe was developed. What set it apart from other Polynesian-type canoes was its solid one-piece hull, made possible because of a providential supply of tall hardwood trees that the Hawaiian named koa (*Acacia koa*), the largest of the native forest trees of Hawaii. Once developed, the Hawaiian canoe became the major watercraft throughout the Hawaiian Islands in pre-historic times, where it was used for many purposes including fishing, racing, warfare, and transportation of people and goods. Irrespective of its particular use, however, the Hawaiian canoe was a work of utilitarian art; it was not only useful, it was also beautiful to look at.

The Founding of the Polynesian Voyaging Society

The Polynesian Voyaging Society (PVS) was founded in 1973 to carry out an experiment that would help answer a question that had been asked by Captain Cook: how did the Polynesians settle the far-flung islands of the mid-Pacific – by accident or by design? Did their canoes and their knowledge of navigation enable them to sail purposefully over the vast sea distances between Pacific islands?

In 1956, New Zealand historian Andrew Sharp claimed that the Polynesians could not have intentionally set out to explore and settle their island realm because their canoes were too flimsy and unseaworthy, their wayfinding methods too imprecise, and their seamanship skills too lacking for the task of sailing east against the easterly Pacific trade winds, from Indonesia and Melanesia to the Polynesian archipelagos. Sharp believed that the islands had been settled by accident – by the crews of canoes that had been blown off course during storms or that had simply went of course due to navigational incompetence or to cloudy weather hiding their navigational stars. He believed that the stories of long-distance, open-ocean voyaging found in the traditions of the Pacific islands were pure fantasy.

Could the ancient Polynesians have been limited to intentional voyages of 300 nautical miles, as Sharp claimed? Or could they have purposely sailed longer distances, for example, the 2,250 nautical miles between Hawai`i and Tahiti, as the legendary voyagers Mo`ikeha and Pa`ao were said to have done?

In the mid-60's, David Lewis, a scholar who had grown up in Rarotonga of the Cook Islands, made an experimental voyage from Tahiti to New Zealand, navigating without instruments. He used methods of navigating by stars, sun, and ocean swells, which he had learned, from traditional navigators in Micronesia. About the same time, Ben Finney built and tested a replica of a 40-foot traditional Hawaiian double-hulled sailing canoe called Lalehia to show that such a canoe was capable of sailing downwind and across the wind, and could be tacked slowly to windward.

These two experiments led Finney to believe that the Polynesians had played an active, seafaring role in the discovery and settlement of their islands. He, along with Tommy Holmes and Herb Kane, decided to reconstruct a long-distance voyaging canoe to navigate if from Hawai`i to Tahiti and back using traditional wayfinding. To create this project, the three men formed Polynesian Voyaging society (PVS).

PVS has successfully tried out the project, building the voyaging canoe Hokule`a and sailing it to Tahiti in 1976, without the use of navigational instruments; it extended the experiment even further by sailing Hokule`a to Tahiti and back in 1980 and as far as Aotearoa and back in 1985-7, again without the use of navigational instruments. These voyages proved that a canoe of Polynesian design could be sailed windward, making easting against the easterly trades, and maintain a course over long distances, by orienting the canoe to celestial bodies and ocean swells.

Hokule`a has played an important part in an ongoing revival of Polynesian cultural. Several communities, like Tahiti, Samoa, Fiji, and the Cook Islands have built or are building their own double-hulled canoes. Hokule`a has become a symbol of the Hawaiian people, the fulfillment of dreams and a joy to share. It has generated interest in Hawaiian language, arts, dance, music, navigational skills, social and religious practices and other aspects of Hawaiian culture.

Although the majority of the members of PVS are from Hawai`i, it also has members from Poland, Finland, Ireland, France, Mexico, Australia, New Zealand, Japan, Martinique, Turkey, many of the Pacific Islands, and the continental United States.

(Adapted from Finney, B. (1992). *Voyaging in to Polynesia's Past*. In *Sea to Space*. Palmerston North, New Zealand: Massey Press. And Froiseth, W. (1980). *History of Hokule`a*. In *Polynesian Seafaring Heritage*. Honolulu, HI: Kamehameha Schools Press. The article it self was taken from Kamehameha Schools. (1994). *No Na Mamo*. [An educational packet]. Honolulu, HI: Kamehameha Schools Press).

The Building of Hokule'a 1973 – 1975

Hokule'a was completed in 1975. It has two 62-foot hulls; eight 'iako, or crossbeams, joining the two hulls; pola, or decking, lashing to the crossbeams between the two hulls; rails along the decking; and two mats. Herb Kane designed the canoe from Cook Islands models, architects Warren Seaman and Rudy Choy drew up the plans and Curtis Ashford was the shipwright.

The canoe was named for the Northern Hemisphere. Hokule'a means "Star O Joy," according to some translators; or "Clear Star" (Ruby Kawena Johnson). This star is the zenith star of Hawai'i, passing directly overhead as it crosses the meridian. It is a fitting name for the canoe, for the star may have been a guide star for navigators returning to the islands from long voyages to the South Pacific.

Hokule'a was launched on March 18, 1975 at Kualoa on the windward side of O'ahu. Ka'upena Wong organized the religious ceremonies for the launching, with Kalena Silva and Keli'i Tau'a assisting in the rituals. Kahu Kaupu gave the Christian blessing. Hokule'a made its first voyage to and from Tahiti in 1976.

The 8-ton Hokule'a can be loaded with about 11,000 pounds, or 5.5 tons, including the weight of a crew of 12 –16 people and equipment and supplies. It can make up to 10 –12 knots sailing on a reach in strong winds.

Since Hawaiians had ceased long-distance, open-ocean voyaging eight centuries ago in the 12th century, no examples of actual ancient voyaging canoes were available as models for Hokule'a. Hawaiian artist Herb Kane based the design of Hokule'a on drawing of canoes made by artists and draftsmen employed by Captain Cook and other early explores of the Pacific.

How close to an ancient voyaging canoe is Hokule'a? Hokule'a is considerably smaller than the 100-foot plus Polynesian canoes seen by early European visitors. Also, while the design of the hulls and upper parts of the canoe was based on what is known of the traditional Polynesian canoe, the design of the sail-rig departed from traditional precedents. The traditional Polynesian spirit sail was typically laced to two spars, one of which acted as the mast and the other as the boom. The rig Hokule'a consists of a sail attached to a spar and boom plus a shorter mast on which the spar, boom and sail are raised and stayed, was used to facilitate the raising and lowering of the sail.

Although the Polynesian Voyaging Society (PVS) wanted to use traditional materials (koa wood hulls, lauhala sails, sennit lashing) and traditional tools (adzes, bone gouges, coral files, and sharkskin for sanding) in building the canoe, the construction would have been too time-consuming as the builders tried to relearn the arts of working with such materials and tools. Instead, the hulls were constructed out of plywood, fiberglass, and resin, and the sails were made from canvas; the lashing were done with synthetic cordage.

Because of the use of modern materials, sailing the canoe could not tell PVS about the strength and durability of traditional canoes. However, the builders strove to approximate the shape and weight of a traditional canoe, avoiding such innovations as wider stance for the hulls for greater stability and a deeper keel for improved sailing capability; so the canoe was a “performance accurate” replica, handling much like the voyaging canoes that once sailed in Polynesian seas.

(Adapted from Finney, B. (1992). *Voyaging in to Polynesia's Past*. In Sea to Space. Palmerston North, New Zealand: Massey Press. And Froiseth, W. (1980). *History of Hokule`a*. In Polynesian Seafaring Heritage. Honolulu, HI: Kamehameha Schools Press. The article it self was taken from Kamehameha Schools. (1994). No Na Mamo. [An educational packet]. Honolulu, HI: Kamehameha Schools Press).

Voyaging Into the New Millennium

For many, the year 2000 held memories of the past, while ushering in new hopes and dreams for the future. For the Polynesian Voyaging Society (PVS), the year 2000 was a celebration of a quarter-century of visions seen, hopes believed, and dreams achieved.

From March 1975 to March 2000, thousands watched and took part as Hokule`a, the first traditional Polynesian voyaging canoe to sail in 600 years, sailed more than 90,000 nautical miles or nearly four times around the globe. All of this began with a dream, a vision. Three visionaries, Dr. Ben Finney, Herb Kane and Tommy Holmes founded the Polynesian Voyaging Society in 1973 to demonstrate that the ancient Polynesians sailed their double-hulled canoes using non-instrument navigation to settle their vast nation. How their dream has grown in the quarter century that Hokule`a has been sailing.

In 1973, there was only one known deep-sea navigator. Today, there are nine with more in training. Six voyaging canoes have been built, and several more are under construction. Hokule`a, which means “star of Gladness” in Hawaiian, has reached every point of the Polynesian triangle and has also traveled to the West Coast of the United States, bridging communities, renewing cultures and creating opportunities for growth and learning.

Through these voyages of exploration and discovery, the Polynesian Voyaging Society has sought to celebrate the importance of history and heritage, and honor the values which are fundamental to sailing on the canoe. PVS supports the vision of Malama Hawai`i – that Hawai`i, our special island home, is a place where the people, land and sea are cared for and communities are healthy and safe.

For the PVS, the new century was welcomed with a miraculous and once improbable voyage to **Rapa Nui**, one of the most isolated inhabited islands in the world.

As Hokule`a and her crew sailed east, navigators Nainoa Thompson, Chad Baybayan, and Bruce Blankenfeld, used the stars, ocean swells, and favorable winds to guide her along. Following a successful and swift 19-day, 1,450 mile voyage from the tiny island of Mangareva, crew member Max Yarawamai sighted Rapa Nui through a small hole in a wall of clouds. Hokule`a’s visit to the island brought a renewal of culture, environment and health for Rapa Nui. The completion of the voyage was bittersweet – reaching the final point in the Polynesian triangle brought a feeling of pride, but also a feeling of sadness in the closing of this chapter of deep sea voyaging.

A Homecoming Celebration, honoring the past 25 years of achievement by PVS and the safe return of Hokule`a from its epic 10 month voyage to Rapa Nui, was held on March 12. The event began with the arrival of the voyaging canoes Hokule`a, Hawai`i Iloa, Makali`i and Mo`olele in the early morning, followed by various ceremonial activities, including chants, songs and dances, to welcome the crew in the traditional fashion. A ho`olaule`a celebration followed, with food, exhibits and entertainment by some of Hawai`i’s finest performers.

During this homecoming month, Governor Ben Cayetano proclaimed **Hokule`a a State Treasure**. “Hokule`a has become a living treasure to the people of Hawai`i,” said Governor Cayetano. “Her crews have traveled more than a hundred thousand miles throughout the Polynesian triangle, and she has stimulated great pride among all the people of our islands. I urge citizens to visit the Hawai`i Maritime Center to pay tribute to this beloved symbol of Hawaiian heritage.” Hokule`a is the first ever proclaimed State Treasure in the State of Hawai`i.

Polynesian Voyaging Society. (2001, Spring). *Voyaging Into the New Millennium*. (001 ed.) [Nesletter]. Honolulu, HI: Olomana Marketing LLC, pp. 1, 3.

Marine and Terrestrial Ecology of the NWHI

NWHI Reefs & Marine Ecosystems

Underwater Apartment Building

New Species Evolve by Adapting to New Environment

Habitat Description

Coral

Glossary of Coral Technical Terms

Algae

Marine Invertebrates

Invertebrate Habitat Descriptions & Community Integrity

Fish

Shallow Reef, Mid Reef & Open Ocean

Marine Turtles

Monk Seals

Terrestrial Environment

Terrestrial Studies

Seabirds of the NWHI

Names of the Sea and Land Birds of the NWHI

Bird Habitat Descriptions & Community Integrity

Insects

Plants

Scientific Classification System / Categories

Model for Making an Evolutionary Tree

Northwestern Hawaiian Islands Reefs & Marine Ecosystem

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 1500 years ago.

A number of unique species of corals, marine invertebrates, algae and sea grasses, fishes, sea turtles, and marine mammals all make the reefs of NWHI their homes. The islands are also home to rare and endangered plants and insects.

The small islands in the NWHI make a vital habitat for breeding and nesting for more than 14 million seabirds. Nearly all of the world's population of Laysan Albatross returns each year to the NWHI.

More than 9 out of 10 of the Hawaiian population of the Hawaiian Green Sea Turtle nest at the French Frigate Shoals. Occasionally, other species of sea turtles visit the NWHI as well.

The NWHI is also home to the endangered Hawaiian Monk Seal. The majority of the population of 1,400 seals relies on the protected isles and reefs for food and breeding grounds.

Other marine mammals like the Humpback whales travel through the NWHI on their yearly migrations.

The reefs of the NWHI are much more diverse than those found in the Main Hawaiian Islands. Of the more than 7,000 different species that have been recorded in the Hawaiian Islands, more than half are only found in the NWHI.

Underwater Apartment Building

Coral reefs serve many purposes. They protect our coastlines, house many underwater plants and animals, and they produce sediment. Here in Hawai'i marine creatures living on and within coral reefs are the sole source of sand for our beaches. Just think, some of those grains of sand used to be alive!

New Species Evolve by Adapting to New Environments

Detective work with Hawaiian cave insects provides clues to how new species arise. Rock crickets, for example, live where waves splash on the shore. They prefer salty water and have little trouble traveling across the ocean. Long ago, one species arrive in Hawaii and colonized the shores of each island. Then a few of these insects has an adaptive shift and switched to drinking fresh water and eating debris blown in by the wind. A whole new world opened up for them on new lava flows away from the shoreline. Later, as plants covered the flows, organic materials percolated underground. Some crickets followed the food underground and adapted to the dark, wet 3-D mazes in caves. They became a new species too!

Habitat Description

The Northwestern Hawaiian Islands contain more reef acreage than all of the Main Hawaiian Islands, as well as greater diversity in habitat (e.g., lagoon complexes and barrier reefs). The islands comprise only 1% of land for the entire Hawaiian archipelago, but about 65% of the shallow water marine habitat. Fringing reefs and atoll reefs surrounding shallow lagoons are extensive in the area.

Corals are the most conspicuous members of the reef community, although other organisms such as coralline algae, mollusks, echinoderms, and foraminiferans aid in the reef building process. Coral reefs of the Hawaiian Islands National Wildlife Refuge provide habitat, shelter, and food for most [of the] hundreds of marine species. The species composition of corals on all reefs in the archipelago is remarkably uniform.

The geological and biological characteristics of the nearshore marine community in the Hawaiian Islands National Wildlife Refuge are intimately tied to the volcanic origin of the Hawaiian Islands, coral reef formation, and the northwestward movement of the Pacific plate. The emergent portion of all islands north of Gardner consists entirely of calcium carbonate, deposited by coral reefs and associated marine organisms. Were it not for coral growth, these islands would have sunk at the latitude of Gardner Pinnacles millions of years ago. Instead, corals and other calcifying organisms have built reefs, which have kept pace with sinking and erosion of the volcanic islands.

Recent studies have clearly demonstrated a pattern of reduced coral growth rates as a function of latitude, yet no large differences in coral community structure have been documented with the archipelago. Variations in coral species dominance do occur and some types of coral, such as the genus *Acropora*, are restricted to the center of the chain. The coral reefs of Hawaiian Islands National Wildlife Refuge offer a variety of habitat types, including seaward and leeward reefs, lagoons, coral flats, banks, and shoals.

CORAL



Corals are colonial invertebrate marine animals whose skeletons help to build up reefs. Corals are relatives of animals like jellyfish, but unlike them, corals are not free swimming. Coral reef ecosystems are some of the most productive, diverse, complex and beautiful places on earth.

Certain corals are called zooxanthellate corals, and are actually two creatures living together: a coral and a plant-like algae. Because the algae in zooxanthellate corals need light for photosynthesis, those corals are generally limited to shallow water environments less than 20 m (65 ft) deep.

The total number of coral species that live in the reefs of the Hawaiian Islands is relatively low. Scientists think that this is because of the isolation of the Hawaiian Islands. On the other hand, because of this isolation, a number of coral species live nowhere else on earth. Scientists estimate that more than 25% of the corals in Hawaiian waters are endemic.

The coral reefs of the Northwestern Hawaiian Islands (NWHI) encompass over 11,000 square kilometers of coral reef habitat, over 65 % of all coral reefs in the U.S. waters. The reefs are comprised of forty-seven species of hard coral and eight species of soft coral, a diversity that rivals the Main Hawaiian Islands.

Coral reefs are the foundation of an expansive ecosystem that hosts an interdependent association of vertebrates (i.e., monk seals, reef and bottom fish, turtles, birds, and sharks), invertebrates (i.e., corals, anemones, jellyfishes, mollusks, shrimps, crabs, lobsters, sea urchins, sea stars and sea cucumbers), sea grasses and algae.

Bishop Museum. (2002). *Life on Islands*. Join a Research Expedition to the Northwestern Hawaiian Islands. Retrieved May 22, 2002, from <http://bishopmuseum.org/research/nwhi/biology.shtml>

Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve. (2002). *The Region: The Coral Reef Ecosystem*. Retrieved May 10, 2002, from <http://www.hawaiireef.noaa.gov/region/region.html>

Related Coral Sites:

Waikiki Aquarium <http://waquarium.otted.hawaii.edu/>

Hawaii Coral Reef Network <http://www.coralreefnetwork.com/>

Glossary of Coral Technical Terms

CALYX (plural, CALICES): depression that houses the polyp

COENOSTEUM: common surface of corallum between calices

COLUMELLA: central structure of the calyx formed by fusion of the septa

CORALLUM (plural, CORALLA): skeleton of entire coral colony

CORALLITE: skeleton produced by an individual polyp

COSTA (plural, COSTAE): extensions of the septa outside the calyx unto the coenosteum

PAPILLAE: rounded nipple-like projections covering the coenosteum; found in Montipora

THECA: wall of corallite

SEPTUM (plural, SEPTA): skeletal plates that project into the calyx from the theca; may be subdivide into primary, secondary, and tertiary septa

VERRUCAE: small cylindrical projections arising from the corallum that contain calices; found in Pocillopora

ALGAE



Algae are photosynthetic organisms that can grow in a variety of places, ranging from hypersaline water to ocean water to freshwater. They vary from small, single-celled forms to complex multicellular forms, like kelps, seagrasses and seaweeds. In the Northwestern Hawaiian Islands, coralline algae is important in the formation of reefs. Many types of algae are used by humans for food (like the limu kohu, above), medicine and other products.

Algae are important as primary producers at the base of the food chain. Hawaiian Green Sea Turtles, for example, spend a lot of time gliding over the reefs, browsing on the seaweeds and algae there.

Algae also provide oxygen for other aquatic life. Unfortunately, with pollution or other environmental damage, algae reproduction may run amok and contribute to mass mortality of other organisms, in the case of algal blooms, for example (Bishop Museum, *Life on Islands*).

Algae & Sea Grass

Based on a 1989 report, approximately 205 known species of macroscopic algae exist for the Northwestern Hawaiian Islands, including Midway and Kure Atolls. Of this list, approximately 48 species are green algae (*Chlorophyta*), 33 species are brown algae (*Phaeophyta*), and 124 species are red algae (*Rhodophyta*). These numbers should increase dramatically with publications currently in preparation and the completion of the taxonomic identification of the 2,055 Northwestern Hawaiian Island algae specimens held by the Bishop Museum in Honolulu (United States Fish and Wildlife Services, *About the Northwestern Hawaiian Islands*).

Bishop Museum. (2002). *Life on Islands*. Join a Research Expedition to the Northwestern Hawaiian Islands. Retrieved May 22, 2002, from <http://bishopmuseum.org/research/nwhi/algae.shtml>

United States Fish & Wildlife Services. (2002). *About the Northwest Hawaiian Islands*. Honolulu, HI: Author.

MARINE INVERTEBRATES



(Photos by Keoki Stender)

Marine invertebrates include a number of very different types of animals: crabs, shrimp, lobsters, clams, sea urchins, starfish, snails, worms, clams, and many others. These animals make up many of the species that make the coral reefs of the Northwestern Hawaiian Islands such a diverse and interesting ecosystem.

Articles: October 11, 2000 - **WHAT ARE SPONGES?**

By Ralph De Felice

Sponges are the most primitive of multicellular animals (metazoa). They have a cellular grade, which means they have no true tissues. Adults are asymmetrical or radially symmetrical. Sponges are exclusively aquatic (water dwelling), most are marine. They are found from deepest oceans to the edge of the seam and from the coldest oceans to the tropics. Sponges play important roles in so many marine habitats but we still know very little about their diversity, biology and ecology as compared with most other animal groups. In many benthic (sea bottom) habitats sponges are often the dominant animals.

Sponges have an amazing range of growth forms, best described as highly irregular and sometimes completely plastic, frequently altered by prevailing external conditions (currents, turbidity, salinity etc.). Sponges come in just about every color imaginable. Adult sponges are sedentary (sessile), attached to the seabed or other substrate for most of their lives, although many have larvae that motile, swimming or crawling away from their parent. Sponges have sexes that are separate, or sequentially hermaphroditic, although most population dispersal and recruitment is asexual (through budding, fragmentation from storm events, etc). Larvae are motile, incubated within the parent or broadcast into the seawater.

Sponges filter sea water to eat, breath and excrete waste products. Sponges often have complex water canal systems running throughout the body, with smaller inhalant (ostia) and larger exhalant pores (oscles). Sponges are able to actively pump up to 10 times their body volume each hour, making them the most efficient vacuum cleaners of the sea. Sponges appear to be very stable, long-lived animals, although growth rates vary enormously between different groups. Some sponges can grow centimeters in weeks, and may have shorter life spans. Others sponges, like the living fossil 'sclerosponges' are VERY slow growing, with the largest known individuals (up to 30cm diameter) thought to be around 5,000 years old (which makes them the oldest living individuals on the planet, if this is true!).

Sponges are a unique group of animals because they have unique collar-cells (choanocytes) which are surrounded by cilia with a central flagellum that moves to actively create a current pulling water in and out of the sponge. These collar cells line the walls of small chambers throughout the water vascular system. There may be 7,000-18,000 of these chambers per cubic millimeter of sponge, and each chamber may pump approximately 1,200 times its own volume of water per day!

Sponges have no tissues or sensory organs but they do have many different types of cells with many different functions that carry out normal bodily routines, including a primitive cell type (called an archaeocyte, an amoeboid-like cell) that is totipotent (able to change functions as required by the sponge [e.g. secrete the skeleton, form the epidermis, become feeding and reproductive cells etc.]) Outer and inner layers of cells (exopinacocytes, basopinacocytes) (= "the skin") lack a basement membrane; middle layer; (mesohyl) is variable but always includes motile cells and usually some skeletal material. Mineral skeleton is present in most (but not all) groups of sponges composed of calcium carbonate, silicon dioxide, and/or collagen fibres. Skeletal elements (spicules) are diverse in their geometry and size.

Sponges are individuals, having a continuous "skin" (epithelium) that contains roving cells inside; they are not colonies (like corals and sea-squirts in which individuals animals group together). Sponges catch, eat, digest their food and excrete their waste products within cells, not within any common body cavity (like a stomach), unlike most multicellular animals. Some sponges (particularly those growing on coral reefs) have a unique symbiosis with cyanobacteria not found in any multicellular animal. These cyanobacteria (or blue-green algae) provide the sponge with nutrients from photosynthesis to supplement those obtained by the sponge from normal filter feeding activities. These extra nutrients greatly augments sponge growth rate and competitive ability in coral reef systems.

Sponges have been around for a long time. They were already well established during the Lower Cambrian (>550 million years ago), and were major reef builders during the Devonian (>370 million years ago) before the reef-building corals "took over" reef formation; most modern genera and species similar to those around today appeared at the beginning of the Cretaceous (>150 million years ago).

WHAT DO SPONGES DO?

Sponges don't appear to do much at all, but in fact they are very active. Sponges sit on the bottom of the sea actively pumping seawater through their bodies. This water, containing nutrients, is filtered through a series of sieve-like pores. Nutrients are actively carried across the cell wall, engulfed by special cells (archaeocytes), and subsequently transferred throughout the sponge. In addition to "regular food", this seawater also contains the toxic chemicals excreted by other plants and animals, such as corals growing on the coral reefs above. Sponges feed on these chemicals, modify and reuse them for their own purposes.

Many of these sponge-modified and sponge-produced chemicals have potent toxicity against human pathogens, cancer cells etc., or are useful against certain human ailments (e.g. anti-inflammatory, cardiovascular, respiratory, analgesic etc. properties).

WHY DO SPONGES NEED THESE CHEMICALS?

Sponges are not mobile, and as such they cannot escape from predators (such as fishes, turtles, gastropods, echinoderms, flatworms). Perhaps they use these chemicals to defend themselves?

Sponges do not have arms or legs and so they cannot physically remove other animals and plants settling on their exterior surfaces and from within water canals. Perhaps they use these chemicals to repel parasites?

Sponges are generally slow-growing, easily out-competed for space and living resources by other faster growing animals and plants (such as corals and ascidians). Perhaps they use this arsenal of chemicals in a chemical warfare against these faster-growing species?

Sponges are often full of small animals and microbes, particularly embedded within body cavities and throughout the water canals. Perhaps many of these chemicals are antibiotic to these microbes?

Some sponges burrow into corals and use chemicals to eat away the calcium, eventually occupying the entire interior surface of the coral (with breathing tubes or fistules poking through the surface). Other sponges grow on top of corals, smothering and eventually eroding the dead coral, and some that bore into oysters and pearl oyster shells killing the animal inside. There are also many sponges that live in between coral branches, at the base of corals and in the substrata surrounding corals that bind the corals together. Perhaps some of these chemicals are important in the continual process of erosion of coral reefs and releasing calcium back into the system, and consolidation of dead coral producing stable reef structures?

Some sponges have intimate, symbiotic relationships with other animals (such as gastropods, hermit crabs, shrimps), or plants (blue-green algae or cyanobacteria), which is frequently species specific. Perhaps these chemicals produce recognition signals between the symbiotic partners?

Probably a combination of all these important factors are why sponges contain so many different chemicals.

HOW MANY SPONGES ARE THERE?

The magnitude of sponge biodiversity is not known yet. In some habitats sponges are the dominant macrobenthic life form; in others they are very scarce.

Some places in the world have a relatively well-known sponge faunas (e.g. Mediterranean, Caribbean, British Isles), basically reflecting the relatively long period of time scientists have worked on these faunas. Each of these regions contains about 500-800 species.

Some areas have moderately well known faunas (e.g. Madagascar, New Caledonia, New Zealand, Sri Lanka, Micronesia, Japan) mainly as a consequence of recent scientific exploration during the past 20 years or so. Each of these regions probably has between 400-600 species.

Other places have poorly known sponge faunas, and (worse still) most of our knowledge is from old expeditions (pre-1900s; which makes "data" even more dubious). These areas include Australia, Indonesia, Papua New Guinea and other parts of the Indo-Malay archipelago. However, it is well known from studies on other groups of animals that this region has the highest proportion of the world's marine biodiversity, and there is no reason to show us that this is different for sponges. In Australia there are about 1,400 species described in the scientific literature, but we estimate that there are probably at least 5,000 species living in continental and territorial waters.

It is thought that this Indo-Malaysian region may contain a very high diversity, perhaps in the order of 4000-6000 species, but it is probably also the least comprehensively documented fauna by modern standards given that most of our knowledge of the fauna derives from pre- and early 1900 literature (plus generally unreliable identifications made by collectors for chemical studies).

Hawaiian Islands: There are about 100 species described from Hawaii. Most work on Hawaiian sponges was conducted in the 1950s and early 60s, before the widespread use of SCUBA. Based on recent work, it is estimated there are between 200-300 species in Hawaii. More than half of these are probably endemic (found only in Hawaii).

Worldwide: In the literature there are about 7,000 "valid" species published worldwide, BUT we estimate that there are at least 15,000 living species in all the world's seas and lakes.

HOW ARE SPONGES IDENTIFIED?

Sponges are often soft bodied, many are fragile and colors are generally unstable. Many sponges are also harmful to humans, producing physical damage (e.g. from sharp spicules protruding through the surface) and/or with an irritating mucus and other chemicals, sometimes causing severe dermatitis. Consequently, special care is taken when collecting to minimize damage to both the sponge and collector.

Collections of sponges intended for identification should be accompanied by underwater photographs and adequate documentation (locality, habitat, surface features, color notes etc.).

In many species both coloration and morphology may change dramatically following collection and preservation, and identifications, even by specialists, are often greatly facilitated if there are adequate color photographs of live material.

Sponge identifications are primarily based on morphology. Some of these morphological characters vary substantially between widely separated populations, or those living in different habitats, whereas other features are much more consistent between individuals. There are many morphological characters which can be used to aid in sponge identification including shape, distribution of surface pores, color, ornamentation of the surface, texture, structure and composition of the organic skeleton and water canal system, and the structure, composition, size and geometry of the inorganic skeleton (spicules).

Organic and inorganic skeleton of a sponge are usually the primary characters used for identification. The organic (spongin fiber) skeleton is composed of strands of collagen, and the patterns they form, and the material contained within the fibers are important characters used in classification. An inorganic (spicule) mineral skeleton, is often found within and outside spongin fibers. Spicules are constructed of either silica (glass) or calcite, and the shape, ornamentation, size, origin and arrangement of these spicules inside the sponge are also important characters used for classification.

Most sponges are not easy to identify, even for experts, requiring specialized techniques for preservation of the specimen, examination of spicules and thin sections of the sponge under a light microscope and/or a scanning electron microscope (SEM). Therefore most sponges cannot be identified with confidence without extensive and time consuming work in the laboratory.

WHAT IS THE ROLE OF TAXONOMISTS? AND WHY ARE MUSEUM COLLECTIONS IMPORTANT?

Documenting and describing biodiversity is a long, time consuming process that requires accuracy and patience, but it is an essential prerequisite to conservation and management of our marine resources. Collections and collection databases (containing accurate locality data, accurate descriptions of species' characteristics) are the main functions of museums and provide them with unique resources that other scientists don't have (usually no time to build collections and maintain them).

The taxonomist's role is to publish these species descriptions and distributions, with the (maybe impossible) aim of fully document regional biological resources in a systematic, scientific way.

Good taxonomy underpins every other branch of biological and biochemical science. Comprehensive, accurate descriptions, with recognizable illustrations and accurate locality data are essential for determining the relationships between species and regions (biogeography), how many species are shared between closer or more distant regions (species' dispersal potential, reproductive mechanisms etc.), habitat preferences

(ecology), population variability (genetics) and chemical relationships (chemotaxonomy, marine natural products chemistry).

Bishop Museum. (2002). *Life on Islands*. Join a Research Expedition to the Northwestern Hawaiian Islands. Retrieved May 22, 2002, from <http://www.bishopmuseum.org/research/nwhi/sponges.shtml>

De Felice, R. (1998). What are Sponges? Adapted From: Hooper, JNA. 1998. Sponguide, version April 1998. Queensland Museum, Australia. Retrieved May 22, 2002, from <http://www.bishopmuseum.org/research/nwhi/sponges.shtml>

Invertebrates Habitat Descriptions & Community Integrity

The terrestrial arthropods and land snail faunas of the Hawaiian Islands National Wildlife Refuge are the most poorly known components of the land ecosystem. However, endemic insects are described for several of the Refuge units, and more will likely be discovered. Several insect species may have been lost before they were ever described. Research into host plants and other ecological relationships of these faunas is desperately needed to enable managers to enact adequate protective measures.

Nihoa Island: The relatively pristine state of the lowland coastal ecosystem at Nihoa supports at least 35 species of endemic, terrestrial arthropods, and 5 species of endemic land snails. Nihoa is an example of a native land arthropod and mollusk community that once occurred throughout the arid lowlands in the Main Hawaiian Islands prior to human arrival.

Necker Island: For a tiny island with only five species of plants, Necker Island has a surprisingly large native invertebrate fauna with at least 15 endemic arthropod species and one endemic land snail.

French Frigate Shoals: Arthropod collections at French Frigate Shoals have been made on six occasions since the first in 1923 by the Tanager Expedition. At least 17 indigenous species exist but there are probably more since the ectoparasites, mites, and intertidal faunas have not been adequately sampled. On one of the islands formally known endemic species (moth) has already gone extinct and another one, a plant bug, is apparently being displaced on its host plant by a newly established alien species.

Laysan Island: Laysan has had more frequent visits by entomologists than many of the other islands in the archipelago. These began in 1893 and have resulted in the identification of 75 species, 15 of which are endemic to Laysan. A new species of endemic moth was discovered by a Service biologist in 1994. Endemics most vulnerable to the devastation of the rabbits were those that relied on specific host plants and could not adjust once the rabbits had eaten that species. The indigenous intertidal species, predators, and parasites fared better. More than 125 alien species of arthropods have been reported from Laysan and at least 100 are still present. The rate of alien introductions seems to have slowed with the enactment of new Refuge protocols for cleaning and freezing gear.

FISH

There are probably more than 240 different species of fish that are found in the Northwestern Hawaiian Islands. This is roughly half the total number of species that are found in the Main Hawaiian Islands. Researchers believe this lower diversity is due to the smaller size of the islands and their surrounding reefs, cooler water temperatures, and a more limited variety of habitats to occupy.

The NWHI are home to an interesting behavior by some of the top predators in the ecosystem. While fledgling albatrosses are learning to fly in the summer months, the NWHI are visited by large numbers of Tiger Sharks. The sharks feed on the birds that can't stay aloft.

Many fish in the NWHI have been tested for ciguatera poisoning and some of the top predator fish are considered to be toxic. Ciguatera poisoning occurs when fish feed on certain types of algae that live in coral reef systems. As smaller fish are eaten by larger ones, the toxins gradually become concentrated in the muscles of the fishes at the top of the food chain.

The reef community is characterized by fewer herbivores, such as surgeonfishes and an increase in carnivores, such as damselfishes, goatfishes, and scorpionfishes. The Northwestern Hawaiian Islands are considered integral to fishes in the Main Hawaiian Islands as sources to replenish commercial and recreational fish and lobster populations.

Bishop Museum. (2002). *Life on Islands*. Join a Research Expedition to the Northwestern Hawaiian Islands. Retrieved May 22, 2002, from <http://www.bishopmuseum.org/research/nwhi/fish.shtml>

Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve. (2002). *The Region: The Coral Reef Ecosystem*. Retrieved May 10, 2002, from <http://www.hawaiireef.noaa.gov/region/region.html>

Fish Links

Hawai'i Coral Reef Initiative Page of the Fish of Hawaii
<http://coralreefnetwork.com/marlife/fishes/fishes.htm>

Bishop Museum's Hawai'i Fishes page
<http://www.bishopmuseum.org/research/natsci/fish/fishimages.html>

Learn more about ciguatera poisoning
<http://www.emedicine.com/emerg/topic100.htm>

Fishes

Approximately 240 fish species were recorded in the Northwestern Hawaiian Islands during a comprehensive fish survey conducted by the State of Hawaii, Department of Land and Natural Resources in 1984. Compared to the 536 fish species known from the Main Hawaiian Islands, Hawaiian Islands National Wildlife Refuge (HINWR) has a relatively low species diversity. Researchers hypothesize that this is due to cooler water temperatures, the relatively small size of the atolls and the islands, and a more limited variety of habitats.

Nonetheless, HINWR reef fish populations are healthy, and the fish biomass is higher than in the Main Hawaiian Islands, due largely to reduced fishing pressures. All trophic levels are well represented, including jacks and several species of sharks. A unique occurrence, peculiar to the Northwestern Hawaiian Islands, is the increased presence of tiger sharks inside lagoons from June to August, which gather to feed on fledging albatross chicks. Pelagic fish species, found outside the lagoons, include yellowfin, albacore, and skipjack tuna; mahimahi; billfish; various sharks; and many others.

Ciguatera tests conducted in the Northwestern Hawaiian Islands identified *Cheilinus unifasciatus* as the most toxic fish species. The authors hypothesized that ciguatera may play a role in the downward population trend of endangered Hawaiian monk seal, although a shortage of prey may play a more important role.

Marine Turtles

English Name	Hawaiian Name	Scientific Name
Hawaiian Green Turtle	Honu	<i>Chelonia mydas agassizi</i>
Hawksbill Turtle	‘Ea	<i>Eretmochelys imbricata</i>
Leatherback Turtle		
Olive Ridley Turtle		

Marine turtles are air-breathing, cold-blooded reptiles that have become highly adapted for life in the sea. Powerful flipper-like limbs and a streamlined body make it possible for these gentle creatures to swim rapidly through the water. Green sea turtles are one of seven species of sea turtles; all of which are listed either as endangered or threatened. In Hawaii, there are four kinds of sea turtle: the endangered Leatherback, Olive Ridley, the Hawksbill and the threatened Green Sea Turtle.

The Hawksbill is known to nest on the Big Island, and the Green Sea Turtle has nests on all islands. The Hawaiian Green Turtle is the more abundant of the two species of marine turtles native to the Hawaiian chain. Green Sea Turtles are primarily vegetarians that feed on marine plants growing in shallow coastal waters. The turtle’s common name comes from the color of the fat found inside its body rather than the color of the shell or skin. Most adult Hawaiian Green Sea Turtles are heavily pigmented on the upper surfaces, with some being almost completely black.

Although it is difficult to get an accurate count on how many green sea turtles are in Hawaii, it is believed to be under 1000 breeding females, substantially lower than in pre-Western contact times. Green Sea turtles are found throughout the Main Hawaiian Islands (MHI) and Northwestern Hawaiian Islands (NWHI). Although they historically have nested on all islands, due to beach development and other factors they tend to migrate between their main feeding grounds in the main chain to their breeding and nesting grounds in the NWHI.

In the months of May –September, female turtles who are at least 25 –60 years of age come ashore on quiet, undisturbed, dark, sandy beaches to nest. Nesting takes place on land where the female comes ashore at night several times during each breeding season to bury a clutch of leathery eggs. After crawling from the ocean, a nesting site is selected and excavation first takes place using the front flippers. They dig a pit a few feet deep, then a narrow, circular egg chamber another foot or so deep. The hind flippers then take over and working alternately, carefully scoop out a chamber to receive the eggs. After laying a clutch of around 100 ping-pong ball size eggs, the turtle covers the nest and returns to the ocean before the daylight makes her too warm. Each female will dig up to six nests each season, and 80-90% of all Hawaiian Green Sea Turtles make their nests at French Frigate Shoals. Its long, prehensile tail that extends beyond the hind flippers identifies the adult male. The female’s tail barely reaches beyond the end of the shell.

After two months (60 days) of unattended incubation, the small hatchlings work as a group to dig to the surface, possibly attracted by the glimmer of light off the waves. They wait just below the surface until the sand cools down, usually at night, and scamper quickly into the sea. Each hatchling weighs about an ounce, and fits nicely into the palm of an adult's hand. When sexually mature, they will weigh between 200 and 375 pounds, and can be four feet long.

From the moment they emerge from the nest, hatchlings face a treacherous life journey. Ghost crabs, fish and sharks prey on hatchlings, and they can become entangled in vegetation or marine debris, and never make it to the water. Some hatchlings become confused, possibly by light on the beach, and travel the wrong direction, again never reaching the ocean. If the hatchling makes it to the water, it will feed on fish eggs, sponges and worms until it reaches adulthood, or about 14 inches. Adult turtles carry out periodic migrations, often over long distances, between resident feeding areas and beaches where reproduction takes place. The nesting beach is believed to be the same site where the turtle itself was originally hatched.

Green sea turtles have played an important role in Hawaii's history. They were used by the ancient Polynesians for food, tools and ornamentation. The ali'i held strict a kapu on Green Sea Turtles and the turtle population was very healthy. During the 1800's turtle hunters decimated the population, including the NWHI. Today, Green Sea Turtles are listed as threatened, which means they are protected from poaching, and harassment in U.S. waters. Green Sea Turtles need two basic habitats to survive. They need quiet, undisturbed beaches, which are dark at night for both basking and nesting, and undeveloped near-shore areas for foraging.

The Hawksbill Turtle is the second species of native Hawaiian marine turtle, but its range is confined to waters around the MHI. The Hawksbill is easily distinguished from the Green Sea Turtle by its pointed hawk-like beak. Also, the horny plates of the juvenile's shell clearly overlap one another. This characteristic often disappears in the adult. Hawksbill feed on crabs and other bottom dwelling marine invertebrates. Their specialized beak is used to probe into coral and rock crevices in search of food.

Two of the greatest threats to the survival of the Green Sea Turtle are marine debris and a disease called fibropapilloma. Marine debris, especially plastics are particularly hazardous to sea turtles. Turtles can become entangled in certain kinds of debris, and often mistake other kinds for food and ingest it. Cigarette lighters, ballpoint pens, and numerous other kinds of plastics have been found in the stomachs of turtles. Plastics can clog the digestive tract of marine animals, including turtles, causing the animal to either starve to death, or a fatal ulcer to form. Fibropapilloma is a viral disease, which causes large tumors to grow on turtles, often to a size that obscures their vision or interferes with avoiding predators and feeding. Scientists are struggling to research and find cures or preventative measures to halt the spread of this disease.

Himschoot, R. (1997). [Northwestern Hawaiian Islands National Wildlife Refuge: Environmental Educational Outreach Program]. Unpublished manuscript & raw data.

Monk Seals

English Name	Hawaiian Name	Scientific Name
Hawaiian Monk Seal	Ilio Holo I Kauaua	Monachus schauinslandi

Only two species of these rare marine mammals remain in the world. One inhabits remote areas of the Mediterranean Sea, and the other lives in the Northwestern Hawaiian Islands (NWHI). A third species formally existed in the Caribbean, but was forced into extinction during the early 1950's by an increase human use of the seal's habitat. The Hawaiian monk seal is considered endemic to Hawaii (other monk seals are a different species).

Monk seals travel over a wide range, but are not really migratory. They make several deep dives when foraging, sometimes-exceeding depths of 400 feet. Although residing in warm waters, monk seals nevertheless still possess a thick layer of blubber like the seals found in cold climates. The food of monk seals consists of eels, lobster, small octopus and reef fish which are captures at night. During the daytime, resting takes place on isolated and undisturbed beaches and rock ledges. Monk seals were listed as endangered under the endangered Species Act in 1976.

Monk seals live mainly in the Northwestern Hawaiian Islands (NWHI), but occasionally can be seen around the Main Hawaiian Islands (MHI). The population is now probably less than 1,200 and appears to be declining. Besides a ciguatera-related die-off around Laysan Island I the 1970's, it is believed the main cause of this decline is a lack of food. Entanglement in marine debris also costs many seals' lives each year. A behavior called "mobbing" has challenged survival rates among young seals, and many young seals are lost each year in shark attacks. Biologists are struggling to not only understand this cryptic and endangered seal, but to preserve the population with numbers which makes a wild population viable.

Monk seals begin reproducing usually around 5 to 6 years of age, and then usually will pup every two years. Between March and July, mother Hawaiian Monk Seals haul out on beaches of the NWHI to give birth to a single, fully developed black pup, weighing around 25 -30 pounds. In preparation for this event, the mother becomes extremely obese and may weigh over 600 pounds. Extra fat reserves are necessary to produce milk for the hungry pup and also to sustain the mother's own body. During the nursing period, she does not go out to sea in search of food, but rather stays continually with her offspring.

When the pup is a few days old, the mother takes it into the ocean for the first swim. Only the shallow protected waters close to shore are used. This is prevent the inexperienced pup from being swept away by strong currents and exposed to deep waters inhabited by sharks. Several swimming lessons a day are carried out for the duration of the nursing period.

With a continuous supply of rich milk, the pup grows rapidly, and its coat changes from black to silver gray. By the time five weeks have passed, the pup has increase from a birth

weight for 35 pounds to 140 pounds. During this period, the mother's reserves are depleted and she becomes very thin. Weaning takes place by her sudden and permanent departure from the island. From that day on, the young seal is on its own.

Biologists are concerned because they are finding many adult females who will pup when they're still too thin, so the mother must wean the pup early in order to avoid her own starvation. However, the pup may not be fat enough to survive long enough to learn to forage. This cycle of starvation has cost many seals their lives, especially in the French Frigate shoals area of the NWHI. The normal life expectancy of a monk seal in the wild is 25 to 35 years.

For those pups that do survive weaning, there exists another immediate danger. Because the population of monk seals has become skewed, with a much higher number of males to females, young pups of both sexes are often "mobbed" by older males. Without their mother's protection, these pups can be overrun by adult males, and often will drown. In response to the mobbing problems in the NWHI, biologists relocated 22 male seals to the MHI in 1994. Although this has alleviated some of the stress on newly weaned seals on the breeding grounds of the NWHI, it has created a strong need for increased education among the public in the MHI as seal-human interfaces increases.

In addition, pups are largely defenseless against the tiger sharks, which live near the pupping beaches. The sharks will prey on the monk seals, turtle hatchlings and adults, and newly fledged seabirds, which land on the water and may struggle to take off again.

A number of seals are lost each year to entanglement in marine debris, especially fishing gear. Even if they are not drowned as a result of this entanglement, seals can either drag gear or become injured in attempts to free themselves. Dragging gear is not only exhausting, but can also impede free movement, making the seal susceptible to shark attacks or unable to feed. Injuries from entanglement can become infected and become fatal for the seal. Because of the high incident of seal entanglement, the Western Pacific Regional Fishery Management (WESPAC) established a Protected Species Zone in 1991, which encompasses the main foraging and breeding grounds of the Hawaiian monk seal.

Balazs, G. H. (1976). *Hawaii's Seabirds, Turtles and Seals*. Honolulu, HI: World Wide Distributors Ltd.

Himschoot, R. (1997). [Northwestern Hawaiian Islands National Wildlife Refuge: Environmental Educational Outreach Program]. Unpublished manuscript & raw data.

Terrestrial Environment

President Roosevelt's 1909 Executive Order setting aside the Hawaiian Islands Reservation had a profound effect on the biological history of the Northwestern Hawaiian Islands. By stopping the economic exploitation of the islands in order to protect native birds, he allowed it to remain free rats. Today this group of islands is the largest rat-free, contiguous group of islands left in the tropics. As a result it has a relatively intact seabird fauna and healthier insect and plant communities than it would otherwise.

Habitat types on the Refuge range from coastal, dry, mixed communities and coastal, dry shrubland on Nihoa, Necker, Laysan, and Lisianski to coastal dry grasslands and uplands on the smaller, lower islands of French Frigate Shoals and Pearl and Hermes Reef. These vegetation types have become so rare on the Main Hawaiian Islands that textbooks often use photographs from the Refuge to illustrate them. Nihoa Island, for example, is one of the most biologically pristine islands in the Pacific, and probably most closely represents the original island appearance and biota present before humans came to the Hawaiian Islands.

The low sandbar islets of French Frigate Shoals and Pearl and Hermes Reef support very little vegetation, most of it grass, herbaceous clumps, and prostrate vines. A few larger shrubs survive the rigors of winter washovers by storm waves and low soil moisture to become the prized nesting sites of red-footed boobies, black noddies, and great frigatebirds. Space is highly contested by the terrestrial animals of the atoll and breeding, feeding, and basking take place on three levels – in burrows, on the surface, and in the few shrubs available.

The Northwestern Hawaiian Islands have one of the highest rates of endemism in the Pacific for terrestrial (and many marine) species. Researchers estimate that these islands are home to 12 endemic species of plants, 7 endemic land mollusks, 64 endemic arthropods, and 4 endemic species of land birds. Nihoa alone has 2 endemic lands birds, 2 endemic plants, 6 endemic land snails, and at least 35 endemic arthropods. Unfortunately, as is the case with many island endemics, their distribution and habitat requirements are highly limited, and they are often susceptible to predators and being outcompeted by alien species. As a result, the Hawaiian Islands National Wildlife Refuge contains 14 species listed under the Endangered Species Act and 22 Species of Concern.

Seabirds of the Northwestern Hawaiian Islands

Seabirds have the same basic characteristics of other birds, which enable flight, but also have some additional adaptations to their marine environment, which make them quite different from terrestrial birds. Seabirds spend most of their lives at sea, coming to land only for breeding and nesting. There are around 30 species of seabirds in Hawaii, and many of them can only be found in the Northwestern Hawaiian Islands (NWHI). Biologists are hard at work ensuring the future success of these birds, as well as researching their lives histories in order to better understand them.

Like terrestrial birds, seabirds have hollow bones, feathers, and stream-like bodies, all of which make flight possible. Also like land birds, seabirds can, and many do, migrate many thousands of miles annually. Just as land birds, seabirds have specific bill adaptations to help them catch the food they eat. Finally, just as land birds, seabirds add to the food chain by becoming prey, depositing guano on land and in the ocean, or when they decompose, thereby adding or returning nutrients back to the cycle of life.

Since seabirds spend the majority of their lives at sea, they are adapted to a marine environment. They can eat, sleep and rest at sea, needing land only for a few short months to build a nest and raise their young. Seabirds possess a special gland behind their eyes, which desalinates saltwater, so that they can obtain drinking water from the ocean. They have webbed feet, which allow them to take off and land very skillfully on the water's surface. Many seabirds have their feet placed further back on their bodies, in order to use them to help propel themselves downwards during a dive, or to swim and dig burrows better in some species. Some seabirds also will use their wings to help them swim downwards during a foraging dive. Seabirds have monocular vision, useful in spotting both predators and prey.

Seabirds can live at sea only coming ashore to reproduce. In fact, the sub-adult birds of many species can stay at sea many years before they mature to a breeding age. Seabirds nest in colonies of a few hundred to several thousand and even millions of birds. Each species will usually live within a colony of its own, and each has its own kind of nest. For example, the albatross nest either on open, sandy area or in light vegetation, while many petrels and shearwaters dig out burrows and still other species, such as noddies, some bobbies, and frigatebirds build nests of sticks and twigs and other materials in the branches of low beach bushes. Most of the seabirds of the Hawaiian Islands rear their chicks together, with each parent taking turns either brooding the egg, and chick, or travelling sometimes great distances, out to sea to forage.

Seabirds vary from species to species a great deal. In general, however, it can be said they eat fish, squid, and floating materials such as fish eggs. They live anywhere from 5 to 45 years and can have a wingspan of a few inches up to 11 feet. They weigh from a few ounces up to several pounds and some nest only once a year, while others reproduce twice a year. Some seabirds in Hawaii are plunge divers some dip; some scavenge, and some even obtain a portion of their food requirements through pirating. All are threatened in many ways by human activities, and many of the seabirds found in the

NWHI can no longer be found on the Main Hawaiian Islands (MHI), except in small, remote colonies.

Although the threat of feather hunters (for use in stuffing pillows or adorning hats), or other hunters looking for seals, whales or turtles are no longer a great threat for seabirds, humans still impact them greatly. Food chain contamination, whether natural (ciguatera) or human-caused (DDT or agriculture runoff) effect seabirds, as they are very high up in the food chain. Disturbance of breeding and nesting grounds by humans is not frequent in the NWHI, but remains a problem for seabirds attempting to breed or nest on the MHI. Perhaps, the greatest threat to seabirds, and the most humanly preventable, is the entanglement in marine debris, especially plastics. Of particular threat is fishing gear (the NWHI is now a Protected Species Zone, since 1991, which limits fishing activities in the area), and plastic trash, such as soda rings and small, disposable cigarette lighter. All of these plastics have been found in the boluses of seabirds, and can be fatal through either ingestion, which can block the digestive tract or cause ulcers, or entanglement.

Biologists devote much time in the NWHI to the monitoring and study of the various seabirds found there. On Laysan Island, serious efforts have been made to eliminate introduced grass species, which erode nesting habitat, and out compete native vegetation. On Tern Island, most species of seabirds that nest there are banded and monitored for reproductive success. Banding helps scientist to observe, and identify individual birds, while giving information about site and mate fidelity, as well as age and migration of banded birds. Although the birds are generally left to the course of nature, if a bird has suffered a negative impact at the hands of humans (entanglement, oiling, etc.), refuge staff will make an attempt to assist the bird.

Hawaii Audubon Society. (1971). *Hawaii's Birds* (2nd ed.). Honolulu, HI: Hawaiian Audubon Society.

Himschoot, R. (1997). [Northwestern Hawaiian Islands National Wildlife Refuge Environment Education Outreach Program]. Unpublished manuscript & raw data.

Muro, G. C. (1971). *Birds of Hawaii* (6th ed.). Tokyo, Japan: Charles E. Tuttle Co., Inc.

Rauzon, M.J. (2001). *Isles of Refuge: Wildlife and history of the Northwestern Hawaiian Islands*. Honolulu, HI: University of Hawaii Press.

TenBruggencate, J. (1986). *The Honolulu Advertiser's Wildlife of Hawaii* (1st ed.). Honolulu, HI: The Honolulu Advertiser

Bird Habitat Descriptions & Community Integrity

The Hawaiian Islands National Wildlife Refuge provides breeding sites for all but three of Hawaii's 22 species of seabirds. Enormous numbers of central Pacific seabirds congregate in these islands to breed. They nest in burrows and cliffs, on the ground, and in trees and shrubs. For some species it is their only breeding site.

More than 99% of the world's black-footed albatross return to the Northwestern Hawaiian islands each year to reproduce. For some species such as Bonin petrels and Tristram's storm-petrels, these mammal-free islands provide the last safe nesting place as more and more islands in other parts of the Pacific are infested with rats. For land birds the islands have provided less secure habitat, but four of the seven original species still remain. Three endangered passerines and one of the world's rarest ducks are found in the Refuge.

Nihoa Island: In the evening, this tall island sometimes resembles a hive of bees as uncounted numbers of Bulwer's petrels, wedge-tailed shearwaters, and Christmas Island shearwaters return to their nests. Six species of tropical terns, three kinds of boobies, frigatebirds, tropicbirds and albatross also nest on Nihoa. Nihoa is the only home of two endangered, endemic passerine birds, The Nihoa finch and Nihoa millerbird. The Nihoa finch is a Hawaiian honeycreeper with a heavy finch-like bill. Between 1,000 and 2,000 of these brown and yellow streaked birds are thought to remain on Nihoa. The Nihoa millerbird is an exceedingly rare insectivore and perhaps as few as 200 individuals alive in the world, all on Nihoa.

French Frigate Shoals: The islets of French Frigate Shoals support 19 species of breeding seabirds. French Frigate Shoals has been continuously occupied by Service since 1979. As a result, continuous seabird monitoring data, including population size and reproductive performance, is available over a 20-year period. This constitutes one of the best time series of these data for any tropical seabird colony in the world and has been used by climate change scientists and fisheries biologists to test hypotheses and understand their systems. Using both satellite tags and simple banding and color marking, ornithologists have discovered that breeding seabirds at French Frigate Shoals may travel all the way to Alaska, and to Wake and Johnston Atolls.

Gardner Pinnacles: The frosted appearance of Gardner Pinnacles indicates its importance as a roost site and breeding station for 12 species of tropical seabirds.

Laysan Island: Laysan has the largest land area in Hawaiian Islands National Wildlife Refuge and is an important bird colony. The world's largest group of black-footed albatross (22,000 pairs) breeds here. The colony is monitored closely because of concern about the species interaction with longline fisheries in the North Pacific. Laysan albatross are also abundant on the island after which they are named. The island has the largest populations of Christmas shearwaters and wedge-tailed shearwaters in the archipelago. Many bristle-thighed curlews winter at Laysan.

The resourceful Laysan finch also makes a living in this remote site by being willing to taste anything that looks remotely edible. The most unusual ornithological feature of the Laysan Island is the endangered Laysan duck. This bird has the most restricted range of any duck in the world and its population had fluctuated around 200 individuals in recent years. It lives on the shores of Laysan Lake, feeding on the tiny brine flies that swarm over the mud. Three other landbirds did not survive the loss of vegetation due to rabbits at the beginning of this century. The Laysan honecreeper, Laysan millerbird, and Laysan rail were gone by 1923. Sadly, a population of Laysan rails that had been transferred to Midway was still extant there until 1943, when rats were introduced during the war. If the rails from Midway had been repatriated to Laysan after the rabbits were gone, the extinction would have been averted.

Lisianski: Lisianski has the largest Bonin petrel colony in the Refuge and in some years the island is home to over a million sooty terns. Seabird colonies and vegetation were decimated by human activities and introduced rabbits in the late 19th and early 20th centuries, but are recovering.

Pearl & Hermes Reef: A small population of Laysan finches ekes out a living on the tiny islands of Pearl and Hermes Reef where they were relocated in the 1960s. The rest of the resident birds are seabirds.

Insects

Like the other plants and animals of the Northwestern Hawaiian Islands, isolation has led to the evolution of unique species of insects. Scientists estimate that the NWHI may be home to more than five dozen species of endemic arthropods.

Animals and plants that have evolved on island ecosystems are vulnerable to introduced pests. In the case of insects, new species that hitch rides on ships can compete with the native species who often lack defenses or behaviors that can stop invasive species.

Because of the delicacy of the island ecosystems, researchers take special care that they do not accidentally introduce new insect species to the NWHI. To make sure, all clothing and bags have to be frozen before use, and only used on one island. While it may be inconvenient, these precautions help to preserve insect communities that are found nowhere else on earth.

Bishop Museum. (2002). *Life on Islands*. Join a Research Expedition to the Northwestern Hawaiian Islands. Retrieved May 22, 2002, from <http://www.bishopmuseum.org/research/nwhi/insects.shtml>

Insect Links

US Fish and Wildlife Page on Insects on Midway
<http://www.r1.fws.gov/midway/wildlife/invert.html>

Bishop Museum's Interactive Species Database
<http://hbs.bishopmuseum.org/arthrosearch.html>

PLANTS

Like most Pacific islands, the plant communities of the Northwestern Hawaiian Islands have been affected greatly by the activities of human beings. Guano mining or military development World War II wiped out many plant species on a number of islands, in turn threatening birds and insects who had depended upon them.

Nihoa and Necker are relatively undisturbed, with a few interesting endemic species such as *Amaranthus brownii*. Some aliens are established on Pearl and Hermes Reef and French Frigate Shoals, but they are not spreading. The original plants found on Laysan and Lisianski were devastated by rabbits. Some alien species, like ironwood, were planted intentionally on a few islands but they have not spread. Kure Atoll has predominantly alien flora.

To help preserve some of the plant communities, workers have built a nursery on Laysan and are propagating native plants. In order to prevent the spread of unwanted weeds and other pest species, researchers take extreme care when visiting the NWHI. Scientists on the NOWRAMP cruise for instance are required to have a brand new set of clothes, shoes and even equipment bags for each island that they visit.

Bishop Museum. (2002). *Life on Islands*. Join a Research Expedition to the Northwestern Hawaiian Islands. Retrieved May 22, 2002, from <http://www.bishopmuseum.org/research/nwhi/plants.shtml>

Plant Links

US Fish and Wildlife Service page
<http://www.r1.fws.gov/midway/wildlife/plants.html>

University of Hawai'i Native Plants Page
<http://www.botany.hawaii.edu/faculty/carr/natives.htm>

Human Impact

Marine Debris & Pollution

Alien Seaweeds in Hawai'i

10 Things To Help Protect Hawai'i's Coral Reefs From Alien Seaweeds

Threats to Habitats & Species

Polynesian Culture

Panala'au: Living on an Atoll in 1935

How Military Powers Affected Atolls

Environmental Effects of Aquaculture

Research in the NWHI National Wildlife Refuge

Marine Debris & Pollution

Pollution of the marine environment can take many forms, and can be both naturally occurring and man-made. Pollution can take the form of oil spills, chemical contamination, direct dumping of sewage, and garbage, or naturally occurring chemical toxins. Perhaps the greater threat to ocean life, and the most humanly preventable, continues to be plastics.

Oil spills of any size are harmful to marine life. When oil coats the skin, fur, or feathers of ocean animals, the animal often loses its ability to insulate and will die of hypothermia. If the animal attempts to clean the oil off itself, the ingestion of the oil can also be toxic.

Chemical contamination often occurs from agricultural runoff. As herbicides, fertilizers, and pesticides are carried off of fields by rainwater, they contaminate all freshwater drainages on their way to the ultimate terminus of every waterway, the world ocean. The damage these contaminants causes can be two-fold: first, it will pollute the food chain, beginning with the most primary, tiny animals, and second, it kills coral polyps and their resident algae, ultimately damaging the reef, which supports thousands of marine species and serves to protect beaches from erosion. Chemical contamination of the world ocean can also occur through local spills or sources such as factories, and is a silent, but very deadly, pollutant.

The dumping of sewage and garbage can cause both chemical and physical pollution. The most far-reaching result of ocean dumping, by far, seems to be plastics. Plastics are among the most durable fibers ever created, so that they remain in the environment for literally hundreds of years. In 1960, Americans produced about three pounds of plastic garbage each day; in 1987 this number had risen to about five pounds per day. Although the U.S. and 59 other nations signed an agreement in 1972 to outlaw the ocean dumping of durable plastics, the sharp increase in the production of plastics has resulted in continually increasing amounts of plastic in the world ocean.

Plastics are harmful to the ocean in three ways. First, and probably least critical, it is simply unsightly. Second, and of primary importance, many marine animals mistake plastics for prey and ingest them. Once in the digestive system of an animal, plastics can form a plug or cause an ulcer, both of which can be fatal. In a study conducted in the NWHI in the 1980's, 45 out of 50 albatross studied were found to have ingested plastic, and 60 % of wedge-tailed shearwaters. Finally, plastics are a major cause of wildlife entanglement. It has been estimated up to two million seabirds and 100,000 marine mammals die annually as a result of entanglement in plastics. Plastics enter the ocean as lost fishing gear, and from the many urban areas whose rivers lead ultimately to the sea. It is of utmost importance for students to understand they can have a direct impact on the health of the ocean through the choices they make in purchasing and disposing of plastics in their daily lives.

Himschoot, R. (1997). [Northwestern Hawaiian Islands National Wildlife Refuge: Environmental Educational Outreach Program]. Unpublished manuscript & raw data.

Alien Seaweeds in Hawai'i

Dave Gulko, Division of Aquatic Resources
Fall 2001

Ecological Concerns:

Typical natural reefs in Hawai'i have high coral cover, high number of fish, and a few native limu species.

Hawai'i has the highest level of endemism (unique species) on coral reefs anywhere on the world. These unique fish, limu, coral and other invertebrates evolved without defense against competitively superior alien species found outside Hawai'i. Many of our unique species are directly threatened by alien introductions.

Low nutrients and high grazing activity by herbivorous fish and urchins keep many algae from blooming and allowing our slow growing corals to dominate. Overfishing and nutrient runoff from shore create conditions which drive these algae blooms.

Phase shifts alter our native reef ecosystems. Slow growing corals are replaced by a single species of seaweed, thereby changing the entire habitat from one characterized by a multitude of native coral to that of single alien seaweed. This change reverberates throughout the ecosystem as fish, tako and other invertebrates which lived in the coral reef habitat leave the area and don't return.

Alien seaweeds have life history characteristics that promote rapid spread and rapid growth. Often these aliens reproduce asexually, often through fragmentation (breaking off a section that regrows into a new seaweed) – such fragmentation can occur naturally through wave action or be influenced by human activity such as boat wakes, trampling snorkeling/diving, collecting and fishing activities. Successful aliens tend to be extremely tolerant of a wide range of physiological/environmental conditions, and often tend to be competitively superior at capturing nutrients. All of these features make alien seaweeds difficult to control.

Economical Concerns:

88 % of the over 7 million visitors to Hawai'i each year engage in some form of marine water activity, most come here to experience, in one way or another Hawai'i's unique natural resources. Phase shifts caused by alien seaweeds directly threaten the \$800 million per year marine tourism industry.

Excess algae from algal blooms often wash ashore on Hawaiian beaches where they create major eyesores and smell awful as they decay, directly threatening the \$11 billion dollar per year overall Hawaiian tourism industry which relies heavily on images of clean sandy beaches.

Algal blooms also raise public health concerns in regards to decaying materials on beaches and in regards to marine materials provided expanded substrates for the dinoflagellate which causes ciguatera poisoning in humans which consume fish in which it's concentrated.

Alien algae displaced many of our native limu gathered for food by a wide range of people.

Natural reef habitats directly support a wide range of economic and recreational activities. Phase shifts by alien seaweeds directly affect a wide range of boating, commercial fishing, recreational fishing, subsistence fishing, aquaculture, surfing, diving, military and cultural activities.

Mechanisms of Alien Seaweed Introduction:

At least four out of the six alien seaweeds known to be causing serious problems on our reefs were accidentally introduced through research and aquaculture activities.

Algae associated with aquarium organisms (ingested or attached to animals or plants sold through the trade) followed by accidental release from home aquariums directly into stream and coastal areas.

Attachment to vessel hulls or in ballast water of ships coming to Hawai'i (i.e.: cruise ships, transport vessels, barges, recreational boats and military vessels).

Illegal Importation

Possible Vectors (Ways which these seaweeds are spread to new areas in Hawai'i):

Movement of marine animals, substrates and plants from one islands (or section of an island) to a neighbor island (or new section of the same island), for the aquarium trade, research, aquaculture, or public display.

Attachment to vessel hulls or in ballast water of ships coming to Hawai'i (i.e.: cruise ships, transport vessels, barges, recreational boats and military vessels).

Fragmentation of alien seaweeds by collectors seeking other organisms.

Attachment to fishing gear, nets and traps, dive gear and dive bags, and other in-water equipment which may be used in an infected area and then used later in a non-infected area.

Management Needs:

Stronger control and oversight of research and aquaculture activities to minimize accidental introductions.

Support for broad public educational efforts and targeted efforts at specific marine resource user groups.

Research into life history characteristics of alien seaweeds.

Research into control mechanisms.

Support for active control of marine alien seaweeds.

Support for more active management of coral reef resources, including stronger controls on nutrient input and stronger support for regulating overfishing of coral reef organisms.

Sources used in the preparation of this material:

- Materials produced by Dr. Celia Smith, UH – Botany
- Materials produced by Jennifer Smith, UH – Botany
- Materials produced by Scott Godwin, Bishop Museum

Gulko, D. (2001, Fall). *Alien Seaweeds in Hawai'i*. Internal technical report presented by the Division of Aquatic Resources (DAR), Honolulu, HI.

10 Things You Can Do To Help Protect Hawai'i's Coral Reefs from Alien Seaweeds

1. Support strict controls on organisms allowed into the State for aquaculture and research.
2. Thoroughly inspect all fishing gear, nets, dive gear, boat hulls, and motors every time such gear is removed from the water.
3. Never dump aquarium animals or plants into streams or coastal waters. Don't transplant any marine organisms.
4. Report suspected alien marine animals or plants to the Division of Aquatic Resources (DAR) at 808-587-0100.
5. Always soak your dive gear, wetsuits and dive bag in 100% freshwater after each use.
6. Take steps to decrease overfishing. Herbivorous fish help to keep down algal growth.
7. Learn more about our unique reefs and practice resource stewardship.
8. Support the creation and maintenance of functional marine reserves.
9. Be a wastewater crusader! Get involved in monitoring and preventing sewage and runoff from introducing nutrients and chemicals onto our reefs.
10. Spread the word, help to promote awareness of the importance of Hawai'i's coral reefs and the dangers of alien species!

Gulko, D. (2001, Fall). *Alien Seaweeds in Hawai'i*. Internal technical report presented by the Division of Aquatic Resources (DAR), Honolulu, HI.

Threats to Habitats & Species

- Potential launching of target missiles from Tern Island could result in disturbance, injury, and/or mortality to seabirds, sea turtles, monk seals, and coral reefs.
- Invasive alien species (weeds, insects, and marine species) can displace and outcompete native species; ants are an especially serious threat.
- Plastic materials that only dispersed into the marine environment accumulate on beaches and can entangle or are ingested by wildlife.
- Oil spills and tarballs of unknown, marine origin foul birds' feathers and are sometimes ingested by birds and turtles.
- Abandoned fishing nets entangle and drown birds, monk seals, and sea turtles. Commercial fisheries result in incidental bycatch and entanglement, and could be reducing the marine prey base used by monk seals and seabirds.
- Gradual seawall erosion on Tern Island will result in wildlife entrapment, loss of the landing strip and field station, habitat loss, and release of buried debris.

POLYNESIAN CULTURE

In his great history of cultural evolution, Arnold Toynbee listed three civilizations that were arrested in development by the environment. The Polynesians, Eskimos, and Nomads, respectively conquered the tropic sea, the polar snow, and the desert by what Toynbee regarded as a *tour de force*. The Polynesians, for example, by audacious voyages reached the extreme limits of the powers of their culture. They could do no more and remained in a precarious equilibrium with their environment for long ages (so he thought), until the Europeans arrived. There is much to be said for these views except, perhaps, for the idea that the equilibrium was precarious. It may, in fact, have been quite stable. The instability lay in the potential for intrusion by an alien culture that would not be content with equilibrium or able to reach it with the island environment.

Consider, for example, the relations between Polynesians and atolls. An atoll has hardly any land, so there is no way for a large human population to accumulate. An atoll has a long shore perimeter for its area, and it has an enormous lagoon. Hence there is a very large source of easily acquired protein. A few vegetables and fruits are easy to grow and, in the right latitudes, rainwater is abundant. An atoll is an environment almost ideally designed so man cannot get out of equilibrium with it. It might have taken a catastrophe like an ice age or a giant wave from a large meteorite impact in the ocean nearby to dislodge Polynesians from an atoll. They certainly knew how to survive hurricanes and their high waves.

Polynesian culture on high islands may also have been stable with regard to the environment. The very characteristics that, by some classifications, would identify the culture as arrested would make for stability. There was no metal weapons or clay for bricks. Consequently there was no incentive to burn the native forests in kilns or forges as in the early civilizations of India and elsewhere. Moreover, the island interiors were very steep for farming, so there was no incentive to clear the forests for that. The stability of the rivers and forests was not due to any equilibrium between large herbivores and carnivores. Thus, there was no opportunity for the Polynesians to upset the equilibrium by killing the carnivores. By a mercy, the Polynesians did not bring goats or rabbits, so the forest growth was not destroyed by feral animals. The end result of all these facets of Polynesian culture and its environment was that the forests were preserved and with them the soil, watersheds, water supply, and the coastal food supply that depended on clear water. Moreover, given isolation, the equilibrium with environment was not apt to change significantly. Certainly no need for kilns or forges would have arisen on oceanic islands. Of course, continental islands are different. Once the Polynesians arrived in New Zealand and had the giant moas to exterminate, they exterminated them.

Panala`au: Living on an Atoll in 1935

Imagine yourself on a tiny island in the middle of the Pacific Ocean. Just a few feet above sea level, the island is nothing more than sand, coral and a few patches of brush. There is no running water or electricity. You have to catch your meals, and your only companions are the dozen other men who have volunteered to spend a few months on an otherwise deserted island.

Doesn't sound like your typical high school graduation party, does it? But for William Hutchinson and many other Kamehameha graduates, colonizing five coral islands in the equatorial Pacific Ocean was a great post-high school adventure.

“A lot of us Kamehameha boys volunteered to go and applied with the (U.S.) Coast Guard,” recalls Bill. “We were paid by the Department of Interior \$3 a day. In those days, \$3 was big money.”

From 1935 to 1941, the United States departments of Commerce and Interior sent young men to the South Sea Islands of Jarvis, Howland, Baker, Canton and Enderberry for six weeks to four months at a time.

These colonists, or *panala`au*, helped the United States determine what role the strategically located islands could play in developing air routes across the central Pacific from California to Australia. Could emergency airplane landings be made? What were the seasonal weather conditions? Who did the islands belong to anyway?

“The government wanted to colonize so nobody else (like the British) could claim it,” says Bill. “My only duty down there was to record the weather three times a day. The next day I'd be off and the day after that I'm the cook.”

Just what did the *panala`au* eat?

“We had lobster tails coming out of our ears,” Bill exclaims. “And the *wana* – ho! Big as a basketball and fat, too! All you had to do to catch fish was get a stick and hit the fishes on the head.”

When Bill wasn't fishing, swimming or lifting weights, he kept busy by making feather *lei*. He caught the birds himself, being careful not to kill or injure them. Bill's favorite bird was the Bos'n Marlin.

“It's neck feathers shine pearly pinkish in the sun,” says Bill. “They're beautiful.”

Bill would tease a bird with a stick and then grab hold of its beak so it couldn't bite, put one wing under each foot and then plucks feathers from the live bird. He soon became quite adept at the ancient Hawaiian art of *lei hulu* [feather lei].

Bill spent three months on Howland, and returned to Hawai'i more mature, robust, strong and independent – qualities that attracted Honolulu Police Department recruiters.

“When the police department knew you went down there, boy they'd pick you up quick,” says Bill, who retired from HPD [Honolulu Police Department] in 1957 after 16 years on the force. “They knew we Panala`au were all tough guys,” he adds. After a career in law enforcement, Bill started his own successful driver's education business. He was one of only two retired police officers who advertised their instructional services in the newspaper and was in big demand.

“That's how I paid for this house,” he says of his Makiki Heights residence. He lives there with his wife Mary Anne. Their two sons and two grandchildren also graduated from Kamehameha, but it would be hard for them to top Bill's adventures in the South Seas.

“We were 100 percent tan,” Bill remarks while looking at a picture in a scrapbook. “From the time the Coast Guard dropped us off on the island, we'd take off our shirts and wave goodbye, and never put them back on.” He smiles, remembering his carefree days in the sun. “It was paradise.”

How World Military Powers Affected Atolls

The unarrested industrial civilizations of Europe, America, and Japan have proved capable of destroying while islands and, without even trying, their biota. The stable relations between mankind and atolls only persisted as long as the users of an atoll were also the permanent occupants. Successively the Germans (in WWI), the Japanese, and the Americans conceived of atolls as fleet anchored and fortified them as advance bases. Then, in 1941, the Japanese launched the first modern battles on atolls and captured Wake from the United States but were disastrously defeated at sea west of the atoll of Midway. The American counterattack in the central Pacific began with a naïve assault on Tarawa atoll in the Gilbert Islands. The inexperienced naval commanders believed that there would be scarcely any organized survivors on the tiny islands of the atoll after massive shelling and bombing. It was part of my job at that time to assess such damage, and we all tended to forget the trivial effects of endless shelling of the trenches in World War I. An atoll has no relief and no cover. The Marines assaulted across the reef into still intact fortifications, and a thousand died in four days before the last of 4700 Japanese defenders was killed.

The amphibious landings at Eniwetok (now Enewetak) and Kwajalein went a little better for the attackers, but each of these victories required the destruction of every last small bunker and gun emplacement. The aftermath was the utter destruction of the surface of one or more islands per atoll. However, the atolls survived. Rain fell and water percolated down to the Ghyben-Hertzberg layer; solution and precipitation of limestone began to cement the exploded fragments together; and plants and animals migrated from the undamaged islands to repopulate the barren landscape. Except for the danger of unexploded ordnance, the atolls were essentially restored within half a dozen years. The reef flats were not as attractive because they were imbedded with bits of landing craft, bombs, and beer cans, but these were rusting away. Certainly the conventional weapons of World War II were unable to end the long lives of atolls.

With the dawn of the nuclear age, industrial man conceived of a new use for atolls. After a few residents were persuaded to leave, an atoll could be an ideal site for nuclear tests. It was isolated, provided a good anchorage, and, except to the former residents, was not much good for anything else. So Bikini, in the Marshalls, became famous as the site of a shallow-water nuclear test in the lagoon. Enewetak was used a few years later to test the first hydrogen bomb. It vaporized the test island. Within a few years, I was on each of these atolls, which looked a little the worse for wear. However the longer-term effects of radiation on the atolls and on the former human residents who sought to return remains to be determined. Meanwhile, Great Britain tested its first hydrogen bomb on Christmas Island in the Indian Ocean. This former atoll, uplifted on the outer arch of the Indonesian subduction zone, had already been defaced by phosphate mining. The French, not to be outdone, established a (still) permanent test site at Mururoa atoll, in the Tuamotus.

Murky Waters: Environmental Effects of Aquaculture in the U.S.

R. Goldberg & T. Triplett, with The Environmental Defense Fund

Aquaculture Production

Most Americans would be surprised to discover that their last seafood meal may have been raised on a farm, rather than caught in the ocean. Largely because of declines in wild fisheries and rising demand for seafood, aquaculture has become the source of an increasing percentage of seafood consumed in the United States and throughout the world. Although precise figures are not available from the aquaculture industry or government, most of the catfish and trout, roughly half the shrimp, and approximately one-third the salmon consumed in the United States is raised by aquaculture, or fish farms.

World aquaculture production has more than doubled since 1984, and reached a record 20,900,000 metric tons (mt) of fish and shellfish in 1995, the latest year for which statistics are available. This farmed seafood was worth more U.S. \$36.2 billion and represented 18.5% of the total world seafood supply. Aquaculture is now the source of 27% of seafood consumed by people worldwide, since more than a quarter of wild fish harvests are used in animal feed.

Similarly, the value of U.S. aquaculture production has grown 5 – 10% each year over the past decade, and aquaculture is regarded as the fastest-growing segment of U.S. agriculture. Fish are now farmed in every state and territory in the United States, and U.S. aquaculture production totals more than 400,000 mt of fish and shellfish (shell weight included), worth \$729 million...

...U.S. aquaculture production is expected to continue to increase steadily. Some observers believe that there is a natural transition underway to obtaining fish from aquaculture rather than wild fisheries, similar to the transition our society has made to obtain meat from farming and ranching rather than hunting. However, wild fisheries are unlikely to disappear. Compared to many land animals, fish populations tend to have high reproductive rates and can generally sustain high harvest levels. Seafood demand is steadily growing around the world, along with the growth of populations and affluence. Aquaculture will almost certainly be used to supplement wild fish catches, not to replace them.

Moreover, aquaculture production is not an alternative to fishing unless only fish that are largely herbivorous (such as tilapia, catfish, carp, oysters and clams) are farmed. In fact, many farmed fish are carnivores and depend on diets of wild fish that are caught to feed them.

Troubled Water

Aquaculture is commonly presented as a clean industry. Nevertheless, intensive (densely stocked) aquaculture systems can produce large quantities of polluting wastes, as with other forms of intensive animal production. There is, however, a difference: Wastes from terrestrial farms (such as hog and poultry operations) usually reach natural water bodies only indirectly, for example, in runoff when storms cause waste lagoons to overflow. In contrast, aquaculture wastes are often released directly into natural bodies of water, because fish farms are located in them or because effluent is discharged into them...

Fish Introductions

Pollutants from aquaculture facilities are not necessarily chemical in nature. Biological pollution from aquaculture such as the introduction of unwanted non-native species to natural ecosystems, can harm ecosystems by altering species composition or reducing biodiversity. Few aquaculture facilities are escape-proof, and very large numbers of fish sometimes escape from certain types of facilities...

Environmentally Friendly Aquaculture

Aquaculture need not be a polluting industry. A wide variety of technologies and practices now are available to make aquaculture facilities environmentally friendly, and many of these are now used on commercial fish farms. As is the case, with any industry today, aquaculture has a spectrum of approaches available to it to manage pollutants. The most preferred approach – termed source reduction – is to prevent or reduce the production of pollutants in the first place. Source reduction technologies and practices in aquaculture minimize the production of nutrient, synthetic chemical, or biological pollutants. In decreasing order of preference, other available approaches are to recycle and reuse wastes, treat wastes and (least preferred) dispose of wastes in the environment.

Goldburg, R. & T. Triplett. (1997, January). *Murky Waters: environmental Effects of Aquaculture in the U.S.* Retrieved on June 6, 2002, from The Environmental Defense Fund at <http://www.environmentaldefensefund.org>

Research in the NWHI National Wildlife Refuge & Kure Atoll Wildlife Sanctuary (Human Impact)

Marine debris cleanup by U.S. Coast Guard, USFWS, US Navy, UH Sea Grant, NOAA, Center for Marine Conservation

Beginning in 1996 and continuing to the present large scale comprehensive marine debris survey and removal efforts have been occurring at Lisianski Island/Neva Shoals, Kure Atoll, Pearl and Hermes Reef, and Midway Atoll. This current multi-agency effort removes, monitors, and identifies the source of marine debris in the near-shore coral reef habitat. Snorkel and SCUBA divers conduct surveys to document the distribution and density of derelict fishing gear and undertake removal of said seals, turtles, and other wildlife while concurrently restoring the reef. Data collected from retrieved debris includes location, depth, weight, dimensions, type of item, mesh size/twine diameter/material type for all nets, industry responsible for each type of debris, and when possible, country of origin.

Wreck damage assessment

Four hundred meters of permanent monitoring transects have been set up and surveyed off the grounding site of the Swordman II, a longline vessel that came aground at Pearl and Hermes Reef in May 2000. Fieldwork is completed, analysis is underway and another survey trip is being planned for 2002. (Collaborators-USFWS and Hawaii Division of Aquatic Resources).

Assessment of Tern Island contaminated marine debris during 1998-2000

Location, analysis, and removal of contaminated debris (e.g., lead, PCBs) is occurring in the lagoon waters around Tern and East Islands of French Frigate Shoals. In previous years divers were used to locate and remove debris (collaboration U.S. Coast Guard and U.S. Naval Reserve HazMat Divers, USFWS Environmental Contaminants).

Collaborators with UH have been funded with USFWS Environmental Contaminant money to do use an underwater mapping group to side-scan sonar and tow magnetometer to locate underwater debris around remote islets and lagoon waters of FFS. If this procedure proves to be effective, will be used for surveys in other atoll of NWHI (Midway, Pearl and Hermes, Kure).

Laysan Dead Zone

Studies conducted by consultants hired by USFWS found that the cause of the localized invertebrate deaths was probably a carbonate pesticide, carbofuran. Investigation by US Army Chemical and Biological Defense Command, Aberdeen Proving Ground concluded that no warfare nerve agents were present. Investigations by USFWS and University of California-Davis (Kate Scow) found that there is no underground source, but biodegradation is not occurring due to a paucity of microbial community and an unusual inability of the microbes to degrade the compound. Research by UH adapted standard analytical techniques to confirm that the compound was carbofuran. Long-term monitoring by on-island staff confirmed that the impacts are confined to the one small area.

Laysan Dead Zone clean-up

USFWS Environmental Engineering funded the cleanup of the Dead Zone on Laysan that began March 2002. The cleanup consisted of removing approximately 3 cubic meters of highly contaminated sand (carbofuran 50-6,000 mg/kg) and the facilitated physical degradation of the remaining contamination. The pesticide has been shown (UH research on Dead Zone contaminated sand) to break down quickly in sunlight, so the remaining contaminated sand (1-50 mg/kg) will be washed with sea water to dissolve any particles and turned over (via rototiller) for full sun exposure. This will continue until on-site analysis of the sand shows no remaining contamination. The removed sand will be packed and sent to an appropriate contained landfill on Oahu. Long-term monitoring by the FWS personnel on-island will insure complete remediation was achieved.

PCB and metal contamination in a coral reef ecosystem

In collaboration with UH (Qing Li) and U.S. Coast Guard sampling and analyses occurred on biota, coral, and sediment from various locations in FFS 1999-2001. Biota were selected to incorporate various trophic levels, and localized vs. far-ranging species. Analyses assessed metabolism and transfer of PCBs through the trophic structure, contaminant sources, and French Frigate Shoals vs. Oahu. This work resulted in 3 publications and was funded with USFWS Environmental Contaminants funds.

Contaminant threats to sea turtles 1999-2002

Investigations occurred on green sea turtles to identify contaminant source and possible relationship between contamination of the turtles and: a) tumor occurrence b) nest size, and c) nest success. In collaboration with UH, Graduate Students Vanessa Pepi and Julie Rocho followed marked individual nesting females through the 1999 nesting season collecting data on tumor occurrence, nest frequency, nest size, nest success, and collected turtle blood, eggs, hatchlings, and nest sand for contaminant (and for blood: hormone) analyses. Lab analyses are being completed. Work will result in MS thesis and several publications.

Contamination of monk seal

In collaboration with National Oceanic Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS) and UH and University of Alaska, blood and blubber samples collected from monk seals at FFS and analyzed by UH Graduate Student Maia Willcox at NOAA Montlake Lab, Seattle. Results were basis of Ms Willcox's MS thesis (1999) and will soon be published. In 2000-2001, additional samples were collected by NMFS and are being analyzed by University of Alaska Graduate Student Matt Myers for contaminant analysis at NOAA's Montlake Lab, Seattle (PCBs & DDT) and hormone analyses. Results will be used as part of Mr. Myers's PhD dissertation and several publications.

Local and global threats to black-footed albatross

Graduate student Kater Bourdon (UH) completed field work to evaluate if contaminated nest soil contributes to chick/adult contaminant body burdens, hormonal status (e.g., thyroid), and chick fledgling success in black-footed albatross. These data will be used for several publications and Ms Bourdon's MS thesis (2003/4). USFWS Volunteer (and U.S.

Geological Survey/BRD employee) Shiway Wang, assisted in the black-footed albatross contaminant research and performed some additional analyses on stress hormones relative to nest/body contamination. Ms Wang is currently preparing a proposal for additional research (potential MS thesis) on this topic for FY2002/4 to be funded by USFWS Environmental Contaminant funds.

Ant eradication project

The goals of this project include: establish baseline information on ant species and their associated habitats and determine bait station design, bait, and placement densities. This project may lead to future project designs used to reduce or eradicate alien arthropods within the Northwestern Hawaiian Islands. Study plots, established in 1999, contain varied bait station spacing at three locations on Sand Island. This project continued in 2000 with the testing of new baits and placement design. In 2001 baiting was conducted on Spit Island (6 acres) in hope of eradicating the ant population there. This project will continue at the least into year 2002.

Midway scarab beetle (*Protaetia pryeri*) eradication project

Researchers Adam Asquith, Ph.D., Michael Klein, Ph.D., and Catharine Mannion, Ph.D. began research on the ecology of the scarab beetle in 1999 at the refuge. Baseline information on this alien species has developed into the current design and implementation of an eradication program for the beetle on Midway Atoll. The development and demonstration of an eradication program should be applicable for similar alien species on other islands within the Northwestern Hawaiian Islands. In 2001, eradication efforts will continue on Eastern and Sand Islands. This project will continue during the 2002 summer season.

Marine entanglement debris cleanup

Discarded fishing nets, ropes, fish traps, and other floating debris entangle and kill marine species. Over 15 years of research on the Northwestern Hawaiian Islands has shown increasing trends in accumulation of debris and in the number of seals, turtles, and seabirds found entangled. The marine debris project's main objective is to document the quantity, type, distribution, and annual recruitment rate of entanglement debris on the emergent reef and within the lagoon of Midway Atoll. In 1999, the refuge implemented a pilot project in cooperation with Hawaii Wildlife Fund, Midway Phoenix Corporation, National Marine Fisheries Service, and Oceanic Society using volunteers and interested visitors to recover marine debris from the marine ecosystem. This project is ongoing and part of a larger Northwest Hawaiian Islands debris clean-up effort. In 2001, marine debris cleanup continues within the lagoon, its' emergent and patch reefs, and the islands beaches within the atoll. This is an annual project, which is planned well into the future of the refuge.

Malama & Actions for the Future

Legal Status & Protection

Executive Order 1019 – President Theodore Roosevelt

Executive Order 13178 / 13196 – President Bill Clinton

Expedition Conservation Protocols

Research in the NWHI National Wildlife Refuge

13 Things You Can Do To Protect Hawaii's Coral Reefs

Legal Status & Protection

These islands are all part of the State of Hawaii but are owned and administered as a wildlife refuge by the U.S. Fish and Wildlife Service (Service). President Theodore Roosevelt established the Refuge in 1909, by Executive Order 1019, to protect seabirds from slaughter for the millinery trade. Refuge administrative boundaries include the land area of the eight islands and atolls and extend seaward to 10 fathoms, except for Necker, where the boundary extends to 20 fathoms.

Fishing is prohibited within Refuge boundaries. The State of Hawaii Department of Land and Natural Resources, Division of Aquatic Resources, has jurisdiction over fishing from the Refuge boundary out to 3 nautical miles, are controlled by the Western Pacific Regional Fishery Management Council, and regulations are enforced by the U.S. Coast Guard and National Marine Fisheries Service (NMFS).

The Western Pacific Regional Fishery Management Council has established a Protected Species Zone to protect endangered Hawaiian monk seals that extends for 50 nautical miles around each Refuge island and includes a 100 nautical mile-wide corridor connecting the Refuge islands. Pelagic longline fishing is prohibited within this zone, but other fisheries are allowed.

Special Status Species:

Green Sea Turtle	Listed as Threatened under the ESA
Hawksbill Sea Turtle	Listed as Endangered under the ESA
Hawaiian Monk Seal	Listed as Endangered under the ESA
Humpback Whale	Listed as Endangered under the ESA
Nihoa millerbird	Listed as Endangered under the ESA
Nihoa finch	Listed as Endangered under the ESA
Laysan finch	Listed as Endangered under the ESA
Laysan duck	Listed as Endangered under the ESA
<i>Cenchrus agraminoides</i> var. <i>laysanensis</i> (plant)	Listed as Endangered under the ESA May be extinct
<i>Mariscus pennatiformis</i> ssp. <i>bryanii</i> (plant)	Listed as Endangered under the ESA
<i>Pritchardia remota</i> (plant)	Listed as Endangered under the ESA
<i>Schiedea verticillata</i> (plant)	Listed as Endangered under the ESA
<i>Amaranthus brownii</i> (plant)	Listed as Endangered under the ESA
Bristle-thighed curlew	Species of Concern
5 plant species	Species of Concern
22 arthropod species	Species of Concern

Executive Order [No. 1019]

It is hereby ordered that the following islets and reefs namely: Cure Island, Pearl and Hermes Reef, Laysan Island, Laysan Island, Mary Reef, Dowsetts Reef, Gardiner Island, Two Brothers Reef, French Frigate Shoal, Necker Island, Frost Shoal and Bird Island, situated in the Pacific Ocean at and near the extreme western extension of the Hawaiian archipelago between latitudes twenty-three degrees and twenty-nine degrees north, and longitudes one hundred and sixty degrees and one hundred and eighty degrees west from Greenwich, and located within the area segregated by the broken lines shown upon the diagram hereto attached and made a part of this order, are hereby reserved and set apart, subject to valid existing rights, for the use of the Department of Agriculture as a preserve and breeding ground for native birds. It is unlawful for any person to hunt, trap, capture, willfully disturb, or kill any bird of any kind whatever or take the eggs of such birds within the limits of this reservation except under such rules and regulations as may be prescribed from time to time by the Secretary of Agriculture. Warning is expressly given to all persons not to commit any of the acts herein enumerated and which are prohibited by law.

This reservation to be known as the Hawaiian Islands Reservation.

THEODORE ROOSEVELT

The White House,
February 3, 1909

**Expedition Conservation Protocols for 2000
Northwestern Hawaiian Islands Rapid Assessment Expedition
For the Rapture Participants and Rapture Crew**

Due to the pristine and sensitive nature of the shallow water NWHI areas that the NOWRAMP expedition aboard the Rapture will be visiting, a set of protocols will be put in place for the ship, its crew and the researchers in order to minimize potential impacts.

- A) **Sewage:** In accordance with Federal and State Laws, there will be no intentional release of sewage from the Rapture during the expedition. All sewage will be held in a proper storage tank until it can be off-loaded to proper handling facilities.

- B) **Grey Water:** Grey water is water that has been used for washing clothes, bodies, ect. (as opposed to sewage). Where possible, grey water will be diverted to holding tanks until it can be off-loaded to proper handling facilities.
 - i) **Soaps:** Because decktop showers will be occurring frequently, and this water may reach the ocean, only biodegradable soaps will be on board. Sports, Camping and Outdoor Supply stores often sell concentrated forms of this type of soap and all participants should purchase this type of soap for personal use prior to boarding the ship.
 - ii) **Laundry:** All NOWRAMP participants will be strongly encouraged to consolidate their laundry with others to minimize the number of loads done per day and to conserve water. NOWRAMP will purchase biodegradable soap for use on-board the ship.

- C) **Chemical Use:** Any chemicals used to preserve samples on-board the Rapture will be used in agreement with established UH Environmental Health & Safety Office regulations. At no time will any chemicals be disposed of by pouring overboard.

- D) **Tender Vessel Ops**
 - i) **Outboard Engines:** All outboard engines used on NOWRAMP will be two-stroke outboard engines which have been shown to be less polluting than the older four-stroke engines. They also do not require the pre-mixing of oil into the fuel, thereby decreasing the likelihood of small oil spills during refueling operations.
 - ii) **Refueling:** Refueling of tender vessels from fuel stores aboard the Rapture will be accomplished using small fuel containers that can be refilled aboard the Rapture and then carried to the tender vessels; in

this way, no refueling of tender will occur on the tenders themselves, thereby minimizing inadvertent spills of small amounts of fuel directly into the nearshore waters. Refilling of fuel containers will be done by a minimum of two crew members in order to minimize any possible spills of small amounts of fuel on the decks of the Rapture itself.

- iii) **Operation in Shallow Reef Areas:** Tender vessels will operate at slow speeds and with a bow lookout in shallow water coral reef areas in order to minimize prop or bow damage to three dimensional coral reef habitat or endangered monk seals or sea turtles.

E) Monk Seals and USFWS Refuge Islets: All NOWRAMP participants and Rapture crew will endeavor to avoid interacting with the endangered Hawaiian Monk Seals, *Monachus schauinslandi*. No activities will purposely be conducted in close proximity to monk seals except that done under the direct supervision of USFWS refuge personnel and following established rules and regulation. Similar actions will be taken with any visits to any of the islets of the NWHI which function as USFWS refuges in regards to plant and seabird life.

F) Anchoring

- i) **Rapture:** Every effort will be made to ensure that the Rapture does not anchor on living coral reef areas in the NWHI.
- ii) **Tenders:** Every effort will be made to ensure that the tenders do not anchor on living coral reef areas while conducting inshore operations. In those areas where anchoring needs to occur adjacent to living coral resources, placement and retrieval of the anchor by hand will be done whenever possible this procedure can be done in a safe and prudent manner.

G) Diving Ops: There will be no recreational SCUBA diving conducted off of the Rapture or any of its tenders during the NOWRAMP expedition. There will be no spearfishing allowed. All divers will make every effort to minimize destruction of any three-dimensional benthic habitat as a result of laying transect lines or collecting data.

H) Organism Collection: Organisms will be collected in limited numbers for voucher specimens for Bishop Museum, identification purposes and pigment analysis. Organisms will be collected following the rules and regulations stipulated under the State of Hawai'i Department of Land and Natural Resources Scientific Collecting Permit and the USFWS NWHI Refuge Permit issued for this expedition. No collection for personal use will be allowed.

- D) Fishing:** Given the scientific and environmental concerns involved with this expedition and the unique access to extremely pristine areas, no fishing or taking of marine life for consumption will be allowed on the NOWRAMP expedition while the Rapture is within the USFWS refuge boundaries or within three nautical miles of any emerged area in the NWHI (whichever is greater).

13 Things You Can Do To Help Protect Hawai'i's Coral Reefs

- 1 Support reef-friendly businesses.** Ask what your dive shop, fishing store and tour operators, hotels and other businesses are doing to save Hawai'i's coral reefs. Insure that their operations do not damage our reefs. Encourage businesses to sponsor and donate a share of their profits to reef management and education activities.
- 2 Please don't pollute.** In the water plastic can damage and kill a wide variety of marine life (including fish, sea turtles, sea birds and marine mammals). Garbage and human wastes introduce chemicals and nutrient levels not naturally found on reefs and can result in a decrease of coral cover (and a decrease in the diversity of marine life associated with coral cover). Understand that the pollution released on our islands eventually winds its way into the ocean and or reefs.
- 3 Learn more about our reefs.** Volunteer your time for an environmental organization/agency, participate in a reef or beach clean up, participate in reef education programs, become a member of a local aquarium, zoo, or environmental center. Participate in training or educational programs that focus on the ecology of reef systems. When you further your own education, you can help others understand the fragility, value and wonder of Hawai'i's coral reefs.
- 4 Report dumping, poaching or other illegal activities.** Environmental enforcement officials cannot be everywhere. While it is important to not directly confront possible violators, you can take down as much detailed information about the activity as possible and contact the appropriate authorities.
- 5 Never anchor directly on reef.** Make use of the State's Day use Mooring System where available; otherwise anchor in sand away from reefs whenever possible.
- 6 Take steps to decrease overfishing.** Depletion of our near-shore and coastal fisheries are occurring at an alarming rate, some fear many of them are close to collapse. Given our population and technological increases, methods of fishing that were acceptable just a few years ago may be detrimental in today's world. Without protection, there may be no fish for your own children or grandchildren to catch in the near future.
- 7 If you SCUBA dive or snorkel, don't touch.** Observe the marine environment, don't alter it. In the water your fins, hands and diving equipment can be lethal weapons that damage the delicate, tiny animals that build the reef substrate. Take a moment to think about your other actions in the water; activities that affect the natural behavior of the reef inhabitants affect the entire ecology of the reef.

- 8 Get involved in the legislative process.** Contact your elected officials and encourage them to support legislation that will protect Hawai'i's reefs. Did you know that while Hawai'i has the fourth longest coastline in the U.S., we rank 48th in overall funding for fish and wildlife protection, and last in overall State spending on environmental protection!
- 9 Be an informed consumer and responsible aquarium hobbyist.** Consider carefully the impact on the ecosystem of purchasing preserved coral (note: such coral by law has to come from outside the State of Hawai'i; still their removal causes negative impact on the reefs of the country they're from) or aquarium fish. How were these organisms collected? Is there a management plan in place to minimize impact from their collection on the reef environment? Exotic aquarium species should never be released into Hawaiian waters. Hawai'i is a very unique place containing marine organisms found nowhere else in the world; introduction of non-native marine life can severely affect the ability of our native species to survive.
- 10 Be a wastewater crusader!** Get involved in monitoring and preventing marine water pollution (sewage and runoff). Make sure that such inputs have been properly treated to minimize nutrients and harmful chemicals (such as pesticides and fertilizers). Conserve freshwater.
- 11 Support the creation and maintenance of marine parks and preserves.** Most of Hawai'i's marine resources are over-fished and disappearing at alarming rates. Setting aside and protecting habitat is often the most cost-effective and productive way to not only preserve a wide variety of species, but over time will result in enhancement of nearby areas allowing renewed fishing and gathering opportunities.
- 12 Promote responsible development.** Uncontrolled coastal development and population increases may have profound impacts on adjacent marine ecosystems. As we develop more and more of our undeveloped coastal (and inland) areas, we place greater and greater pressure on the natural ecosystems to adapt. Most of our native island species depend on precious few undeveloped natural habitats and have nowhere to go.
- 13 Practice resource stewardship.** Learn the rules and regulations about fishing, gathering, and use of our marine resources. Follow them in ways that minimize your impact. The use of reef resources is a privilege not a right. Learn more about the ecosystems of the State of Hawai'i and what you can do to protect them. Buy into the idea that these resources are unique to Hawai'i and require an active role on our part to protect them. Encourage others to do the same.

NOTE: Many of these ideas were adopted from the NOAA Coral Reef Home Page (www.coralreef.noaa.gov) and the DLNR Partnership for Resource Protection brochure, the IYOR informational brochure and the ICUN Coral Reefs of the World lists of Impacts on Reefs.

References and Additional Resources

Reference List

Online Web Site Resources

Relevant Newspaper Article Reference List

Additional Resources & Literature

Glossary of Terms

Reference List

- Balazs, G. H. (1976). *Hawaii's Seabirds, Turtles and Seals*. Honolulu, HI: World Wide Distributors Ltd.
- Beckwith, M. W. (1919). *The Hawaiian Romance of Laieikawai*. Translation of Laieikawai by S.N. Hale`ole. Washington D.C.: Government Printing Office, pp. 285-666.
- Bishop Museum. (1998). *Explores of Mauna Kea*. Planetarium Program Educator's Guide. An Education partnership with NASA. Honolulu, HI: Bishop Museum.
- _____. (2001, December). *X-Treme Science: Exploring Oceans, Volcanoes and Outer Space*. Honolulu, HI: Bishop Museum, as part of the "Explores Program" an educational partnership with NASA.
- _____. (2002). *Life on Islands*. Join a Research Expedition to the Northwestern Hawaiian Islands. Retrieved May 22, 2002, from <http://bishopmuseum.org/research/nwhi.shtml>
- _____. (1999, July). *Kaho'olawe: As sense of place*. Honolulu, HI: Bishop Museum Native Hawaiian Culture & Arts Program (NHCAP), funded through the National Park Service, U.S. Department of the Interior
- _____. (2002). *Kumulipo*. Retrieved June 6, 2002, from <http://explorers.bishopmuseum.org/sciencegarden/dClassification/taxonomy.html>
- Blaisdell, K. (n.d.) *Kumulipo/Hawaiian cosmos*. Retrieved on June 6, 2002, from <http://www.alohaquest.com/scripts/kumulipo.htm>
- Buck, P. H. (1959). *Vikings of the Pacific* (Originally published as *Vikings of the Sunrise* in 1938). Chicago, IL: UC Press.
- Cleghorn, P. (1987). *Prehistoric Cultural Resources and Management Plan for Nihoa and Necker Island, Hawai'i*. Honolulu, HI: Bishop Museum.
- Corney, B.G. (1919). *The Quest and Occupation of Tahiti by Emissaries of Spain during the Years 1772- 1776* (ed). London: Hakluty Society.
- Cuddihy, L.W. & C.P. Stone. (1990). *Alteration of Native Hawaiian Vegetation: Effects of humans, their activities & introduction*. Cooperative National Park Resources Studies Unit, University of Hawaii at Manoa. Honolulu, HI: University of Hawaii Press.

- De Felice, R. (1998). What are Sponges? Adapted From: Hooper, JNA. 1998. Sponguide, version April 1998. Queensland Museum, Australia. Retrieved May 22, 2002, from <http://www.bishopmuseum.org/research/nwhi/sponges.shtml>
- Emerson, N.B. (1965). *Unwritten Literature of Hawaii: The Sacred Songs of the Hula*. (First published in 1909 by Bureau of American Ethnology) Rutland, Vermont: Charles E. Tuttle Co., Inc.
- Emory, K. P. (1928). *Archaeology of Nihoa and Necker Islands*. Honolulu, HI: Bishop Museum.
- Finney, B. (1992). *Voyaging in to Polynesia's Past*. In *Sea to Space*. Palmerston North, New Zealand: Massey Press.
- Froiseth, W. (1980). *History of Hokule'a*. In *Polynesian Seafaring Heritage*. Honolulu, HI: Kamehameha Schools Press.
- Goldburg, R. & T. Triplett. (1997, January). *Murky Waters: environmental Effects of Aquaculture in the U.S.* Retrieved on June 6, 2002, from The Environmental Defense Fund at <http://www.environmentaldefensefund.org>
- Grimble, A. (1989). *Tungaru Traditions: Writing on the Atoll Culture of the Gilbert Islands*. Honolulu, HI: University of Hawaii Press.
- Gulko, D. (2001, Fall). *Alien seaweeds in Hawai'i*. Internal technical report presented by the Division of Aquatic Resources (DAR), Honolulu, HI.
- Gulko, D. & J. Maragos. (eds.). (2002). *Coral Reef Ecosystem 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: 46 pp.
- Hawaii Audubon Society. (1971). *Hawaii's Bird* (2nd 3ed.). Honolulu, HI: Hawaiian Audubon Society.
- Hawai'i Coral Reef Network. (2002). *Marine Life of Hawai'i: Glossary of Technical Terms*. Retrieved on May 10, 2002, from <http://www.coralreefnetwork.com/marlife/glossary.htm>
- The Hawai'i Millennium Commission. (2000 – 2001). *Malama Hawai'i*. [Brochure]. Honolulu, HI: Polynesian Voyaging Society & The Bishop Museum.
- Himschoot, R. (1997). [Northwestern Hawaiian Islands National Wildlife Refuge: Environmental Educational Outreach Program]. Unpublished manuscript & raw data.

Kamehameha Schools. (1993, Spring). [Brochure]. *Imua*. Honolulu, HI: Kamehameha Schools Press.

_____. (1994). [An educational packet]. *No Na Mamo*. Honolulu, HI: Kamehameha Schools Press.

Kawaharada, D. (1995). Polynesian Migrations, Canoes, and Wayfinding. In T. Henry and others in *Voyaging Chiefs of Hawai'i*. Honolulu, HI: Kalama Ku Press (pp. vii-xv).

_____. (n.d). *Personal Stories of Nihoa and Necker Islands*. Honolulu, HI: Bishop Museum.

Kearns, C., H. Sonoda, J. Norris. (2002, May). *The Ancestral Beginnings*. The Office of Hawaiian Affairs. Ka Wai Ola [Newsletter], p. 12.

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.

Kirch, P. (1987). *Feathered Gods and Fishhooks: An Introduction to Hawaiian Archaeology and Prehistory*. Honolulu, HI: University of Hawaii Press.

The Kumulipo: A Hawaiian Creation Chant. (1981) (2nd ed). Honolulu, HI: The University of Hawaii Press.

Lake, J. K. (2000). *Hawaiian Land Divisions, Terminology's and Locations*. [Brochure] Honolulu, HI: Bishop Museum.

“Language map” Series. (2001). *Hawaiian: A language map*. [Brochure]. Bilingual Books, Inc. Seattle, WA: Kristine K. Kershul.

Lewis, D. (1972). *We, the Navigators*. Honolulu, HI: University of Hawaii Press.

_____. (1978). *The Voyaging Stars: Secrets of the Pacific Island Navigators*. New York, New York: W.W. Norton.

Maui Ocean Center. (2000). *Shallow Reef, Mid Reef, and Open Ocean*. [Brochure]. Wailuku, HI: Maui Ocean Center.

Menard, H. W. (1986). *Islands*. New York: Scientific American Library, pp. 206-207.

Munro, G. C. (1971). *Birds of Hawaii* (6th ed.). Tokyo, Japan: Charles E. Tuttle, Co., Inc.

- National Marine Sanctuaries. (2002, February). *Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve Draft Reserve Operations Plan (DROP)*. (Draft No. 2/02). Hilo, HI: U.S. Department of Commerce, National Oceanic and Atmospheric Administration National Ocean Service (NOAA).
- Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve. (2002). *The Region: The Coral Reef Ecosystem*. Retrieved May 10, 2002, from <http://www.hawaiiireef.noaa.gov/region/region.html>
- Piianaia, A. (1993). *Preface and Acknowledgements: To the Second Edition*. In T. Holmes (eds.), *The Hawaiian Canoe* (pp. Vi, vii). Honolulu, HI: Editions Limited.
- Polynesian Voyaging Society. (2001, Spring) *Voyaging Into the New Millennium*. (001 ed.) [Newsletter]. Honolulu, HI: Olomana Marketing LLC, pp. 1, 3.
- Pukui, M. K. (1983). *'Olelo No'eau: Hawaiian Proverbs & Poetical Sayings*. Honolulu, HI: Bishop Museum Press.
- Pukui, M. K. & S. H. Elbert. (1986). *Hawaiian Dictionary* (5th ed.) Honolulu, HI: University of Hawaii Press.
- Pukui, M. K., S.H. Elbert & E.T. Mookini. (1984). *Place Names of Hawaii* (2nd ed.). Honolulu, HI: University of Hawaii Press.
- Rauzon, M.J. *Isles of Refuge: Wildlife and history of the Northwestern Hawaiian Islands*. (2001). Honolulu, HI: University of Hawai'i Press.
- Sacred-Texts. (n.d.). *Kumulipo: A Hawaiian Creation Chant*. Translated with commentary by Martha Warren Beckwith (1951). Retrieved on June 6, 2002, from <http://www.sacred-texts.com/pac/ku/ku31.htm>
- Stone, C.P. & D.B. Stone (1989). (eds.). *Conservation Biology in Hawaii*. Honolulu, HI: University of Hawaii Press.
- Tava, R. & Keale, M.K. *Ni'ihau: The Traditions of an Hawaiian Island*. Honolulu, HI: Mutual Publishing.
- TenBruggencate, J. (1986). *The Honolulu Advertiser's Wildlife of Hawaii* (1st ed.). Honolulu, HI: The Honolulu Advertiser.
- United States Fish & Wildlife Services. (2002). *About the Northwest Hawaiian Islands*. Honolulu, HI: Author.
- United States Fish & Wildlife Service. (2002, March). *Research in the NWHI National Wildlife Refuges and Kure Atoll Wildlife Sanctuary*. Honolulu, HI: Author.

United States Geological Survey. (1999). *Hotspots- Mantle of Thermal Plumes*. Retrieved on May 22, 2002, from <http://pubs.usgs.gov/publications/text/hotspots.html#anchor19596916>

United States Geological Survey. (1999). *The Long Trail of the Hawaiian Hotspot*. Retrieved on May 22, 2002, from <http://pubs.usgs.gov/publications/text/Hawaiian.html>.

Western Pacific Regional Fishery Management Council. (2002). *History of the Fisheries in the Northwestern Hawaiian Islands*. Retrieved May 15, 2002, from <http://www.wpcouncil.org/history.html>

Online Website Resources

The Bishop Museum

www.bishopmuseum.org
<http://explores.bishopmuseum.org/nwhi>
<http://bishopmuseum.org/research/nwhi/index>
<http://hbs.bishopmuseum.org/hbsl.html>
<http://www2.bishopmuseum.org/noaanwhi/index.asp>
<http://www2.bishopmuseum.org/nwhiobjects/index.asp>

U.S. Fish and Wildlife Services

www.pacificislands.fws.gov.midway.fws.gov
www.midway.fws.gov
<http://www.fws.gov>
<http://www.r1.fws.gov/pacific>
www.state.hi.us/dlnr/dar/index

National Oceanic and Atmospheric Administration (NOAA)

<http://noaa.gov>
<http://www.hawaiireef.noaa.gov>
<http://coralreef.gov/>
<http://www.coralreef.noaa.gov>
<http://www.biogeo.nos.noaa.gov>

NOAA Ship Townsend Cromwell's Home Page

<http://atsea.nmfs.hawaii.edu>

National Marine Sanctuary Programs

<http://sanctuaries.nos.noaa.gov>

State of Hawaii Department of Land and Natural Resources

<http://www.state.hi.us/dlnr>

University of Hawaii Botany Department

<http://www.botany.hawaii.edu/ReefAlgae>
<http://www.botany.hawaii.edu/Invasives>

Hawaii Coral Reef Initiative Research Program

<http://coralreefnetwork.com>
<http://www.hawaii.edu/ssri/hcri>

National Marine Fisheries Services

<http://atsea.nmfs.hawaii.edu>
<http://www.nmfs.hawaii.edu>

National Marine Fisheries Service

<http://www.nmfs.noaa.gov>

NOWRAMP

<http://www.hawaii.edu/ssri/hcri/NOWRAMP>

Polynesian Voyaging Society

www.pvs-hawaii.org

NASA

<http://www.nasa.gov>

<http://education.nasa.gov>

<http://kids.earth.nasa.gov/archive/hurricane/index.html>

<http://kids.earth.nasa.gov/archive/pangaea/index.html>

http://science.nasa.gov/headlines/y2002/10apr_hawaii.htm?list640090

Environmental Defense Organization

www.environmentaldefense.org

www.ed.org/hawaii

Certified Marine Expeditions

<http://www.rapture-expeditions.com/>

Reef Environmental Education Foundation

<http://www.reef.org>

University of California at Santa Cruz

<http://www.biology.ucsc.edu/people/potts>

USGS Geology of Hawaii

<http://geology.wr.usgs.gov/docs/stateinfo/HI.html>

List of Hawaiian Geology Links

<http://www.winona.msus.edu/geology/Hawaii/HawaiiLinks.html>

University of Hawaii Department of Geology and Geophysics

<http://www.soest.hawaii.edu/GG>

University of Hawai'i Diving Safety Program

<http://www.hawaii.edu/ehso/diving>

School of Ocean and Earth Science (SOEST) - University of Hawai'i

<http://www.soest.hawaii.edu>

Hawai'i Sea Grant (SOEST) - University of Hawai'i

<http://www.soest.hawaii.edu/seagrant>

Sail on the Rapture - Join 3 to 5 day expeditions in Hawaii or California

<http://www.rapture.cc>

The Oceanic Institute

<http://www.oceanicinstitute.org>

National Hurricane Center

www.nhc.noaa.gov

Hurricanes 2002 dot Com

www.hurricanes98.com

El Nino

<http://elnino.noaa.gov>

El Nino and La Nina Forecasts and Impacts from the National Weather Service

http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/

El Nino Disaster Management from the NOAA / Committee on Earth Observation Satellites

<http://www.ceos.noaa.gov/elnino.html>

Resources for Teachers

(Including subject information on Oceans, Atmosphere, Fisheries, Storms and El Nino)

<http://www.oar.noaa.gov/k12/html/tload.htm>

http://www.oar.noaa.gov/k12/html/el_nino.html

City & County of Honolulu

www.co.honolulu.hi.us

Navy Region Hawaii Public Affairs Office

www.hawaii.navy.mil

Accuweather Information

www.accuweather.com

Coral

Waikiki Aquarium

<http://waquarium.otted.hawaii.edu/>

Hawaii Coral Reef Network

<http://www.coralreefnetwork.com/>

Algae

University of Hawaii Page

<http://www.botany.hawaii.edu/ReefAlgae/reds1&2commonspeices.htm>

Coral Reef Initiative Page

<http://www.botany.hawaii.edu/GradStud/smith/websites/ALIEN-HOME.htm>

UH Botany Page

<http://www.botany.hawaii.edu/ReefAlgae/Algae%20in%20Hawaii%20pages/Algae%20in%20Hawaii.htm>

Marine Invertebrate Links

Bishop Museum Databases

<http://www.bishopmuseum.org/research/natsci/invert/invertdata.html>

Bishop Museum Page with Hawaiian names of Marine Invertebrates

<http://www.bishopmuseum.org/research/natsci/invert/hawaiianames.html>

Hawaii DLNR Shellfish Regulations Page

<http://www.hawaii.gov/dlnr/dar/regbk/pages/marinverts.html>

Coral Reef Network Page

<http://coralreefnetwork.com/marlife/inverts/inverts.htm>

Fish Links

Hawai'i Coral Reef Initiative Page of the Fish of Hawaii

<http://coralreefnetwork.com/marlife/fishes/fishes.htm>

Bishop Museum's Hawai'i Fishes page

<http://www.bishopmuseum.org/research/natsci/fish/fishimages.html>

Learn more about ciguatera poisoning

<http://www.emedicine.com/emerg/topic100.htm>

Insects Links

US Fish and Wildlife Page on Insects on Midway

<http://www.r1.fws.gov/midway/wildlife/invert.html>

Bishop Museum's Interactive Species Database

<http://hbs.bishopmuseum.org/arthresearch.html>

Plant Links

US Fish and Wildlife Service page

<http://www.r1.fws.gov/midway/wildlife/plants.html>

University of Hawai'i Native Plants Page

<http://www.botany.hawaii.edu/faculty/carr/natives.htm>

History Links

Battle of Midway

<http://www.bishopmuseum.org/research/nwhi/batmid.shtml>

Tanager Expedition

<http://www.bishopmuseum.org/research/nwhi/tanager.shtml>

A essay on a trip by members of Hawai'i's royalty to Nihoa

http://www.bishopmuseum.org/research/nwhi/nec_nih.htm

Stone images from Necker

<http://www.bishopmuseum.org/research/nwhi/neckii.shtml>

Hawaii and Polynesia Links

Polynesian Voyaging Society Page examining similarities between Hawaiian and Marquesan cultures

<http://leahi.kcc.hawaii.edu/org/pvs/migrationspart1.html>

Polynesian Voyaging Society Page on the history and importance of marae in voyaging traditions

<http://leahi.kcc.hawaii.edu/org/pvs/migrationspart1.html>

USEFUL LINKS ABOUT THE NORTHWESTERN HAWAIIAN ISLANDS:

The Hawaii State DLNR page on recent conservation work in the NWHI

http://www.state.hi.us/dlnr/exhibits/nwhi/NWHI_1.htm

An introduction to Hawaii and the islands of the Pacific

<http://biology.usgs.gov/s+t/SNT/noframe/pi179>

A site about military life on Tern Island in the French Frigate Shoals

<http://www.radiojerry.com/frigate>

A detailed site about Hawaiian green sea turtles

<http://earthtrust.org/wlcurric/turtles>

A detailed site about the Hawaiian monk seal

<http://earthtrust.org/wlcurric/seals>

The U.S. Fish and Wildlife Services Midway Atoll National Wildlife Refuge homepage

<http://www.r1.fws.gov/pacific/wnwr/midwaynwrindex.html>

The United States Coast Guard, 14th District Home Page

<http://www.uscg.mil/d14>

KidScience, produced by the Hawaii Department of Education and Pacific Resources for Education and Learning

<http://www.kidscience.net>

Turtle Trax: A Page Devoted to Marine Turtles

<http://www.turtles.org>

Relevant Newspaper Article Reference List

- Aguiar, E. (2002, April 12). Keiki hooked on old fishing arts. *Honolulu Advertiser*, pp. A1, A12.
- _____ (2002, June 2). Kailua waterways cleanup may be coming. *Honolulu Advertiser*, p. A27
- Beamish, R. (2002, May 14). Clinton's rules for NW islands could weaken. *Honolulu Star-Bulletin*, p. A9.
- _____ (2002, May 14). El Nino fears may force delay of Hokule'a trip. *Honolulu Star-Bulletin*, p. A9.
- Bernardo, R. (2002, May 14). Sea policy panel hears turtle appeal. *Honolulu Star-Bulletin*, p. A3.
- _____ (2002, May 27). Jellyfish invasion surprises Kailua. *Honolulu Star-Bulletin*, pp. A1, A7.
- Bricking, T. (2002, June 6). Canoe club honors master carver. *Honolulu Advertiser*, p. E1.
- Blakeman, K. (2002, March 16). Sanctuary system moves forward. *Honolulu Advertiser*, p.B1.
- Burlingame, B. (2002, April 28). Boys of The Panala'au. *Honolulu Star-Bulletin*, pp. D1, D6.
- Cole, W. (2002, June 6). Midway a place of history, heroes. *Honolulu Advertiser*, pp. A1, A2.
- Coleon, S. (2002, June 6). Oceanic curiosities in new exhibit. *Honolulu Advertiser*, p. A9.
- Creamer, B. (2002, April 17). Signs of El Nino brewing. *Honolulu Advertiser*, pp. A1, A11.
- Estermann, P. and C. Sanburn. (2002, April 14). Both victory and defeat from Sandy Beach dispute. *Honolulu Advertiser*, pp. B1, B4.
- Gee, P. (2002, May 19). Hurricane preparedness urged. *Honolulu Star-Bulletin*, pp. A13, A16, A17.
- Gonser, J. (2002, March 21). Limu species targeted for eradication. *The Honolulu Advertiser*, p. B1.

- Hoover, W. (2002, April 7). Environment meetings clash. *Honolulu Advertiser*, p. A25.
- _____ (2002, June 5). Shark's cove fishing ban stuns old-timers. *Honolulu Advertiser*, pp.A1, A2.
- Hurley, T. (2002, April 14). Koa's magic lures poachers. *Honolulu Advertiser*, pp. A1, A4.
- Krauss, B. (2002, May 15). Crueler sea encroacher on atoll. *Honolulu Advertiser*, p. B1.
- _____ (2002, May 26). No more rabbits on Rabbit Island. *Honolulu Advertiser*, p. A25.
- Kubota, G. T. (2002, May 8). Wasteful practice of gill-netters denounced by Maui residents. *Honolulu Star-Bulletin*, p. A6.
- _____ (2002, May 10). Whales unhurt by sea lab's sounds. *Honolulu Star-Bulletin*, p. A2.
- _____ (2002, May 10). Maui whale count comparable to levels observed last year. *Honolulu Star-Bulletin*, pp. A1, A7.
- _____ (2002, June 10). Weather, seawalls cited in Maui beach erosion. *Honolulu Star-Bulletin*, pp. A1, A6.
- _____ (2002, June 12). Size Matters. *Honolulu Star-Bulletin*, pp. A1, A11.
- Lautenbacher, C. (2002, May 12). Oceans key to predicting global climate changes. *Honolulu Advertiser*, p. B3.
- Leone, D. (2002, May 15). U.S. ocean panel urged to get Pacific input. *Honolulu Star-Bulletin*, p. A5.
- Manson, C. (2002, May 31). Remembering Midway Atoll. *Honolulu Advertiser*, p.18.
- Markrich, M. (2002, May 5). Planting a future. *Honolulu Advertiser*. pp. B1, B4.
- Tsai, M. (2002, May 26). Colonizers recall wartime survival. *Honolulu Advertiser*, pp. A1, A11.
- Rosenblum, M. (2002, May 12). Maui's troubled waters. *Honolulu Star-Bulletin*, pp. D1, D6.
- Roth, S. (2002, March 14). Marine Sanctuary hearing tense. *Honolulu Advertiser*, p. A30.
- Sakurai, J. (2002, April 25). Delegates debate whale-catching rules. *Honolulu Advertiser*, p. A8.

- Scott, S. (2002, May 10). Glowing mysteries dwell among oceanic nutrients. *Honolulu Star-Bulletin*, p. A2.
- _____ (2002, May 24). Isle seasonal differences are subtle yet noticeable. *Honolulu Star-Bulletin*, p. A2.
- Silverstein, D. (2002, March 24). Our tribe must make all islands survivors. *Honolulu Advertiser*, p. B1.
- Song, J. (2002, May 2). Navy halts bombing in Marianas. *Honolulu Advertiser*, p. B2.
- TenBruggencate, J. (2000, September 26). Alien bugs invading remote island. *Honolulu Advertiser*, p. B4.
- _____ (2002, February 2). Service cuts at Midway raise protest. *The Honolulu Advertiser*, pp. A1, A7.
- _____ (2002, March 4). How our forest have changes. *Honolulu Advertiser*, p. B5.
- _____ (2002, April 7). Sanctuary status sought for Northwestern Hawaiian Islands. *Honolulu Advertiser*, pp. A23, A28.
- _____ (2002, April 8). Japan seeks to reduce sea debris. *Honolulu Advertiser*, p. B1.
- _____ (2002, April 8). Taape may not deserve ill repute. *Honolulu Advertiser*, pp. B1, B5.
- _____ (2002, April 30). New firm to manage Midway Atoll services. *Honolulu Advertiser*, p. B1.
- _____ (2002 May 5). Fewer sever quakes hit Big Island. *Honolulu Advertiser*, pp. A25, A31.
- _____ (2002, May 11). U.S. panel on ocean policy in search of new proposals. *Honolulu Advertiser*, p. B6.
- _____ (2002, May 12). Conflicts sink Midway venture. *Honolulu Advertiser*, pp. A23, A30.
- _____ (2002, May 24). Ceremonies to mark 60th anniversary of Battle of Midway. *Honolulu Advertiser*, p. B4.
- _____ (2002, May 27). We're to blame for oily seas. *Honolulu Advertiser*, p. B1.
- _____ (2002, June 3). Nature contributes to bad air in Hawai'i. *Honolulu Advertiser*, p. B1.
- _____ (2002, June 10). Devices can keep debris out of storm drains. *Honolulu Advertiser*.

Additional Resources & Literature

Storybooks for Young Children:

- Armitage, K. (1998). *Limu: The Blue Turtle*. Waipahu, HI: Island Heritage.
- Ching, P. (1994). *The Hawaiian Monk Seal*. Honolulu, HI: University of Hawaii Press.
- _____ (2001). *Sea Turtles of Hawaii*. Honolulu, HI: University of Hawaii Press.
- _____ (2001). *The Story of Hina*. Waipahu, HI: Island Heritage.
- Coste, M. (1995). *Honu*. Honolulu, HI: University of Hawaii Press.
- Feeney, S. & Fielding, A. (1989). *Sand to Sea*. Honolulu, HI: University of Hawaii Press.
- Hayashi, L. A. (2000). *Fables from the Sea*. Honolulu, HI: University of Hawaii Press.
- Orr, K. (1998) *Hawaii's Sandy Beaches and Tidepools* (3rd ed). Waipahu, HI: Island Heritage.
- Yee, T. (1998). *The Littlest Opihi*. Waipahu, HI: Island Heritage.

Activity Books for Young Children:

- Green, Y. (2002). *Hawaiian Marine Life Coloring and Activities Book*. Waipahu, HI: Island Heritage.
- Juvik, J. O., T. R. Paradise, & S. P. Juvik. (2002) *Student Atlas of Hawaii*. Honolulu, HI: Bess Press.
- Wreh. (1995). *Kid Stuff: About the Ocean Creatures of Hawaii*. Honolulu, HI: MnM Books.

Informative Adult Reference Books:

- Hazlett, R. W. & D. W. Hyndman. (1996). *Roadside Geology of Hawaii* (2nd ed). Missoula, MT: Mount Press Publishing Co.
- Kay, A. (1994). *A Natural History of the Hawaiian Islands: Selected Readings II*. Honolulu, HI: University of Hawaii Press.
- Morgan, J. R. (1996). *Hawaii: A Unique Geography*. Honolulu, HI: The Bess Press.
- TenBruggencate, J. (1999). *Hawaii Land of Volcanoes*. Honolulu, HI: Mutual Publishing.

Glossary of Terms

Active Volcano	An “active volcano” usually refers to one that is currently erupting or showing of unrest (earthquakes, venting, gases, ect...) Some volcanologists consider any volcano that has erupted in the historic past as “active”.
Archipelago	A group of islands; A large body of water with many islands.
Arthropod	Any group of invertebrates with a segmented body and jointed limbs, including insects, spiders, and crustaceans.
Atoll	A ring shaped coral reef enclosing a lagoon.
Aquaculture	The cultivation of aquatic animals or plants.
Basalt	Formed from the cooling of lava at or near the Earth’s surface, a hard, dark, dense volcanic (extrusive igneous) rock.
Betia	Traditional seamarks used by navigators.
Biota	The flora and fauna of a region.
Carnivore	An animal that eats flesh; A plant that eats insects.
Chlorophyll	The green pigment of plant leaves, essential to photosynthesis.
Climatology	A quantitative description of climate showing the characteristic values of climate variables over a region. Climate refers to the statistical collection of weather conditions over a specified period of time. Note that the climate taken over different periods of time (30 years, 1000 years) may be different.
Desalinate	To desalt.
Dinoflagellate	Any order of chiefly marine planktonic usually solitary phytoflagellates that include luminescent forms, important in marine food chain
Dormant Volcano	A “dormant volcano” is one that is not currently active but could erupt at some time in the future.
Ecology	The branch of biology dealing with interactions between organisms and their environment
Ectoparasites	A parasite that lives on the outside of its host

El Niño	A term originally used to describe the appearance of warm (surface) water from time to time in the eastern equatorial Pacific region along the coasts of Peru and Ecuador. It was once suggested that minor El Niño events occurred about every two to three years and major ones about every eight to 11 years. Today, scientists note that El Niño has a return period of four to five years. When an El Niño event occurs, it often lasts from 12 to 18 months.
Endangered	At risk of extinction.
Endemic	Belonging exclusively or confined to a particular place or people.
ENSO	Is the term currently used by scientists to describe the full range of the Southern Oscillation that includes both SST increases (a warming) as well as SST decreases (a cooling) when compared to a long-term average. It has sometimes been used by scientists to relate only to the broader view of El Niño or the warm events, the warming of SSTs in the central and eastern equatorial Pacific. The acronym, ENSO, is composed of El Niño-Southern Oscillation, where El Niño is the oceanic component and the Southern Oscillation is the atmospheric component of the phenomenon. The broader definition of El Niño has sometimes been used interchangeably with ENSO, because ENSO is less well known in the popular electronic and printed media.
Entomologist	A scientist who studies insects.
Entomology	The branch of zoology dealing with insects
Extinct Volcano	An “extinct volcano” is one that is no longer active or no longer in use.
Fauna	The animal or animal life of a given region or period.
Fibropapilloma	A viral disease causing large tumors to grow on turtles.
Guano	Manure composed chiefly of the excrement of sea birds, valued as a fertilizer.
Herbivorous	Feeding on plants.
Hot Spot	An area in the Earth’s crust where molten rock breaks through, creating volcanic seamounts and island chains near the center of the lithospheric plates.

Hurricane	A tropical cyclone with winds of 74 miles per hour or greater that is usually accompanied by rain, thunder and lighting, that sometimes moves into temperate latitude.
Indigenous	Originating in and characteristic of a particular region or country
Insectivorous	Feeding chiefly on insects.
Invertebrate	Without a backbone or spinal column.
Island	A tract of land completely surrounded by water and not large enough to be called a continent
Isle	A small island
Islet	A very small island
La Niña	Refers to the appearance of colder-than-average sea surface temperatures (SSTs) in the central or eastern equatorial Pacific region (the opposite to conditions during El Niño). Many scientists do not like the use of the term and prefer to call it a cold event.
Lithospheric Plates	Solid sections of the Earth's crust that float on the mantle and move relative to one another due to currents in the mantle.
Magma	Molten rock inside the Earth's crust
Mantle	The hot, semi-molten layer of the Earth between the crust and the core.
Marine	Of the sea.
Migratory	To move from one country, region, or place to another; to pass periodically from one region or climate to another.
Native	Belonging to the original inhabitants of a region.
Omnivorous	Eating all kinds of foods, both plant and meat.
Ornithologist	A scientist who studies birds.
Ornithology	The branch of zoology that deals with birds
Parasite	An organism living in or on another organism in parasitism.
Pelagic	Of the open ocean or seas.

Petrel	Any of various oceanic tube-nosed seabirds.
Photosynthesis	The production of carbohydrates from carbon dioxide and water, using sunlight as the source of energy and with the aid of chlorophyll.
Phylum	The primary subdivision of a taxonomic kingdom, grouping together all classes or organisms that have the same body plan.
Plate Tectonics	Geologic theory that describes how the Earth's crust is broken into sections called "plates". These plates move due to currents in the mantle. Where the plates meet, earthquakes, volcanoes, and trenches are formed.
Propagate	To cause (an organism) to multiply by natural reproduction.
Reef	A ridge of rock, sand, or coral at or near the surface of the water.
Rookery	Colony or breeding place of creatures living in flocks or herds.
Species	A basic category of biological classification composed of related individuals that are able to breed among themselves.
Shoal	A shallow place in a body of water; a sandbank or sand bar.
Southern Oscillation	A see-saw of atmospheric mass (pressure) between the Pacific and Indo-Australian areas. For example, when the pressure is low in the South Pacific high pressure cell and high over Indonesia and Australia, the Pacific trade winds weaken, upwelling of cool water on the Pacific equator and along the Peruvian coast weakens or stops, and SSTs increase in these areas where the upwelling weakens.
Southern Oscillation Index (SOI)	Has been developed to monitor the Southern Oscillation using the difference between sea level pressures at Darwin, Australia, and Tahiti, although other stations have sometimes been used. Large negative values of the SOI indicate a warm event, and large positive values indicate a cold event (also referred to as La Niña). It is important to note that there is not a one-to-one correspondence between the occurrence of Southern Oscillation events and El Niño events, using the spatially restrictive original definition of El Niño.
Stewardship	The individual's responsibility to manage their life and property with proper regard to the rights of others.

Substrate	The base on which an organism live
Terrestrial	Representing the earth; of land as distinct from water.
Tsunami	A great sea wave produced by submarine earth movement or volcanic eruption.
Vertebrae	Having a spinal cord; belonging to a subphylum of animals having a spinal column and comprising mammals, birds, reptiles, amphibians, and fishes.
Viscosity	The state or quality of being viscous; The property of a fluid that resists the force tending to cause the fluid to flow.
Volcano	A vent in the Earth's crust through which lava, steam, and ashes are expelled.
Volcanologist	A scientist who studies volcanoes.

Current Issues: ANIMALS

Bernardo, R. (2002, May 27). Jellyfish invasion surprise Kailua. *Honolulu Star Bulletin*, pp. A1, A7.

Krauss, B. (2002, May 26). No more rabbits on Rabbit Island. *Honolulu Advertiser*, pp. A25.

Bernardo, R. (2002, May 14). Sea policy panel hears turtle appeal. *Honolulu Star-Bulletin*, pp. A3.

Kubota, G. T. (2002, May 10). Maui whale count comparable to levels observed last year. *Honolulu Star-Bulletin*, pp. A1, A7.

Kubota, G. T. (2002, May 10). Whales unhurt by sea lab's sounds. *Honolulu Star-Bulletin*, pp. A2.

Sakurai, J. (2002, April 25). Delegates debate whale-catching rules. *Honolulu Advertiser*, pp. A8.

TenBruggencate, J. (2002, April 8). Taape may not deserve ill repute. *Honolulu Advertiser*, pp. B1, B5.

TenBruggencate, J. (2000, September 26). Alien bugs invading remote island. *Honolulu Advertiser*, p. B4.

Posted On: Thursday, April 25, 2002, A8.

Delegates debate whale-catching rules

Joji Sakurai
Associated Press

SHIMONOSEKI, Japan – Delegations from around the world debated new rules for catching whales today, with Japan promising to lobby hard for a resumption of commercial whaling.

The message Japan is sending out by choosing this southwestern port town as the venue for the International Whaling Commission's annual meeting could not be more clear.

The city has for centuries been guardian of Japan's whaling traditions, home to families that have hunted whales for generations and to dozens of shops that sell meat to the numerous whale restaurants that line the streets. Japan is allowed to sell meat collected during scientific expeditions.

"We've pushed for lifting the moratorium on commercial whaling every year, and you can bet it'll be on the agenda this time around," said Toshiharu Tarui, an official with the Foreign Ministry's fisheries bureau.

The monthlong conference started today with a scientific committee meeting to discuss population trends among minke whales. Japan is expected to present its findings from research whaling expeditions and argue that the species is now so plentiful that a limited commercial hunt would not endanger it.

There are an estimated 760,000 minke whales in the Antarctic Ocean, according to the IWC, which acknowledges the 400 or 500 killed under Japan's scientific whaling program does not pose a threat.

A leader of the Japanese delegation said today there is no scientific basis for continuing the ban on commercial whaling, and that Japan is being unfairly singled out for criticism. Indigenous tribes in the United States and elsewhere are allowed to hunt some whales.

"The U.S. is a whaling nation, Canada is a whaling nation, Russia is a whaling nation," said Joji Morishita, head of Japan's scientific delegation to the IWC meeting. "But Japan is being singled out. There are cultural factors going back to the 1980's when Japan-bashing was fashionable."

Morisita, representative of the U.S. delegation and representatives of the London-based IWC declined to comment on the content of today's scientific committee meeting.

Conservationists say endorsing commercial whaling may cause the hunting to get out of control.

“There is no way to guarantee limits will be obeyed,” said Motoji Nagasawa, a whale campaigner with environmental group Greenpeace. “Even if Japan’s monitoring systems are good, many poor countries will start whaling to provide Japan’s market with whales.”

But residents in Shimonoseki say the opposition to whaling is an affront to their way of life.

“There was whale meat on my plate ever since I was a child,” said Masataka Hindemura, the manager of a shipyard that serves Japan’s research whaling fleet. “This is our culture.”

Sakurai, J. (2002, April 25). Delegates debate whale-catching rules. *Honolulu Advertiser*, pp. A8.

Posted On: April 8, 2002, B1, B5.

Taape may not deserve ill repute.

Jan TenBruggencate
Advertiser Science Writer

The colorful yellow and blue taape, or blue-lined snapper, is considered by some to be the scourge of the Hawaiian reef.

After it was introduced here in 1955, many anglers complained that it crowded out preferred fish and ate the eggs, larvae and keiki of many prized species. Scientists say they cannot find proof of that.

“I’m certainly not one who would say the taape has no effect on our native species. But it’s hard to find clear evidence that there’s any effect at all,” said Jim Parrish, leader of the Hawai’i Cooperative Fishery Research Unit, a joint effort of the U.S. Geological Survey, Department of Land and Natural Resources and University of Hawai’i.

“They eat a lot of things and there’s a lot of them down there. I think there’s a definite effect,” said Chris Kelley, a biologist with the UH Hawaii Undersea Research Laboratory.

Taape was introduced from French Polynesia by fisheries official because Hawai’i lacked a shallow water snapper. The species was released off O’ahu, but quickly crossed the channels. Now taape is found across the archipelago. Bottom fishermen began hauling them up as they fished ‘opakapaka grounds hundred of feet deep.

“We found taape on the ‘opakapaka grounds off Kane’ohe, Penguin Banks and the north shore of Moloka’i,” Kelley said. Taape tend to be found only to about 450 feet.

Kelly said fishermen complained that they would go out for ‘opakapaka and get nothing but taape. Anglers said taape were eating the eggs of deep-water snappers, cutting yields.

But he said there’s no evidence to support those complaints.

In shallow and deeper waters, Parrish said, over fishing, sedimentation, dredging and other factors probably have a bigger impact on declining fisheries than taape.

Taape has limited marketability despite being a quality snapper.

“It’s nice, clean meat. It’s a good eating fish,” said Guy Tamashiro, vice president and buyer for Tamashiro Fish Market in Honolulu.

Tamashiro said he can sell taape, but at a low price, because demand is low.

Troy Wada at the Fish Express in Lihu'e said his fish store doesn't even bother trying to buy or sell taape. "It tastes good, but there's no market here," he said.

"The obvious solution is for more people to catch them and eat them. But maybe people just aren't accustomed to eating a yellow fish with blue stripes," Parrish said.

TenBruggencate, J. (2002, April 8). Taape may not deserve ill repute. *Honolulu Advertiser*, pp. B1, B5.

Posted On: Friday, May 10, 2002, A1, A7

Maui whale counts comparable to levels observed last year

By Gary T. Kubota
gkubota@starbulletin.com

LAHAINA >> Sightings of endangered humpback whales in Maui County waters got off to a slow start but eventually rose this year, coming close to last year's numbers, observers say.

"It did seem slower, then they were all over the place," said Claire Cappelle, Maui liaison for the Hawaii Islands Humpback Whale National Marine Sanctuary.

Whale season officially extends from Dec. 15 through May 15 in Maui County waters – a period in which the state has banned thrill crafts from operating in South and West Maui coastal waters.

Acting sanctuary manager Naomi McIntosh said people on the Big Island began seeing humpback whales in late January, with whale sightings later increasing in Maui County, then off Oahu and Kauai.

Researcher Dan Salden, president of the Hawaii Whale Research Foundation, said that in his trips from West Maui toward Lanai from Jan. 21 through April 29, he counted 1,445 whales compared with 1,460 for about the same period last year.

Salden said the counts should not be regarded as a census of the whale population, since there could have been multiple sightings of the same whale, but the numbers do give some indication about the presence of the humpbacks off Maui.

The numbers had appeared lower earlier this year when, on Feb. 23, volunteers working with the educational group Pacific Whale Foundation counted 673 humpbacks, or 23 percent fewer whales off South and West Maui than last year.

Whale researchers said the peak of the whale season occurred later than usual, with the most whales sighted in March.

Researchers said they also noticed more dead whales and whales in distress this year off Maui but do not know what the causes might be. They also do not know if the numbers indicate an increase in problems related to whales or people noticing more problems.

Salden said a greater need seems to be emerging for developing procedures and a network of people able to respond quickly to reports of dead whales and whales in distress, such as four calves abandoned by their mothers this season.

"I don't think there was really a sense of what to do with them," Salden said.

Salden said if the sanctuary is going to have value, it is going to have to assess what is happening in whale migration areas in Hawaii, including the use of the habitat, the impact of runoff contaminants from land, and water quality.

Some native Hawaiians have criticized federal officials for failing to establish a culturally sensitive policy in the treatment of dead whales.

Hawaiian kahu Charles Maxwell said according to native culture, dead whales should be returned to the sea instead of buried on land, as in the case of a pygmy sperm whale last month.

Researchers said while the National Marine Fisheries Service is the lead agency responding to whale strandings on beaches on Maui, its main office is in Honolulu, and federal officials will have to determine if the sanctuary should play a larger role.

McIntosh said this whale season was the first year the sanctuary had a specialist assigned to respond to whales in distress, and the sanctuary is developing a system.

She said sanctuary officials obtained some valuable information, taking photographs of whales entangled in lines and doing necropsies of dead whales.

McIntosh said sanctuary officials were able to determine that the lines were from old fishing nets, and are awaiting the results of the necropsies.

Kubota, G. T. (2002, May 10). Maui whale count comparable to levels observed last year. *Honolulu Star-Bulletin*, pp. A1, A7.

Posted On: Friday, May 10, 2002, A2.

Whales unhurt by sea lab's sounds

By Gary T. Kubota
gkubota@starbulletin.com

LAHAINA >> Emitting low-frequency sounds to measure ocean temperatures off northern Kauai does not appear to affect the migration of humpback whales, according to a whale researcher's preliminary results.

"They're not going down. They're not running away from the sounds," said whale researcher Joe Mobley. "Thus far, I've seen no response."

Mobley, who has been conducting a federally funded study, said his preliminary findings indicate the noise from the Scripps Institution of Oceanography's North Pacific Acoustic Laboratory on Kauai does not seem to affect the humpbacks presence in the waters.

He said the number of humpback whale sightings increased this year while the North Pacific Acoustic Laboratory was emitting periodic low-frequency sounds.

An official with Earthjustice Legal Defense Fund, which has been critical of the use of low-frequency sounds, said his group has not seen the study and would need to consult with scientists to evaluate the information.

Earthjustice staff attorney David Henkin said he was skeptical about the use of a whale count to determine the impact of low-frequency sounds and the source of the study funded by NPAL and the Office of Naval Research.

"It doesn't give me any degree of confidence," Henkin said.

Mobley, a University of Hawaii professor specializing in animal behavior psychology, said the number of humpback whale sightings in waters off northern Kauai totaled 83 this year compared with 75 last year when the sound was off.

Mobley said the increase seems to follow his previous observations of an average of a 7 percent increase annually in whale sightings.

Mobley said the sound from the laboratory, located eight miles north of Hanalei Bay, was about 195 decibels at the source, a little less than the 200 decibels produced by an oil tanker.

He said the sound was on for 20-minute periods with a four-hour break a day every fourth day.

He said he conducted aerial surveys on an airplane within 25 miles of the source once a week for eight weeks from Feb. 1 through March 30.

Mobley said his findings are preliminary and could change as he continues to gather more information during the five-year study.

He said the results of his survey have been turned over to the National Marine Fisheries Service and the state Department of Land & Natural Resources.

Kubota, G. T. (2002, May 10). Whales unhurt by sea lab's sounds. *Honolulu Star-Bulletin*, pp. A2.

Posted On: Tuesday, May 14, 2002, A3

Sea policy panel hears turtle appeal

By Rosemarie Bernardo

Fisherman Tom Webster recommended the U.S. longliner fleet be included in an international management plan due to its assistance in collecting data on sea turtles.

Excluding the fleet is detrimental to sea turtles, said Webster, who owns a 75-foot vessel, Havana, based in Honolulu.

"Without the data, the sea turtles are ultimately the victims," he added.

Webster was among five panelists who stated their concerns for a unified approach towards, conservation of sea turtles, seabirds and the ocean's resources before the U.S. Commission on Ocean Policy yesterday at the Ilikai Waikiki Hotel.

The commission consists of 16 members appointed by President Bush to conduct an in-depth analysis of the problems coastal regions face as they deal with the current workings of ocean and coastal management laws and policies on all levels.

The commission plans to develop a comprehensive national ocean policy to preserve the world's oceans and their resources. Hawaii is the fifth of nine major coastal regions the commission will be visiting. Commissioners are expected to submit a final report next spring to Congress and the president.

Retired Adm. James Watkins, chairman of the commission, said, "In the 36 years since the bulk of our federal oceans policies were created, our nation, the world and our oceans have changed drastically."

"Our coastal populations have exploded, resulting in a boom in coastal development and economies. Oceans-based international trade has risen dramatically, and ocean laws and regulations have become a bureaucratic nightmare. There is clear evidence of this right here in Hawaii and throughout the Pacific Islands," Watkins said.

Retired Vice Adm. Conrad Lautenbacher Jr., administrator of the National Oceanic and Atmospheric Administration, said an integrated and sustained ocean observing system is needed to understand the "interactions between the oceans and atmosphere and to improving our climate assessment and predictions capabilities."

A total of \$18 million was proposed under the president's budget for new climate research funding for NOAA. Of that, \$4 million was to support the development of an ocean observing system.

"We need to take a pulse of Mother Earth so we can diagnose what's going on,"
Lautenbacher said.

The public is invited to comment today starting at 4 p.m

Bernardo, R. (2002, May 14). Sea Policy panel hears turtle appeal. *Honolulu Star-Bulletin*, pp. A3.

Posted On: Monday, May 27, 2002, A1, A7.

Jellyfish invasion surprises Kailua

By Rosemarie Bernardo
rbernardo@starbulletin.com

A rare invasion of box jellyfish in Kailua Bay over the last three days left dozens of swimmers in pain and lifeguards bewildered.

Normally the stinging creatures show up along South Shore beaches at specific times. But yesterday, no one could explain why they suddenly showed up in Kailua. Lifeguards reported that 15 people were stung yesterday, while 40 people were stung on Friday.

Lifeguards posted signs yesterday at Kailua Beach Park warning beachgoers of the box jellyfish, and they will assess the situation again this morning.

The signs did not stop most people from going into the water.

Kaleo Pereza of Kailua said he has never been stung by a box jellyfish, but that did not stop him and his son, Tyler, from playing in the sand near the shoreline.

"You take your chances," Pereza said.

Others, however, were more cautious. After seeing other beachgoers who were stung, Kailua resident Cheryl Knowles said, "I'm thinking twice about getting into the water."

Fifteen minutes after Jens Nordahl entered the water, the 28-year-old from San Jose, Calif., noticed a stinging sensation and a welt on his right wrist, similar to a mosquito bite. He walked to the lifeguard tower where Shannon Clancey sprayed vinegar on the affected area.

Clancey advised Nordahl to take Benedryl to reduce the swelling and irritation.

Clancey, who was born and raised in Kailua, said it is uncommon for box jellyfish to appear in Kailua.

"I've never seen box jellyfish in Kailua. It's a phenomenon. We normally get Portuguese man of war," she said.

Most of the stings that occurred yesterday were minor irritations, according to John Hoogsteden, acting captain of the Ocean Safety Division's Windward office.

A lifeguard at Kailua Beach Park discovered about six box jellyfish scattered near the shoreline, he said.

Two types of box jellyfish in Hawaii -- *Carybdea alata* and *Carybdea rastonii* -- are known to appear along the South Shore up to 10 days after a full moon. Commonly affected areas include Waikiki Beach, Ala Moana Beach Park and Hanauma Bay.

Box jellyfish are described as nearly transparent. The body is about 1 to 3 inches long with tentacles up to 2 feet long.

Those who are stung by a box jellyfish are advised to douse the affected area with vinegar. Ice also is recommended to reduce the pain. Medical attention is advised for those who suffer from severe reactions, as stings from the box jellyfish can cause anaphylactic shock.

Angela Granger, 19, enjoyed the warm waters yesterday afternoon even though she was stung on Saturday afternoon.

"At first, I freaked out," said Granger, who is vacationing in Honolulu from Oregon. After 90 minutes the pain subsided but left a dark reddish mark on her upper right arm.

The 19-year-old said her fears of being stung again were eased after she saw residents and tourists playing in the water.

Bernardo, R. (2002, May 27). Jellyfish invasion surprises Kailua. *Honolulu Star-Bulletin*, pp. A1, A7.

Posted on: Sunday, May 26, 2002, A25

No more rabbits on Rabbit Island

By Bob Krauss
Advertiser Columnist
OUR HONOLULU

The only person I've met who has lived on Rabbit Island, the little hump-backed crater off Makapu'u Point, is Dr. Bill Brown, the new president of Bishop Museum.

"That's something people would like to hear about," I said.

"Let go out there," he said. "I'll show you my cave."

A visit to Rabbit Island, a bird sanctuary, is not like driving to Waimanalo. You have to get permission. We swam in from a Boston whaler piloted by Dave Smith, wildlife manager for the state Division of Forestry and Wildlife.

Three-quarters of the way from Makai Pier, two wildlife officers in another Boston whaler raced out to check our credentials. City police watch from the highway and report people fooling around the island.

Once ashore, I felt like a castaway on the pristine beach, blue sky overhead, the ocean stretching to infinity. The only other visitor was a monk seal sunning himself on a wave-washed rock shelf. Birds, like hives of bees, swarmed around the crater rim.

Brown was more interested in checking on noddy terns than describing his life as a hermit. There is no water on the island, and no trees except for 10 black stumps of coconut palm trunks inside the crater. Brown said he lived there for three months in 1971 and for six months in 1972.

"I was studying the breeding biology of the sooty tern; measuring their eggs, when they lay, what they eat, how fast they grow," he explained. "I was doing my doctoral dissertation at the University of Hawai'i."

He said he lived in a bird blind on the beach, visiting the "mainland" occasionally in an inflatable raft powered by a three-horsepower Sea-gull outboard. "The waves can get up to 20 feet," he said. "I flipped the raft eight times."

Brown brought back food and water in five-gallon plastic containers. By bathing in the ocean, he got by on three five-gallon containers of fresh water a week. He ate a lot of canned beef stew. A mouse took a drink every time he turned the tap on a container.

The cave is on the west side of the island overlooking a tidal flat where ghost crabs came out at sunset.

"I spent hours watching the waves," he said. "There was a colony of night heron across on Waimanalo Beach. The sun sets right between the twin peaks of Olomana."

There aren't any rabbits on Rabbit Island anymore. Brown said he caught the last one. That may be why there is more vegetation now. Naupaka has taken hold above the beach sand. The slopes of the crater are greener, he said.

"I never saw a monk seal or green sea turtles," he said. "Now there are many turtles." There were lots of tern eggs but no chicks. Brown said he didn't know why.

It's a wild, lonely island, no sounds but the wash of surf, the squalling of terns and the ghostly moans of wedgetailed shearwater in their dark burrows.

Krauss, B. (2002, May 26). No more rabbits on Rabbit Island. *Honolulu Advertiser*, pp. A25.

Posted on September 26, 2000, B4.

Alien bugs invading remote island.

Jan TenBruggencate
Advertiser Science Writer

A plague of alien insects has infested Nihoa Island in spite of its isolation far beyond Kaua'i and Ni'ihau.

One of the pests is large, far-flying grasshopper related to the African desert locust, and it is eating native 'ilima bushes and competing with native insects.

Nihoa is a lonely slab of rock 130 miles northwest of the islands just 170 acres, and its 910-foot peak is the highest spot in the Northwestern Hawaiian Islands.

"The extent of alien insects on Nihoa is surprising," said Bishop Museum entomologist Gordon Nishida, who spent 10 days on the island as part of a multi-agency research effort to learn more about the islands from Nihoa to Kure Atoll.

He was plucked off Nihoa Thursday by the Rapture, one of two ships participating in the Northwestern Hawaiian Islands Rapid Assessment and Monitoring Program. For more information on the project, visit explores.bishopmuseum.org.nwhi.

Nishida said the alien insects, which include the giant grasshopper, three species of ants, leafhoppers, wood-boring beetles and Australasian cockroaches, outnumber the native insects on the island.

Nihoa, although rocky and eroded, has about two dozen plant species, almost all of them native. U.S. Fish and Wildlife Service biologist Beth Flint said that except for the insects, life on Nihoa is largely native.

"Nihoa is a relatively undisturbed ecosystem," Flint said. "Of the 26 plant species that have ever been found there, only six were alien. We found only two...non-natives on this trip. There are no non-natives birds or mammals on Nihoa."

That makes the insect invasion both unusual and a greater concern.

"Many of them were found to be feeding on native plants, perhaps causing significant damage," Nishida said. "Others may be feeding on native insect species. Their impacts on the island's native population are unclear."

Nihoa is so remote and access so difficult that humans may not be the major source of new insect introductions.

The grasshopper may have managed to fly on its own from O'ahu where it was found about 15 years ago at Sand Island.

“Many of the insects likely arrived on Nihoa on their own,” Nishida said. “Some of the insects like the larger grasshopper, which I found all over the island, are capable of flying great distances. Other perhaps hitchhiked on birds or were transported by the jet stream.”

The grasshopper, in feeding on 'ilima, is competing with native insects for food, he said.

The last insect survey on Nihoa was in 1996. Nishida said he will need to study the results of his collecting before he knows better how much the insect environment on the island has changed.

TenBruggencate, J. (2000, September 26). Alien bugs invading remote island. *Honolulu Advertiser*, p. B4.

Current Issues: EL NINO

Wright, W. (2002, May 21). Active hurricane season forecast. *Honolulu Advertiser*, pp. A1.

Wright, W. (2002, May 21). More tropical cyclones expected this year. *Honolulu Advertiser*, pp. A12.

Cataluna, L. (2002, May 21). Time to be ready is now. *Honolulu Advertiser*, pp. B1.

Gee, P. (2002, May 19). Hurricane preparedness urged. *Honolulu Star-Bulletin*, pp. A13, A16, A17.

Beamish, R. (2002, May 14). El Nino fears may force delay of Hokule'a trip. *Honolulu Star-Bulletin*, pp. A9.

Lautenbacher, C. (2002, May 12). Oceans key to predicting global climate changes. *Honolulu Advertiser*, pp. B3.

Creamer, B. (2002, April 17). El Nino gradually building steam. *Honolulu Advertiser*, pp. A11.

Creamer, B. (2002, April 17). Signs of El Nino brewing. *Honolulu Advertiser*, pp. A1.

Posted On: Wednesday, April 17, 2002, A11.

El Nino gradually building steam.

By: Beverly Creamer
Advertiser Education Writer

El Nino appears to be on its way, with a hot, dry summer and fall ahead and a heightened risk of winter hurricanes, according to University of Hawai'i scientists.

During the last two weeks there has been a rapid increase in Pacific water temperatures off the coast of Peru and Ecuador in South American and a continuing warming of central Pacific waters- definite signs of the weather patterns named after the Christ child for its Christmas appearance.

The evidence of a new El Nino has been building for some time.

"In the last few weeks, warming areas in the eastern Pacific popped up," said UH oceanographer professor Roger Lukas, who has spent two decades studying El Nino conditions.

Typically, El Nino brings cloudless skies and hot, dry days.

"It's great weather for tourists," Lukas said.

But it also increases the likelihood of a winter drought, with accompanying concerns about conserving water and heightening energy demand for air conditioning.

"We've been impacted already," Lukas said. "We've had a rainer-than-usual winter because of warming (of ocean surface temperatures) by the dateline, and on trade winds in spring, when we should have.

"And we could look at record highs for September and October."

During El Nino years, warmer oceans and unusual wind patters raise concerns about more tropical cyclones forming in the central Pacific, along with an increase in fall and winter storms.

Hawai'i was hit by hurricanes in El Nino years 1982 and 1992. It was also the El Nino year in 1957 that brought record gusts of about 60 mph at Honolulu International Airport, said associate professor Thomas Schroeder, director of the Joint Institute for Marine and Atmospheric Research.

Conversely, El Nino brings fewer summer and fall tornadoes to the Mainland. But it tends to bring winter storms to Southern California: warmer, drier winter to the Pacific Northwest, and a wetter winter to the Southeast.

The weather picture is further complicated by the Pacific Decadal Oscillation, which is in a cool phase and could moderate and shorten El Nino conditions.

Creamer, B. (2002, April 17). El Nino gradually building steam. *Honolulu Advertiser*, pp. A11.

Posted on: Wednesday, April 17, 2002, A1

Signs of El Niño brewing

By Beverly Creamer
Advertiser Education Writer

El Niño appears to be on its way, with a hot, dry summer and fall ahead and a heightened risk of winter hurricanes, according to University of Hawai'i scientists.

During the last two weeks there has been a rapid increase in Pacific water temperatures off the coast of Peru and Ecuador in South America and a continuing warming of central Pacific waters — definite signs of the weather pattern named after the Christ child for its Christmas appearance.

The evidence of a new El Niño has been building for some time.

"In the last few weeks, warming areas in the eastern Pacific popped up," said UH oceanography professor Roger Lukas, who has spent two decades studying El Niño conditions.

Typically, El Niño brings cloudless skies and hot, dry days.

"It's great weather for tourists," Lukas said.

But it also increases the likelihood of a winter drought, with accompanying concerns about conserving water and heightened energy demand for air conditioning.

"We've been impacted already," Lukas said. "We've had a rainier-than-average winter because of warming (of ocean surface temperatures) by the dateline, and no trade winds in spring, when we should have.

"And we could look at record highs for September and October."

During El Niño years, warmer oceans and unusual wind patterns raise concerns about more tropical cyclones forming in the central Pacific, along with an increase in fall and winter storms.

Hawai'i was hit by hurricanes in El Niño years 1982 and 1992. It was also the El Niño year 1957 that brought record gusts of about 60 mph at Honolulu International Airport, said associate professor Thomas Schroeder, director of the Joint Institute for Marine and Atmospheric Research.

Conversely, El Niño brings fewer summer and fall tornadoes to the Mainland.

But it tends to bring winter storms to Southern California; a warmer, drier winter to the Pacific Northwest; and a wetter winter to the Southeast.

The weather picture is further complicated by the Pacific Decadal Oscillation, which is in a cool phase and could moderate and shorten El Niño conditions.

This repetitive pattern lasts 10 or more years, and overlaps El Niño near the North Pacific.

It involves an "east-west see-saw of surface temperature and wind in the North Pacific," Lukas said.

Reach Beverly Creamer at bcreamer@honoluluadvertiser.com or 525-8013.

Creamer, B. (2002, April 17). Signs of El Nino brewing. *Honolulu Advertiser*, pp. A1.

Posted on: Sunday, May 12, 2002, B3

Oceans key to predicting global climate changes

By Vice Adm. Conrad C. Lautenbacher Jr.

COMMENTARY

The U.S. Commission on Ocean Policy is taking stock of our nation's oceans and their effect on global climate.

The message I will deliver to the commission when it meets this week in Honolulu is that oceans play a key role in climate change. Climate change is a pressing international issue that requires improved scientific understanding and increased international cooperation.

Three weeks ago in Seoul, South Korea, the United States called on the 21 countries at the first Asia-Pacific Economic Cooperation ocean-related ministerial meeting to support expansion of the rudimentary global observing system that is in place today. The APEC members agreed and issued a strong statement on the importance of that system.

Now, the international community must commit resources to make this a reality. The United States is doing its part. President Bush pledged to help developing nations implement components of this system, to help build understanding about their own regions and to share in global interests.

The administration also has increased financing of data-collection buoys, calling on other developed countries to do the same. The United States, the European Union, Japan and others are developing state-of-the-art modeling to improve the quality of predicting causes and consequences of climate change.

While the existing system offers an exciting array of technological marvels — sea-level gauges, ocean robots, data-collection floats that ride the currents, and more — there is still a pressing need for complete, sustained global observation system.

Weather is what we experience day to day. Climate affects weather patterns over a season or longer. The air we breathe and the sea washing our shores respect no national boundaries. Global pollution shows up in Antarctica's snow. Dust from the Africa's sandstorms show up in Florida's coral reefs.

Climate services will become as critical in this century as weather services in the last. Without the participation of every nation, we will have gaps in understanding.

Data may not only forewarn Africans about impending floods and drought but alert Americans that warm air and winds in that region may bring a season with more hurricanes. Buoys in the Pacific demonstrated the value of observing systems in seasonal

climate forecasts when El Niño's 1997-98 warmer-than-normal sea-surface temperatures triggered devastating effects around the world.

The effects could have been even worse if the buoy system hadn't provided the data to allow the National Oceanic and Atmospheric Administration to issue an unprecedented six months' alert.

From temperature monitors at various depths in the Pacific Ocean, we have early indications that another El Niño is brewing. With a relatively small investment in observing systems and prediction models, we will be able to save lives and hundreds of millions of dollars.

The United States already has much on the table. A realistic new yardstick will measure greenhouse gas emissions relative to economic activity. Goals have been set to reduce their intensity by 18 percent over the next decade. Achieving this cut beyond current forecasts in a cost-effective way will depend directly on a continuing global effort to monitor and apply sound science.

With the critical support of international partners, we will for the first time take the pulse of Mother Earth and build the detailed science base necessary to develop sound and fiscally wise public policy on climate change.

Vice Adm. Conrad C. Lautenbacher Jr., USN (Ret.), is undersecretary of commerce for oceans and atmosphere, and NOAA administrator. He will address the U.S. Commission of Ocean Policy, which meets tomorrow and Tuesday in Honolulu, on this issue.

Lautenbacher, C. (2002, May 12). Oceans key to predicting global climate changes. *Honolulu Advertiser*, pp. B3.

Posted On: Tuesday, May 14, 2002, A9

El Nino fears may force delay of Hokule'a trip

By Rita Beamish
Associated Press

Traditional Hawaiian voyagers may have to postpone a planned canoe journey to the Northwestern Hawaiian Islands because of likely El Nino conditions that could put them at risk, the president of the Polynesian Voyaging Society said yesterday.

New weather data from the National Oceanographic and Atmospheric Administration indicates that the El Nino phenomenon could extend the hurricane season and also make storms move faster and create more severe conditions on the high seas, master navigator Nainoa Thompson said.

In that case, the sailors piloting the voyaging canoe Hokule'a would not have enough time to get out of harm's way, said Thompson, who spoke yesterday at the U.S. Commission on Ocean Policy's Hawaii and Pacific Islands Regional Meeting.

"What we don't know is what is the risk," he said.

The society's steering committee could decide by next week whether to postpone the trip, which is planned for September, Thompson said.

Even if the trip has to be postponed, Thompson said he would spend the year raising awareness and educating people about the importance of the voyage, whose purpose is, in part, to explore the ecological importance of the islands' reef system, and also to rebury the bones of ancestral Hawaiians that have been in the custody of the Bishop Museum.

The group plans to visit the two islands closest to the main Hawaiian Islands -- Necker Island and Nihoa Island -- for Hawaiian history. The canoe then would travel to the other eight islands to inspect the coral reefs, he said.

Hawaii already has been feeling the effects of the latest El Nino, with unusually heavy winter rainfall and a lack of springtime tradewinds.

Scientists from the University of Hawaii said last month that could signal more than the normal number of Pacific storms this season.

Since it was launched on March 8, 1975, the Hokule'a has used traditional Hawaiian navigation techniques to cover nearly 100,000 miles of the vast reaches of Polynesia.

Beamish, R. (2002, May 14). El Nino fears may force delay of Hokule'a trip. *Honolulu Star-Bulletin*, pp. A9.

Posted On: Sunday, May 19, 2002, A13, A16, A17

Hurricane preparedness urged

By Pat Gee
pgee@starbulletin.com

Hawaii residents should expect above-average storm activity during hurricane season, June 1 to Nov. 30, and start preparing now, said Tom Heffner, a meteorologist with the Central Pacific Hurricane Center.

Heffner, the hurricane warning coordinator, will be among Hawaii officials at a press conference tomorrow as part of Hurricane Awareness Week, which starts today.

The average number of "tropical cyclones," which includes all storms, depressions and hurricanes, is four to five per season, he said. Heffner plans to give out detailed information tomorrow on this season's forecast.

A mild to moderate El Nino is forecast this year in the Pacific, which means increased tropical storm and hurricane activity.

People have become rather complacent about preparing for hurricanes since Iniki devastated Kauai on Sept. 11, 1992, Heffner said.

"The challenge is convincing those who have not had a recent brush with a hurricane that they are just as susceptible as the folks on Kauai," Heffner said. "The level of preparedness of people on Kauai is much greater than on any other island because of the experience they've had."

The most important thing is to have an action plan, which includes having a rendezvous point for family members in case of a storm, he said.

"Everyone should have a survival kit," he added.

"Water is at the top of the list. Then a battery-powered radio as a way to get information on the weather. I can't stress enough having a supply of dry goods -- food," he said.

People should also know what kind of risk their home is vulnerable to and take appropriate action. If their home is not in a coastal or flood zone, it may be at risk to high winds if it is located atop a hillside, Heffner said.

He recommended that residents refer to the disaster preparedness section at the beginning of the phone book for information on what to assemble for a survival kit and how to prepare for a hurricane.

ANATOMY OF A HURRICANE

Hurricanes are generally defined as tropical cyclones with winds that reach sustained speeds of 74 mph or more. There have been a few that have caused major damage to the Hawaiian Islands in the past 50 years. Experts say hurricanes are rare occurrences here because the islands are a relatively small target, far from areas prone to tropical storm genesis. Hawaii is also protected by vertical wind shear (change of wind speed and direction from near the ocean surface up to an altitude of about 8 miles), which is a major disrupter of hurricane formation (See Figure Anatomy of a Hurricane).

THE STORM SURGE

A storm surge is a dome of water 50 miles wide that sweeps the coastline near the area where the hurricane hits land. The low pressure in the hurricane acts like a plunger, pulling up the water level and unleashing massive waves. Storm surges are responsible for 90 percent of all hurricane-related fatalities. (See Figure Hurricane Storm Surge).

CATEGORIES

The Saffir-Simpson Hurricane Scale is a 1-to-5 rating based on hurricane intensity. This is used to give an estimate of the potential property damage and flooding expected along the coast from a hurricane landfall. The scale was created in 1969 (See Figure Hurricane Destruction Images).

CATEGORY	WINDS (MPH)	DAMAGE	STORM SURGE (FT)	EXAMPLES
1	74-95	Minimal damage to vegetation	4-5	Dot, 1959; and Iwa, 1982 (Hawaii)
2	96-110	Moderate damage to houses	6-8	Kate, 1985 (Fla.)
3	111-130	Extensive damage to small buildings	9-12	Alicia, 1983 (Texas)
4	131-155	Extreme structural damage	13-18	Iniki, 1992 (Hawaii); Andrew, 1992 (Fla.)
5	155 plus	Catastrophic building failure possible	18 plus	Camille, 1969 (La. & Miss.)

STAY OUT OF HARM'S WAY

Recommendations on what to do before, during and after a hurricane:

Stay or leave?

When a hurricane threatens your area, you will have to decide whether you should evacuate or whether you can ride out the storm in safety at home. If local authorities recommend evacuation, you should leave!

If you live on the coastline, an offshore island, near a stream/river or in a flood plain, a high-rise or mobile home, plan to leave.

If you live in a sturdy structure and away from coastal and rainfall flooding, consider staying.

At the beginning of hurricane season

- >> Learn the elevation and the flooding and wind damage history of your area.
- >> Learn safe routes inland if you live near the coast.
- >> Learn location of official shelters.
- >> Determine where to move your boat in an emergency.
- >> Trim back dead wood from trees.
- >> Check for loose rain gutters and downspouts.
- >> If shutters do not protect windows, stock tape and boards to cover glass.

When a hurricane watch is issued

- >> Check often for official bulletins on radio, television, or National Oceanic and Atmospheric Administration Weather Radio.
- >> Fuel car.
- >> Moor small craft or move to safe shelter.
- >> Stock up on canned provisions.
- >> Check supplies of special medicines and drugs.
- >> Check batteries for radio and flashlights.
- >> Secure lawn furniture and other loose material outdoors.
- >> Tape, board or shutter windows to prevent shattering.
- >> Wedge sliding glass doors to prevent their lifting from their tracks.

When a hurricane warning is issued

- >> Stay tuned to radio, TV or NOAA Weather Radio for official bulletins.
- >> Stay home if sturdy and away from the coast.
- >> Board up garage and porch doors.
- >> Move valuables to upper floors.
- >> Bring in pets.
- >> Fill containers (bathtub) with several days' supply of drinking water.
- >> Turn up refrigerator to maximum cold and don't open unless necessary.
- >> Use phone only for emergencies.
- >> Stay indoors on the downwind side of the house, away from windows.
- >> Beware of the eye of the hurricane.
- >> Leave areas that might be affected by storm tide or stream flooding.
- >> Leave early, in daylight if possible.

- >> Shut off water and electricity at main stations.
- >> Take small valuables and papers, but travel light.
- >> Leave food and water for pets (shelters will not take them).
- >> Lock up house.
- >> Drive carefully to nearest designated shelters using recommended evacuation routes.

After the "all-clear" is given

- >> Drive carefully; watch for dangling electrical wires, undermined roads, flooded low spots.
- >> Don't sight-see.
- >> Report broken or damaged water, sewer and electrical lines.
- >> Use caution when re-entering home. Check for gas leaks. Check for food and water spoilage.

Source: Civil Defense Agency and National Oceanic and Atmospheric Administration
(See Figure Hurricane Damage Control).

SOURCES: HSB 5-19-02 A16

City and County of Honolulu: www.co.honolulu.hi.us
National Hurricane Center: www.nhc.noaa.gov
Navy Region Hawaii Public Affairs Office: www.hawaii.navy.mil
Accuweather: accuweather.com
San Diego State University: edweb.sdsu.edu
Hurricanes 2002 dot Com: www.hurricanes98.com

Gee, P. (2002, May 19). Hurricane preparedness urged. *Honolulu Star-Bulletin*, pp. A13, A16, A17.

Posted On: May 21, 2002, A1

Active hurricane season forecast

By Walter Wright

The National Weather Service is forecasting an active hurricane season this year with six to seven tropical cyclones in the Central Pacific. Some might be hurricanes that will affect Hawai'i.

The National Weather Service said in 2002 it expects more than the average of 4 1/2 tropical cyclones per season.

Typically those cyclones include one hurricane, two tropical storms and 1 1/2 tropical depressions.

Weather Service officials said yesterday that their message for Hawai'i residents before the start of the June 1 to Nov. 30 hurricane season is to be prepared, regardless of the number of the storms expected.

"It only takes one storm to cause devastating effects," said coordination meteorologist Tom Heffner said.

Ellen Ching of Kaua'i knows the problem all too well.

Ten years ago, she watched as Hurricane 'Iniki ripped the roof off her home, pushed sliding glass doors into the house and pulverized jalousie windows into a blizzard of powdered glass.

At the height of the storm that hit 80 percent of the houses on Kaua'i, Ching was cowering in a bathtub in a guest bathroom, pulling blankets and towels down around here.

Wright, W. (2002, May 21). Active hurricane season forecast. *Honolulu Advertiser*, pp. A1.

Posted on: Tuesday, May 21, 2002

More tropical cyclones expected this year

By [Walter Wright](#)

Advertiser Staff Writer

The National Weather Service expects six to seven tropical cyclones in the Central Pacific this hurricane season, and the storms could include hurricanes which might affect Hawai'i.

The outlook for this year is higher than the average of 4 1/2 tropical cyclones per season in the region over the past 41 years, storms which typically included one hurricane, two tropical storms and 1 1/2 tropical depressions each year.

Weather Service officials said yesterday that their message for Hawai'i residents before the start of the June 1 to Nov. 30 hurricane season is to be prepared, regardless of the number of the storms expected.

"It only takes one storm to cause devastating effects," warning coordination meteorologist Tom Heffner said.

Ellen Ching of Kaua'i knows the problem all too well.

Ten years ago, she watched as Hurricane 'Iniki ripped the roof off her home, pushed sliding glass doors into the house and pulverized jalousie windows into a blizzard of powdered glass. At the height of the storm that hit 80 percent of the houses on Kaua'i, Ching was cowering in a bathtub in a guest bathroom, pulling blankets and towels down around her.

Ching, executive director of ARC of Kaua'i, an organization serving developmentally disabled children, recalled her 'Iniki terror during a press conference at the Weather Service's Honolulu Forecast Office at the University of Hawai'i-Manoa.

It was 1992 when Iniki swerved into Kaua'i and caused an estimated \$2 billion worth of damage. Even then, Ching said, Kaua'i residents seemed more prepared than others in Hawai'i for such storms, although Ching had to talk her 76-year-old father down out of a tree he was trimming, and couldn't stop her husband from setting off on a trip to O'ahu that September day.

"I am filling all the tubs with water and taking down anything that could be a flying projectile," she remembered, "and in my mind there is this Wizard of Oz vision of my husband's car flying off the highway."

The first half of the storm was "a little bit hairy," and then the eye of the storm brought a lull for about 30 minutes, Ching said. "Then the second half came. It started with a huge gust, and huge clapping noises — all the cabinet doors were flapping back and forth until they were blown off their hinges, and the wall unit flew off the wall."

"I was afraid of getting buried," Ching said of hiding in the tub. "I could hear our roof lifting off. I hit the deck and, sure enough, three-quarters of our roof was blown off.
"Our message from Kaua'i to the rest of the state is get with it."

Wright, W. (2002, May 21). More tropical cyclones likely this year. *Honolulu Advertiser*, pp. A12.

Posted on: Tuesday, May 21, 2002, B1.

Time to be ready is now

By [Lee Cataluna](#)

Advertiser Columnist

The evening of Sept. 10, 1992, Safeway Kapa'a on Kaua'i's east side was packed with people trying to scoop up hurricane survival essentials: batteries, toilet tissue, disposable diapers, rice. By the next morning, as word got around that Iniki was on a head-on course for Kaua'i, the line of panicked people snaked out the door, down the shopping complex, across the parking lot and down the street of every grocery store and supermarket on the island. Everyone looked afraid, and though folks tried to be congenial, it's hard to watch someone heading to their car with a shopping cart full of stuff when you're number 257 in line. There was little left on the shelves for those who actually made it into the stores before county officials ordered everyone off the streets. Canned juice, saimin, dried fruit, kakimochi — people were buying anything just to feel like they weren't facing the storm empty-handed.

Kaua'i people learned hard lessons about preparedness. When they rebuilt, they did so with hurricane clips and ties. Families now have deep pantries with ample supplies of non-perishable foods and lots of containers for water. They know the first thing to do when you hear a storm is on the way is to make sure you have an adequate supply of prescription medication. And they know that masking tape X's on jalousies don't provide much protection.

As we head into hurricane season, 10 years after Iniki, there is danger that these critical lessons may be forgotten. Hawai'i may have been lulled into a false sense of security. O'ahu residents may feel that, hey, that's a Kaua'i thing. We don't have to worry.

Or worse, people may think that, if a hurricane hits, then somehow, someone will take care of them.

The thing is, that someone has to be you.

The National Weather Service Central Pacific Hurricane Center has teamed up with the state Civil Defense, American Red Cross and Hawai'i Army National Guard to emphasize preparedness during Hurricane Awareness Week. The theme of the joint effort is "Working Together to Save Lives" — but a crucial part of the "together" they're talking about involves us, the community. It's up to each one of us to get informed and be prepared.

Now is the time to make the big shopping run. Now is the time to sit with your family and come up with plans for evacuation, safe shelter, and prepping the house if a storm is on the way. Now is the time to pick up a weather radio. Now is the time to decide that, if a hurricane is coming, we're packing up the dog, the cooler and the sleeping bags and heading to Auntie Cookie's windowless basement "bunker."

We knew for days that 'Iniki was on its way, though the seriousness of the situation only sank in the last 24 hours before the hurricane hit land. Still, for some, it wasn't enough time to prepare.

So start now.

Cataluna, L. (2002, May 21). Time to be ready is now. *Honolulu Advertiser*, pp. B1.

Current Issues: ENVIRONMENT

- TenBruggencate, J. (2002, June 10). Devices can keep debris out of storm drains. *Honolulu Advertiser*.
- Kubota, G.T. (2002, June 10). Weather, seawalls cited in Maui beach erosion. *Honolulu Star-Bulletin*, pp. A1, A6.
- Coleon, S. (2002, June 6). New Waikiki gallery showcase exotic Pacific sea life. *Honolulu Advertiser*, p. A9.
- TenBruggencate, J. (2002, June 3). Nature contributes to bad air in Hawai'i. *Honolulu Advertiser*, p. B1.
- Aguiar, E. (2002, June 2). Kailua waterways cleanup may be coming. *Honolulu Advertiser*, p. A27.
- TenBruggencate, J. (2002, May 27). We're to blame for oily seas. *Honolulu Advertiser*, p. B1.
- Scott, S. (2002, May 24). Isle seasonal differences are subtle yet noticeable. *Honolulu Star-Bulletin*, pp. A2.
- Thompson, R. (2002, May 21). Seaweed group explores ocean of possibilities. *Honolulu Star-Bulletin*, pp. A5.
- Krauss, B. (2002, May 15). Crueler sea encroacher on atoll. *Honolulu Advertiser*, pp. B1.
- Rosenblum, M. (2002, May 12). Maui's troubled waters. *Honolulu Star-Bulletin*, pp. D1, D6.
- Scott, S. (2002, May 10). Glowing mysteries dwell among oceanic nutrients. *Honolulu Star-Bulletin*, pp. A2.
- Kubota, G. (2002, May 8). Wasteful practice of gill-netters denounced by Maui residents. *Honolulu Star-Bulletin*, pp. A6.
- TenBruggencate, J. (2002 May 5). Fewer sever quakes hit Big Island. *Honolulu Advertiser*, pp. A25, A31.
- Song, J. (2002, May 2). Navy halts bombing in Marianas. *Honolulu Advertiser*, pp. B2.
- Hurley, T. (2002, April 14). Koa's magic lures poachers. *Honolulu Advertiser*, pp. A1, A4.

Estermann, P. & C. Sanburn. (2002, April 14). Both victory and defeat from Sandy Beach dispute. *Honolulu Advertiser*, pp. B1, B4.

TenBruggencate, J. (2002, April 8). Japan seeks to reduce sea debris. *Honolulu Advertiser*, pp. B1.

Gonser, J. (2002, March 21). Limu species targeted for eradication. *The Honolulu Advertiser*, pp. B1.

TenBruggencate, J. (2002, March 4). How our forest have changes. *Honolulu Advertiser*, pp. B5.

Posted On: March 4, 2002, B5.

How our forests have changed

By Jan TenBruggencate
Hawai'i's Environment

If you walked ashore on one of the Hawaiian Islands before the first Polynesian voyagers arrived, what would it look like?

Fossil and pollen evidence suggest that in addition to a complex collection of bird life, you'd find coastal forests unlike anything growing today. And you'd find evidence of species growing together that no longer do so.

Researchers can identify many species of plants from their pollen, even in soil samples that can be dated to long before human arrival in the Islands.

Early pollen work on O'ahu found that parts of the island were made up of dense palm forests --- not coconuts but the native *Pritchardia* fan palm, loulu.

Another common plant was the kanaloa, of which only one plant still survives in the world, on Kaho'olawe.

New work from a coastal limestone sinkhole at Maha'ulepu on Kaua'i, done under the direction of Fordham University biologist David Burney, found that the prehuman botany of South Kaua'i was far different.

Common seeds and pollen came from *Prichardia* lams and the shrub whose seeds have wings --- 'a'ali'i.

There was also plenty of the fragrant-flowered alahe'e, whose hard wood the Hawaiians used for digging sticks.

There were relatives of the 'olapa, the forest species whose leaves flutter in the slightest breeze, and of lama, a relative of the persimmon.

The woods of this region had 'ohia, whose colorful sap-filled flowers are so prized by nectar-eating birds, and the olive relative known as olopua.

There was a soapberry --- a relative of a'e or manele --- and something related to one of the plants known as kawa'u.

Additionally, there were traces of pollen from hala, kou and 'iliahi, or sandalwood.

Burney and his co-authors discuss the pollen evidence in their paper, "Fossil Evidence for a Diverse Biota from Kaua'i and Its Transformation since Human Arrival," published in the journal *Ecological Monographs*.

Their work also suggests that many of the plants of the wet, intermediate and dry climates of present-day Hawai'i once coexisted in this one region. That suggests that what scientists now consider to be plants of a specific environment might not be.

"Many plants may be restricted to high elevations and wet sites today simply because these remote locations have, by nature of their difficult topography and climate, resisted most human impacts more effectively than the coastal lowlands," Burney and his associates write.

They concede, however, that it is possible the Maha'ulepu site may have been geologically unique and able to sustain an assembly of plants unlike those elsewhere.

TenBruggencate, J. (2002, March 4). How our forest have changes. *Honolulu Advertiser*, pp. B5.

Posted on: Sunday, April 14, 2002, A1, A4

Value of koa hardwood growing on black market

By Timothy Hurley
Advertiser Staff Writer

HILO, Hawai'i — It's the premier timber tree of Hawai'i, a native species linked to the power of the ali'i, the carving of traditional Hawaiian canoes and the crafting of the finest 'ukulele. It's quite simply a magical name in the state's woodworking industry.

Koa grows nowhere else but Hawai'i, and while it is not considered an endangered species, harvesting is scarce and its value has never been greater. A mature tree can turn out tens of thousands of dollars worth of finished koa products.

"It's practically worth its weight in gold," said Andrea Gill, executive director of the Hawai'i Forest Industry Association.

But the prized hardwood and its rising value have spawned a growing black market. While no one knows the scope of the illegal activity, foresters and state conservation enforcement officials say they're spending an increasing amount of the time dealing with the problem of koa thefts.

A koa tree theft ring was busted on Kaua'i last year, and a Big Island grand jury filed indictments in a separate case this year. There have been reports of other recent thefts, including some on O'ahu. State conservation enforcement officers say they're now investigating an even larger case on the Big Island.

"What we're seeing is just the tip of the iceberg," said John Holley, Big Island state conservation enforcement officer.

Some say the problem is likely to continue because few eyes are watching over Hawai'i's vast koa forests. On the Big Island, where most of the state's koa grows, there are about 20 officers responsible for about 1 million acres of state Department of Land and Natural Resources land, along with the ocean extending 12 miles from the shore.

In the Ka'u District, a single officer oversees an area the size of O'ahu.

The state Division of Conservation and Enforcement has increased its patrol of prime koa stands and lobbied for legislation that would make it illegal to transport forest products without records detailing where they were obtained.

But it remains a daunting task to protect the koa forests.

"We can't be everywhere," said Lenny Terlep Sr., the division's Hilo branch chief. "We're being used for security at the ports, as escorts in the courts ... We rely heavily on tips and good, solid information."

One reason for the rising value of koa is the fact that its natural range has diminished during the years because of logging and land clearing for agricultural production and cattle grazing. Thousands of acres that were originally forested are now dry hills covered by thorny shrubs and grass.

The resource continues to decline today under pressure from grazing, an influx of alien plant species and harvesting.

"It's getting mined like it's a mineral," state forester Michael Constantinides said.

Demand for koa far exceeds the supply, which generally is available only on private land, mostly from pastures that contain the remnants of koa forests. Harvesting on state lands is generally limited to a few areas where permittees are allowed to take only trees that have fallen down on their own.

With a shrinking supply, prices have shot up seven to 10 times in the past 20 years.

"Koa is like a god," said Mel Pau'ole, a professional woodworker from Kailua, Kona. "It plays such a big role in the culture. So many people here look upon it as a really special wood."

In furniture, jewelry, picture frames and paneling, koa says "Hawai'i."

"It's our heritage wood, part of our identity," Gill said. "And it's a great, beautiful wood."

Recognized worldwide

Indeed, koa is recognized around the world for its textural pattern, from plain to curly, and its color, from reds to deep chocolate-browns and blond. While the grain is fine and the texture medium-coarse, it is the pattern of the wood that puts koa in a class of its own. A good finish can give it a stunning three-dimensional quality.

Although the Hawai'i Forest Industry Association has been actively pushing other native woods in a bid to establish new markets and take the pressure off koa, the effort has been slow-going. Koa still represents 90 percent of Hawai'i's \$30 million timber industry.

Gill said koa has developed its own unshakable mystique during the years. She recalls seeing some hair brushes made from different woods, including koa and mango, during a recent visit to Ala Moana Center. The sales clerk insisted they were all koa.

"If you had eight different samples, a lot of people couldn't even pick (koa) out of a lineup," Gill said. "Even though other woods can be just as beautiful and the quality of

workmanship just as good, koa is the wood of choice. It really is top-of-mind. "It's very successful marketing, and not on purpose; it just happened."

Today, premium curly koa costs as much as \$45 a board foot, with regular koa priced as high as \$25 a board foot. A newly made koa jewelry box can cost upward of \$500, a small dining set in excess of \$6,000.

Koa has gotten so expensive that one of Hawai'i's biggest koa manufacturers, Martin & MacArthur, is buying about half as much koa as it did seven years ago.

W. Lloyd Jones, the company's CEO, explained that while 90 percent of its furniture and 75 percent of its gift items are still made of koa, most of the picture frames are now made with only a koa veneer.

"People are starting to respect the other woods, but koa is still king," Jones said.

Forest stakeouts

On the Big Island, a downed power line last May 8 eventually led to the arrest of two men suspected of poaching koa trees from state land. Hawai'i Electric Light Co. crews responded to the problem in the Hilo Forest Reserve and were the first to see the koa stumps. They called authorities.

Holley, a former Big Island policeman who enjoys wood carving himself, led an investigation that included two weeks of stakeouts in the forest. Holley hid in a bush in the rain waiting for the poachers to return for more trees or to claim logs already chopped down and waiting to be hauled out.

The stakeouts proved fruitless and frustrating.

In the end, a tip led to the arrest of the men, who were stopped

May 27 by police with a pickup load of logs. They were charged with first-degree theft for stealing \$104,000 worth of koa trees — 31 from the Hilo Forest Reserve and several more from a couple of other locations. The men face 10 years in prison in a trial scheduled next month.

Key to the investigation were state foresters who were able to match the stumps of cut koa to some of the logs in the suspects' possession. Some of the trees were close to 100 years old.

On Kaua'i, conservation enforcement officers caught two men in the act of cutting koa trees April 1, 2001, on state land at Koke'e. They later arrested three others and confiscated more than 50 logs from homes where they were being stored. Following grand jury indictments, the five men, ranging in age from 19 to 41, also are to go on trial next month.

Holley said he's seeing a trend in which koa is being cut for quick sale to support drug habits. And while many woodworkers and mill operators are honest, hard-working people, he said, some will go for the relatively cheap, black market deals.

Big Island conservation enforcement officers say they are conducting an investigation into an even larger koa theft case, but they won't discuss details. However, Terlep last October acknowledged an investigation into alleged illegal logging on conservation-zoned land under lease to the Damon Estate's Kahuku Ranch.

Environment damaged

In addition to stealing a public resource, the thieves are damaging the environment by forging new roads, cutting native plants, eliminating bird habitat and allowing openings in the forest for alien species, foresters said.

Some in the forest industry believe the state's policy of not permitting koa harvesting in state forests has as much as anything to do with the declining habitat, the high price of koa and the growing illegal activity.

"Some say that when you outlaw access to the wood, only the outlaws have the wood," said Stephen Smith, a Kaua'i forestry consultant who is president of the Hawai'i Forest Industry Association.

Smith said selective harvesting should be allowed not only to better manage the koa forests but to place more eyes in the wilderness to watch out for illegal activity.

"Right now it can be the wild west out there, with outlaws in the bushes, with their chainsaws and their piles of wood," he said.

"The arch enemy of the forests is the state government," insisted Bill Eger, former Hawai'i Forest Industry Association board member who is running as a Democrat for the 4th House seat that represents Puna.

Eger and others in the industry contend the state has failed to properly take care of its lands — both in its agricultural leases and forest reserves — allowing old koa trees to die and inviting invasive species to move in. They believe the state is bowing to those who insist that no harvesting take place whatsoever.

In the early 1990s, state officials proposed a 1,200-acre koa management area on former leased pasture land at Kapapala on the Big Island. The plan, according to state forestry program manager Carl Masaki, was to demonstrate to ranchers that their pastures could be worked for koa harvesting. But the proposal died after environmental groups objected.

"We have such a broad mandate. It's hard to please everybody," Masaki said.

The Sierra Club Hawai'i Chapter has adamantly opposed koa logging on state lands, saying the forests represent a last haven for many rare, threatened or endangered species of endemic birds, insects and plants.

In a formal position statement, the organization calls for a moratorium on the purchase of koa products until such a time as they can come from an "environmentally sound koa forest industry."

"In an ideal world, there would be no logging of koa," said former Hawai'i Chapter Chairman David Kimo Frankel. "In an ideal world, (koa) logging could be done in a sustainable way. But we're a long, long way from that."

Brighter tomorrow

Despite worries about the koa wood supply, there is optimism within the industry for a brighter tomorrow:

- The state Department of Hawaiian Home Lands is poised to launch a koa salvage and reforestation project on about 125 acres at Humu'ula on the Big Island. The department plans to use the revenue from the logs for alien species control and land management.
- Kamehameha Schools, which owns 294,000 acres on the Big Island, is conducting a biological assessment and timber inventory in an effort to determine if it can begin selective harvesting.
- The Nature Conservancy has hired a scientist to conduct research in hopes of developing a koa forestry model on land recently purchased in Kona. The agency aims to demonstrate to landowners how to maintain both the biological and economic value of their lands.
- The Hawai'i Agriculture Research Center is looking into koa genetics to develop seed for improved varieties.
- Big Island ranches, such as McCandless and Parker, are turning some grazing lands into koa forests, hoping to find a new revenue source.

Some companies, such as Maui Land & Pineapple Co., are also experimenting with koa.

There are now an estimated 20,000 acres of koa being grown commercially. But the supply of wood will continue to be sporadic for at least 15 to 20 years, when some of the new plantations will be ready for harvest.

Until then, it's likely John Holley and his small band of state conservation enforcement colleagues will be forced to deal with the koa black market as best they can.

"Wherever there's a commodity and it's not being watched, people are going to take," Holley said. "People are going to take until they are caught."

Reach Timothy Hurley at thurley@honoluluadvertiser.com or (808) 244-4880.

Hurley, T. (2002, April 14). Koa's magic lures poachers. *Honolulu Advertiser*, pp. A1, A4.

Posted on: Sunday, April 14, 2002, B1, B4

Both victory and defeat came from Sandy Beach dispute

By Phil Estermann and Curt Sanburn

FOCUS

Fifteen years ago this month, the Honolulu City Council was poised to approve a proposed luxury housing development on an artificial berm across Kalaniana'ole Highway from Sandy Beach. It was a proposal that alarmed many O'ahu residents, who saw that it meant the eventual urbanization of O'ahu's most accessible and spectacular wild coastline.

What happened in April of 1987 triggered a wave of grassroots efforts and historic events that eventually led to the open-space protection of the undeveloped land between Koko Head and Makapu'u. That wave swept up just about everyone in it, from Honolulu's leading politicians, to the Hawai'i Supreme Court, to Bishop Estate, to the Legislature, to the neighborhood boards, and to thousands and thousands of regular folks.

In early April 1987, an array of organizations and individuals lined up at the City Council hearings to oppose the proposed development (211 luxury homes on the 31-acre parcel). The uproar included tour-bus operators, labor unions that service the visitor industry, artists, watchdog organizations such as the League of Women Voters, Hawai'i's Thousand Friends, Life of the Land, Sierra Club, and scores of concerned citizens from all parts of O'ahu.

At the same time, a majority at the City Council was intent on deal-making with the developers. They ignored the hue and cry and, on April 15, voted 5-4 to approve the project. Their deaf ear to public sentiment ignited the flame of citizen activism.

After the council vote, a loose group of people met to figure out what to do. They met again. And again. They decided to turn back the council's action (and the planned development) with a three-pronged strategy:

First, by going to court to challenge the legality of the council's action. This would slow down implementation of the council's decision and buy time to organize the community's clear support for open space at Sandy Beach. To do this, the Sandy Beach Defense Fund was organized.

Second, by organizing an initiative drive that would allow voters on O'ahu to overturn the council's action. For this campaign, the Save Sandy Beach Initiative Coalition was created.

Third, by getting government support to plan and dedicate the entire coastline from Koko Head and Makapu'u for open space. For this, the Ka Iwi Scenic Shoreline Park Committee began to meet.

All three efforts were initiated and carried out by a small, fluid group of about a dozen volunteers at any one time, meeting on a weekly basis and operating by consensus. Meetings were public and open to all. The group had critical support from a few key politicians, particularly then-City Council members Marilyn Bornhorst and Gary Gill.

While the Defense Fund retained an attorney to fight the City Council's action in court, the Initiative Coalition hit the streets with an army of petition circulators who obtained 40,000 signatures in 10 weeks. In September 1987, the signatures were verified and the petition certified, setting the stage for the Sandy Beach initiative election in the fall of 1988.

The developers and landowner Bishop Estate tried very hard to stop the election. At one point their lawyers attempted to subpoena 53 petition signers. After nearly a year of high-profile court action, the Hawai'i Supreme Court allowed the election to go forward as part of the November 1988 general election.

The campaign was intense, with the Bishop Estate spending \$10,000 a day during the final month on a last-ditch media campaign urging the public to vote "No." The coalition battled back with a low-budget media and grassroots campaign that said "Yes." Opinion polls showed strong support across the board for the initiative. (Of all ethnic groups on O'ahu, Native Hawaiians showed the strongest support.) Both daily newspapers endorsed the initiative, as did neighborhood boards islandwide and 81 candidates running in federal, state and local elections.

On Election Day, voters across the island supported the initiative, voting 2-to-1 to rezone the property from residential to preservation. It was a huge victory for citizen activism and for the environment.

The developers and Bishop Estate immediately went back to court to overturn the election results, and in May 1989, the Hawai'i Supreme Court struck down the Sandy Beach initiative. Furthermore, the court stripped voters in all four counties of their land-use initiative voting rights.

The court's ruling must be remembered as one of the most decisive and anti-democratic power plays in the ongoing saga of land and power in Hawai'i.

Several weeks later, the City Council, bowing to the public sentiment, voted unanimously to rezone the Sandy Beach parcels from residential to preservation. The developer immediately contested that rezoning in court.

With Sandy Beach protected but the land-use initiative lost, the coalition went to the state Legislature to ask that state law be amended, pursuant to the Supreme Court ruling, to restore voters' rights. The coalition was energized by poll numbers which showed that a rock-solid majority of the public wanted their voting rights back. But legislators with ties

to Bishop Estate and other major landowners, the development industry, banks and construction unions proved to be immovable obstacles.

After three years of exhausting lobbying and grassroots work, from 1989 to 1992, the coalition gave up.

But the Sandy Beach message had been heard. Incoming Gov. Ben Cayetano signaled his intention to protect the Ka Iwi coastline in perpetuity, and, in 1998, the state purchased the 305 acres at Queen's Beach from Bishop Estate with the intention to manage a wilderness park there.

Mayor Jeremy Harris likewise made clear his vision for an open coastline when he took office in 1996. In February of this year, the city announced the purchase of the Sandy Beach parcel, as part of a settlement of developer claims against the city. As soon as the settlement is certified by the courts, the entire Ka Iwi coastline will be in public hands.

Looking forward, management issues for the coastline must be addressed: issues of access, parking and the degree of park development; the restoration of wetlands and protection of native species; and the defense of Ka Iwi's rugged and untamed character.

These won't be dramatic struggles, but they will require vigilance and sensitivity, so that our children and their children will always have a place near the sea where nature rules.

What started out as a public uprising against bad land-use planning and arrogant politicians was vindicated in the end by an overwhelming acknowledgment of the inherent value of that beautiful coastline. It's just that the public knew it before its leaders did.

On the other hand, the saga of Sandy Beach is a sober reminder of how easy it was to extinguish a right as basic as voting, when it threatens powerful interests. It needs pointing out that today the public could not defend Sandy Beach as it did in 1988.

Are we better off?

Phil Estermann and Curt Sanburn have worked to protect open space on the Ka Iwi coastline for 15 years.

Estermann, P. and Curt Sanburn. (2002, April 14). Both victory and defeat from Sandy Beach dispute. *Honolulu Advertiser*, pp. B1, B4.

Posted On: April 8, 2002, B1

Japan seeks to reduce sea debris.

Jan TenBruggencate
Hawai'i's Environment

Japanese fishery officials are working on changing the equipment used in oyster farming to minimize the release of plastic tubes that end up on Hawai'i beaches by the thousands.

The polyethylene tubes are hollow and a half-inch thick, in lengths from 1 or 2 inches to 8 or 9 inches.

Their origin was a mystery until last year, when Hawai'i officials discovered they are used in the Japanese coastal oyster fishery.

The tubes are used as separators between clusters of oysters growing on scallop shells, which are strung on cords under rafts. During storms, the rafts sometimes break loose, setting thousands of plastic tubes adrift on the North Pacific currents.

Once the tubes are adrift, seabirds can eat them. Dead albatross have been found with their bellies full of them.

Rick Steiner, a biologist and professor with the University of Alaska Marine Advisory Program, brought the issue to Japan fishery officials and said the response has been positive.

Steiner said he met recently with officials of the Japan Fisheries Agency and the Japan Environmental Action Network. Japanese officials were impressed by photographs of marine debris on Hawaiian shores and of dead seabirds stuffed with plastics, he said.

“They began a research project to learn more about all of this,” he said. “They queried all prefectures in Japan and found that some 24 prefectures do oyster farming, of which one uses largely bamboo pipes, thus not really a problem for us. Ten use the plastic pipes. The other 12 prefectures use another method entirely: a twisted rope within which the scallop substrate shells are secured at fixed intervals, with no need for the plastic pipes.”

Steiner said the Japanese government asked the largest oyster-farming prefecture, Hiroshima, to consider switching from plastic spacers to the twisted-rope method.

The oyster growers also are looking into methods to prevent rafts from breaking free in typhoons.

“All of these oyster growers now know of the problem and feel a sense of responsibility to help resolve the issue. They don’t want to lose their gear, and now know that it is having broad impact across the Pacific,” Steiner said.

The changes in the oyster fishery could stop the release of polyethylene tubes in the Pacific.

“This is a wonderful step toward resolving this issue,” Steiner said. “Of course, this is just the tip of the proverbial iceberg when it comes to the marine debris problem, but it is a start.”

TenBruggencate, J. (2002, April 8). Japan seeks to reduce sea debris. *Honolulu Advertiser*, pp. B1.

Posted On: Friday, May 10, 2002, A2.

Glowing mysteries dwell among oceanic nutrients

By Susan Scott
Ocean Watch

Last week, while snorkeling across the mouth of Hanauma Bay, my friend Tim called me over. "There's something in the water that looks like pieces of blue glitter," he said. "Come tell me what it is."

I swam over but saw nothing. A few minutes later, he called me again. "Susan. Come look. What are these things?"

Again I swam over. Again I saw nothing.

"I can't believe it," he said. "They were right here!"

We swam together for a while, and then I drifted off, scanning this wide-open space for big animals, like manta rays or dolphins. A few feet away, I could see Tim diving down, reaching out to touch something I could not see. The man needs to get more sleep, I thought. (Tim works nights.)

And then, there they were right in front of me: a ballet of blue dots, each glowing bright as a neon light. I dove down, reached out -- and the lights disappeared. Tim joined me, and we both tried to catch one. No luck. "They're turning themselves on and off," he said. "What the heck are these things?"

Tim was right. Whenever we reached out to touch a blue sparkle, it disappeared.

It was another magical moment in the weird world of plankton.

Before I got to know plankton, I thought it was boring. Who cared about a bunch of nearly invisible plants and animals drifting aimlessly around the ocean? But I learned to care a lot because these tiny organisms keep us, and everything else on this planet, alive. Besides that, some are out-of-this-world beautiful.

The word plankton refers to tiny organisms swimming, or suspended in the water, near the surface. Most plankton can move up and down in the water but are too small to move against the ocean's currents. Planktonic organisms are true drifters.

Plankton comes in two forms: plants, called phytoplankton, and animals, called zooplankton. Besides phytoplankton forming the base of the marine food chain, its uptake of carbon dioxide and release of oxygen keeps our atmosphere habitable.

Tiny plants called dinoflagellates are a significant part of phytoplankton. Some of these

dinoflagellates are known as fire algae because they glow in the dark. When we stamp our feet in wet beach sand at night, the greenish light that sometimes appears is the glow of dinoflagellates.

As for zooplankton, a huge number of fish and invertebrates pass through a planktonic larval stage in their life cycles. Some don't resemble their parents at all during this phase and look more like tiny aliens. These strange little life forms make up much of the ocean's zooplankton, and therefore are at the mercy of the ocean's currents and carnivores.

This may not seem the best way to grow up, but in the ocean it has its advantages. First, tiny larvae can graze on the richest food source in the world, phytoplankton. Second, ocean currents can carry larvae great distances, giving them a chance to settle in new habitats or replenish diminishing ones. We in Hawaii should be grateful for this roaming. It's the reason we have as many marine animals as we do.

A third advantage of young marine animals having their own shapes and drifting away from home is that it eliminates competition between adult and offspring. The young and old occupy different spaces and eat different food.

OK, so what were the blue dots? Plants? Animals? Creatures from outer space?

I have absolutely no idea. If you know what this organism might be, please tell me. Tim is waiting.

Scott, S. (2002, May 10). Glowing mysteries dwell among oceanic nutrients. *Honolulu Star-Bulletin*, pp. A2.

Posted On: Sunday, May 12, 2002, D1, D6.

Maui's troubled waters

By Mort Rosenblum
Associated Press

HANA, Maui >> On the paradise island of Maui, where some of the world's heaviest rains pelt lush peaks, scientists say big users squander water so much that main wells soon may be contaminated by salt.

"They'll be lucky if they have another five years at this rate," said William Meyer, who recently retired as the U.S. Geological Survey's regional director. "This is a train-wreck scenario."

Maui, water experts say, is an alarming example of what happens in an isolated microcosm -- an island, in this case -- as conflicting interests must fight over runoff from rains and dwindling underground reserves.

Although by itself only a dot in the Pacific, Maui is viewed as a revealing laboratory not only for the rest of Hawaii, but also the wider world beyond.

"Places like this have no Colorado River to fight over," Meyer said. "When they realize they're out of water, it is all of a sudden, and it is too late."

Already, Hawaii farmers who plant taro see streams go dry at a quickening rate because agriculture barons and land developers use their historical rights to divert water. That may be only the beginning.

On volcanic islands, rain that does not run out to sea settles in porous underground pools, forming what geologists call a lens of fresh water above encroaching salt water.

But, hydrologists say, for each foot of fresh water taken from these subsurface aquifers, heavier salt water pushes up 40 feet. Uncontrolled pumping can mean calamity in a hurry.

Hastened by four years of drought, levels have plummeted in Maui's Iao aquifer, from 18 feet above sea level in 1990 to 10 feet in 2001. That left only 400 feet in the fresh-water lens.

Planners say Maui's population of 150,000 could reach 1 million by 2050 as tourism expands, making hard choices inevitable. A hotel or golf course needs a million gallons a day, enough for 10,000 people.

Even now, few people talk about the crisis.

"This is our dirty little secret," said Lucienne de Naie, a Maui conservationist who tracks supply and demand. "Everyone needs water so everyone is afraid to criticize the people who control it."

She said Maui leaders lack even the political will to determine how much water they have. "With a precious resource, when you are in doubt about something, you don't do it," she said.

Experts warn of other impending crises on the islands of Oahu, Kauai and Molokai, where they say aquifers also are emptying faster than rain can recharge them.

The bulk of Maui's water is collected or pumped by Alexander & Baldwin Inc. Its elaborate ditch system carries water from wet areas to dry ones.

The company takes 60 billion gallons a year from streams that cross public land, paying the state of Hawaii only \$160,000 annually, officials say.

Elsewhere, U.S. Geological Survey agents add, A&B pumps underground water from its private wells -- millions of gallons daily -- that are not reported to anyone.

Much of the water is used to grow sugar cane, which requires a ton of water for every pound of sugar produced and relies heavily on federal price supports.

"Sugar is only a place marker for future development," said Jonathan Starr, an outspoken member of Maui County's water board, who believes the company refuses to share its water rights for fear of losing them.

"Whoever controls the water has a lock on the economy," he said. "Alexander & Baldwin's vision is that sugar cane will eventually turn into houses."

While at least 700 people have waited 10 years for water meter permits so they can build on their land, A&B has developed luxury property with water it controls, he said.

Starr sold a successful sign business in New York to settle in Maui, building a solar-powered house with a rainwater catchment system.

He was able to block one large real estate development by exposing secret plans between land companies and local officials to tap scarce water, but he fears uphill fights in the future.

Starr and a chorus of others angrily protested recently when Gov. Benjamin Cayetano named an A&B vice president, Meredith Ching, to the State Water Commission.

Some legal experts called this a blatant conflict made worse by the fact that two of the other three appointed commissioners also represent big agriculture and the third is a labor leader.

Ching, who supervises community relations at A&B, refused any comment on her appointment. She also declined to answer questions about company water use.

Linda Howe, media relations director, also would not comment.

"This is more of a perceived conflict than an actual one," said state Sen. Avery Chumbley, D-East Maui, North Kauai, who also heads a land company that sells water. "I believe in my heart and mind she (Ching) is a person of integrity."

Alan Murakami, attorney for the Native Hawaiian Legal Corp., argues that Ching is bound by law to support A&B's best interests or risks lawsuits from stockholders.

Even if she recuses herself on Maui decisions, any water commission action sets a precedent for the rest of the state, he said.

Murakami said Meyer had volunteered to serve on the water commission, but his nomination was blocked by large commercial interests.

In her first commission meeting, Ching challenged what conservationists praised as a landmark decision to restore diverted agricultural water to two spectacular falls on the Big Island.

William Tam, a Honolulu lawyer who wrote the state water code as deputy attorney general assigned to the commission, calls the appointment an "irreconcilable conflict" that puts authorities in "very difficult circumstances."

Tam was dismissed from state service in 1997. No official reason was given, but at the time the attorney general criticized him when a judge granted him a delay in a minor trial because of a personal emergency.

Privately, state legislators say he was fired after he spoke out at community meetings for native and individual water rights.

Hawaii has some of America's most stringent public-trust water laws, but they are poorly understood and essentially ignored, Tam said. He blames this partly on official mismanagement and conflicts of interest.

Unlike in the western mainland United States, where water rights were claimed mostly on a first-come, first-served basis, Hawaii follows the New England practice of sharing available water among all users.

In the landmark Waiahole decision in August 2000, the Hawaii Supreme Court upheld the water commission's power to protect streams, domestic use and traditional rights. But even that has not been sufficient, Tam said.

"Think of 19th-century colonialism," he said, explaining that many relics of old ways now define modern practices.

Tam fears court tie-ups as more users battle old entrenched companies and other large interests over water supply. He expects disputes to grow fierce when dwindling fresh water is all committed, forcing reallocation.

Occasional public outbursts already crackle with emotion.

In one meeting, small farmers pleaded for more stream water, but Garrett Hew, who heads A&B's Maui water operations, flatly refused. Hew declined to comment for this story.

Linnel Nishioka, deputy director of the Water Commission, said in Honolulu that Ching's appointment was no problem since she would take no part in matters related to Maui or flow standards for Hawaii's streams.

She said state authorities keep watch on the water supply and are confident they can meet future challenges, but she added that their resources are severely limited.

"We're managing a long-term problem in a short-term world," she said, lamenting what she called a desperately tight budget that prevents accurate measure of water resources and limits enforcement.

Like the others, Nishioka fears protracted legal battles as water grows scarce. She said significant resources are siphoned off in court costs.

On Maui, a quiet war already has begun.

Ed Wendt, who grows taro near Hana, organized other residents to go to court. He rallied planters to submit separate petitions to save 29 of perhaps 100 threatened streams.

"It's so ridiculous, we just laugh," he said when asked about the controversy over Ching. "The only way we'll get anything is to fight. I'm pretty optimistic about our chances."

His backers include Ernie Schupp, a 46-year-old carpenter who spends his nights and weekends trying to restore a taro field. Only a fraction of the water he is promised ever reaches his stream.

"Developers want the water," he shrugged, when asked where the remainder went. "Unfortunately, they don't care about anybody else."

Letters to the Maui News reveal a simmering undercurrent.

Jim Hylkema wrote that he was forced off the board of a group that revives Hawaiian

fishponds because the tax-exempt Alexander and Baldwin Foundation withdrew support when he criticized Ching's nomination.

Taking up his cause, conservationist Daniel Grantham asked legislators to look into public testimony in support of real estate development by community groups that received support from corporate sources.

Because of Wendt's efforts, authorities have agreed to a three-year study of stream flows by the U.S. Geological Survey.

Chumbley personifies the problem, in Maui and in the wider world beyond. His company sells water that runs from state-owned mountains across his land.

"I'm torn and conflicted," he said. "My vision is publicly owned water. All water in Hawaii should be in public trust." This means the greatest good for the greatest number, he said.

Yet he controls 50 million gallons a day he does not need. Despite objections, he insists his company is entitled to sell it.

"We don't take it all," he said, "but when there are lower levels of rainfall, the stream flows are drastically reduced."

He acknowledged that Maui's main aquifer is being overdrawn up to 27 million gallons a day, dangerously narrowing the margin between fresh water and the surrounding sea.

He called it "shameful" that Hawaii has not been able to enforce its strict water code, particularly on Maui.

"Water is not being managed by anyone," Chumbley said. "Maui has a tremendous amount of water. But we have no system to catch it, store it, transport it. We just waste it."

Rosenblum, M. (2002, May 12). Maui's troubled waters. *Honolulu Star-Bulletin*, pp. D1, D6.

Posted On: May 15, 2002, B1.

Crueler sea encroaches on atoll.

By Bob Krauss
Our Honolulu

Majuro Atoll, Marshal Islands – People on this low-lying atoll are concerned and confused about global warming and the rise in sea levels, much more so than people in Our Honolulu. They should be. It affects atolls first.

I talked to half a dozen knowledgeable residents here to find out what might be in store for us in Hawai'i.

“Clearly, there is climate change afoot,” said Giff Johnson, editor of the Marshall Islands Journal and son of a former University of Hawai'i history professor Walter Johnson.

“We see more intense storms, higher high tides. People remember where they used to picnic at Laura (20 miles across the lagoon) is now 40 feet from the shore.

“My house sits 12 feet from the lagoon. Now, when there's a storm, I have to nail a strip of plywood against the front door to keep the waves out.

“Ten years ago, a high tide washed sand onto the runway and closed the airport for a week. Last year, an amazingly high tide flooded Majuro between downtown and Gibson's (a department store). Water was a foot-deep in stores. The government had to mobilize bulldozers to scrape sand and debris off the road.”

Donald Capelle, secretary of health for the Republic of the Marshall Islands, affirmed that these disasters are costly for the government.

Marie Maddison, secretary of foreign affairs, agreed it's a major issue “but it's difficult to get scientific data.” A mapping project of aerial photos is under way to compare today's coastlines with those of World War II.

“There is no evidence on the outer islands that they are losing land,” Maddison said. This suggests that the problem on Majuro Atoll may be as much from massive development as climate change. Dredging of beach sand that interrupt tidal flow into the lagoon may change tidal currents and wave levels.

Johnson said he believes that causeways built over the reef to connect islets in the atoll are part of the problem on Taravao and Kiribati as well as Majuro. But it's difficult to get the government and business to address the issue.

At the same time, he insists that it's a mistake to ignore rising sea level and climate change. "Something is happening," he said. "If we don't deal with it now, an irreversible process will set in and the atolls will be done for."

At the College of the Marshall Islands, Ted Stepp, a former Maryknoll High School teacher, said his students often choose global warming as topic for their themes.

Silvia Pinca, coordinator of the marine science program, said: "I am stunned that people can still be skeptical about sea-level rise. We have proof from all over the world. I went home to Italy and found that Venice got flooded 53 times last years. Bangladesh is losing land."

Pinca is afraid that coastlines all over the world, prime residential and resort property, may eventually suffer the same fate.

Krauss, B. (2002, May 15). Crueler sea encroacher on atoll. *Honolulu Advertiser*, pp. B1.

Posted on: Thursday, May 2, 2002, B2

Navy halts bombing in Marianas

By Jaymes Song
Associated Press

An injunction to halt bombing and other military training on a tiny Pacific island could hinder America's ability to defend itself and to prepare for war, a Navy spokesman said.

The Navy ceased using Farallon de Medinilla in the U.S. Commonwealth of the Northern Mariana Islands on Tuesday after U.S. District Judge Emmet Sullivan in Washington issued a 30-day injunction immediately halting all U.S. military activities.

The uninhabited island — measuring 0.3 miles wide and 1.7 miles long — was the only site in the Western Pacific authorized for live-fire exercises.

"If denied long-term use of the range, it would have a tremendously negative impact on Navy readiness," Lt. Cmdr. Jeff Gordon, spokesman for the U.S. Pacific Fleet, said yesterday.

Sullivan ruled March 13 on a lawsuit filed in December 2000 by Earthjustice Legal Defense for the Center for Biological Diversity that the military was violating the Migratory Bird Treaty Act of 1918.

The organization claimed the bombing and shelling of Farallon de Medinilla was killing several bird species on the 206-acre island 52 miles from Saipan, the commonwealth's capital. The military has been training on the island since 1971.

Although the ruling is in effect for 30 days, it may lead to a permanent cessation of training on the island, unless the act is amended or the Navy receives a permit to continue training, the Navy said.

Among the birds on the island are masked, brown and red-footed boobies and great frigates.

Gordon said the Navy worked with biologists to strategically place seven targets around the island, away from nesting and environmentally sensitive areas, as well as performing surveys.

"The bird population there has maintained similar growth patterns as the rest of the islands in the Marianas," he said.

Song, J. (2002, May 2). Navy halts bombing in Marianas. *Honolulu Advertiser*, pp. B2.

Posted On: Tuesday, May 21, 2002, A5.

Seaweed group explores ocean of possibilities

By Rod Thompson
rthompson@starbulletin.com

HILO >> Seaweed is in your ice cream, your chocolate milk, your paint, your beer. Seaweed is in the glop your dentist uses to make impressions of your teeth.

Despite seaweed extracts being in products all around us, not many botanists study commercial seaweeds.

Starting tomorrow, 30 Pacific Basin seaweed experts from Thailand to Chile will gather at the University of Hawaii-Hilo for a weeklong workshop on economically valuable species.

Those 30 represent a major portion of all the commercial seaweed botanists in the Pacific, says Karla McDermid, a marine science professor at UH-Hilo.

"It's not the same (numbers) as fish people or coral people. In general, seaweeds have been overlooked," McDermid said.

Looking was what led McDermid to seaweeds. "I'm nearsighted, so fish move too fast," she said. "Algae stay put."

She was also encouraged by her professor at Stanford University, Isabella Abbott, 82, who began learning about seaweeds from her Hawaiian schoolteacher (who was also her mother) as a child on Oahu.

Tomorrow's workshop is Abbott's ninth, which she has put on every two years, since starting on Guam in 1984.

The workshops have focused on classifying seaweeds, Abbott said. But they are also intended to train younger scientists and to find seaweeds with commercial uses.

People have been finding uses for seaweeds for at least 10,000 years, the age of seaweed found in a Japanese archaeological site, McDermid said.

The Chinese used it as a flavor enhancer in 2000 B.C., and Romans were using it as fertilizer in 300 A.D.

Perhaps the first seaweed extract was agar, a substance with an Indonesian name although it probably originated in China, McDermid said.

A new extract, alginate, was discovered in 1880. A third, carrageenin, came into use in the 1940s.

The extracts make food stick together without adding calories. When McDonald's took the fat out of beef to make McLean burgers, they added carrageenin to keep patties from falling apart, McDermid said.

Chocolate used to settle to the bottom of chocolate milk until carrageenin was added.

Seaweed extracts by themselves cannot be digested by humans.

Some seaweed, such as nori, used to make sushi, is farmed, but much is still harvested from the sea.

How much stress this is putting on wild species is not clear. In 1993, alginate use was growing 10 percent to 30 percent per year. When McDermid visited Nha Trang, Vietnam, she found reefs with absolutely no seaweed because it was all harvested for food.

In Hawaii, limu manaua, better known by the Japanese name ogo, was once common. Now it is only found in secret places, McDermid said. It is also farmed.

The Legislature has responded by making it illegal to take the "holdfasts" of male ogo or to take any female ogo, the ones with the red bumps.

Thompson, R. (2002, May 21). Seaweed group explores ocean of possibilities.
Honolulu Star-Bulletin, pp. A5.

Posted on: Sunday, June 2, 2002, A27

Kailua waterways cleanup may be coming

By Eloise Aguiar
Advertiser Windward O'ahu Writer

KAILUA — Ka'elepulu Pond in Enchanted Lake serves as something of a natural air-conditioner for nearby homes. The wind blows across the pond, generating a cooling breeze. But when the water is low and the pond's bottom exposed, that breeze can carry a foul odor.

For decades, residents of the area have complained that the waterways in Kailua, including the marsh, canals, streams and pond, are polluted from silt, runoff, animal waste and human activities.

Now the Kailua Bay Advisory Council is preparing to set priorities for water quality problems and solutions that could lead to cleanup projects in Kailua waterways. Advisory council director Maile Bay said the group is seeking the views of people who hold a stake in the outcome.

"We've long needed a comprehensive plan to look at all the waterways in Kailua as an integrated whole," said Jan Cook, who has led a cleanup of noxious weeds in Ka'elepulu Pond. "It's all one system. What affects one part affects the whole."

That is borne out by reports received by the advisory council.

"Simplistically, all of our technical reports came back and said: Dredge the pond and (re)connect the (broken) waterways to each other," Bay said.

But the council wants to see what the community will propose.

Bay said that before the area was developed, water flowed from Maunawili, through Kawainui Marsh, across the land and out toward the Ka'elepulu pond and stream.

Then people built businesses and homes and tried to prevent flooding. But they ended up creating pools of standing water around them, such as the pond and the canal between Coconut Grove and the marsh.

In Ka'elepulu, one problem is the siltation that piles up around the bird sanctuary, Cook said. The pond's stream flows out to sea at Kailua Beach Park, but the outlet is often blocked by sand buildup, and some water tests there have shown high bacterial counts.

High bacterial count is among the waterway issues that the stakeholder group will examine. The others are high nutrient concentrations, excessive turbidity and stream-side litter and debris.

The waterways under consideration are Kailua Bay, Kawainui Marsh, Ka'elepulu Pond, and the associated streams and canals.

The Kailua Bay Advisory Council has \$3.1 million to put toward the problems. That isn't enough to resolve all problems, but with the priority list the group can seek more money, Bay said.

The council was formed in 1995 as a result of lawsuits filed against the city for wastewater violations. Its goals are to oversee volunteer water quality monitoring, study nonpoint sources of pollution in Kailua, Kane'ohe and Waimanalo, determine how to resolve the problems and oversee any mitigation measures.

Under a contract with the advisory council, Tetra Tech EM Inc., an environmental consulting firm, will compile a list of potential members for the Advisory Stakeholder Group for the Kailua Waterways Improvement Program.

"The project goal is to make sure we can come up with a cleanup plan that the community can accept and support," said Jason Brodersen, project manager. "But my primary emphasis is to ensure the stakeholder group represents the community."

Bob Bourke, a marine biologist who tried to help solve an odor problem in the pond several years ago, said residents familiar with the history of the waterways should get involved. Knowledge and experience that people bring to the table and how well they work together will affect the program's success.

"The science will tell you exactly what the problem is," Bourke said. "How you go about solving it is more in the realm of political and social. That's where the real difficulties are and that is why it's extremely important that a broad sector of the community participates."

Aguiar, E. (2002, June 2). Kailua waterways cleanup may be coming. *Honolulu Advertiser*, p. A27

Posted on: Monday, June 3, 2002, B1.

Nature contributes to bad air in Hawai'i

By Jan TenBruggencate
Advertiser Columnist

We don't have much smog in the Islands, but that doesn't mean Hawai'i is easy on the lungs.

Honolulu doesn't even turn up in the American Lung Association's list of cities with serious air pollution.

The state gets an A grade on the group's state-by-state review of ozone pollution, which is associated with the burning of fossil fuels.

A lot of the air pollution we do have is naturally caused. For those who are at risk for problems with the air they breathe, that can still be dangerous.

The lung association estimates the at-risk groups in Hawai'i include 203,000 kids age 14 and under, 139,000 elderly, 69,000 with asthma, 34,000 with chronic bronchitis and 12,000 with emphysema.

The acrid volcanic haze known as vog causes serious problems for some folks.

Nobody's figured out how to convince Kilauea volcano to stop producing the stuff.

In the wet winter time, molds can be a problem for many people. In the dry summer, dust becomes an issue. Spores and pollen can be threats for those with specific allergies.

Going indoors might not be a solution, either. There have been several reports in the Islands of in-building air problems. Sometimes, it's called "sick building syndrome."

In the home, allergens like pet dander, dust and mold are threats. And in homes that have been sealed and air-conditioned, many residents are worried about trapped toxic agents that may be released by their freshly painted walls, treated wood products, carpets, furniture and bedding.

The clean environment publication, "The Green Guide," suggests residents pay close attention to what they're putting into their environments when they are remodeling, repainting or building new.

"Nothing looks fresher than a newly painted wall. Paradoxically, few household products match conventional paint's toxic sheen of chemicals," the publication says in its May/June 2002 issue.

The guide doesn't say to not paint, but rather to pick your paints carefully and to ventilate painted areas well for a couple of days before moving back in.

One of the recommendations in the issue is the use of indoor plants to help clear the air.

Some plants can reduce carbon dioxide as well as reduce volatile organic compounds in indoor air, the report says. It suggests checking the New York Botanical Garden Web site for more information.

It lists a number of hardy indoor plants, including ferns, figs, palms and other plants, that will do the job.

TenBruggencate, J. (2002, June 3). Nature contributes to bad air in Hawai'i. *Honolulu Advertiser*, p. B1.

Posted on: Thursday, June 6, 2002, A9

Oceanic curiosities in new exhibit

By Shayna Coleon
Advertiser Staff Writer

A 167-pound clam and a family of jellyfish that gracefully dip and sway around each other are part of a new gallery opening today at the Waikiki Aquarium.

After nine months of renovation, the new gallery is the showcase for an interactive computer display and some of the most exotic and diverse sea life from the South and West Pacific.

"Gallery I: South Pacific Marine Life Communities" has more than 145 marine and coral species from places like Tahiti and the Republic of Palau.

For the first time, aquarium visitors can use a touch-screen computer to identify any fish and marine life in the exhibit.

"We're really pleased to see it all come together," said Cindy Hunter, the aquarium's interim director. "The exhibit was basically built to show how intrinsically beautiful and valuable the shorelines and coral reefs of the South and West Pacific are, and also to bring awareness that they are under constant threat from coastal construction and fishing."

The coral reefs of the south and west Pacific Ocean contain the greatest diversity of marine life on Earth — more than 5,000 species of fish and 500 coral species have been found from these rich marine communities, Hunter said.

"Visitors will be able to see a lot more animal life by coming to the new exhibit than if they simply went out and did a reef walk," said Alan Nelson, a aquarium biologist.

"The exhibit is more encompassing, and you must also remember that a lot of the marine life in the gallery is not found in Hawaiian waters because they are from the South Pacific," he said.

Renovations to the gallery cost more than \$500,000. Separate viewing windows allow visitors to explore a typical South Pacific shoreline; reef relationships between sea anemones and anemone fishes; a lagoon coral community; and lagoon drifters, the transparent jellyfish that glow against black lights.

"With anything that deals with a living animal, we at the aquarium really understand and hope that these new conditions will provide the stability that these animals need to thrive," Hunter said. "That is why we make sure that we are providing excellent standards."

A fifth exhibit, the largest in the gallery, contains a barrier reef with a 15-foot long and 6-foot high viewing window that holds about 5,000 gallons of salt water, said aquarium biologist Charles Delbeek, who created gallery's barrier reef.

Delbeek, an avid deep-sea diver who has explored the waters around the Solomon and Marshall islands, said that the gallery's barrier reef accurately mimics the real thing.

"We also have two, 250-gallon tanks that simulate surges in the reef," Delbeek said. "These tanks release fresh water into the tank every couple of minutes, while evacuating some of the air."

The fish in the South Pacific gallery were either bought from private collectors or were already part of the aquarium's collection for years, Delbeek said.

"The coral, however, all grew here at the aquarium and started around this size," Delbeek said as he held up his pointer finger.

The gigantic clam was the size of a man's fist when it arrived at the aquarium 20 years ago. Over the years, Delbeek said, many have asked him what the clam would taste like.

"I just tell them it would taste like an old leather boot," said Delbeek, laughing as he inched toward the giant clam as if warding off tempted visitors.

This newest gallery is an addition to three others.

The money for the renovation came from sponsored gifts from the Harold K.L. Castle Foundation, Friends of the Waikiki Aquarium and individual contributors.

Administered by the University of Hawai'i, the Waikiki Aquarium is the third oldest public aquarium in the United States, and is home to more than 2,000 animals representing 400 species of Hawai'i and the Pacific.

Coleon, S. (2002, June 6). New Waikiki Aquarium gallery showcases exotic Pacific sea life. *Honolulu Advertiser*, p. A9.

Posted On: March 21, 2002, B1.

Limu species targeted for eradication

By James Gonser,
ADVERTISER URBAN HONOLULU WRITER

A group of university professors, scientists and the state are joining forces to eradicate an aggressive alien species of seaweed that has taken over a quarter-mile stretch of reef along the coastline fronting the Waikiki Natatorium, though they are not sure how to do it.

Gracilaria salicornia, a reddish limu, was planted here by researchers in the 1960s and '70s to foster commercial development of the alga for food products and medical research, but that industry never materialized and the seaweed is now pushing out corals and native algae on which Hawai'i's marine communities depend for food and shelter.

The seaweed grows into a thick mat, covering the reef and blocking sunlight, which kills the reef. Among the ideas for getting rid of the alien seaweed are removing it and replanting native species such as ogo, or using high-powered hoses to wash it off the reefs.

Smith said there are no nurseries growing native seaweed stock to replant on the reefs.

In California, \$4 million was spent last year to eliminate a similar seaweed by using bleach as poison.

"Their response was like to an oil spill," Smith said. "Our problem is worse and we can't use the same type of measures."

Bleach would kill everything on the reef, not just the seaweed, Smith said.

Using poison in the Mediterranean Sea has failed to remedy an alga problem there; the alga always comes back. The U.S. Environmental Protection Agency has spent millions of dollars studying a different type of floating alga causing problems along West Maui that has been detrimental to tourism. No solution has been found.

Left unchecked, this alga could come to dominate the entire Waikiki ecosystem on both sides of Diamond Head, threatening the ocean environment, said University of Hawai'i botany professor Celia Smith in announcing the joint effort yesterday in Waikiki.

"There are 500 species of seaweed statewide in competition with this aggressive alien species and it's winning," Smith said. "We need to create a greater level of awareness that we have a substantial problem and start a conservation effort."

UH, the state Department of Land and Natural Resources and the Hawai'i Coral Reef Initiative are looking for a way to rid Waikiki and Kane'ohe Bay of alien limu, including *Gracilaria salicornia*, and are seeking federal grants to pay for the effort.

Lyman Higa, a retired postal worker, swims at the natatorium several times a week and wants to make sure the water remains safe for swimmers.

"I don't want to see poison in the water," Higa said.

Gonser, J. (2002, March 21). Limu species targeted for eradication. *The Honolulu Advertiser*, pp. B1.

Current Issues: MIDWAY

Cole, W. (2002, June 6). Midway a place of history, heroes. *Honolulu Advertiser*, pp. A1, A2.

Manson, C. (2002, May 31). Remembering Midway Atoll. *Honolulu Advertiser*, p.18.

TenBruggencate, J. (2002, May 24). Ceremonies to mark 60th anniversary of Battle of Midway. *Honolulu Advertiser*, pp. B4.

TenBruggencate, J. (2002, May 12). Conflicts sink Midway venture. *Honolulu Advertiser*, pp. A23, A30.

TenBruggencate, J. (2002, April 30). New firm to manage Midway Atoll services. *Honolulu Advertiser*, pp. B1.

TenBruggencate, J. (2002, February 2). Service cuts at Midway raise protest. *The Honolulu Advertiser*, pp. A1, A7.

Posted On: February 2, 2002, A1, A7.

Service Cuts at Midway Atoll Raise Protests

By: Jan TenBruggencate

Midway Phoenix Corp.'s announcement that it will stop providing airport, utility and tourism services on Midway Atoll has raised a firestorm of criticism – most of it aimed not at Midway Phoenix but at the U.S. Fish and Wildlife Service.

Many appear to fear that the company's departure will mean the end of public access to Midway. The Fish and Wildlife Service, however, insists that it is committed to continued public use of the site.

The agency will find another operator or multiple operators to run facilities if Midway Phoenix leaves, but the company has not said it is pulling out, said Rob Shallenberger, deputy project leader for the Hawaiian and Pacific Islands National Wildlife Refuge Complex.

Midway Phoenix executive vice president Bob Tracey said the company has stopped flights to the atoll, is no longer accepting reservations for visitors and "we're demobilizing our operation as we speak."

He said the company hasn't had time to send a formal letter of withdrawal.

However, Tracey also said the company would like to stay but under different circumstances – perhaps with government stipend to help cover its losses, or in partnership with a different government agency [other] the Fish and Wildlife Service.

He said the company concluded that it cannot recoup its investment in running Midway under the restrictions that the fish and Wildlife Service places on it. The service is so committed to its views of conservation that it does not concede the needs of a commercial operator, he said.

Among the complaints: Fish and Wildlife Service officials have chopped down scenic trees, limited visitors' access to many areas and ordered Midway Phoenix to deny landing rights at times to planes seeking to refuel, from which the company makes a profit.

"Unfortunately, we're dealing with the wrong agency," he said.

Ultimately, another Department of Interior agency, such as the National Park Service, would have been a better partner, Tracey said, since it has more experience dealing with private business entities.

Midway, an atoll near the end of the Northwestern Hawaiian Islands, lies 1,200 miles northwest of Honolulu. It has a firm place in military history – the battle that turned the

tide of World War II in the Pacific occurred around it. It continued as a Navy base through the mid-1990s, and tens of thousands of military personnel and contractors have stayed there. Many developed a deep love for the place, and have returned as visitors during the past five years.

It also has a long history as a wildlife refuge. The other Northwestern Hawaiian Islands were designated a seabird refuge in 1903 by President Theodore Roosevelt, but Roosevelt turned over Midway to the Navy. Despite a century of human activity, it remained dense with nesting seabirds, and was regularly visited by seals and turtles. When the Navy had no more use for it, the Fish and Wildlife Service took over.

In an unusual step, the service invited a contractor to manage the old military base, run its airport and establish an eco-tourist and history tour center, partly as a way to defray its expenses in managing such a remote site.

Midway Phoenix has been the contractor for more than five years. It said it has sunk nearly \$20 million into the island and now does not believe it can make a profit there, given the service's aggressive conservation stances.

The service makes no apologies for its efforts at preservation, which it sees as its mission.

A point of contention is trees. Tracey concedes that early photographs of the island show no trees at all, and that imported trees were planted by the Navy for both shade and to retain eroding sand.

Most people who have visited the island during the past half century have known a Midway thick with trees, and many are appalled by the Fish and Wildlife Service's removal of all the trees from eastern Island, one of the two largest islands with Midway Atoll, and the removal of a small portion of the trees on Sand Island, where human activity is centered.

"This (Eastern) was the island from which the bombers and fighter planes flew from in World War II," said Michael Dension, who worked on Midway as a contractor in 1940 and 1941. "It is one of the very few places belong to the United States that a battle was waged from during that war. Now it is naked."

Bob Wilson, a Midway Phoenix employee and the harbormaster at Midway, said: "There is a map showing the areas of priority for tree removal on Sand Island (the only inhabited island in the atoll), with the stated intention to have all trees removed in 15 years."

Shallenberger said his staff has removed about 10 percent of the ironwood trees on Sand Island, and plans to cut down the trees from another one or two coastal acres, to provide additional habitat for black-footed albatross, a species whose numbers are declining. He said the service does not intend to remove all the trees, and said some species on Sand Island, notably terns, have begun using ironwood trees for nesting habitat.

But the service is also actively planting. The trees being removed are mostly introduced ironwoods. The service wants Midway revegetated with native species, most of which are much lower-growing than ironwoods. “Naked” Eastern Island is in the intermediate stage between ironwood removal and a new growth of native coastal plants, said the Fish and Wildlife services public information officer Barbara Maxfield.

Wilson said he believes Fish and Wildlife Service officials ultimately want all humans off the Northwestern Hawaiians Islands so the agency’s personnel can have the islands to themselves.

“These ‘island paradises’ are entirely supported by tax dollars, but the various agencies are quite reluctant to have any ‘outsiders’ see how they spend the monies supplied by taxpayers,” Wilson said.

Guy Haggard, a Florida resident who once lived on Midway, agrees: “My opinion is that the real aim of FWS is eliminate any evidence of man on Midway.”

Maxfield said that perception is incorrect.

“We saw it as a unique opportunity to experience a remote island wildlife spectacle and a historical treasure,” she said. “We were convinced it could be done, and I don’t think we’ve changed our minds on that.”

TenBruggencate, J. (2002, February 2). Service cuts at Midway raise protest. *The Honolulu Advertiser*, pp. A1, A7.

Posted on: Tuesday, April 30, 2002, B1

New firm to manage Midway Atoll services

By Jan TenBruggencate
Advertiser Science Writer

The U.S. Fish and Wildlife Service has hired a Portland, Ore., engineering firm to keep the utilities working and the airport open on Midway Atoll when its longtime contractor, Midway Phoenix, leaves tomorrow.

The six-month, \$1.27 million contract with GeoEngineers does not call for the company to operate tourism facilities. The service hopes by the end of the term to have located a contractor that will provide long-term services, including both the operation of facilities and tourism.

"Although we are not in a position at this time to reopen our doors to visitors, we hope to be able to do so in the future," said Craig Manson, assistant secretary of the Department of Interior for Fish and Wildlife and Parks.

He said the Fish and Wildlife Service is working with the Navy to arrange a special event in early June to celebrate the 60th anniversary of the Battle of Midway.

The Navy turned over Midway to the Fish and Wildlife Service in the mid-1990s to run it as a wildlife refuge. The service hired a contractor, Midway Phoenix, to keep the old Navy base operating, but now as a site for limited tourism. People came for fishing, viewing seabirds and other wildlife, and to pay homage to the atoll's military history.

But visitor numbers did not meet expectations. After five years, Midway Phoenix said it was pulling out, saying federal restrictions prevented it from recovering its investment.

One of the reasons the Fish and Wildlife Service sought a commercial operator was to defray the costs of running the refuge. Midway is 1,200 miles from the main islands and requires constant maintenance to keep the airport operational and water and power systems running. Without the airport, all access would be via long open-ocean ship voyages.

Manson said the service has not determined just what form the atoll operation will take. He said the agency hopes to have decided how to proceed, and to have selected a long-term operator by Nov. 1, when the GeoEngineers contract ends.

GeoEngineers has 200 employees and specializes in engineering and environmental science work.

TenBruggencate, J. (2002, April 30). New firm to manage Midway Atoll services.
Honolulu Advertiser, pp. B1.

Posted on: Sunday, May 12, 2002, A23, A30

Conflicts sink Midway tourism venture

By Jan TenBruggencate
Advertiser Science Writer

Months after contractor Midway Phoenix Corp. and the U.S. Fish and Wildlife Service agreed to walk away from an arrangement that brought 2,000 tourists a year to Midway Atoll, the hard feelings persist.

Midway Phoenix's last employees left Midway at the end of April, more than five years after the firm took over management of the refuge that is rich in wildlife and World War II history.

The remote area 1,300 miles northwest of Hawai'i is a wonderland of fish, coral reefs and seabirds. The atoll is where U.S. forces turned the tide against Japan in the war in the Pacific.

A new contractor is keeping the power on and the water purifiers operating pending a decision by the Fish and Wildlife Service on future management.

The agency insists it plans to reopen the atoll to visitors of all kinds. Midway Phoenix representatives say they doubt anyone but biologists and college students on research trips will be welcome.

Company officials say the Fish and Wildlife Service never wanted the kind of ecotourism it signed up for with Midway Phoenix in 1996.

"I just can't see us sitting back and having the Fish and Wildlife Service carry on with this charade, this smoke and mirrors," said Bob Tracey, executive vice president of Midway Phoenix. "Why weren't they actively engaged as our partner?"

The Fish and Wildlife Service found Midway Phoenix to be a difficult partner that failed to pay bills and "failed to address operational deficiencies," said Hugh Vickery, a spokesman for the U.S. Department of the Interior in Washington.

Despite the rancor between the contractor and the wildlife service, the future will see restored public access to Midway, both for its military history and its wildlife, said Craig Manson, assistant secretary of the Interior for Fish and Wildlife and Parks. He is an Air Force veteran and a colonel in the Air National Guard.

"We are committed to preserving the military heritage of Midway as well as the wildlife values. I don't think those are incompatible," Manson said. "There will be public access to Midway."

The Fish and Wildlife Service proposed a grand experiment when it took over Midway from the Navy. For the first time, it would try to conduct a major commercial tourism enterprise within a wildlife refuge.

It selected Midway Phoenix, a subsidiary of defense contractor Phoenix Air, to run the Midway airport and harbor, to keep the power and water systems operating, and to conduct an ecotourism operation that allowed tourists to stay in restored barracks while visiting the site of the Battle of Midway and a remote coral atoll where millions of seabirds nest.

In exchange for keeping the facilities on Midway functioning at no cost to the government, the company was allowed to keep its profits from its ecotourism business and airport operations.

Tracey said it started out well, but the contractor soon determined that those in charge did not really support the concept of commercial activities at the refuge.

"We tried our hardest to make it work, but we didn't get a fair shake," he said. "They wouldn't allow us to have revenue streams."

Vickery said his review of the documents in the Midway file suggests the service bent over backward to accommodate Midway Phoenix, within the overall mission of protecting the ecosystem.

"They claim that additional restrictions were put on them that made it unprofitable," he said. "The restrictions were clearly spelled out in the (original) agreement. If anything, we eased up on them."

An example: Midway Phoenix arranged to have cruise ships stop at Midway, providing a lot of people who would pay to take tours of the island.

The company said the Fish and Wildlife Service so restricted the visits that they couldn't be made to work. The biggest ships were required to anchor outside the lagoon and bring visitors to shore in small groups. Without being able to dock at the harbor, ship operators decided it wasn't worth the trouble.

Vickery said the service allowed smaller cruise ships in, but concluded the big ones were too much of a risk because of their deep draft.

"Allowing cruise ships was a concession from the original agreement to allow them to make some money," he said. "But the big ones are too deep for the lagoon, and they were not allowed in for safety reasons."

Don Pressnell, the last Midway Phoenix island manager, said he was repeatedly prevented from doing things that were needed to make the island profitable for the company.

"It was not a partnership. It was a partnership they wanted out of," he said.

Midway Phoenix operated the atoll for more than five years, and by the end of that time, both sides wanted out, Vickery said. One major issue was fuel. Honolulu is the closest port, and fuel is needed to run all Midway's systems.

A \$2 million congressional appropriation gave the island a one-time fill-up. Midway Phoenix and the Fish and Wildlife Service still disagree on how the fuel was to be handled. The company says it used some of the fuel to run generators and pumps, but that it also sold fuel to passing ships and planes, often at a profit.

"We viewed that as a subsidy," Tracey said. "We paid the government back by running a free airport for the Commerce Department, for the Coast Guard ... Every nickel we ever made on that island we reinvested into salaries, the doctor, maintaining (buildings and equipment), termite protection. We built a million-dollar French restaurant."

Vickery said the fuel supply was a one-time deal and that the Fish and Wildlife Service was expecting to collect money from fuel sales and to use the money to buy more fuel.

"The concern was that Midway Phoenix was draining the tanks and not repaying for it. We, the government, needed fuel out there," Vickery said.

Tracey countered that the Fish and Wildlife Service was not paying the company back for many of the services it provided, including telecommunications. Ultimately, the service and the company sat down and on March 6 of this year signed a "no-cost settlement agreement" in which both sides dropped any financial claims.

"The sides were talking a few million dollars each. Both sides would incur tremendous costs (litigating the issue). We felt the best thing to do was to shake hands and each side goes home," Vickery said.

That might have been the end of it, but Tracey said he became angry when he found out that the agency had hired another company, GeoEngineers of Oregon, to keep the power and water systems running on Midway for six months for a fee of \$1.3 million. With that kind of money as a subsidy, Midway Phoenix could have kept running a full-scale ecotourism operation for a year, he said.

Instead, there are just 13 people on the island, and the Fish and Wildlife Service is paying a great deal of money for what is essentially a "base camp," he said.

"This is more than insulting to us and our company and the 150 people who lost their jobs," Tracey said.

The old military airport, which Midway Phoenix kept open as a certified field, has now lost its FAA certification.

"It's closed," FAA Pacific representative Tweet Coleman said. "None of the navigational aids work. They've been depowered. There's no fuel. There's nobody there with GeoEngineers with airport knowledge."

Trans-Pacific twin-engine aircraft are required to have a mid-flight emergency landing base. With Midway gone, they've had to change their flight paths farther to the southwest to keep Wake Island as their emergency site.

"The Japanese airlines are impacted the most," Coleman said.

The Coast Guard is limited by the lack of fuel availability in its ability to conduct long-range search-and-rescue and law enforcement flights in the mid-Pacific.

"I think we could still land there, but it would limit the area that we could cover," said Capt. Jim Angert, chief of the Search and Rescue Branch of the U.S. Coast Guard in Honolulu.

Vickery said the Fish and Wildlife Service is working hard to find a way to get the airport reopened, but there is no timetable for it.

"Everybody lost on this deal," Tracey said.

On that, both sides could agree.

TenBruggencate, J. (2002, May 12). Conflicts sink Midway venture. *Honolulu Advertiser*, pp. A23, A30.

Posted on: Friday, May 24, 2002, B4.

Ceremonies to mark 60th anniversary of Battle of Midway

By Jan TenBruggencate
Advertiser Science Writer

The Fish and Wildlife Service plans to have the Midway Atoll airport open and to fly in dignitaries June 5 for the 60th anniversary of the Battle of Midway, which was a turning point in World War II's War in the Pacific.

Among those scheduled to participate are Assistant Navy Secretary H.T. Johnson, Rear Adm. Anthony L. Winns and Craig Manson, assistant secretary of the Interior for fish and wildlife and parks, along with other senior military officials and representatives of veterans groups. They are expected to fly aboard a chartered Aloha Airlines jet.

The Fish and Wildlife Service, which manages the atoll as a wildlife refuge, will also hold a reception for Midway veterans June 3 at the Hale Koa Hotel in Honolulu.

Public access to Midway has been halted since the Fish and Wildlife Service's contractor, Midway Phoenix, withdrew from managing the island's utilities and its ecotourism operation. With its withdrawal, the FAA removed the Midway airport's certificate.

Another contractor is keeping the island operating under a six-month, \$1.3 million contract, and the service is seeking another operator. The Fish and Wildlife Service expects within a few days to announce details of the reopening of the airport.

"The Department of the Interior is fully committed to restoring public access to Midway. ... We are working to reopen the island as quickly as possible so that veterans, birders and the general public once again can have the opportunity to experience the significant historic and wildlife resources so abundant on this atoll in the middle of the Pacific," Manson said.

Meanwhile, in Washington, Rep. John J. Duncan, R-Tenn., introduced a resolution this week calling for the Interior Department to take management away from the Fish and Wildlife Service and give it to another Interior agency.

Duncan said the service appears to be too concerned about wildlife and not sufficiently committed to the history of the place. The atoll in 2000 was designated by Congress the Battle of Midway National Memorial.

"Unfortunately, the Fish and Wildlife Service has not been able to effectively manage this unique wildlife refuge that is also home of the national Midway memorial," he said.

Don Walker, a member of Duncan's staff, said that the National Park Service or the Bureau of Land Management are possible alternative agencies.

Manson, an Air Force officer who oversees both the Fish and Wildlife Service and the National Park Service within the Department of the Interior, said the Interior secretary is being advised by a group of veterans and others on how to manage the Battle of Midway National Memorial.

TenBruggencate, J. (2002, May 24). Ceremonies to mark 60th anniversary of Battle of Midway. *Honolulu Advertiser*, pp. B4.

Posted on: Friday, May 31, 2002, A18.

Remembering Midway Atoll

Craig Manson is assistant secretary of the interior for fish, wildlife and parks.
Island Voices

The morning Japan attacked Pearl Harbor, two Japanese destroyers shelled a tiny atoll 1,200 miles northwest of Hawai'i defended by a small detachment of Marines.

One of the shells penetrated a command post manned by Lt. George Cannon, damaging the post and crushing his pelvis. Cannon refused medical treatment until he could restore communications from his command post. The delay cost him his life. For his heroism in defending Midway Atoll, he became the first Marine to receive the Congressional Medal of Honor in World War II.

Seven months later, the Japanese again attacked Midway as part of a planned invasion in what would turn out to be one of the pivotal naval battles of American history. More than 300 Americans gave their lives in this battle, which turned the tide of the war in Pacific.

On June 5, Assistant Secretary of the Navy H.T. Johnson and I will join veterans on Midway to commemorate the 60th anniversary of the battle.

Many buildings, bunkers and other original World War II facilities have been restored or protected by the U.S. Fish and Wildlife Service, which now manages the atoll as a national wildlife refuge. As part of the ceremony, we will lay a wreath in honor of Lt. Cannon and the thousands of Americans who fought so bravely.

We will not be alone. Around the world, naval officers and sailors will hold events in honor of those who fought at Midway. Here in Honolulu, veterans are gathering today for an annual symposium hosted by the International Midway Memorial Foundation. The Fish and Wildlife Service also will hold a reception in their honor next week.

Midway is remembered for more than its World War II history, however. The atoll was the last link in a global telegraph system, inaugurated by a message from President Teddy Roosevelt on the Fourth of July, 1903. It was a prominent landing site for Pan Am Clippers en route across the Pacific Ocean in the late 1930s. In the years after World War II, the naval air facility on the atoll played a pivotal role in support of the Korean War, the Cold War and the Vietnam War.

The atoll also is a stunning example of a Pacific island ecosystem and home to 2 million birds, including the world's largest population of Laysan albatross, or "gooney birds." Endangered Hawaiian monk seals, green sea turtles and spinner dolphins ply the waters of its lagoon.

Thousands of veterans, bird watchers and others with an interest in the historical significance and natural treasures of the atoll have visited it since it was opened to the public five years ago. The Fish and Wildlife Service has worked hard to provide visitors access while still protecting the atoll, its wildlife and historic sites. We remain committed to this mission and believe both can be done in responsible and meaningful ways.

Unfortunately, the unexpected departure of the tour operator caused visitor access to be temporarily suspended in January. I have made restoring this access one of my highest priorities. Meanwhile, the Fish and Wildlife Service has hired a contractor to maintain the visitor facilities and airport in anticipation of negotiating an agreement with a new tour operator.

Americans deserve the opportunity to visit Midway and enjoy its rich history and abundant wildlife. I am confident we will provide that opportunity once again.

In the meantime, let us take the opportunity of the 60th anniversary of the Battle of Midway to honor those who made the ultimate sacrifice for our freedom.

Manson, C. (2002, May 31). Remembering Midway Atoll. *Honolulu Advertiser*, p.18.

Posted on: Thursday, June 6, 2002, A1, A2

Midway: A place of history, heroes

By [William Cole](#)

Advertiser Military Writer

MIDWAY ATOLL — Sixty years ago, with 107 Japanese warplanes raining bombs and bullets on this atoll, Frank Tompkins had no way of knowing he was helping to turn the tide of World War II.

What the U.S. Marine and 37 mm anti-aircraft gunner did know was that a large-scale Japanese air attack was under way, and that sandbags on the beach were all that separated him from a world of trouble.

"We were close to the reef. Our planes were coming in and were out of ammo," the 85-year-old Tompkins said. "The Zeros were waiting to pounce on them."

One American flier winged low over the reef with a Zero behind — hoping Tompkins' gun would find the pursuer.

"We fired right in between the two," the California man said, adding that later, his crew was able to shoot down a Japanese plane.

The night before, his sergeant said, "Men, get a good night's sleep, it'll probably be your last."

Radar had picked up the invading force when it was 100 miles out.

The Marine, then 25, was hoping an outgunned U.S. armada lying in wait 390 miles northeast of Midway would be his salvation.

Luckily, for Tompkins and the United States, it was.

June 4-6, 1942, in a battle that historian Walter Lord said logistically it "had no right to win," the U.S. Pacific Fleet used advance knowledge of the attack on Midway to sink four Japanese aircraft carriers and stem further attacks on Midway.

Six months after the demoralizing Japanese attack at Pearl Harbor on Dec. 7, 1941, the Battle of Midway dealt the Imperial Navy a crippling blow from which it never recovered.

Yesterday, amid tall ironwoods and thousands of Laysan albatross that military people still call "gooney birds," the 60th anniversary of that crucial victory was marked with a visit to Midway by more than two dozen World War II veterans, and Navy and U.S. Fish and Wildlife Service officials.

For this anniversary, some of the aging veterans arrived with wheel chairs and walkers, and children and grandchildren.

"When we listen to the stories of the real heroes of the Battle of Midway, the same heroes have been a part of our American history since day one — but Midway brought it all together and gave us an excellent example ... of how uncommon folks can rise to meet the situation when it comes," said Assistant Secretary of the Navy Hansford T. Johnson.

Rear Adm. Anthony L. Winns, commander of the Pacific Fleet's patrol and reconnaissance force, said the Japanese plan to lure the Pacific Fleet by attacking Midway was a good one, but one "that didn't take into account the war-fighting spirit and heroism of our great U.S. Navy — sailors whose names have been immortalized ... like Admirals Nimitz, Spruance, Fletcher."

When the sea battle was over, 307 Americans were dead, and the aircraft carrier Yorktown was lost.

Japanese "Kate," "Val," and Zero warplanes struck Midway for 17 minutes, destroying almost every building on Eastern Island — one of two major islands comprising the atoll.

Forty-nine Marines died and 53 were wounded. But the Japanese lost far more: 2,500 men, 100 fighter pilots, more than 300 aircraft, and the carriers Kaga, Soryu, Akagi and Hiryu — the same carriers that attacked Pearl Harbor.

The naval air facility at Midway was closed in the early 1990s, and the atoll was turned over to the federal Interior Department in 1996.

The Fish and Wildlife Service has held Battle of Midway commemorations every year — but usually in Honolulu, said Pacific region spokeswoman Joan Jewett.

"This year is important because it's the 60th, and it may be the last time on a significant anniversary that there are veterans able to participate," she said.

Today, Midway is a mix of ecology and history.

Its combined 1,550 acres support the largest Laysan albatross colony in the world, 15 other species of migratory seabirds and four species of migratory shorebirds. Endangered Hawaiian monk seals and threatened green sea turtles are found in its waters.

But it retains the scars of Japanese attacks.

The Japanese had hoped to entrap the Pacific Fleet at Midway and use the tiny outpost 1,300 miles from Honolulu as a forward-operating base.

But code-breakers working at Pearl Harbor had cracked the Japanese Navy 25, or JN-25 code, and Nimitz ordered the carriers Enterprise, Hornet and Yorktown — patched up at Pearl Harbor after receiving bomb damage in the Battle of the Coral Sea — to lie in wait 390 miles northeast of Midway at a spot designated "Point Luck."

Ralph Brevik of Eugene, Ore., a musician 3rd class who played guitar in a 21-piece band on the Enterprise, didn't know where the carrier was headed.

"It was going to be a big one — that's all they said — that we were going to beat the Japanese fleet," Brevik said.

But it wouldn't be easy.

Fifteen Devastator torpedo bombers from the Hornet's Torpedo Squadron 8 were quickly shot down.

Of 25 Marine fighters taking off from Midway, meanwhile, only eight survived. But masses of following SBD Dauntless dive-bombers found their targets, and in a span of six minutes, three Japanese carriers — the Kaga, Akagi and Soryu — were ablaze.

Bill Tuntstall, 82, who maintained one of the ill-fated Torpedo Squadron 8 aircraft, made the trip to Midway from Portland with his wife, Dorothy. He remembers a radioman 2nd class asking him to take his wallet in case something happened.

"I said, put it back in your pocket, nothing is going to happen to you," Tuntstall said. But the radioman was among those who never returned that day 60 years ago.

"It's a real sentimental type" of experience coming to Midway, Tuntstall said. "I enjoy being out here because I see this memorial that reminds me of some very, very fine people."

Cole, W. (2002, June 6). Midway a place of history, heroes. *Honolulu Advertiser*, pp. A1, A2.

Current Issues: PEOPLE

Hoover, W. (2002, June 5). Shark's Cove fishing ban upsets longtime anglers. *Honolulu Advertiser*, pp. A1, A2.

Bricking, T. (2002, June 6). Canoe club honors master carver. *Honolulu Advertiser*, p. E1.

Tsai, M. (2002, May 26). Colonizers recall wartime survival. *Honolulu Advertiser*, pp. A1, A11.

Markrich, M. (2002, May 5). Planting a future. *Honolulu Advertiser*. pp. B1, B4.

Burlingame, B. (2002, April 28). Boys of The Panala'au. *Honolulu Star-Bulletin*, pp. D1, D6.

Aguiar, E. (2002, April 12). Keiki hooked on old fishing arts. *Honolulu Advertiser*, pp. A1, A12.

Posted On: April 12, 2002, A1, A12.

Keiki hooked on old fishing arts.

Eloise Aguiar
Advertiser Windward O'ahu Writer

Waimanalo – The ocean gives you life, but it can take your life away.

Those are two of the fishing lessons 91 children from Halau Lokahi charter school learned from Waimanalo kupuna Wednesday at a shoreline classroom at Kaiona Beach Park. The children from kindergarten to 11th grade also learned how to mend and throw a net; gut and scale a fish; read the wind and currents; safely pick 'opihi; set up an octopus lure; and paddle a canoe.

The Hawaiian fishing traditions and techniques, accumulated over generations by the members of the Waimanalo Ramp Fisherman Club, flowed freely to the younger generation, many of whom were not Hawaiian.

But the desire to preserve the information has prodded these kupuna, or elders, to find repositories for their skills and wisdom.

“It’s fading away,” said Haywood Kalima, 55, president of the fisherman’s club that organized the lessons and provided lunch. “We want to teach what we know – the knowledge, the culture – so they can go on in life and teach their children.”

The ocean is a big icebox. If you know how to throw a net, you’ll never starve.

The kupuna-teachers, whom the students called uncle and auntie, said it was easy to learn to throw a net. But the children had their doubts until they tried. They concentrated as Uncle Bully Duarte patiently showed them how.

“It’s hard to hold the net up on your body,” said Kalima Watson, 10, who had to grasp one-third of the net in his left hand; place another third under his right armpit and hook it over his right shoulder; and drape the last third over his right knee. He opened the portion that was on his knee and took hold of a lead weight – and the net was ready to throw.

Duarte moved among the groups of students reviewing each step as the children reviewed each step as the children struggled with the nets. He said he’s eager to pass his knowledge to the students.

“All of my kids are on the Mainland,” Duarte said. “I have to teach the kids or all the knowledge will die with me.”

The lessons lasted all day under a blue sky dotted with scattered puffs of clouds and next to a clear ocean of gentle waves that washed upon the shore without breaking.

Besides members of the Ramp Fisherman Club, members of the Waimanalo Canoe Club taught the children. The only other time they taught was last summer, to University of Hawai'i freshmen from the Hawaiian studies class.

Sometimes it was difficult to tell where the lessons ended and the fun began, with children swimming, snorkeling and taking turns in the canoe.

The canoe is like a person who is deserving of respect and aloha. So when you're out in the water, if you take care of the canoe, it will take care of you.

Pomai Grube-Hose, 9, said it was fun to get a canoe moving through teamwork and to learn to clean a fish. Even the teachers are learning, said Grube-Hose, who enjoyed the family-like atmosphere at the beach.

"When we come here, you think this is your real family," she said.

"They take care of us. They bring us in their situation."

At Halau Lokahi, learning is based on traditional Hawaiian values as well as on the Hawai'i Content Standards, said Leimaile Quitevis, in charge of the gifted and talented program at the school located at Palama Settlement. The students will return to the campus and use the computers and the Internet to research similar Western traditions, Quitevis said.

"We're using the beach as a learning environment, a learning center," she said.

Whatever the 'opihi eats, you eat. When you're picking 'opihi, always watch the ocean: It's dangerous and can take your life.

Long after many of the students dashed into the water to play, three to four of them were still focusing their efforts on learning to add eyes to throw-nets, under the supervision of net-maker Uncle Louis Palea.

Kele Anderson, 15, said learning the technique was difficult, but once he caught on, it went faster. Still he said he had to really concentrate to do it right.

Pakea, 58, has told the students about the different parts of the throw-net; the piko, or center; the hula skirt, which traps the fish; and the pu'umana, added eyes that make it possible for the net to open.

Girls usually don't take to the net, Palea said, but several had expressed a keen interest, including Kuupilialoha Akana, 14.

“I never did this before,” Akana said, after spending close to an hour working on the net. “I’m just trying a new thing.”

Aguiar, E. (2002, April 12). Keiki hooked on old fishing arts. *Honolulu Advertiser*, pp. A1, A12.

Posted On: Sunday, April 28, 2002, D1, D6

Boys of The Panala'au

By Burl Burlingame
bburlingame@starbulletin.com

Immediately following the attack on Pearl Harbor on Dec. 7, 1941, the Imperial Navy's submarines RO-13, RO-64 and RO-68 used their deck guns to shoot up "enemy flying-boat installations" on Howland and Baker islands near the equator, south of Hawaii. What they actually shot at were shacks manned by Hawaiian teenagers, there because of a bizarre territorial dispute that had erupted six years earlier.

Pan American Airlines had plans to pioneer air travel across the Pacific, and in 1935 came to an understanding with the U.S. government: It would establish refueling bases on remote atolls for its short-legged flying boats with help from the U.S. Navy. The Navy agreed. The agreement gave it an excuse to establish hegemony over far-flung areas of the Pacific, a concept essential for countering suspected Japanese buildups in the mandated islands.

Bill Miller, director of the Bureau of Air Commerce -- a single desk within the Department of the Interior -- came up with the idea of colonizing uninhabited atolls known as the Equatorial Line Islands, sun-blasted guano heaps called Jarvis, Baker and Howland. The islands had been claimed by the United States according the Guano Act of 1856, and had been steadily mined of bird droppings for 20 years. Phosphates gleaned from the droppings were turned into explosives. Americans abandoned the islands in 1877, and the British briefly inhabited them before they, too, left them to the seabirds.

By the 1930s, both countries were competing for air routes, and the Equatorials, almost halfway between the United States and Australia, once again looked promising. In Hawaii, Miller sprang the colonization idea on Albert Judd, a trustee of Bishop Estate. Judd suggested that boys from Kamehameha Schools would be ideal candidates for settlers.

The Hawaiian background of these boys made them excellent pioneer material, claimed Judd. He pointed out that they were used to hot weather and living off the sea, and were disciplined by years at a private school in which ROTC was a requirement. Miller was sold, and the operation began in 1935.

England got wind of the plan and rushed her own settlers to the islands, using New Zealand as a stand-in. Lt. Harold A. Meyer of the 19th Infantry, who advised Miller on military aspects of the settlement, made the extraordinary step of telephoning Washington directly from Schofield Barracks. In a two-hour phone call, Meyer begged for swift action.

Meyer was placed in charge. Within the day, March 20, 1935, the Coast Guard cutter Itasca was outfitted with supplies and Hawaiian settlers, and raced off for the Equatorials. Lt. Cmdr. Frank Kenner, skipper of Itasca, later recalled that the little cutter never made better speed.

The Hawaiians had no clue as to their destination. Nor did the dozen or so soldiers who accompanied them. They had been told simply that it was a security matter. Despite a scare when the ship spotted another vessel and a brief stop at Palmyra atoll to dig up some palm trees for transplanting, the Hawaiians and the soldiers managed to raise the American flag first on the contested atolls.

Every six months or so thereafter, depending on the availability of Itasca, four boys were deposited on each of the three islands. By the time of the Pearl Harbor attack, some 135 Hawaiian teens had participated in the settlement.

"When we were invited to participate, there was a rush of applicants," recalled Abraham Piianaia, one of the first recruited. "They only wanted graduates, and for boys right out of high school, at the height of the Depression, the \$3 a day they paid was good money." It was more than the salary of the soldiers who were rotated off the islands after a few months, leaving the boys alone.

At first the Hawaiians lived in pup tents, eventually graduating to wooden shacks dubbed "Government Houses," which were open on the sides to let the cool night breezes blow through. All fresh water had to be brought to the islands. The 50-gallon water drums were too heavy to boat to the shore, so each was dumped over the side of the supply ship and allowed to drift ashore. If the drums landed on the wrong side of the island, the boys walked across the island to get a drink. Whenever it rained, open containers on the island were set out.

Jarvis Island, nearly 1,000 miles east of Baker and Howland, had a ghost town still standing, testimony to American and British guano miners of the previous century. A 25-foot-high sign still read "The Pacific Phosphate Company of London and Melbourne." On the beach was the wreck of the barkentine Amaranth, which provided lumber for furniture, shacks and surfboards.

The settlers' main tasks were logging hourly weather reports, clearing land for a runway and servicing a small lighthouse. They also collected wildlife samples for the Bishop Museum of Honolulu. Otherwise, it was very much a Robinson Crusoe existence on the islands, which rose barely a dozen feet above the sea. Responsibility for the project was transferred to the Department of the Interior. Meyer's involvement was remembered in a billboard-sized sign, which declared Baker's few buildings to be the town of "Meyerton." In the opening days of 1937, Howland Island was suddenly taken over by Navy engineers, who put in a short airstrip. The runway was built in anticipation of Amelia Earhart's planned 'round-the-world flight. When Earhart cracked up her Lockheed on the runway at Luke Field in Pearl Harbor, while taking off for Howland, the flight was rescheduled for the summer.

Earhart next tried to fly around the world in the opposite direction. On the leg between Lae, Papua New Guinea, and Howland, her aircraft disappeared, the last radio signals being picked up by Itasca, which had paused along her route to give bearings. Earhart and her aircraft vanished despite a massive Navy search. A shower and private bedroom the Hawaiians had built for Earhart went unused. They grieved for her and built a 20-foot sandstone monument, which they called the Amelia Earhart Lighthouse.

Things were quiet for the next few years, marred only by the death of a colonist in 1938 of peritonitis brought on by appendicitis. Coast Guard cutter Taney traveled 1,310 miles at full speed to save the boy, but arrived too late.

Canton and Enderbury islands were added to the program the same year, and were the subject of an exchange of notes between the United States and Great Britain in 1939, the upshot being an agreement to joint administration for at least 50 years, after which the agreement could be extended indefinitely. Each government was to be represented by an official, and the islands were to be available for communications and airports for international aviation -- but only of American or British-empire airlines.

Similar circumstances prevailed at Christmas Island, under the administration of the British high commissioner of the Pacific, headquartered in Suva, Fiji. America claimed a seaplane base there, as both countries claimed sovereignty based on occupancy. Britain, however, controlled the island from the end of World War I to 1941. Johnston Island, actually a string of islets that were technically part of the Hawaiian Sea Frontier, was under sole jurisdiction of the United States. All the islands were prized solely for their location.

The Kamehameha students serviced the islands' meager facilities, and spent the rest of their days fishing and working on their tans. "Lobster every day, which we ate raw," said Piianaia. "And the island had these big rats, which ate the pili grass. Vegetarians. We used to catch them and roast them for red meat. They were delicious!"

"We were paid our salary in a lump sum when we went back to Honolulu, and it was quite a bit of money. We let our hair and beards grow long; it made us feel like explorers. But as soon as we went home, we hit the barber shop."

At night, the bowl of the universe blazed above the isolated atolls. Falling stars were so bright they'd cast shadows. One night, the waters roiled with hundreds of porpoises, a pod that seemed to stretch to the horizon. Some evenings were reserved for ghost stories, punctuated by the sound of birds crying eerily in the darkness.

There was magic there.

Burlingame, B. (2002, April 28). Boys of The Panala'au. *Honolulu Star-Bulletin*, pp. D1, D6.

Posted on: Sunday, May 26, 2002, A1, A11

Colonizers recall wartime survival

By Michael Tsai
Advertiser Staff Writer

Elvin Mattson remembers it was just after noon, Dec. 8, 1941, when the first Japanese bombs fell on Howland Island.

"We were drying fish," he said.

Mattson and Tom Bederman hit the ground and didn't look up until the bombing stopped 15 minutes later. When they got up, they found comrades Joseph Keli'ihanui and Richard Whaley dying from shrapnel wounds.

"Tom went to get medicine, but they died before he could get back," Mattson said. "We wrapped them in our canvas blankets and buried them in a bomb crater."

The four men were part of a historically significant, if little known, U.S. operation that used young men from Hawai'i to colonize remote desert islands in the equatorial Pacific in the years before World War II.

Yesterday, Mattson joined five other Hawai'i-born colonizers, part of a select group now dubbed Hui Panala'au, at Bishop Museum for the opening of a extraordinary exhibit honoring their contributions.

Also present were James Carroll, Arthur Harris, George Kahanu, Victor Kim and Abraham Piianaia.

"At first there was secrecy (about the operation), then publicity, then the war, and finally a tragic ending," said Noelle Kahanu, project director and granddaughter of George Kahanu.

For seven weeks after the initial bombing, Mattson and Bederman were left to survive on their own on the tiny, deserted island, completely cut off from the rest of the world.

They spent their days on the shore break trying to avoid the shelling of a Japanese submarine and bombing by Japanese aircraft. They survived on a small ration of canned goods, beer, and whatever rain water, fish or birds they could collect with their bare hands.

Mattson and Bederman were eventually rescued by the USS Helm on Jan. 28, 1942. Bederman died two years ago, leaving Mattson as the only survivor of the last Howland party.

In all, some 130 young men — most of them Native Hawaiian — took part in the project from 1935 to 1942.

The project grew out of military and commercial interest in Pacific air routes between Australia and California, and from a desire to assert jurisdiction over three main islands: Baker, Jarvis and Howland.

The U.S. military worked with Bishop Museum and Kamehameha Schools to recruit young men who could survive the rigors of unadorned island life. The men signed on as federal employees and were paid \$3 per day.

The first group included Kamehameha students Henry Ahia, William Kaina, James Kamakaiwi, Killarney Opiopio, Daniel Toomey and Piianaia. They joined 12 enlisted men for the first of a series of expeditions that lasted from March 1935 to March 1936. A second phase began in June 1936 with the U.S. annexation of the three islands.

Piianaia participated in four expeditions and played a crucial role in leading his Hawai'i comrades.

"You could call that first group colonists," said George Kahanu. "But I would call them pioneers.

"They were brave enough to go from the modern age to the dark ages. They were able to go to these places without knowing what was going to happen."

Kahanu was assigned to Jarvis during the second phase of the operation. Thanks to a 1913 shipwreck on the island, the colonizers had enough wood to make a permanent structure. "It was the best island of the three," he said. "The others had nothing."

Life on all of the islands was harsh. Kahanu remembers using seasoning extract to hide the taste of oil and gasoline from the water they drank out of old oil drums.

Harris, who spent two months on Baker, remembers the pounding surf — and sharks grabbing his oars as he tried to row near shore.

"The island was a half-mile by 1 mile and no more than 15 feet above sea level," Harris said. "It's not worth a damn, but at the time it was strategically important because it was so close to the war zone."

Tsai, M. (2002, May 26). Colonizers recall wartime survival. *Honolulu Advertiser*, pp. A1, A11.

Posted on: Sunday, May 5, 2002, B1, B4.

Planting a future

FOCUS • HAWAII'S RURAL LEGACY

By Mike Markrich

Kailua-based writer and researcher

In 1972, Mabel Wilcox was 90 and the unquestioned matriarch of the Wilcox clan, one of Hawaii's leading missionary families. She had grown up on Grove Farm, which in that year was still one of Hawaii's leading sugar plantations.

However, despite her position at the pinnacle of Hawaii's kama'aina social register, the members of the Grove Farm Board of Directors, ignored her wishes. Where she saw something beautiful in agriculture: green fields, pastoral farm life and memories of a lifetime of working the land, they envisioned tract homes, condos and commercial real estate. Where she saw enduring value, they saw a revenue stream.

The board members tried hard to convince her that she had to change with the times. After all, as they explained, people throughout Hawaii, with the right political connections, were making fortunes, getting their agricultural land rezoned for residential and commercial real estate. All they had to do was upzone, leverage the land into real estate loans and develop. How could they lose? Sadly by the 1990s Wilcox's intuitive sense proved correct. Kaua'i was hit by two devastating hurricanes followed by nine years of continuous economic downturn. Grove Farm suffered serious financial setbacks. It was recently purchased by AOL titan Steve Case, whose grandfather, Hib, long ago, worked for Wilcox on the plantation.

What Wilcox objected to, the dramatic change in the Hawaii rural landscape, is still taking place.

Each year since 1987, according to an estimate by the Hawaii State Department of Agriculture, about 2,500 acres of agricultural land is rezoned for commercial real estate, condos, and residential subdivisions. This represents only a small fraction off the 1.9 million acres in Hawaii that are designated for agriculture. But Hawaii is a small place and as agricultural fields give way to homes and asphalt, Hawaii loses the very thing tourists come here for from all over the world: its open space, vivid green beauty and subtle ecological balance.

Many of our new developments are Southern California-like, in their expansive use of concrete, their sprawling dimensions and use of land and water. However, our resources are finite and these developments are often built without acknowledgment of the basic limitations of island living.

Unfortunately, this basic truth is not reflected in official land classification records, which continue to classify land as rural, conservation, agriculture and urban.

"Officially 47 percent of the land in our state is designated agriculture," says Anthony Ching, the Executive Officer of the State Land Use Commission. "However I estimate that 5 percent or 100,000 acres of the designated 'ag land' in our agricultural district is being used for residential subdivisions. In some cases the densities of those parcels rivals those of the urban districts. In the long term, we face a challenge to maintain some capacity for agriculture in the state.

"Let's be honest and say land not really being used for agriculture anymore should be rezoned as rural," Ching says. "If you mix ag and rural subdivisions they may prove incompatible, and we lose the ability to establish new agricultural activities that can replace sugar and pine."

Some communities are happy to trade the loss of open green space for a source of quick jobs and investment. But those societies, which depend on tourism for a living have taken a different view. Places such as Sonoma County, California, Tuscany in Northern Italy and parts of Provence in the south of France depend on the beauty of their landscape for their tourism livelihoods. They have a long term view of agriculture that acknowledges both its costs and benefits.

Part of the problem in Hawai'i is that there is no one definition of what agriculture really is. It varies from county to county. In many places so called gentleman farms, expensive homes with decorative farm-like fencing, where nothing is produced, are counted as the real thing.

"The definition of ag activity is very generous. If I have one horse on a five acre estate, or a single fruit tree for personal consumption that might qualify me as engaged in agriculture," Ching says. Since zoning land as agricultural brings a tax benefit, those who can, claim farm status.

Agricultural production accounts for a small fraction (about \$530 million) of Hawai'i's \$40 billion dollar economy. However, it plays an important role in the food processing and restaurant trade. It also supplies things such as coffee, chocolate and macadamia nuts for tourists, Asian vegetables to restaurants, watermelons, organic vegetables, trees and exotic fruits. The extensive water infrastructure that was built for the plantations a century ago would likely take hundreds of millions of dollars to replace today.

The two large scale sugar plantations that still exist increasingly find themselves in conflict with recently built upscale communities whose new residents do not want to deal with the chemical spraying and burning that is associated with large-scale agricultural. But these are side issues.

Virtually none of the arguments surrounding new development recognize that in addition to the tremendous beauty agriculture adds to the landscape, Hawai'i, because of its ideal growing conditions, now attracts the top corporate agricultural scientists in the world. According to the U.S. Department of Agriculture, there is more advanced agricultural biotechnology breeding research done in Hawai'i than any other state. The scientists have

been motivated in part by the tremendous gains in world population numbers that put a premium on new seeds and food sources. There is also a need to insure, in case of emergency, that Hawai'i has the land, water and capability to produce fresh food for its population.

Despite this, agriculture in the state has few advocates. At the University of Hawai'i, internationally recognized horticulturist Jim Brewbaker, says that the only students he has that are interested in agricultural biotechnology are haoles. Why is Hawai'i turning its back on perhaps its greatest opportunity? Why don't its people care more about the future of the agricultural landscape that is the basis of their livelihood?

"Because many of the local people here want something better for their children," another UH professor says. "Their parents or grandparents grew up on farms or plantations and they want their children to be out of it. They want them to be orthodontists, computer scientists, lawyers, doctors or work in government. Anything but work on a farm. The problem is that that a small island community can only support so many doctors and lawyers and there is no future in an economy with such a narrow base."

Part of Hawai'i's history

From the beginning agriculture played a large role in the development of Hawai'i. Ancient Polynesians brought sweet potato, taro, bananas and other food crops. Agriculture was so important to the lives of Native Hawaiians that special temples, built around their god Lono, were created to organize the rituals of planting and harvest.

During the time of Kamehameha I, his personal advisor, Don Francisco de Marin, established huge gardens of orange, lime, avocados, mangoes, chinese plums, Tahitian coffee, bananas, grapes and medicinal plants. These planting, began about 1814. During the 1820s Honolulu became famous for its wines. There were huge vineyards in what is now Honolulu, hence the present street name.

When other groups settled in Hawai'i, there was a long search to match markets with potential crops that could be grown here: potatoes were grown for whaling ships or to sell to hungry miners during the California gold rush. Cattle were a successful west coast export for many years. Rice was grown by Chinese and Japanese immigrants. Filipino farmers brought their own vegetables. Today, Thai, Samoan, Tongan, Laotian, Mexican and organic farmers continue this process. There were also continual experiments with other potential export crops: coffee, tobacco, cacao for chocolate and others. But it was not until a plantation system for sugar was developed that wealth grew in Hawai'i.

Sugar was used in rum, and rum was consumed in massive amounts throughout much of the western world in the 19th century. After a treaty was worked out exchanging the strategic use of Pearl Harbor to the United States in exchange for special tariff status on sugar, venture capital poured into Hawai'i.

The sugar industry expanded onto all the main islands. The purchase or long term lease of land from Native Hawaiians below its true value, cheap imported labor from Asia and high prices for sugar in California made investors in sugar plantations wealthy.

However, the great wealth brought unexpected problems. Sugar plantations ended up using virtually all the available water and the best lands. There was little encouragement for the few independent entrepreneur farmers who might have wanted to do something else.

Seeds of change

After World War II, years of resentment coalesced. Japanese and Filipino plantation workers were mobilized to vote by the Democrats and when John Burns became governor in 1962, he responded to their needs. The Democrats didn't want to get rid of sugar; they wanted a better cut for workers.

Burn's appointment of Kenneth (Kengo) Otagaki made waves. Otagaki, who grew up in the tiny town of Laupahoehoe on the Big Island, was an unqualified supporter of diversified agriculture. After years of absolute control of the rural economy, the sugar plantation establishment could barely tolerate him. "They wouldn't even look at me," Otagaki said of those early days. Hawai'i is a traditional place, and it is difficult under any circumstances to be a visionary here.

But Otagaki had lost an eye, a leg and two fingers on the battlefields of Italy. He also had a Ph.D. in biochemistry from Berkeley.

The sneers of the sugar planters didn't bother him. He told them that if they didn't diversify and look for new ways of selling finished or value added products, instead of raw commodities, they would go out of business.

There was no way, he asserted, that in the long term Hawai'i could compete with the cheap land and labor in Asia to produce raw sugar. They thought he was mad. In 1963, Otagaki invited the first seed crop researchers to come to Hawai'i.

During the next forty years what Otagaki had predicted came true. The pay increases to sugar workers ultimately caused the costs for Hawai'i producers to go up as world prices for sugar slumped. The Japanese investment boom caused land values to spike. Caught between rising labor and land costs and declining cane sugar prices, most of Hawai'i's sugar plantations collapsed. Nearly 250,000 acres of sugar land were cultivated in the 1970s. Today only 68,000 acres remain. The balance of unused sugar lands lays mostly vacant, or in grazing. Hawai'i's most important new agricultural crops come, as Otagaki predicted, from diversified agriculture.

What needs to be done

- There must be a strategic recognition that the beauty of Hawai'i sells Hawai'i. Generous incentives must be found now for land landowners who want to keep land in agriculture and to grant long term leases to farmers. New developments should be in Sonoma County-style clusters that mix housing with open fields. In Maryland, this has taken the form of legislation called the Rural Legacy Act, giving land owners tax incentives for agriculture and developers tax incentives to build on land, already urbanized.

They call this approach Smart Growth. One of Hawai'i's problems is that even as developers seek new agricultural lands for development, whole neighborhoods of homes, particularly in Honolulu, are on the point of collapse because of old age and termite damage.

- Farming is an art. There are only 2,700 farmer entrepreneurs, and 5,500 farms in Hawai'i, and many of those risk everything every year to make a living. The State and County governments needs to look for models in the rural development activities of other states to help Hawai'i farmers lease land and market their goods. Not everything is going to work. Many things won't. But only by helping farmers experiment, helping them find markets for their goods and helping landlords defer the high opportunity costs of committing large tracts of land to farming will the rural economy prosper.

- The University of Hawai'i College of Tropical Agriculture needs a serious infusion of money. It has a new dean, Andrew Hashimoto, but is short on new faculty and modern equipment. There are a number of cases where communities have seized the possibilities in niche agriculture and made billions. Our niches are the world markets for tropical fruits, flowers, pharmaceuticals and marine organisms. And of course our tropical beauty on which so much of our tourism marketing depends. We will only be able to make the most of them if we give real support to the College of Agriculture and independent organizations such as the Hawai'i Agricultural Resource Center.

The tragic events of Sept. 11 have changed Hawai'i as it did everywhere else in the United States. What has not changed is our need to creatively adapt to changing circumstances. While it is true that the pain of the plantation experience still resonates in Hawai'i literature, the reality is that lifestyle and population is mostly gone. We have to look forward. As in Sonoma County, Hawai'i's beauty and rural landscape are its principal assets. When tourism returns, Hawai'i will need to be more beautiful than all the other island destinations that will compete with us.

We should help our farmers make sure this happens.

Markrich, M. (2002, May 5). Planting a future. *Honolulu Advertiser*. pp. B1, B4.

Posted on: Wednesday, June 5, 2002, A1, A2

Shark's Cove fishing ban stuns old-timers

By [Will Hoover](#)

Advertiser North Shore Writer

In a simpler age, the public notice would have been so short — two words — that any Tom Sawyer or Huck Finn would have had no doubt about its meaning:

"No Fishing."

Those days are gone.

Yoshio Tsue, 79, was just a kid the first time he fished at Shark's Cove, and he said he and his children and grandchildren have fished there together many times over the years. But last week, when told that fishing hasn't been allowed at the popular destination for more than two months, he didn't believe it.

"You can pole-fish," said Tsue, who has lived for more than half a century directly across the road from Shark's Cove. To back up his claim, Tsue pointed to a wordy, technically written sign that was recently planted in the sand across from his home.

A more careful reading, though, showed that the sign actually says fishing is no longer allowed at Shark's Cove.

Decades of fishing tradition are colliding with new restrictions intended to preserve the sea life and prevent overfishing at this noted angling spot. The changes affect hundreds of O'ahu residents accustomed to hooking, netting or spearing their fish here.

Though the rules took more than three years to draft and went into effect in late March, many ocean users such as Tsue are just now learning how severe the restrictions are.

What is allowed is pole-fishing at the Waimea Bay end of the 170-acre Pupukea Marine Life Conservation District, which includes Shark's Cove at its Sunset Beach end.

That's it, save for the 2 pounds of limu that can be harvested by seaweed gatherers.

Tsue doesn't get it, and he isn't the only person scratching his head.

"We've had people come in who don't understand the new rules," said Barry Sweet, proprietor of the Hale'iwa Fishing Supply. "They don't know if the new rules have gone into effect or if the new rules will be going into effect."

The rule changes are the result of a protracted community input process initiated in 1999 by Sen. Robert Bunda, D-22nd (Wahiawa, Waialua, Sunset Beach), and the state Department of Land and Natural Resources.

After numerous meetings, the Pupukea Task Force — consisting of representatives from 10 interest factions — made recommendations to greatly expand the preserve to include Waimea Bay and to restrict fishing-related activities.

In a nutshell, the new rules prohibit all fishing in the district with the exception of pole-fishing from the shore of Waimea Bay where for years, in late summer and early fall, hundreds have pole-fished from the shoreline for halalu, or young akule.

David Hara, who represented the recreational fishers at Pupukea, presented the task force with a petition signed by 800 people asking that recreational fishing in some form be allowed within the district. He's pleased that traditional halalu fishing will continue to be permitted at Waimea Bay, but he is not happy that he and his friends will never fish Shark's Cove again.

"Shark's Cove is done," said Hara, who lives at Sunset Beach. "I haven't seen the new sign yet. I was too sad to look at it. I thought this was going to be my retirement fishing haven."

The changes were needed, said Alton Miyasaka of the DLNR's Division of Aquatic Resources, because too many competing factions — pole fishers, spear fishers, commercial net fishers, recreational fishers, divers, snorkelers, tide pool explorers, boaters and scientists, among others — were compromising the preserve's waters.

"There was a growing conflict between the user groups," said Miyasaka.

Bunda had sounded the alarm because he was worried about the depletion of marine life at Pupukea, which had more fishing exemptions than any other of Hawaii's 10 Marine Life Conservation Districts.

The new rules were a compromise among task force members. About the only thing everyone in the community agreed on was that something needed to be done at the Pupukea district, which was established in 1983 to protect the ecosystem.

"I can definitely see a need for conservation," Sweet said. "But the problem from the recreational fishermen's standpoint is that Three Tables (near Shark's Cove) is the only place on the North Shore where they can catch akule, which is not an endangered fish. In other words, they're cutting those people off for no good reason."

"I like the idea of making the reserve bigger," added Joe Greene, who owns the Surf-N-Sea surfing and scuba shop. "But it's like they made too many rules. I don't even know if it's enforceable."

John Lane, whose wife, Wilma, was an alternate member of the task force, is not happy with the outcome. Characterizing the new rules as difficult to comprehend, he points to the Shark's Cove sign as an example. He's also miffed that spear fishers are subject to fines if they use the reserve to gain access to spearfishing waters.

"There was no consideration to these people whatsoever," Lane said. "They cannot even cross this area with their gear. And they should have left a small area outside the mouth of the cove for pole fishermen who have been fishing here for years."

Any way you look at it, though, the conservation district had become "significantly diminished" because of overfishing, said Bob Leinau.

"Invariably, most of the special-interest groups say it's the other guy — the net guys say it's the fishermen, the fishermen say it's the divers," said Leinau, who represented the North Shore Neighborhood Board on the task force. "Hardly anybody's saying, 'Hey, what if we all back off and give the natural resources a chance to prosper?'"

Leinau admitted that the new rules are tough for folks like Yoshio Tsue.

"You can't always balance the greatest good against one individual's personal interest," he said. "There needs to be places set aside. And some guys do lose. If a guy has fished out there all his life and then he's told you can't do that anymore, he is giving up something for future generations.

"Is it for the highest good? I think so."

Miyasaka said the new rules will be less confusing after people undergo a "period of education." So far, DLNR enforcement officers have issued few, if any, citations, and are concentrating on informing the public about the new rules.

"We're talking to these people," officer Roger Dainard said. "You've got old residents and Hawaiians who have been fishing that area for a long, long time. We're doing our very best to get folks to understand this is the way it is now."

Hoover, W. (2002, June 5). Shark's Cover fishing ban upsets longtime anglers.
Honolulu Advertiser, pp. A1, A2.

Posted on: Thursday, June 6, 2002, E1

Canoe club honors master carver

By [Tanya Bricking](#)
Advertiser Staff Writer

He's 95 years old and has just given up driving his car.

But Wright Bowman Sr. is still in his Nu'uanu wood shop every day, turning out his signature canoes and paddles and pieces of Hawaiian history.

Today, Bowman has another award to add to his collection. Duke's Canoe Club gave him a surprise honor yesterday, naming him the 2002 winner of the fourth annual Duke's Ho'okahiko Award, for exemplifying "the finest traditions of Hawai'i."

"He is a living treasure," said Ka'ili Chun, who has been studying under Bowman for seven years as his apprentice. "He comes from a time past, born in 1907. Today, you can't get away from the cars and traffic. He was born in a time where there were no cars in Hawai'i."

Bowman developed a passion for wood-carving when he watched canoe builders while growing up on the Big Island. He later honed his own skills in a General Electric apprentice program for machinery pattern makers.

When he returned to Hawai'i during the Great Depression, he practiced on cultural icons such as canoes, paddles, digging sticks and calabashes. He earned a reputation as a master woodworker while at Kamehameha Schools, where he taught for 23 years before becoming an independent craftsman.

When the Hokule'a and the Hawai'i Loa voyaging canoes were under development, the builders turned to Bowman for his expertise. His work include the koa pulpit in the church at Kalaupapa, and his pieces can be seen in the Hawaii Maritime Museum and the Bishop Museum.

Bowman passed his skills to a son, Wright "Wrighto" Bowman Jr., who carved voyaging canoes himself but died of a heart attack in 1997.

"Wrighto" was his father's true legacy, Chun said. But Chun now drives her mentor to doctor's appointments and to the grocery store. From him, she says, she's learned humility and many skills beyond woodworking.

Chun feels a responsibility to carry on the skills Bowman taught her by teaching others, she said.

"One motto of his is if a friend asks you for help, you help, no matter what," she said, "and don't expect anything in return."

Yesterday, Duke's Canoe Club had something to give back: thanks.

Bowman has shared his skills with a new generation of canoe voyagers and woodworkers, said Jeff Apaka, director of community relations at the Waikiki Community Center, which honored Bowman in January as part of the Ala Wai Challenge canoe race.

"He has been an inspiration," Apaka said. "He is one man, a genius wood carver."

Bowman's tools are on display at All Star Hawaii, 2080 Kalakaua Ave., for another month. Apaka is looking for another place to showcase the tools next, as a kind of moving museum to the living legend.

Bricking, T. (2002, June 6). Canoe club honors master carver. *Honolulu Advertiser*, p. E1.

Current Issues: POLICY

Kubota, G.T. (2002, June 12). Size Matters. *Honolulu Star-Bulletin*, pp. A1, A11.

Leone, D. (2002, May 15). U.S. ocean panel urged to get Pacific input. *Honolulu Star-Bulletin*, pp. A5.

Beamish, R. (2002, May 14). Clinton's rules for NW islands could weaken. *Honolulu Star-Bulletin*, pp. A9.

TenBruggencate, J. (2002, May 11). U.S. panel on ocean policy in search of new proposals. *Honolulu Advertiser*, pp. B6.

Hoover, W. (2002, April 7). Environment meetings clash. *Honolulu Advertiser*, pp. A25.

TenBruggencate, J. (2002, April 7). Sanctuary status sought for Northwestern Hawaiian Islands. *Honolulu Advertiser*, pp. A23, A28.

Silverstein, D. (2002, March 24). Our tribe must make all islands survivors. *Honolulu Advertiser*, pp. B1.

Blakeman, K. (2002, March 16). Sanctuary system moves forward. *Honolulu Advertiser*, pp. B1.

Roth, S. (2002, March 14). Marine Sanctuary hearing tense. *Honolulu Advertiser*, pp. A30.

Posted On: March 16, 2002, B1.

Sanctuary System Moves Forward

By: Karen Blakeman

Environmental protections for marine life in the Northwestern Hawaiian Islands, sanctioned during the last days of the Clinton administration, were given the green light to continue yesterday by Bush administration officials.

Robert Smith of the National Oceanic and Atmospheric Administration announced yesterday that federal officials will maintain the area as an ecosystem reserve and will eventually create a National Sanctuary, a long term protection strategy.

“We are very pleased,” he said during a meeting with environmentalists, fishermen and reporters at the Hawai’i Maritime Center.

“We are ready to move ahead.”

The Clinton executive order that created the reserve and launched the Sanctuary program at the end of his administration has been under review by the Bush administration for the past year. Bush could have reversed or modified Clinton’s order. Instead, he decided to let it stand.

Cha Smith, executive director of Kahea, an alliance of environmentalists and Hawaiian rights activists who lobbied for the protections, was extremely pleased with the announcement.

“I’m thrilled this process has weathered scrutiny by the Bush administration,” she said. “That’s not a minor accomplishment.”

She credited the thousands of people who spoke out in favor of the protections, along with the fact that Bush has recently been called to task by Congress to account for his record on the environment.

“I just thank God there is no oil in the Northwest Hawaiian Islands,” she said.

The executive order prohibits exploring for oil and gas, along with a long list of other activities. Longline fishing was prohibited in the area prior to Clinton’s order, but the order capped other forms of fishing until further determinations could be made.

Timm Timoney, a bottom fisherman who holds a permit to fish in the Northwestern Hawaiian Islands, took on a hangdog look yesterday when she learned the federal sanctuary system would be moved forward. She and the others who fish the area have been doing so in a sustainable manner for years, she said, but they are not very savvy at presenting their cases in public hearings.

“This is just going to strangle us, slowly,” she said.

The Northwestern Hawaiian Islands are a chain of islands, atolls, banks And reefs that begin about 100 nautical miles west of Kaua’i and stretch across the Pacific for more than 1,200 nautical miles. The area is home to the endangered Hawaiian monk seal, leatherback sea turtle, and an array of coral, fish and sea birds, many of which are unique to Hawai’i. With more than 84 million underwater acres, the reserve constitutes the largest wilderness area under U. S. protection.

The process to make the area a marine sanctuary begins with a series of public meetings April 9-19. For information and reservations, call the Honolulu office of the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve at 397-2657 or 397-2661, or email nwhi@noaa.gov.

Blakeman, K. (2002, March 16). Sanctuary system moves forward. *Honolulu Advertiser*, pp.B1.

Posted On: March 24, 2002, B1.

Our tribe must make all islands survivors

By Duane Silverstein

Millions of viewers are tuning in to “Survivor-Marquesas” to see which of 16 castaways will be the last to be voted off the Beautiful French Polynesian island of Nuku Hiva. Yet a far more consequential contest of survival is taking place on Nuku Hiwa and all of the world’s 100,000-plus islands. Will these islands themselves be voted off the planet?

Although islands evoke images of pristine tropical paradises, they are actually among the world’s most threatened ecosystems. In the last 400 years, 50 percent of extinction of animal species and 90 percent of extinction of bird species have occurred on islands.

Seventy-two percent of plant and animal extinction recorded in the United States have occurred in Hawai’i, a state that makes up less than 0.2 percent of the nation’s land area.

Much has been written about global warming and climate change. Nowhere in the world will its consequences be felt more strongly than on islands, some of which will cease to exist if the seas continue to rise as the polar ice caps keep melting. And islands are far more than the inconsequential specks of land with one palm tree pictured in a New Yorker cartoon. The 125 largest islands alone have a combined land mass equal to Europe’s.

If one counts the exclusive economic zones that cover ocean resources several miles offshore, islands have claim to one-sixth of the world’s surface harboring one-half of our planet’s marine biodiversity. One out of every 10 people on Earth is an islander, most of us will be surprised to learn, so this struggle for survival has enormous consequences.

Four hundred years ago, poet John Donne wrote that “no man is an island.” But in a modern age of jet travel, international fishing fleets, satellite communications and far-reaching ecological trends such as global warming and acid rain, he might correctly write: “No island is an island.”

The very isolation that until relatively recently protected island environments from encroachment now makes their ecosystems extremely vulnerable to damage from such threats as introduced species.

Compounding this problem on land, the coral reefs and mangrove forests that surround most tropical islands are rapidly disappearing because of human interventions such as cyanide and dynamite fishing, sewage discharge, pesticide runoff, and dumping of waste from cruise ships.

Most of the world's islands have small populations and, internationally, little political clout. Nongovernmental organizations such as Seacology are doing what we can to save these invaluable island environments and cultures. It will take a concerted effort by all nations to develop policies that will protect islands, the great repositories of the world's biodiversity.

Without such a new initiative, our tribe will have spoken. By our inaction, we will have voted precious island ecosystems and cultures --- and because of rising sea levels, some islands themselves --- off our planet.

Duane Silverstein is executive director of Seacology, a nonprofit organization whose sole focus is preserving the environments and cultures of islands around the globe. The Web site for Seacology is seacology.org.

Silverstein, D. (2002, March 24). Our tribe must make all islands survivors. *Honolulu Advertiser*, pp. B1.

Posted on: Sunday, April 14, 2002, A30.

Marine sanctuary hearing tense

By Susan Roth
Gannett News Service

WASHINGTON — The simmering conflict between environmentalists and the fishermen of the Western Pacific Fishery Management Council resurfaced in a Washington, D.C., hearing on the marine sanctuary proposed for the Northwestern Hawaiian Islands.

Just before President Clinton left office last year, he ordered the creation of the sanctuary around a chain of small atolls and reefs spanning more than 1,200 nautical miles northwest of the main Hawaiian Islands. The island chain, now part of an ecosystem reserve, is surrounded by some of the most extensive and untouched coral reefs in U.S. waters.

Clinton's executive order riled Hawai'i's fishermen because it severely restricts fishing in the area. Federal officials planning the transition from reserve to the more protected status of sanctuary say they plan to work with the fishery management council.

But council members remain wary, fearing that decisions will be made on the basis of emotion and environmentalists' demands, rather than on what they describe as a scientific basis allowing for fishing along with the preservation of resources. Environmentalists, meanwhile, have attacked the council's management of the area.

At Thursday's hearing, Honolulu attorney and fishery council member Bryan Ho told federal officials that the fishing industry groups want a continuation of "sustainable, well-managed commercial fisheries" in the Northwestern Hawaiian Islands, as well as an advisory council that incorporates "science-based resources management procedures" rather than being "dominated by citizen participation."

David Guggenheim of the Washington-based Ocean Conservancy urged that the new sanctuary advisory council be a "citizen-based group that provides public input."

Judy Lang of the Sierra Club requested that permits for existing fisheries be restricted to present levels. Lang also requested that areas near the islands be closed to all other commercial activity.

John Sibert, program manager of the Pelagic Fisheries Research Program at the University of Hawai'i-Manoa, urged federal officials to look closely at the council's Coral Reef Ecosystem Fishery Management Plan, which it approved in June.

"We don't have to reinvent this wheel," Sibert said. But according to the National Oceanic and Atmospheric Administration, some provisions of the plan appear to conflict with the management regime for the reserve.

Last week's hearing was part of a series of 10 public meetings on the proposal scheduled through this week. Public comments, which can be sent to NOAA until May 17, will be incorporated into a management plan and environmental impact statement.

Roth, S. (2002, March 14). Marine Sanctuary hearing tense. *Honolulu Advertiser*, pp. A30.

Posted On: Sunday, April 7, 2002, A25.

Environment meetings clash.

By Will Hoover
Advertiser Leeward O'ahu Writer

Both sides call the federal foul-up a fluke. But the result has left folks along the Wai'anae Coast trying to figure out how the government expects them to be in two places at the same time.

Against all odds, two government bureaucracies have scheduled two important public comment meetings for the same time and date along the Leeward coast – one in Wai'anae, the other in Nanakuli.

Neither side knows quite how the scheduling confusion occurred.

“It's two different federal entities – the Army and the National Ocean and Atmospheric Administration – and both meetings were set up for 6 p.m. on April 9,” said William Aila, a local leader involved with both issues.

Both scooping meetings are an essential part of the environmental impact statement process.

And each begins the protracted procedure that, according to Aila, means it's critical he attend both.

The Army meeting deals with a contentious legal settlement reached more than a year ago that gives the military, in exchange for conducting an EIS, the right to conduct live-fire exercises at Makua Valley – 4,190 acres many Hawaiians consider sacred ground.

The NOAA meeting has to do with changing the status, from reserve to the more protected sanctuary, of the Northwestern Hawaiian Islands- a 1,200 –mile stretch from Nihoa Island to Kure Atoll that is the largest marine wilderness under U.S. jurisdiction.

Aila represents a coalition of Hawaiian groups that have worked for years to determine the environmental effects of the military's use if Makua Valley.

He also has spent years on the advisory council of the Northwestern Hawaiian Islands Reserve.

“To me, both meetings are equally important,” he said.

Aila said he asked the Army to change the date. It said it could not.

Then, he contacted the NOAA, which said it would schedule a special presentation an hour earlier, at 5 p.m. on Tuesday.

“We understand that Makua Valley is very near and dear to those folks,” said Robert Smith, co-coordinator of the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve. “We couldn’t rescheduled our meeting, so we’re going to do a short version of the meeting at 5 p.m., and then we’re going to do the full-length version at 6 p.m.”

Aila and others concerned parties still faced the problem of attending the hour-long 5 p.m. NOAA meeting at the Multipurpose Building at Wai’anae District Park and then getting to the Army meeting at Nanakuli High School Cafeteria five miles away by 6 p.m. – virtually impossible given the only route via Farrington Highway.

Then Aila was told by the Army that speakers at the Nanakuli meeting would be taken on a first come, first serve basis.

“If that’s the case, I won’t be able to make the NOAA meeting, because I’ll need to be in Nanakuli early to sign up,” he said, “because our strategy is to coordinate our speakers in order to present a more effective message.”

The Army has told Aila he can have a proxy stand in for him until he arrives, but he’s not sure that will work.

Troy Griffin, deputy public affairs officer for the U.S. Army, Hawai’i, said the military was unable to schedule the meeting at any facility other than the Nanakuli High Cafeteria on Tuesday.

“We were trying to make all these things fit,” said Griffin. “There was certainly no intent at all to have a situation where we were butting up against someone else’s scooping meeting at the same time.”

Griffin said the Army had scheduled two scooping meetings – the one Tuesday in Nanakuli and another at 10 a.m. to 3 p.m. Saturday at the Wai’anae Park Multipurpose Building – simply because it wanted to give area residents ample opportunity to express their concerns.

“That’s not good enough,” said Aila. “What I need to do as a concerned citizen is to also listen to what others have to say that may spark something in me. That’s why it’s important to be there early, for the first meeting.”

Hoover, W. (2002, April 7). Environment meetings clash. *Honolulu Advertiser*, pp. A25.

Posted On: April 7, 2002, A23, A28.

Sanctuary status sought for Northwestern Hawaiian Islands.

Jan TenBruggencate
Advertiser Science Writer

The federal government is launching its efforts to change the deep reefs of the Northwestern Hawaiian Islands from a unique coral reef ecosystem reserve into a national marine sanctuary.

That would put it on a par with the Hawaiian Islands Humpback Whale National Marine Sanctuary.

The western end of the Hawaiian archipelago is a string of reefs, atolls and small rocky islands, all of which comprise wildlife refuges run by either the state Department of Land and Natural Resources, or the U.S. Fish and Wildlife Service. In addition to management by those agencies, regulatory and law enforcement roles are played by the Coast Guard, National Marine Fisheries Service and its associate agency the Western Pacific Regional Fishery Management Council.

On top of this confused regulatory framework, the administration of former President Bill Clinton in its final days established by executive order a new overlay the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve.

The reserve is an anomaly: a single-purpose program within the National Ocean Service without a bureaucracy to provide it with stable revenues or political clout.

As a national marine sanctuary, the islands would become part of a different branch of the National Ocean Service, which has more prominence with Congress and administrators.

However, the process of converting one kind of federal creature into another takes time. Reserve coordinator Robert Smith, speaking from his Hilo office, said it would take at least two years. Depending on how the public envisions it, the shape and regulatory framework could change.

“This is as open a process as any I’ve ever experienced,” said Smith, who previously ran the Pacific Islands office of the U.S. Fish and Wildlife Service.

The process follows the requirements of the National Environmental Policy Act, he said, and starts with 10 meetings on six islands and in Washington for two weeks, starting Tuesday. These will not be public hearings, Smith said. Each will begin with a film and presentation, then break into groups to discuss issues and gather public comments.

Some groups already have expressed concern about the proposed regulatory framework, particularly its potential to inhibit commercial fishing in the Northwestern Hawaiian Islands. The Western Pacific Regional Fishery Management Council, which is authorized by Congress to recommend regulatory measures to protect fisheries, is worried that new regulations could suspend fisheries without the scientific basis on which the council tries to base its decisions.

“There are still so many unanswered questions. We don’t know if we will be able to fish in the area at all,” said veteran commercial fisherman Timm Timoney.

Smith said none of those decisions has been settled yet.

“Public input matters a great deal,” he said.

On talking office, the Bush administration announced it was reviewing the Clinton executive order creating the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve. After a yearlong review, the administration announced in mid-March it had decided to let the reserve stand.

That frees Smith and his team to seek sanctuary status. There are 13 national marine sanctuaries. The Northwestern Hawaiian Islands, if it joins the group, would be the largest.

The reserve is 1,200 miles long, covering a swatch 100 miles wide and running from 50 miles east of Nihoa Island, to 50 miles west of Kure Atoll. It contains 14 million nesting seabirds and 250 fish species, many found only in Hawaiian waters.

The islands also provide resting and nesting areas for Hawaiian monk seals and green sea turtles. These areas—on and immediately around the reefs and islands—are excluded from the coral reef reserve. The reserve does not include state waters within three miles of shore. A larger area of federal waters around Midway is excluded from the reserve. The 2.7 million acres of coral reef there represents the largest coral reef ecosystem in the United States and one of the largest in the world.

The deep northwestern islands reefs are largely pristine, not having been subjected to sedimentation and other forms of pollution plaguing the main Hawaiian islands, and having seen only limited fishing for a few species.

Scientific missions in recent years have discovered a range of unique marine life in the region. Some scientists argue that larvae from the Northwestern Hawaiian Islands reefs are a major factor in the re-seeding of overfished reefs in the main islands.

TenBruggencate, J. (2002, April 7). Sanctuary status sought for Northwestern Hawaiian Islands. *Honolulu Advertiser*, pp. A23, A28.

Posted On: Saturday, May 11, 2002, B6.

U.S. panel on oceanic policy in search of new proposals.

By Jan TenBruggencate
Advertiser Science Writer

The United States' approach to governing the oceans, built up a piece at a time, has been criticized as confused and sometimes inconsistent.

The ocean commission hopes to change that.

"The commission wants to untangles the current mess of ocean laws. The patchwork that is there now is just confusing," said Kate Naughten, public affairs officer for the U.S. Commission on Ocean Policy.

The pane; will hold two days of meeting in Honolulu Monday and Tuesday, the fifth in a nationwide series of nine public meetings. A number of speakers from Hawai'i and the Pacific are scheduled to address the commission, and the public is invited to speak out at a hearing at 4 p.m. Tuesday at the Renaissance Ilikai Waikiki Hotel.

Naughten said the panel has not yet developed proposals to bring to Congress and the president.

"We're still in fact-finding," she said.

The 16-member commission mandated in the Oceans Act of 2000, was appointed by President Bush to conduct an 18-month study of the impacts of federal laws and programs involving the oceans. The panel is looking into coral reef protection, fisheries, oil-drilling, coastal development, climate and a range of other issues relating to the seas.

Among the experts scheduled to address the panel in Honolulu are those with interests in reefs, fisheries, the ocean's role in climate, the military, threatened species, tourism and marine debris.

TenBruggencate, J. (2002, May 11). U.S. panel on ocean policy in search of new proposals. *Honolulu Advertiser*, pp. B6.

Posted On: Tuesday, May 14, 2002 A9.

Clinton's rules for NW islands could weaken

By Rita Beamish
Associated Press

The protections that President Clinton mandated for the Northwestern Hawaiian Islands in the waning days of his presidency may not stand as the region is converted into a national marine sanctuary, the administrator of the National Oceanic and Atmospheric Administration said yesterday.

"It certainly could change," Vice Adm. Conrad Lautenbacher, Jr., said in an interview about prospects for the 1,200-mile swath of water, islands, atolls and shoals.

While environmentalists and some government officials interpreted Clinton's executive order as setting a floor for environmental protection when he designated the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve, Lautenbacher said that other concerns, including the livelihood of commercial fishermen, will be considered as NOAA conducts the process of creating a national marine sanctuary.

"The executive order isn't necessarily going to be the final rule system for the national marine sanctuary," Lautenbacher said. "I can't predetermine what that would end up being."

The issue of how the marine sanctuary would take shape has been a contentious one since Clinton in two executive orders created the reserve as a first step, and also mandated the beginning of the process to establish a marine sanctuary that would "supplement or complement the existing Reserve." That process will take two or three years.

In a novel step, he laid out a management regime for the reserve, including specific reef areas where fishing and other activities would be restricted, and even set forth catch limits based on the fishermen's previous five years' landings.

Lautenbacher said that discussions now ongoing could potentially change those protected reef areas, which bottom fishermen have complained are some of their best fishing spots.

The National Marine Fisheries Service allows 17 permits for commercial bottom fishing in the Northwestern Hawaiian Islands, but only nine permit holders are currently active.

"Everything is open for discussion," Lautenbacher said regarding the ongoing public comment and discussion process for the marine sanctuary.

Stephanie Fried, senior scientist for Environmental Defense Hawaii, expressed dismay when told of Lautenbacher's comments and accused the administration of "flip-flopping" after recently announcing that Bush would not overturn Clinton's order.

"If the marine sanctuary is going to represent a Trojan horse for undoing these popularly supported protections, then the Department of Commerce is going to have a big fight on its hands," she said.

Lautenbacher indicated that he sees Clinton's management rules as governing the reserve, but they may not apply once it is converted to an official marine sanctuary.

The sanctuary could end up being more or less restrictive than Clinton laid out, depending on science and public interest, he said.

Reopening the lobster fishery and prospecting for precious corals, both foreclosed by Clinton's order, also are on the table, he said.

"People are really locked in to the executive order and they are worried that if anything will change, that it's undermining the cause. I don't look at it that way," he said.

On the other hand, he said the executive order wouldn't be completely discarded. Because it contained "at least some framework" based on scientific assessment at the time.

He highlighted the importance of coral reefs as "the birthplace of life in the ocean" that need to be managed "in a sustainable way."

He also noted that the Western Pacific Regional Pacific Management Council, which oversees fishing policy in the region, has its own draft management plan for the coral reefs around the Northwestern Hawaiian Islands.

It contains a less restrictive regimen for fishermen than Clinton's order.

While the Commerce Department has decreed that Clinton's executive order trumps any conflicting decisions by the fishery council regarding the current reserve, that scenario "wouldn't necessarily be true for the sanctuary," depending on NOAA's ultimate management plan, he said.

"Part of the National Marine Sanctuary process is that the fishery management council out here has an opportunity to deal with the rules that apply within that sanctuary. So by trying to expedite the national marine sanctuary process we're giving a voice to those interests with a very definite concern in the outcome of the process. That's a critical element," he said.

The Commerce Department, which includes NOAA, wants to get beyond the reserve, which Lautenbacher noted is a "one of a kind system" and move on to a normal marine sanctuary as soon as possible, he said.

Beamish, R. (2002, May 14). Clinton's rules for NW islands could weaken. *Honolulu Star-Bulletin*, pp. A9.

Posted On: Wednesday, May 15, 2002, A5.

U.S. ocean panel urged to get Pacific input

By Diana Leone

The Hawaiian ahupuaa concept offers a model for resolving land-water issues that are a key concern across the nation, the chairman of a panel charged with improving federal agencies' management of ocean resources said yesterday.

An ahupuaa is a land division extending from the mountain or upland to the sea.

Retired Adm. James D. Watkins said it was important that the U.S. Commission on Ocean Policy receive testimony from Hawaii and other U.S. Pacific islands as part of its nine-stop tour of coastal areas this year because islands offer a microcosm example of ocean issues.

"You can't ignore the land side," where poor agriculture, industry and development practices result in dire effects on the ocean, Watkins said during a break in two days of testimony to the commission at the Ilikai Hotel.

"The Hawaiian Islands are a precious commodity" that runs the state's economic engine, Watkins said. "You've got to maintain the beautiful environment, or you won't have tourism."

More than half the world's population lives in coastal areas and that proportion is expected to increase, Watkins said. Concerns for coastal areas include conservation of resources, maintaining fishing grounds, dealing with wastewater and keeping beaches clean.

Congress has charged the commission with finding ways to reduce duplication, improve efficiency, and enhance cooperation among federal, state and local government agencies and private concerns that deal with ocean issues. It is the first comprehensive overview of federal ocean policies since 1966. The commission is to make recommendations to Congress and the president next spring.

Testimony to the commission yesterday included:

>> Former state Board of Land and Natural Resources Chairman Tim Johns urging the commission to listen to local people's ideas for improving things, rather than dictate change from Washington.

>> Lelei Peau, deputy director of the American Samoa Commerce Department, noting that Pacific islanders have much traditional knowledge of resource management that should be tapped.

>> Rear Adm. Robert Willard touting the Navy's record on environmental protection and urging the panel not to jeopardize military readiness by restricting training opportunities.

>> Surfrider Foundation volunteer Peter Etnoyer and Linda Paul, executive director of the Hawaii Audubon Society, calling for more protected marine areas where no fish are caught. Studies show that stopping fishing in some areas increases yields in others, they said.

>> Scott Atkinson of the Nature Conservancy of Hawaii calling for more money to preserve coral reefs, an investment he said would be repaid hundreds of times over by the goods and services that coral reefs provide humans.

>> William Friedl of the Center of Excellence for Research in Ocean Sciences and John Wiltshire, associate director of the Hawaii Undersea Research Laboratory, calling for more investment in research in the ocean.

Leone, D. (2002, May 15). U.S. ocean panel urged to get Pacific input. *Honolulu Star-Bulletin*, pp. A5.

Posted on Wednesday, June 12, 2002, A1, A10.

Size Matters

Gary T. Kubota

KIHEI, Maui >> Recreational diver Roy Ogawa said he's in favor of the state increasing the minimum size of fish that can be caught.

He hopes the proposal will help bring back the abundance of fish to waters off Maalaea, where he now only visits to collect edible seaweed and spear squid on the reefs.

"No sense already for dive around here," said Ogawa, a Kahului resident.

As catch numbers decrease for many Hawaii fish, the state is holding a series of public hearings about a proposal to increase size limits on the taking of fish from the ocean.

The hearings start at 6:30 p.m. tomorrow at the Kaunakakai Elementary School cafeteria, 6:30 p.m. June 18 in the public library on Lanai, 7 p.m. June 25 in the Kealahou High School cafeteria in Kailua-Kona on the Big Island, and at 6:30 p.m. June 27 in the Hilo High School cafeteria.

Additional hearings are scheduled for 5:30 p.m. July 2 at the Wilcox Elementary School cafeteria in Lihue, 6 p.m. July 9 at the Lihikai School cafeteria in Kahului, 6:30 p.m. July 11 at the Lincoln School cafeteria in Papakolea and 6:30 p.m. July 16 at the Waianae Public Library.

State researchers point out that fish catches have steadily declined for a number of species in Hawaii.

For all species of ulua and papio, the catch tons dropped to less than 100 tons by 1998 from more than 300 tons in 1948 and ama`ama or mugil cephalus to less than 25 tons by 1998 from close to 150 tons in 1949.

State aquatic officials point to a study that shows that current size limits weren't large enough so that mature fish could propagate once in their lives and increase in numbers.

"If we can set up a situation where the fish have a better chance to reproduce, greater reproduction should at one point lead to greater fish availability," said William Devick, administrator for the state aquatics division.

Under the proposal, the size limits would apply to persons taking fish from Hawaii waters commercially and for personal uses.

The state rules now set the minimum size for fish that are commercially caught.

State aquatic biologist Alton Miyasaka said the current rules are unenforceable because it's difficult to prove whether a person catching a fish intends to sell it.

He said the new law would enable officers patrolling the beaches to immediately return the small fish to the ocean.

The proposal for increasing the minimum length of a catch includes the kumu, or *parupeneus porphyreus*, to 10 inches from 7 inches, opelu kala, or *naso hexacanthus*, to 16 inches from 9 inches, the moi, or *polydactylus sexfilis*, to 11 inches from 7 inches, and various species of papio and ulua, such as *caranx ignobilis*, to 10 inches from 7 inches for home consumption and to 16 inches if sold commercially.

If found guilty, a person could face a maximum petty misdemeanor penalty of 30 days in jail and \$1,000 fine and a civil fine of up to \$1,000 for each specimen and for each violation.

Paul Abatie, manager of Lahaina Fishing Supply & Marine Hardware, said most shoreline fishermen who are really serious sports people are looking for bigger fish.

Abatie said he supports the proposal.

"I think it would be nice to have a little bit of control on the size," he said.

Curriculum Lessons

Hawaii Science Content Standards At-A-Glance

National Science Content Standards

Make an Atmosphere in Your Classroom

Layers of Living Earth

Map Reading

Putting Hawaii on the Map

Succession on a Hawaiian Volcano

Life of an Island- From Mountain to Atoll

Understanding Erosion

Sand Collection & Identification

Rapid Ecological Assessments

Environment Pollutants on Coral

Honu Survivor

Marine Debris

El Nino

Science Content Standards At-A-Glance

	<i>Science as Inquiry</i>	doing scientific inquiry	<i>Habits of Mind</i>	living the values, attitudes & commitments of the inquiring mind	using unifying concepts & themes	<i>Historical Perspective</i>	understanding scientific inquiry & the character of scientific knowledge	interdependence of science, technology & society	malama i ka aina: sustainability	<i>Organisms & Development</i>	unity & diversity	interdependence	cycle of matter & energy flow	biological evolution	<i>Understanding Ourselves & The World Around Us</i>	learning & human behavior	<i>The Physical Environment</i>	energy, its transformation & matter	forces, motion, sound & light	<i>Earth Systems & The Universe</i>	earth in the solar system	forces that shape the earth
Make an Atmosphere	X	X				X	X										X	X	X	X	X	X
Layers of Living Earth	X				X												X					X
Plates o' Chocolate	X	X				X	X	X												X		X
Map Reading	X	X				X		X							X							X
Putting Hawaii on the Map	X	X			X	X		X							X							X
Succession on a Hawaiian Volcano	X	X	X	X	X	X			X	X	X	X	X	X					X			X
Life of an Island - From Mountain to Atoll	X	X			X	X				X								X	X	X		X
Understanding Erosion	X	X						X														X
Sand Collection & Identification	X	X																				X
Rapid Ecological Assessments	X	X	X	X				X	X													
Environment Pollutants on Coral	X	X	X	X	X			X	X													
Honu Survivor		X	X	X				X	X													
Marine Debris			X	X	X				X	X					X	X						
El Nino	X	X			X			X								X			X	X		X

Hawaii Science Content Standards – At-A-Glance

Science as Inquiry	Doing Scientific Inquiry
Habits of Mind	Living the Values, Attitudes & Commitments of the Inquiring Mind Using Unifying Concepts & Themes
Safety	Doing Safety
Science & Technology in Society	Relating the Nature of Technology to Science
Historical Perspective	Understanding Scientific Inquiry & the Character of Scientific Knowledge Interdependence of Science, Technology & Society Malama I Ka Aina: Sustainability
Organisms & Development	Unity & Diversity Interdependence Cycle of Matter & Energy Flow Biological Evolution Heredity Cells, Tissues & Organs Human Development
Understanding Ourselves & The World Around Us	Wellness Learning & Human Behavior
The Physical Environment	The Nature of Matter Energy, Its Transformation & Matter Forces, Motion, Sound and Light
Earth Systems & The Universe	Universe Forces of the Universe Earth in the Solar System Forces that Shape the Earth

Science Content Standards: Moving from the Blue Book to HCPSII. (2001). State of Hawaii, Department of Education. Honolulu, HI: Department of Education.

National Science Standards At-A-Glance

	<i>Unifying concepts & processes in science</i>	<i>Science as inquiry</i>	abilities necessary to do scientific inquiry	understanding about scientific inquiry	<i>Physical Science</i>	motions & forces	<i>Life Science</i>	structure & function in living systems	populations & ecosystems	diversity & adaptations of organisms	<i>Earth & Space Science</i>	structure of the earth system	earth's history	earth in the solar system	<i>Science & Technology</i>	abilities of technology design	understanding about science & technology	<i>Science in Personal & Social Perspectives</i>	Populations, resources & environments	natural hazards	science & technology in society	<i>History & Nature of Science</i>	science as a human endeavor	nature of science	
Make an Atmosphere	X	X	X	X	X	X					X	X		X	X										
Layers of Living Earth	X	X	X		X						X		X		X						X	X			
Plates o' Chocolate	X	X	X								X		X		X							X	X		
Map Reading	X	X	X								X				X	X	X				X		X		
Putting Hawaii on the Map	X	X	X								X				X	X	X				X				
Succession on a Hawaiian Volcano	X	X	X	X		X	X	X	X	X	X		X								X		X		X
Life of an Island - From Mountain to Atoll	X	X	X	X		X	X	X	X	X	X		X								X		X		X
Understanding Erosion	X	X	X	X		X		X	X												X				X
Sand Collection & Identification		X	X										X												X
Rapid Ecological Assessments	X	X	X	X			X	X	X						X						X				X
Environment Pollutants on Coral		X		X				X	X										X	X					
Honu Survivor				X				X	X										X	X					
Marine Debris								X	X										X	X				X	
El Nino	X	X	X	X		X			X	X	X		X								X	X			

Teacher Curriculum : Geology : Make an Atmosphere in Your Classroom

Teacher Activity Guide

Grades: 4 – 6

Introduction: Why does the sun appear red at sunrise and sunset? Earth's atmosphere contains water vapor, dust, and other suspended particles. The Earth's atmosphere scatters the blue part of the sunlight out of the beam. This scattering causes us to see distinctly reddish hues at sunrise and sunset because the thickness of the atmosphere towards the horizon is very high.

The Experiment: This experiment may be done as a teacher demonstration or in student groups as a lab exercise. You may have noticed that we see extraordinarily reddish sunsets here on Earth after large volcanic eruptions or in the vicinity of forest fires. Huge quantities of ash and gasses are shot high into the stratosphere and circle the earth producing beautiful red sunsets. Looking straight up just before the sun sets you will notice the sky is dark blue. Looking off toward the horizon the sky changes to oranges and reds just as it does in the experiment. Changing the amount of milk you put in the beaker easily modifies this experiment. Practice with differing amounts to achieve the desired effect.

Note: In the activity, if using an overhead projector, stand the beaker on the projector and focus the image onto a screen. This works well as a demonstration.

Name _____
Period _____
Date _____

Activity: Make an Atmosphere in Your Classroom

Introduction:

During sunsets, the sun appears to be very red. What causes sunsets to be like this? In this experiment we will make a sunset and explore why this happens.

Materials:

- Water Small cup of milk (10 ml.)
- Eyedropper Flashlight or overhead projector
- Wide, clear glass bowl or beaker.

What to do:

Fill the glass container with water. Shine your flashlight down from the top of the container. Next, add 10 to 15 drops of milk with the eyedropper. Shine your flashlight down from the top of the bowl.

My Observations:

In the space below write down what you saw when the light was shined down from the top for each circumstance. How was it different after you added the milk?

Now shine the light from the side and look straight at the beam from the other side of the bowl.

What did you see from this angle?

In what way did the color of the light change?

What effect do you think the amount of atmosphere an astronomer has to look through has on her ability to see light from objects in space?

4. Doing More:

Try changing the amount of milk in the bowl and seeing if the colors change. Record what you did and what you discovered by changing the amount of milk. Record what you did and the results in the space below.

What I did: _____

My results: _____

Watch a sunset and look for different colors in the sky and clouds as the sun nears the horizon. Notice how sunsets can vary from evening to evening.

- What do you think would happen to the colors at sunset if there were a brush fire or forest fire in your part of the world?
- What could a volcanic eruption do to sunsets?

Teacher Curriculum : Geology : Layers of Living Earth

Objective: Students will be able to create models of the Earth that shows the various layers.

Materials: Marbles (one for each student), red and yellow play dough (see recipe), enough for each student to have a few tablespoons of each color, but a little more yellow), aluminum, cut into one 6" x 6" square for each student.

Procedure: Students should begin with the marble, which represents the Earth's inner core. Like the marble, the inner core is solid, because it is super hot nickel. Students then cover the marble with the red play dough, which represents the outer core, which is hot and elastic, like salt water taffy. The next layer is the yellow play dough, which represents the mantle, which is still very hot, but more of a liquid – this is the part we call magma. Finally, the foil is wrapped around the model, representing the Earth's crust, which is the only cool layer, and like the foil, also the thinnest.

Salt Play Dough Recipe:

2 c. Flour

2 T. Oil

1 c. Salt

2 c. Water

4 t. Cream of Tartar

Yellow and red food coloring

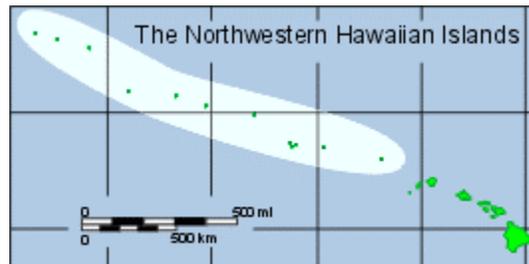
Optional: Vanilla or peppermint flavoring, just to make it smell nice.

Mix all the ingredients in a saucepan over medium heat, stirring until the mixture starts boiling or forms a ball (about 2-3 minutes). Remove from heat and let cool until it can be handled.

Knead the dough like bread until smooth and supple. To store the dough, keep it in a plastic bag in a cool place. It should make enough of one color for a class of 20.

Teacher Curriculum : Map Reading

Map Reading



Grades: 4 – 6

Focus Questions: How can longitude and latitude be used to locate a place on a map?

Lesson at a Glance: Students will use the Northwestern Hawaiian Islands map to orient themselves to the points of the compass, identify the location of atolls or islands given map coordinates, and measure the distance between two points on the map.

Key Concepts: Maps can be used to visualize the geography of a particular area and to determine the location of a place relative to other places. The map of the Northwestern Hawaiian Islands shows the relative position of the islands and atolls from Kaua‘i to Kure. The position of each island and atoll can be identified by using the coordinates of the map to determine its position relative to the Prime Meridian and the Equator. Degrees of longitude are measures of distance East or West of the Prime Meridian, and degrees of latitude are measures of distance North or South of the Equator.

Objectives: Students will be able to:

1. Identify the points of the compass (North, South, East, and West) on a map.
2. Identify longitude and latitude on a map.
3. Use coordinates to determine the location of an island or atoll.
4. Use the map legend to determine the distance between two islands or atolls.

Time: 30 – 45 minutes

Materials: Northwestern Hawaiian Islands (NWHI) Map, 5" section of string to measure distance, globe or world map. Full size (16"X30") are available from Bishop Museum by calling 848-4168. Smaller maps (8.5"X11") can be downloaded with this lesson plan.

Preparation and Procedure: Teachers should review the directions of North, South, East, and West, and the concepts of longitude and latitude on a globe or world map prior to starting this lesson. The Prime Meridian and Equator should be identified for the students as a means of explaining longitude and latitude. The globe or world map can be used to orient students to the part of the Pacific Ocean that is highlighted on the NWHI map. Students should use the Main Map Legend to identify True North and label the borders of the map with North, South, East, and West. A five inch piece of string and the map legend should be used to demonstrate how the distance between two points can be measured on a map. Teachers should explain that the Northwestern Hawaiian Islands are part of the Hawaiian archipelago, and include mostly uninhabited islands and atolls that are much older than the islands between Hawai‘i and Kaua‘i. The map insets can be used to demonstrate the difference between an island and an atoll. Atolls are ring like coral islands and reefs that enclose a lagoon. Islands are small land masses completely surrounded by water. After students have oriented themselves to the map, they should be asked to complete the map reading activity sheet.

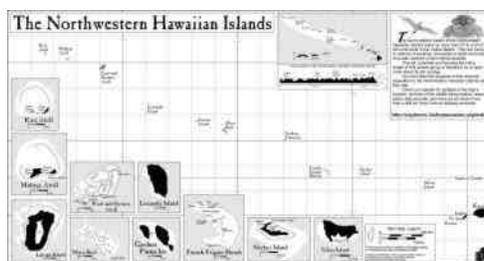
Teacher Background: The Northwestern Hawaiian Islands include the islands and atolls from Nihoa to Kure, and comprise more than 70% of all of the coral reefs in the United States. All of the islands and atolls are part of the State of Hawaii (and the City and County of Honolulu) except for Midway. These islands (excluding Kure which is a State Preserve) are administered by the U.S. Fish and Wildlife Service as federally protected National Wildlife Refuges. Pre-western contact (1778) habitation of Nihoa and Necker have been documented by early 20th century Bishop Museum expeditions. Additional background information, including photographs, of each atoll and island is available on the NWHI website.

Extensions: Students can use the information they learn during this lesson and the NWHI website to track the location of the research ship as it voyages between Hawai‘i and Kure. The education team will post the coordinates, general direction of travel, and average speed of the ship in the daily log.

Map Reading Activity Sheet

Instructions: Use the Northwestern Hawaiian Islands map to complete this worksheet.

1. What two islands are located at 22° north latitude?
2. How many islands and atolls are located north of 27° north latitude?
3. What island or atoll is located near the map coordinates 26° north latitude and 174 ° west longitude?
4. What island or atoll lies directly east of French Frigate Shoals?
5. What is the approximate distance in miles from Kaua‘i to Nihoa?
6. If a research ship is located near the map coordinates 23° north latitude and 163° west longitude, what island or atoll is closest to it?
7. What islands or atolls are located within 300 miles of Gardner Pinnacles?
8. What would the map coordinates of a research ship be if it was anchored near the eastern tip of Ni‘ihau?
9. What is the distance between Kure and Kaua‘i?
10. What is the first atoll west of 176° west longitude?



For a large scale map, download and print the above map at <http://www.bishopmuseum.org/research/nwhi/mapact.shtml>

Bishop Museum 2002, The Northwestern Hawaiian Islands: Join a Research Expedition.
Last updated: Monday, 11-Feb-2002. Map Reading. Retrieved May 22, 2002,
<http://www.bishopmuseum.org/research/nwhi/mapact.shtml>

Teacher Curriculum : Activity Guide : Putting Hawaii on the Map

Activity: Putting Hawaii on the Map

Grades: 6 – 8

Introduction: The Hawaiian Islands are located in the tropics. To understand exactly where Hawaii is located, students will complete this activity to accurately place the islands on a map. Students will be working with the concepts of latitude and longitude in this activity. Some additional instruction may be needed if these skills are new to the students.

Name _____

Date Period ____

Student Activity: PUTTING HAWAII ON THE MAP

Introduction: The Hawaiian Islands are located in the tropics. This allows astronomers who work at the telescope observatories to view much more of the sky than those at higher latitudes. To understand exactly where Hawaii is located, you will complete this activity to accurately place the Hawaiian Islands on a map. Observatories in the tropics are able to see much more of the sky than observatories at other latitudes.

Key Concepts: The Hawaiian Islands are located in a subtropical, oceanic environment far from other large landmasses such as North America or Asia. Look at a globe and find Hawai'i. We will be working with two words that you may not know about, latitude and longitude. Latitude and longitude lines on a map are used to describe a position on the earth.

Here's how: Lines of latitude run parallel to each other around the earth. In fact, they are sometimes referred to as "parallels". The latitude line that runs around the earth, dividing it into two hemispheres is called the Equator. There are 90 degrees of latitude from the equator to the North Pole and 90 degrees of latitude from the equator to the South Pole. Think of it this way: If you were standing in the center of the earth, pointing one arm outward toward the equator and one toward the North Pole, your arms would create a 90 degree angle! Hawaii is 20 degrees north of the equator so its latitude is said to be 20 degrees North. Seattle, Washington is 47 degrees North Latitude. Sydney Australia is about 35 degrees South Latitude. Each degree of latitude is further broken down into minutes. There are 60 minutes in each degree. One minute of latitude anywhere on earth is equal to one nautical mile.

Just remember that latitude is a measure of how far north or south of the equator you are. Question- If one minute of latitude is equal to one nautical mile (6070 feet), how many nautical miles is it from the equator to the North Pole?

$$\begin{aligned} 1 \text{ nautical mile} &= 1 \text{ minute of latitude} \\ 60 \text{ nautical miles} &= 1 \text{ degree of latitude} \\ \underline{\hspace{2cm}} \text{ nautical miles} &= 90 \text{ degrees of latitude} \\ &(\text{distance between equator and North Pole}) \end{aligned}$$

Look on a globe and find your latitude. _____ degrees North Latitude. Lines that run from pole to pole are called **Meridians**. Are they the same distance apart all along their length? No. They are the farthest apart at the equator and touch at the poles. Meridians of longitude begin their numbering from Greenwich (pronounced "Gren'itch"), England. The line that runs from North to South Pole through this town is called "The Prime Meridian" or the zero degree longitude line. From the Prime Meridian, longitude lines move westward to the 180-degree meridian, which is halfway around the world. Remember that a globe or ball can be divided up into 360 degrees. Locations in

the hemisphere of Earth located west of the Prime Meridian are found by using “degrees west longitude”. Hawaii is about 150 degrees West Longitude, or 150 degrees west from Greenwich England.

At the 180-degree mark we begin counting back towards England. This is the Eastern Hemisphere. Locations in the Eastern Hemisphere, like Japan, can be found by measuring degrees of longitude east of the Prime Meridian. Japan is about 135 degrees East Longitude.

Degrees of Longitude are also split into smaller units, again called minutes of Longitude. As with Latitude, there are 60 minutes of Longitude in each degree. Each minute of Longitude IS NOT equal to one nautical mile (except at the equator).

Now that you have seen examples of latitude and longitude, how do we put all this together to give the location of a city or island? Here’s how a geographic position is written:

Refer to a map or globe to follow along. Let’s find the latitude and longitude of Denver Colorado.

1. First find the nearest latitude line just below Denver. That would be the 39-degree North latitude line. The city is just a little bit above the 39-degree line. (44 minutes of latitude to be exact. 60 minutes = one degree)

2. Now look for the closest meridian. It just so happens that Denver sits almost exactly on the 105 degree West longitude line. So, Denver’s position is written like this

39 degrees 44 minutes North Latitude
by
105 degrees 0 minutes West Longitude.

You may also see it written this way: N39 0 44’, W105 0 ,00’

Here’s another example. What city is located at N 35 0 41’- E 139 0 44’ ?

Answer: _____

(Find the answer written at the bottom of the next page)

Objectives: At the end of this activity, you should be able to:

1. Locate the tropics and Hawai`i on a world map.
2. Label the Hawaiian Islands on a grid of latitude and longitude.
3. Describe the general location of the Hawaiian Islands to the nearest large landmass.

Materials: You may work by yourself or with another student. You will need the following things to do this activity:

1. Student Activity Sheet #1 and #2 (get from teacher)
2. Hawaiian Islands map (get from teacher)
3. Crayons or colored pencils
4. World map or globe
5. World Atlas (optional)

What To Do:

1. Before starting this activity, you will review the concepts of latitude and longitude. In the spaces provided write the definitions for these two terms:

LATITUDE: _____

LONGITUDE: _____

2. Using the map of Hawai'i, find and record the latitude and longitude for the following cities: (Remember to tell if it is east or west of the prime meridian, and north or south of the equator!)

Lihue on the island of Kauai Lat. _____

Long. _____

Honolulu on Oahu Lat. _____

Long. _____

Hilo on the Big Island Lat. _____

Long. _____

3. Cut out the four islands from the Student Activity Sheet #1 and place them on the map grid using the Latitude and Longitude coordinates provided in the "Clue Box". Try to do this without using a map or globe. Check those around you and see if other teams placed their islands where you did. How accurate are your placements?

(Check one)

____ Right on the mark! I am a master of mapping!

____ Close, but not quite. Just don't follow me!

____ Way off! I don't get this! I'm never going to sail around the world, anyway!

4. Now refer to the Islands Map to double check your placement and glue the cutouts to the grid. Finish your Hawai'i map by coloring and labeling the islands and surrounding ocean.

Label List (label all of the following on your map)

Geographic Information

1. Pacific Ocean
2. The direction North (use arrow)

Islands:

- | | |
|------------|-------------------------------|
| 1. Kauai | 5. Lana'i |
| 2. Ni'ihau | 6. Maui |
| 3. Oahu | 7. Kaho'olawe (Ka-ho-o-la-ve) |
| 4. Molokai | 8. Hawaii (The Big Island) |

Cities and towns:

1. Hilo
2. Kahaluli
3. Honolulu
4. Kaunakakai (Answer to name of city- Tokyo)
5. Kilauea
6. Lahaina

Student Activity Sheet #1

Put Hawaii on the map by cutting out the island shapes on Activity Sheet #2 and placing them on the geographic grid. Use the coordinates (Lat,Long) give to help you. Do not look at the Hawaiian Island map until you have tried placing all the islands. Then check the map before you glue the islands to the grid. Label your map with the information given in #4 on the previous page.

Answer the following questions:

1. What is the approximate latitude and longitude of the southernmost tip of the Big Island?
2. Is the southernmost tip of the Big Island the southernmost point in the USA? Explain?
3. Using the map scale provided, how long are the Hawaiian Islands, from Ni'ihau to Hawaii? _____ miles.

Use a World Map to find out:

4. Are the Hawaiian Islands located in the Tropics? _____
5. Are the Hawaiian Islands north or south of the equator? _____
6. Which ocean surrounds the Hawaiian Islands? _____
7. How far is it to the closest continent from Hawaii? _____
8. How far is it from Hawai`i to Japan? _____ miles, from Hawai`i to San Francisco? _____ miles.
9. Using a world globe, determine the latitude of the Tropic of Cancer? _____ degrees N.
10. Is Hawai`i north or south of the Tropic of Cancer? _____
11. If you live between the Tropic of Cancer and the Tropic of Capricorn, what kind of climate do you experience? _____

Teacher Curriculum : Geology : Plates o' Chocolate

Objective: Students will learn about the theory of plate tectonics by moving “plates” around on the molten layer of Earth called the mantle.

Materials: Aluminum foil, chocolate, hot plate or microwave

Procedure: Melt enough chocolate to cover a small sheet of aluminum foil with melted chocolate thick enough so that no foil shows through (a small bag of chocolate chips is plenty). On top of this chocolate create an island chain out of unmelted chocolate, then move the chocolate pieces on top of the melted chocolate. The chocolate is the same material, but when it is hot (melted), the cool chocolate on top of it can move around easily. This is similar to how the plates of the Earth’s crust move around on the molten mantle, and is a visual representation of how the Hawaiian Islands have “slided” to their present locations.

Himschoot, R. (1997). [Northwestern Hawaiian Islands National Wildlife Refuge: Environmental Educational Outreach Program]. Unpublished manuscript & raw data.

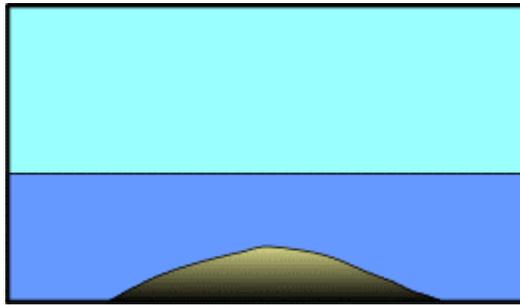
Teacher Curriculum: Geology: Life of an Island - From Mountain to Atoll

Grades: 4 – 6

Focus Question: Why are the Northwestern Hawaiian islands so much smaller than the main islands of the Hawaiian chain?

Lesson at a Glance: Students will learn about the evolution of a volcanic island from origin to erosion. They will be able to determine the relative ages of the Northwestern Hawaiian Islands given their position in the archipelago.

Key Concepts: Volcanic islands form over a hot spot on the ocean floor. Islands form and erode in eight stages (1) deep submarine stage, (2) shallow submarine stage, (3) subaerial shield-building stage, (4) post-caldera stage, (5) erosional stage, (6) stage of reef growth, (7) stage of post-erosional eruptions, and (8) atoll stage. Refer to the website for an animation of this process.



The relative age of an island or atoll can be determined based on its state of growth or erosion. The Hawaiian archipelago rides on the Pacific tectonic plate that is moving in a northwesterly direction. The oldest islands in the archipelago are located northwest of the main islands, and the youngest island (Lo‘ihi) is forming under the ocean off the eastern coast of the island of Hawai‘i.

Objectives: Students will be able to:

1. Identify the eight life cycle stages of an island.
2. Identify the stage of an island based on given criteria.
3. Demonstrate their understanding of the life cycle of an island by illustrating the process and creating their own names for the eight stages.
4. Identify the stage of an island based on photographs.

Time: 30 – 45 minutes

Materials: NWHI website, photographs of selected islands in the Hawaiian archipelago.

Preparation and Procedure: Teachers should explain the concept of plate tectonics and hot spots to show how volcanoes are formed over a single spot in the ocean floor, become islands, and drifted toward the northwest. A map that shows the submerged ridge that connects the islands and atolls in the archipelago can be used to illustrate this concept. The cross-section of the Hawaiian islands in the NWHI map can also be used to stress this point. Aerial photographs of the NWHI can be used to illustrate the different stages of growth and erosion of an island. These photographs can be downloaded from the website. Teachers should begin by showing photographs of eruptions on the island of Hawai'i as an example of an island in the shield-building stage. Systematically working through photographs of the islands from the southwest to the northeast will demonstrate the changes in volcanic activity and island shape and size due to erosion.

Teacher Background: Volcanic islands move through eight stages of growth and erosion. Due to the movement of the Pacific tectonic plate on the floor of the Ocean, the islands on the Northwest end of the archipelago are significantly older than those on the southeast end (the main Hawaiian islands), since they formed over the hot spot first. The island of Hawai'i is approaching mid-life, while Lo'ihi (still submerged) is still in the deep submarine stage. By contrast Kure and Midway atolls are in the final stages of the life cycle of an island. The formation of ringing reefs combined with gradual sinking and erosion of an island cause it to eventually disappear from the surface of the ocean. During this process, reefs grow vertically (upward) and begin to surround the island, eventually becoming separated from the island by a lagoon. If sinking continues, the island disappears and only a circular reef remains --- an atoll.

The website provides additional background information about the each of the islands and atolls of the Northwestern Hawaiian Islands.

Extensions: Students can use the NWHI website to monitor the progress of the research team's rapid environmental assessment, and to see new photographs of the islands and atolls from Nihoa to Kure.

Bishop Museum 2002, The Northwestern Hawaiian Islands: Join a Research Expedition. Last updated: Monday, 11-Feb-2002 12:20:22 HST. Life of an Island: From Mountain to Atoll. Retrieved May 22, 2002, from <http://www.bishopmuseum.org/research/nwhi/geoact.shtml>

Teacher Curriculum : Geology : UNDERSTANDING EROSION

Teaching Tool: Demonstration of Desertification

Grades: 6 – 8

Lesson at a Glance: After experimenting with rainfall on vegetated and barren soils and observing runoff, erosion, and groundwater recharge rates, students obtain a better understanding of environmental issues that effect island ecosystems.

Key Concepts: This exercise demonstrates how vegetation holds water, prevents erosion, and recharges the aquifer.

Objectives: Students will be able to:

1. Compare the effects of erosion on different substrates.
2. Understand key concepts of the water cycle and the importance of vegetation in maintaining the health of the land.
3. Learn experimental methods and recording observations.

Time: Two class periods with possibility of extending with further experimentation.

Subject Areas: Environmental studies, Science, Mathematics.

Materials:

- Six trays about 15 X 12 X 4 inches (about 40 X 30 X 10 cm) deep
(Disposable aluminum turkey roasting pans work well.)
- Three pieces of 2 X 2 (or 2 X 4) blocks of wood about 18 inches (45 cm) long.
- One one-gallon watering can with fine-sprinkle.
- Three pans that hold one gallon of water and fit in front of the trays.
- About ½ cubic foot (about 14 l) of fine loamy soil.
- Patch of sod to fill one tray.
- Glue and tape.
- A watch.
- Notebooks or data-sheets for recording data (sample attached).
- Newspaper or towels to mop up spills.

Supplemental material for those wanting more data:

- Water measuring device to measure fluid volumes from 0.01-1 gallon (0.04-4 l).
- A scale capable of weighing 0.1-10 pounds (0.05-5 kg) of dirt.

Note: Smaller trays than the ones described here may work; however, the larger the trays the more likely the experiment will mimic natural processes. Since cost and problems scale rise with size, we have designed a compromise demonstration. Students may want to experiment with size.

Preparation:

1. Punch or drill several 1/8-inch (3 mm) diameter holes scattered in the bottoms of three trays. All three trays should be cut the same.
2. Cut a U-shaped notch out of the middle of one of the short side walls of the three trays. The notch should be 1-2 inches (2.5-5 cm) wide at the top and extend to the bottom of the tray. Size is not critical but the notches should be equal for the three trays used in a single experiment.
3. Place about ½ inch (1 cm) of soil in the bottom of one tray and place the sod over the soil. Soil and sod should total about 3 inches (7.5 cm) deep. Use less soil if sod is thick.
4. Fill the second tray with 3 inches (7.5 cm) of soil; and lightly pack down. Final depth should be about the same as the soil depth in the sod plus soil tray. (If too much soil "leaks" from the notch, place a piece of tape across the notch the pans are set up ready for the experiment.
5. Fill third tray with about 2 ½ inches (6-7 cm) of soil; that is, about ½ inch (1 cm) less than used in the second tray.
6. Dilute one part Elmer's Glue into 3-4 parts water to make ½ cup (100 cubic cm) of thin milky glue. Pour in spray bottle and wet surface of soil in third tray. (The glue should soak in. If the glue beads on the soil surface, dilute further.) Sift or sprinkle ½ inch (1cm) of soil on top and lightly pack down, then lightly brush to make natural appearing surface. Let harden over night.

Procedure:

1. The three remaining uncut trays will serve as reservoirs beneath the test trays. Place one of the wood blocks across the width of an uncut tray about $\frac{1}{4}$ from one end. Carefully place a tray of soil (test tray) onto the bottom tray and wood block, so that the notched end overhangs the lip of the bottom tray about 1 inch (2.5 cm). Adjust the wood block so that the angle of soil is between 15 and 20% sloping towards the notch. Tape the ends of the two pans together near the lower corners so they do not shift during the experiment.
2. Repeat for the other two test trays. The soil should slope equally for all three trays.
3. Place a shallow pan in front of each tray to catch the runoff and eroded soil.
4. Calculate the amount of water needed to simulate $\frac{1}{2}$ inch (or 1 cm) rainfall. For example, for a pan 15x12inches the formula is $15 \times 12 \times \frac{1}{2} = 180$ cubic inches/ $231 = 0.78$ gallons or about $\frac{3}{4}$ of a gallon.
5. Simulate a $\frac{1}{2}$ inch rainfall on each tray in turn using the sprinkling can. Note time sprinkling starts and ends for each tray. (The amount of water and length of time are not critical but should be the same for each tray.)
6. Note the time it takes the water to runoff from each tray. After the majority of the water has runoff, measure and record the amount of runoff and estimate the amount of dirt washed out (eroded) with the water.
7. Estimate the amount of water dripping into the bottom trays.
8. Leave the trays in place and record how long water continues to drip into the lower tray.
9. After water drainage appears to have stopped or slowed appreciably (10-20 minutes), simulate another $\frac{1}{2}$ inches of rain and record the results.
10. Continue the experiment with additional rain until the results are dramatic.
11. If possible, leave the test set up until the following day, and record whether any water continues to drip into the reservoir.

Teacher Background: Desertification, a process wherein habitat destruction leads to a cascade of biological and physical changes in the land that catastrophically reduce the land's ability to support life. Desertification is a worldwide phenomenon from the Kansas dust bowl to the Sahel region in Africa. Arid environments are more vulnerable, but similar changes even occur in rain forests. Islands are also vulnerable.

Although the details differ among regions, the process of desertification shares many common causes and often follows a similar course. The proximate cause is usually the widespread development of non-sustainable land use practices. These lead to a cascade of biological and physical effects that reduce the land's ability to sustain the activity. These changes also reduce the land's carrying capacity; that is, its ability to support living organisms. If the process continues beyond a threshold, the entire system can collapse, resulting in catastrophic reduction in biodiversity and even the reduction of the land's ability to recover.

Fires:

Many plants are adapted to fire. They can have large roots that regenerate, seeds that ripen in the heat, a bunchy growth form that protects sensitive inner living tissue, or store water for cooling. However, most plants, including many Hawaiian species quickly succumb in a wildfire. The barren ground after a fire becomes available to rapidly growing resistant plants. Where resistant plants can not keep up with frequent fires barren ground results.

Soil Changes:

In warm climates, leaf litter and other organic material falling to the ground, does not accumulate as much as in temperate regions because the warmer temperatures accelerate decomposition. Most organic material accumulates in living tissue. The more rapid weathering leaches out soil nutrients, and insoluble compounds accumulate. The seasonally wet and dry climate alternately soaks and desiccates the soil, swelling and shrinking the particles. The rusty-red iron oxide rich clay called laterite is often characteristic of such environments.

Collapse:

The removal of vegetation exposes the soil to wind and water erosion. Plant roots no longer hold the looser material in place, and in a short while the land appears barren. The major erosional events usually occur with severe storms, often leading to a mistaken belief that the land and the ranching or other human activity were victims of a natural disaster. In truth, such events are often symptoms of over-exploitation of the land.

When the vegetation cover and thin litter layer are removed exposing the laterite to the baking sun, its surface heats unnaturally and irreversibly dries to a hard crust, which becomes virtually impenetrable to water or plant seedlings. Rain water no longer infiltrates the soil to support plant growth and recharge the aquifer. On the MHI rain descends to the ocean carrying with it a heavy load of debris. Once the storm passes, the surface rapidly dries again leaving no water for living things. With little water entering the aquifer, streams and springs dry up and become susceptible to flash foods at each rain.

These biological and physical changes cascade to a collapse of the environment, in which the land can no longer support most former species, and furthermore it has lost the ability to recover. Ironically, a friable soil layer suitable for plants (but relatively infertile) often remains protected from further erosion beneath the hard pan. Given time (usually centuries), natural succession will allow plants to recolonize and litter to accumulate thus reestablishing the water cycle.

Teaching Suggestions:

1. Try graphing the results to better visualize the comparisons and to reinforce mathematical concepts. Bar graphs should work well for comparing the results from different soil types.
2. Encourage the students to experiment with different slopes, different soil types (for example, beach sand vs. loam), different plant cover, and amount of rainfall.

Discussion Questions:

1. Describe what happened with each treatment and why the treatments behaved as they did.
2. Were the results expected? If different, why?
4. What does the experiment tell us about the environment?
5. How do the results relate to the students' backyard, to the school grounds, and to the island in general?

Extended Activities: Students can look for evidence of erosion on the school grounds, at home, or elsewhere and report on their observations.

Further Reading:

Cuddihy, L.W., and C.P. Stone. 1990. *Alteration of native Hawaiian vegetation: Effects of humans, their activities and introductions*. Cooperative National Park Resources Studies Unit, University of Hawaii at Manoa. Honolulu, HI.

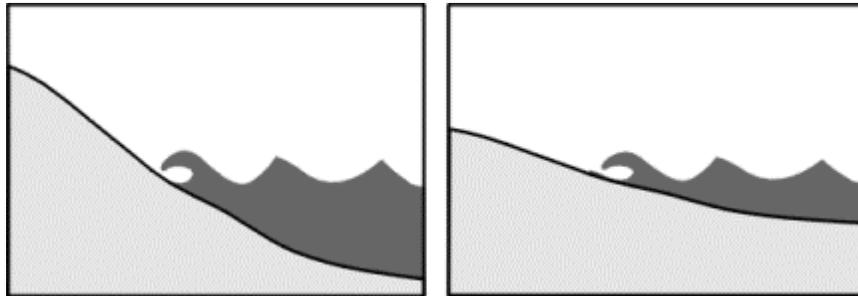
Stone, C.P. & D.B. Stone (eds.) 1989. *Conservation Biology in Hawai'i*. Univ. Hawaii Press,

Bishop Museum (1999, July). Kaho'olawe: As sense of place. Honolulu, HI: Bishop Museum Native Hawaiian Culture & Arts Program (NHCAP), funded through the National Park Service, U.S. Department of the Interior.

Teacher Curriculum : Geology :Sand Collection and Identification



Photo courtesy Hawaiian Lifeguard Association



Grades: 4 – 6

Focus Question: Why do some sand beaches have fine grains of sand and others have coarse grains of sand?

Lesson at a Glance: Students will be asked to collect a small amount of sand from their favorite beach, identify the sand based on provided criteria, and test a hypothesis regarding the type of beach it came from.

Key Concepts: Beaches are formed by the interaction between the forces of the ocean and the material available to create a beach. Beach material comes from either terrestrial or marine sources. The white sand beaches of Hawai‘i have a marine source (coral), and the size of their grains of sand differ based on whether the beach is flat like Kailua Beach or steep like Sunset Beach.

Time: 30 to 45 minutes

Materials: Collection - small zip lock bags, paper and pencil.
Identification- small glass jar filled with table salt, observation log.

Preparation and Procedure: Teachers may elect to collect sand from various beaches on their island or ask students to collect the sand as part of the lesson.

A small amount of dry sand should be collected at a point on the beach no more than one foot above the high watermark. Place the sand in a zip lock bag and record the name of the beach and whether it is flat (like Kailua Beach) or steep (like Sunset Beach).

Students should observe the samples of sand and complete the observation log. A determination of whether the sand is fine or coarse should be made based on a comparison with the grains of table salt in a glass jar. After completing the observation log, students should test the hypothesis that coarse sand is found on steep beaches and fine sand is found on flat beaches. Upon completion of the exercise, teachers are encouraged to return the sand to the beaches where it was collected.

Teacher Background: Beaches are made of either terrestrial or marine material. Examples of this in Hawai'i are the white sand beaches made of pulverized coral (marine) and black or green sand beaches made of basalt or volcanic (terrestrial) material. White sand beaches are familiar to most people, but black sand beaches can be found at Kalapana on the island of Hawai'i, and green sand can be found at places such as Hakioawa on Kaho'olawe.

Teachers should identify beaches on their own island (if any) where black or green sand might be found. Coarse sand can be found on beaches that are exposed to the forces of the ocean, such as most north facing beaches in Hawai'i. On these beaches, the force of waves is great enough to carry coarse grains of sand to the shore creating steep beaches that drop off rapidly to the ocean. Fine sand can be found on beaches that are not exposed to large surf, or at beaches protected from the forces of the ocean by a land formation such as a bay.

Extension: Students can use the information they learn during this lesson and NWHI website to determine the type of sand (coarse or fine, terrestrial or marine) that the education team should find during the expedition. The team will collect sand at each atoll or island and record its findings on the website.

Download this lesson above and a Sand Identification and Classification Log at <http://www.bishopmuseum.org/research/nwhi/sandact.shtml>

Bishop Museum 2002, The Northwestern Hawaiian Islands: Join a Research Expedition:.
Last updated: Monday, 11-Feb-2002. *Sand Collection and Identification*.
Retrieved May 22, 2002, from
<http://www.bishopmuseum.org/research/nwhi/sandact.shtml>

Teacher Curriculum : Environment : Rapid Ecological Assessments

Rapid Ecological Assessments



Photos by Jim Maragos and USFWS

Grades: 3 – 8

Focus Question: How can researchers examine a small a small area and apply those findings to a larger area?

Lesson at a Glance: Students will conduct an ecological assessment of a small area on school property and apply findings to the greater area.

Key Concepts: From the findings of a small area generalizations can be made to a greater area. Time and energy is a factor when evaluating a large area.

Objectives: Students will be able to: Inventory the plant and animal population of a sample area and extrapolate results to a larger area.

Time: One class period

Materials: One metal coat hanger for every two students, notebook or journal to record findings in, map of school grounds. Bug boxes and plant presses are optional.

Teacher Background: Scientists in the field rarely have the opportunity to evaluate the whole environment in which the animal or plant they study lives. Instead they need to look at a smaller area and apply the findings to the whole area. This type of representative sampling can be very scientific and accurate.

One of the challenges that the scientists face is setting up an accurate sample area. This is a key factor in getting the correct count of a species and tracking their progress. On the research expedition to the NW Hawaiian islands the longest stay on a particular island will be 2 – 3 days on Kure Island. On other islands scientists will only have a few hours to gather information. The time is well planned and documented. Scientists use meter squares in which they will concentrate their efforts. The process of replacing the meter square and evaluating a new area is repeated until a good sampling of the larger area is conducted.

Preparation and Procedure:

1. Have the students pair up. Each pair will be given a coat hanger. The top and bottom of the hanger will need to be pulled to create an 8 inch square. These squares will give the students an area in which to focus.

2. Look at a map of the school grounds to determine where good sampling will occur. For a true representative sampling draw a grid over a map of the school grounds choosing 15 (for a class of 30) evenly spaced spots to explore.

3. Assign each pair a location to explore. Each group should have a notebook to record their findings.

4. Give the students 15 minutes to examine the area. Draw a grid to keep track of each plant and animal that is encountered. If a bug box is available for each group, students can take bugs back to classroom for identification. Plants can also be pressed or collected, (within reason) for identification and reporting purposes.

5. When the students return to the classroom have each group report their findings. Record findings on the board.

Was there a plant or animal whose presence was surprising?

What plants/insects are native and which are introduced?

What conclusions about the schoolyard can you draw from the rapid ecological assessment?

Bishop Museum 2002, The Northwestern Hawaiian Islands: Join a Research Expedition. Last updated: Monday, 11-Feb-2002. Rapid Ecological Assessments. Retrieved May 22, 2002, from <http://www.bishopmuseum.org/research/nwhi/ecoact.shtml>

Erosion Data Chart:

Treatment

	Sod	Bare Soil	Hard Pan
First Rainfall (time)			
Amount of runoff			
Amount of erosion			
Duration of runoff			
Amount of recharge (Infiltration)			
Duration of recharge			
Second Rainfall (time)			
Amount of runoff			
Amount of erosion			
Duration of runoff			
Amount of recharge (Infiltration)			
Duration of recharge			
Third Rainfall (time)			
Amount of runoff			
Amount of erosion			
Duration of runoff			
Amount of recharge (Infiltration)			
Duration of recharge			
Fourth Rainfall (time)			
Amount of runoff			
Amount of erosion			
Duration of runoff			
Amount of recharge (Infiltration)			
Duration of recharge			
24 Hours Later (time)			
Amount of runoff			
Amount of erosion			
Duration of runoff			
Amount of recharge (Infiltration)			
Duration of recharge			

NOTES

Teacher Curriculum : Animals : Honu Survivor: **The Green Sea Turtle Experience**



Photo by Robert Shallenberger

Grades: 3 – 6

Focus Question: Since approximately 100 turtle eggs hatch per clutch why are the Green Sea Turtles endangered?

Lesson at a Glance: Students will participate in discussions and role-play to learn the hardships of baby Green Sea Turtles. The students will learn about the low survival rate due to natural predators and man.

Key Concepts: They will learn that the survival rate is extremely low. Students will learn how survival until adulthood are affected by natural predators and humans

Objectives: The students will be able to:

List the predators of the honu.

State how humans play a part in the turtle's endangerment.

Time: Two class periods.

Materials: Paper, pencil, nametags, ropes or cones, string.

Teacher Background: The Hawaiian Green Sea Turtle, also known as honu, is an endangered species. In the past, humans killed them for their meat and shell. The meat was a favorite food for the Hawaiian Chiefs. The shell was used to make combs, glasses and jewelry.

Shells vary in color from black to brown. The Green Sea Turtle gets it's name from the green color of it's fat. Baby turtles weigh approximately one ounce and are about 2 inches in length. The adults grow to approximately 400 pounds and 3-4 feet in length. Juvenile turtles are carnivorous and eat primarily jellyfish. Adult turtles are omnivorous, eating mainly algae.

Female green sea turtles travel, during the summer months, to the Northwest Hawaiian Islands where they lay eggs in nests. The female labors at night digging a hole to lay a clutch of approximately 100 eggs resembling rubbery Ping-Pong balls. Sixty days later the eggs begin to hatch. The baby turtles dig their way out of the sand. If the sand is too hot they don't leave the nest. Hot sand signifies day. The hatchlings wait until the sand becomes cool telling them it is night. When they emerge from the nest they start towards light. Usually it is the light reflecting off the ocean. Sometimes the turtles run towards man made lights, which is a deadly mistake.

Another man-made hazard for turtles is Marine Debris, which they mistake for food or in which they become entangled. They also have natural predators, such as sea birds, sharks, carnivorous fishes and ghost crabs. Usually there are only one or two sea turtles that survive out of a clutch.

Preparation and Procedure:

1. Have a discussion with students. What do they know about the Green Sea Turtle? Discuss the number of eggs that are hatched in a clutch and that only one or two turtles survive. Why are there only one or two survivors? What are the hazards of being a baby sea turtle?

2. Divide the class in half, for example if you have a class of 30 students make two teams of 15. Name one group predators and the other Baby honu. Give the students nametags, which are placed around their necks with string. The nametags will state what/who they are (example, baby honu, human, tiger sharks, carnivorous fish, ghost crab, sea birds, marine debris). You would have 15 honu, 1 tiger shark, 3 sea birds, 1 human, 3 carnivorous fish, 4 ghost crabs and 3 marine debris.

3. Set up three markers (cones or ropes) in an open area. This will cut the area into four zones. The left side is the high tide line where the nest is safe from the surf. The middle left area is the sand. The middle right is the open ocean and the right is the seaweed, which is the safe area.

4. Place the honu in the clutch in the high tide zone.

5. Place the birds and the ghost crabs in the beach zone.

6. Place the sharks, carnivorous fish and marine debris in the open ocean zone.

7. Tell the student that the birds are the only ones that can move between the beach and the ocean. The honu are to try to get to the protection of the seaweed. If a predator catches the honu they must sit down. The predators may catch as many honu as they can.

8. Teacher begins a dialogue: (To honu) "You have been in your clutch for 55 days you are almost ready to hatch. Along comes a person walking on the beach." The student

with the human nametag gets to pick one honu to remove from the game both students sit down. This signifies how humans can disturb and destroy turtle nests.

9. Teacher then says, "Five days have passed, the sun has set and the sand is cool. It is time to leave the nest and head towards the ocean. I hope you are a survivor."

10. The honu may now head towards the ocean and the safety of the seaweed.

11. After they finish the dash, they will trade nametags. The honu will become the predators and the visa versa.

12. Debrief in the classroom. "How many honus survived out of each group?" "What did you learn?" "How did you feel when you were turtle/predator?" Were the birds more successful on the land or the sea? What can humans do to help? Write of their experience. Explain why the turtles are endangered.

Extension: Discussion and or research- Why are the Northwest Islands the breeding grounds of the Green Sea Turtle? Why don't the turtles nest closer to civilization? Why do the turtles leave the nest at night? What may kill green sea turtles after they are grown?

Bishop Museum 2002, The Northwestern Hawaiian Islands: Join a Research Expedition. Last updated: Monday, 11-Feb-2002. Honu Survivor: The Green Sea Turtle Experience. Retrieved May 22, 2002, from

<http://www.bishopmuseum.org/research/nwhi/bioact.shtml>

Teacher Curriculum : El Nino

Grade Level: 5-8

Learner Outcomes:

- Students will access the Internet and collect information about the effects of El Nino for their region
- Students will be able to define global change
- Students will become aware of climatic changes in their region during an El Nino year
- Students will interpret data collected from a web site
- Students will be able to interpret a Standardized Vegetation Index (SVI) and draw conclusions about their region
- Students will draw conclusions about the effects of El Nino on agriculture in their region

Concept Introduction:

After studying about global climate changes and El Nino, students will collect data about rainfall and temperature variation for their region during an El Nino year. Students will then examine a series of standardized vegetation indices with DataSlate to draw conclusions about the effect of EL Nino on their region.

Teacher Preparation:

Technology: This lesson can be used in a one-computer classroom as a demonstration, individually in a lab or in-groups. The lesson is designed to last about one 50-minute period. Teachers need to be familiar with DataSlate and its basic operations. The on-line tutorial can be used to become familiar with this software. Teachers should also be familiar with all of the web sites students will use. The computer used should be at least a Pentium 90 (166 is better) with 16 RAM or a Power Macintosh with 32 MB of RAM. Either platform needs a CD-ROM.

Lesson: The teacher, if not familiar with ENSO events should review the web pages listed in the resource section of this page. Introduce the concept of Global Change and discuss its definitions. Do the same with El Nino and ENSO. Distribute assignments and data sheets. Allow students to complete the activity. Discuss finding as a class. This activity works ideally with cooperative groups.

Tools: DataSlate

Data Sets: SVI DataSlate Data set (zip file 2.5 MB)

Tutorials: Intoduction to DataSlate
Interpreting SVI imagery

Concept Extensions:

- What are the effects of La Nina on agriculture in your region?
- What are the current statistics for your area?

Resources

See Online Resource list at the end of the NWHI Teacher's Manual

This curriculum was taken from the UN Omaha Office of Internet Studies, in partnership with NASA at <http://ois.unomaha.edu/casde/bblocks>, and was last modified on 1-4-99.

Teacher Curriculum : Environment Pollutants on Coral



Photo by Jim Maragos

Grades: 3 – 6

Focus Question: What effect do indirect pollutants like carbon dioxide have on the reef ecosystem?

Lesson at a Glance: Students will perform experiments to examine what effect acid has on coral.

Key Concepts: Coral is the basic building block for reefs. The individual coral polyps are small and soft bodied with a hard external skeleton surrounding it. These small animals live in large colonies building off the skeletons of other polyps. While the coral is strong enough to be used as building blocks for houses it is very susceptible to some environmental factors such as acid rain.

Objectives: Students will be able to:

1. Describe the life cycle of a coral
2. Give examples of how coral is used by people and animals
3. Identify some of the factors that destroy coral reefs

Time: One class period.

Materials: Samples of coral, not collected from a living reef., diagram of a coral polyp and its life cycle, magnifying glass or microscope, pipette, vinegar.

Teacher Background: Coral reefs have existed for over 500 million years. Most reefs are in the tropics, the area between the Tropic of Cancer and the Tropic of Capricorn. These 'rain forests of the sea', contain approximately 25% of the ocean's species.

Coral begins as an individual polyp the size of a pea. The soft-bodied polyp builds a cup-shaped skeleton made of calcium carbonate around its soft body. They reproduce by creating new branches or sprouts. While the individual animals are small a colony can be huge. The Great Barrier Reef in Australia is the only living structure that can be seen from space. These structures made of living and dead skeletons are strong enough to withstand currents, salt water and temperature changes to name a few. Humans have used blocks made of coral for construction for many years. The Chamberlain House and

Kawaiahao Church in Honolulu are examples of coral block construction from the mid-19th century. More recently coral has been used to help build up runways in the Northwestern Hawaiian islands.

The basic structure of the reef is strong but it is not invincible. The reefs reflect the environment around it. If the surrounding area is healthy the reef will often be healthy as well. Acids from our car exhaust eat away at our fragile reefs along with other pollutants. Reefs are especially vulnerable because they take so long to regenerate.

Procedure and Preparation:

1. Brainstorm with the students everything that they know about coral reefs. Write all answers on the board.
2. Define and identify the different parts of a coral polyp.
3. Have students examine a piece of coral under a microscope. Can they identify the individual animals that made the up the piece that they are examining?
4. Using pipette, squeeze one drop at a time of acid (vinegar) onto the coral. Record what is happening.
5. Why did the coral fizz? The acid is eating away at the coral.
6. Brainstorm what we can do to prevent pollutants from reaching our reefs.

Extensions: Some of the research taking place on the expedition will be monitoring the species that live in the reef environment. Check into the website for updates on what the researchers have found.

Teacher Curriculum : Teaching with Object : 50 QUESTIONS

How Do Questions Help Us Understand an Object?

Grades: 3 – 12

Lesson at a Glance: After observing an object for a short time, students will generate many questions about the object.

Key Concepts: In order to really discern an object's meaning or use, you need to generate lots of questions. By asking many questions we are eventually moved past the obvious and start to ask questions about the object's relationship to people and other objects.

Objectives: A group of four students will be able to generate 50 questions about an object in less than ten minutes. Students will classify their questions into groups of similar questions.

Time: One class period.

Subject Areas: Social studies, science, language arts, critical thinking.

Materials: One object per group; A sheet of butcher paper; Two markers

Preparation: Collect at least one object for every group in the class. The object can be an everyday object or it can be an object that the students have little experience with. You may even use a picture instead of an object.

Teacher Background: By generating a large list of questions about a single object, students are forced to move past the obvious questions about its physical characteristics and start to ask questions about the object's origins, construction and social meaning. This process also allows teachers and students to discuss the object in a multidisciplinary and integrated context. Students will also see that they can organize and categorize their questions. By asking and analyzing a lot of questions, students become better at asking questions.

Teaching Suggestions: Put groups of four students in front of an object that is covered by a cloth. Let the students know what the procedure will be. They will lift the cloth and have thirty seconds to observe the object without talking to each other. After the thirty seconds is up the group will begin to generate as many questions as they can in ten minutes. Have one person in the group write down all the questions. The goal is to shoot for fifty questions, or as many as possible. After they have generated the questions, have the students post their questions on the wall. Let the groups walk around the room observing the questions that their peers generated. Have them look for similarities. After they have observed the questions, have them group the questions into categories. Let the students decide on natural groupings of questions.

Bishop Museum (1999, July). *Kaho'olawe: As sense of place*. Honolulu, HI: Bishop Museum Native Hawaiian Culture & Arts Program (NHCAP), funded through the National Park Service, U.S. Department of the Interior.

Teacher Curriculum : Teaching with Object : BLINDFOLDED

What Characteristics Does an Object Have?

Grades: K – 12

Lesson at a Glance: Students will reach into a pile of objects blindfolded and find an object. They will analyze the object with just their sense of touch. After putting the object back into the pile they will try to pull it out again by trying to recognize its physical characteristics.

Key Concept: Objects have physical characteristics. Using a sense that we are not familiar with to make observations may add to our knowledge of an object.

Time: 30 minutes.

Materials: A box of objects to analyze. The more discerning your students are, the more similar you should make the objects. (i.e. For Kindergartens, you should make them all toys of some kind; for high school students, have them discern between objects of the same kind, such as peanuts or sea shells).

Preparation: Make a box of objects. Prepare several blindfolds.

Teacher Background: Identifying an object's physical characteristics is the first step in analyzing what it may have been used for or its construction method. This activity forces students to observe physical characteristics that they may have ignored otherwise in a visual observation.

Teaching Suggestions: Divide class into groups of four students. Give each group a box filled with a few objects in it. Blindfold all the students or just have them close their eyes. Each student reaches inside the box and picks out an object. Let them observe the object with their sense of touch for about three or four minutes. After observing the item for awhile they are to put the object back into the box. After all the objects are back in the box have the students record their observations. This can be done in a variety of ways, such as drawing, writing or, for little ones, verbally reporting with the teacher writing down their observations. Small children may need a bit of prompting to be able to describe their object (they can describe it but may have trouble articulating and describing its characteristics. For example, you may have to ask if it is rough or smooth. Then they may be able to make finer distinctions). After all of the data has been recorded allow students to look at their objects and see if they can find their object.

Bishop Museum (1999, July). *Kaho'olawe: As sense of place*. Honolulu, HI: Bishop Museum Native Hawaiian Culture & Arts Program (NHCAP), funded through the National Park Service, U.S. Department of the Interior.

Teacher Curriculum : Teaching with Objects : I See

What Observations Can We Make About an Object?

Grades: 3 – 12

Lesson at a Glance: Students practice making observations that become more and more detailed.

Key Concept: Observation is the key to discovery.

Objectives: Students will make many observations about the same object.

Time: 30 minutes.

Subject Areas: Social studies, science, math, language arts.

Materials: An interesting object which has multiple characteristics.

Preparation: Display an object in a way that makes it easily observable by all the students.

Teacher Background: Identifying an object's physical characteristics is the first step in analyzing what it may have been used for, or its construction method. Careful observation and keen perceptual skills are necessary to identify a wide range of characteristics about an object.

Teaching Suggestions:

1. Place an object in front of a group of students in a way that makes it easily observable by all.
2. Have a student state one observation about the object. ("I see a round thing with a hole on top"). Record the observation on a board.
3. In a circle or rows, have each student state an observation which has not already been mentioned, and record them.
4. When at least one observation has been made by every student (can be more), review the observations in a discussion and ask the students for ideas on how they might be grouped. Show how the observations may be in categories such as shape, size, construction materials, and so on.

Bishop Museum (1999, July). *Kaho'olawe: As sense of place*. Honolulu, HI: Bishop Museum Native Hawaiian Culture & Arts Program (NHCAP), funded through the National Park Service, U.S. Department of the Interior.

Teacher Curriculum : Teaching with Objects : Mystery Object

How Can We Find Out Information By Asking Questions?

Grades: 3 – 12

Lesson at a Glance: Students will ask different kinds of questions and form hypotheses as to the function and construction of a mystery object.

Key Concept: Asking questions about an object can help us identify its construction method, function, significance in a culture, and other information about it.

Objectives: Students will practice asking questions that give them the most information.

Time: 30 minutes.

Subject Areas: Social studies, science, math, language arts.

Materials: Mystery object

Preparation: You will need to locate a mystery object that you know your students will not have had experience with. Learn as much as you can about the object so you will be able to answer student questions.

Teacher Background: This activity will help your students to learn how to ask questions that are well thought out and, when answered, will provide the most amount of possible information. This inquiry-based activity allows students to decide what is the most critical information needed in order to solve their "mystery".

Teaching Suggestions:

1. Place the mystery object on a table in front of the class. Tell the students that they have to figure out what the object is by asking questions about it.
2. Have all the students ask any question about the object they wish. The questions in this first round will not be answered.
3. After everyone has asked a question, ask the students to ask yes-or-no questions, beginning with the first student. Answer each question as it is asked. During this process, the students may want to take notes on the questions and answers.
4. After everyone has asked their second question, divide the class into small groups. In these small groups, the students will try to come up with

some information and "educated guesses" about the object. Their information should be as detailed as possible.

5. Ask the groups to report their "educated guesses".

Extended Activities: This is also a great method for exploring images and graphs. You will be amazed at how much learning happens when you have students discover for themselves what a graph is saying instead of just telling them everything. To use a graph, just take off the interpretive caption or key on the graph and have the students use this questioning activity to figure out what the graph is conveying.

Bishop Museum (1999, July). *Kaho'olawe: As sense of place*. Honolulu, HI: Bishop Museum Native Hawaiian Culture & Arts Program (NHCAP), funded through the National Park Service, U.S. Department of the Interior.

Relevant Newspaper Article Reference List

- Aguiar, E. (2002, April 12). Keiki hooked on old fishing arts. *Honolulu Advertiser*, pp. A1, A12.
- _____ (2002, June 2). Kailua waterways cleanup may be coming. *Honolulu Advertiser*, p. A27
- Beamish, R. (2002, May 14). Clinton's rules for NW islands could weaken. *Honolulu Star-Bulletin*, p. A9.
- _____ (2002, May 14). El Nino fears may force delay of Hokule'a trip. *Honolulu Star-Bulletin*, p. A9.
- Bernardo, R. (2002, May 14). Sea policy panel hears turtle appeal. *Honolulu Star-Bulletin*, p. A3.
- _____ (2002, May 27). Jellyfish invasion surprises Kailua. *Honolulu Star-Bulletin*, pp. A1, A7.
- Bricking, T. (2002, June 6). Canoe club honors master carver. *Honolulu Advertiser*, p. E1.
- Blakeman, K. (2002, March 16). Sanctuary system moves forward. *Honolulu Advertiser*, p.B1.
- Burlingame, B. (2002, April 28). Boys of The Panala'au. *Honolulu Star-Bulletin*, pp. D1, D6.
- Cole, W. (2002, June 6). Midway a place of history, heroes. *Honolulu Advertiser*, pp. A1, A2.
- Coleon, S. (2002, June 6). Oceanic curiosities in new exhibit. *Honolulu Advertiser*, p. A9.
- Creamer, B. (2002, April 17). Signs of El Nino brewing. *Honolulu Advertiser*, pp. A1, A11.
- Estermann, P. and C. Sanburn. (2002, April 14). Both victory and defeat from Sandy Beach dispute. *Honolulu Advertiser*, pp. B1, B4.
- Gee, P. (2002, May 19). Hurricane preparedness urged. *Honolulu Star-Bulletin*, pp. A13, A16, A17.
- Gonser, J. (2002, March 21). Limu species targeted for eradication. *The Honolulu Advertiser*, p. B1.

- Hoover, W. (2002, April 7). Environment meetings clash. *Honolulu Advertiser*, p. A25.
- _____ (2002, June 5). Shark's cove fishing ban stuns old-timers. *Honolulu Advertiser*, pp.A1, A2.
- Hurley, T. (2002, April 14). Koa's magic lures poachers. *Honolulu Advertiser*, pp. A1, A4.
- Krauss, B. (2002, May 15). Crueler sea encroacher on atoll. *Honolulu Advertiser*, p. B1.
- _____ (2002, May 26). No more rabbits on Rabbit Island. *Honolulu Advertiser*, p. A25.
- Kubota, G. T. (2002, May 8). Wasteful practice of gill-netters denounced by Maui residents. *Honolulu Star-Bulletin*, p. A6.
- _____ (2002, May 10). Whales unhurt by sea lab's sounds. *Honolulu Star-Bulletin*, p. A2.
- _____ (2002, May 10). Maui whale count comparable to levels observed last year. *Honolulu Star-Bulletin*, pp. A1, A7.
- _____ (2002, June 10). Weather, seawalls cited in Maui beach erosion. *Honolulu Star-Bulletin*, pp. A1, A6.
- _____ (2002, June 12). Size Matters. *Honolulu Star-Bulletin*, pp. A1, A11.
- Lautenbacher, C. (2002, May 12). Oceans key to predicting global climate changes. *Honolulu Advertiser*, p. B3.
- Leone, D. (2002, May 15). U.S. ocean panel urged to get Pacific input. *Honolulu Star-Bulletin*, p. A5.
- Manson, C. (2002, May 31). Remembering Midway Atoll. *Honolulu Advertiser*, p.18.
- Markrich, M. (2002, May 5). Planting a future. *Honolulu Advertiser*. pp. B1, B4.
- Tsai, M. (2002, May 26). Colonizers recall wartime survival. *Honolulu Advertiser*, pp. A1, A11.
- Rosenblum, M. (2002, May 12). Maui's troubled waters. *Honolulu Star-Bulletin*, pp. D1, D6.
- Roth, S. (2002, March 14). Marine Sanctuary hearing tense. *Honolulu Advertiser*, p. A30.

- Sakurai, J. (2002, April 25). Delegates debate whale-catching rules. *Honolulu Advertiser*, p. A8.
- Scott, S. (2002, May 10). Glowing mysteries dwell among oceanic nutrients. *Honolulu Star-Bulletin*, p. A2.
- _____ (2002, May 24). Isle seasonal differences are subtle yet noticeable. *Honolulu Star-Bulletin*, p. A2.
- Silverstein, D. (2002, March 24). Our tribe must make all islands survivors. *Honolulu Advertiser*, p. B1.
- Song, J. (2002, May 2). Navy halts bombing in Marianas. *Honolulu Advertiser*, p. B2.
- TenBruggencate, J. (2000, September 26). Alien bugs invading remote island. *Honolulu Advertiser*, p. B4.
- _____ (2002, February 2). Service cuts at Midway raise protest. *The Honolulu Advertiser*, pp. A1, A7.
- _____ (2002, March 4). How our forest have changes. *Honolulu Advertiser*, p. B5.
- _____ (2002, April 7). Sanctuary status sought for Northwestern Hawaiian Islands. *Honolulu Advertiser*, pp. A23, A28.
- _____ (2002, April 8). Japan seeks to reduce sea debris. *Honolulu Advertiser*, p. B1.
- _____ (2002, April 8). Taape may not deserve ill repute. *Honolulu Advertiser*, pp. B1, B5.
- _____ (2002, April 30). New firm to manage Midway Atoll services. *Honolulu Advertiser*, p. B1.
- _____ (2002 May 5). Fewer sever quakes hit Big Island. *Honolulu Advertiser*, pp. A25, A31.
- _____ (2002, May 11). U.S. panel on ocean policy in search of new proposals. *Honolulu Advertiser*, p. B6.
- _____ (2002, May 12). Conflicts sink Midway venture. *Honolulu Advertiser*, pp. A23, A30.
- _____ (2002, May 24). Ceremonies to mark 60th anniversary of Battle of Midway. *Honolulu Advertiser*, p. B4.
- _____ (2002, May 27). We're to blame for oily seas. *Honolulu Advertiser*, p. B1.

_____ (2002, June 3). Nature contributes to bad air in Hawai'i. *Honolulu Advertiser*, p. B1.

_____ (2002, June 10). Devices can keep debris out of storm drains. *Honolulu Advertiser*.

Survival Challenge & Songs

Survival Challenge Overview

Songs: E Pele, E Pele
 Pupu Hinuhinu
 Song of the Workers on Howland Island