The Life Cycle of an Island

Summary
Students are introduced to plate tectonics and the life cycle of an island. By utilizing various forms of instructional media, students will develop a visual diagram of an island’s life cycle.

Objectives
- Students will be able to identify the stages of an island’s life cycle.
- Students will be able to list the environmental features that impact an island’s shape and size.
- Students will be able to explain the effects of plate tectonics and a hot spot.

Materials
For class:
Video on plate tectonics
(http://mm.coexploration.org/video/tcoe/vtw06/bbflv/index.html OR search YouTube.com or Arkive.org)
DVD/VCR and TV setup
Computer with internet connection
Projector hookup to computer
Individual notecards with names of island stages
Individual notecards with descriptions of island stages

For each student dyad:
1 poster paper
Drawing utensils
Coloring utensils

Making Connections
Students will draw from personal and scholastic experience to determine examples of island formation and destruction. The presence of an active volcano, as well as dormant and extinct volcanoes on Hawaii island provide a plethora of experience for students.

Teacher Prep for Activity
Set up computer with internet connection and hook up projector prior to class start. Order, borrow, or rent the DVD for viewing during class OR search for a similar one on YouTube.com or Arkive.org as suggested above. Prepare poster paper and art supplies for student use. Cover tables if art supplies require more cleaning demands.

Concepts
The Northwestern Hawaiian Islands (NWHI) are a prime case to study the life cycle of an island. Starting with a hot spot and plate tectonics, an island is formed. Eventually, erosion will whittle it down to an atoll and the island will submerge back into the ocean.

HCPS III Benchmarks
SC.8.1.1.
SC.8.1.2.
SC.8.2.2.

Duration
90 minutes

Source Material
PRISM
National Geographic
NOAA

Vocabulary
Archipelago
Basalt
Convection current
Fault
Hotspot
Magma
Rift
Tectonic plate
Volcano
Background
The islands that make up the Hawaiian archipelago were formed by volcanic eruptions that began more than 80 million years ago. Volcanoes are commonly correlated with the movement of tectonic plates that form the Earth’s crust. There are approximately a dozen plates that move several centimeters a year relative to each other. Heat, by convection currents, causes these plates to move. These sliding movements create stresses on the boundaries, resulting in earthquakes and potential breaks in the rock known as faults. When tectonic plates move apart from each other, a rift is formed. This allows magma from deep in the Earth to harden into solid rock known as basalt.

Volcanoes can also be formed by hotspots, which are naturally caused veins to reservoirs of magma in the upper mantle of the Earth. The Hawaiian Islands are a result of volcanic activity from a hotspot. Currently, the hotspot is located below the Big Island of Hawaii. As the plate moves across the hotspot, magma erupts and creates volcanoes that eventually become islands. The oldest island is Kure Atoll at the most northern point of the NWHI, and the youngest island is Hawaii at the most southeastern end of the archipelago. As the plate moves northwest, the older islands move farther away from the hotspot. These islands are faced with water and wind erosion, which eventually help to submerge the island below the sea’s surface.

There are eight acknowledged stages of growth and erosion in the Hawaiian archipelago:
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.

Vocabulary
Archipelago – a large group of islands
Basalt – magma hardened into solid rock form
Convection current – flow of a fluid or air due to heating and cooling of the fluid or air
Fault – breaks in the rock at the perimeter of tectonic plates
Hotspot – naturally caused veins to reservoirs of magma
Magma – molten rock found below the surface of the Earth
Rift – separation between two tectonic plates
Tectonic plate – pieces of the Earth’s crust and upper mantle which form the Earth’s surface
Volcano – a vent in the Earth’s crust through which molten lava is ejected

Eight Stages of Island Growth and Erosion
Deep submarine stage – begins with submarine eruptions, eventually reaching the ocean surface
Shallow submarine stage – contains an above-water crater, spouts lava from rifts on the sides of the cone
Sub-aerial shield-building stage – begins with collapse of highest point (summit) on the volcanic cone to form a caldera, volcano continues to emit lava from summit and from rifts in the side of the cone
Post-caldera stage – lava fills and overflows the caldera to form rounded summit, overall volcanic activity may slow
Erosional stage – lava is no longer being added, volcanic cone is attacked by erosion from ocean and rainfall; sea bluff, deep valleys, and ridges are characteristic
Stage of reef growth – volcanic mountains are eroded to the point where they barely break the ocean surface, volcanic island is slowing sinking but coral growth may keep pace forming reefs
**Stage of post-erosional eruptions** – minor renewal of volcanism through few small cones or lava flows are formed

**Atoll stage** – lava rock eroded below sea level and only coral reef remains at surface

**Procedure**

1. Introduce the location of the Northwestern Hawaiian Islands on a physical map or as a screen projection (from [http://www.soest.hawaii.edu/pibhmc/pibhmc_mhi.htm](http://www.soest.hawaii.edu/pibhmc/pibhmc_mhi.htm)).
2. Introduce or review the concepts of plate tectonics and hotspots that end in volcanic activity (see background information above).
3. Show students the Hawaiian Tectonics video (from [http://mm.coexploration.org/video/tcoe/ctw06/bbflv/index.html](http://mm.coexploration.org/video/tcoe/ctw06/bbflv/index.html)).
4. Discuss what was covered in the Hawaiian Tectonics video. Emphasize the movement of plates and thus the movement of the hotspot to create the Hawaiian archipelago.
5. Explain to students that there are eight stages of growth and erosion in the islands of the Hawaiian archipelago (refer to vocabulary above).

*(Elapsed time check: 20 minutes)*

6. Pass out notecards with stage names to eight students in the class.
7. Next, pass out notecards with the stage descriptions to eight other students in the class. (Note: If there are more than 16 students in the class, have them group into pairs first and pass out notecards to the pair).
8. Have students match the names of the eight stages to their descriptions.
9. Students should be in pairs (or groups) as designated by their notecards. Check to make sure that the descriptions are correctly matched with the stage names.
10. Explain to students that they will be drawing a prediction of what Loihi will look like in the stage that they were assigned. They must deduce what Loihi will physically look like, and how human, plant, and animal influence will affect its development and look.
11. Give each student group a poster paper, coloring utensils, and writing utensils to work with. Allow approximately 30 minutes for poster preparation.

*(Elapsed time check: 65 minutes)*

12. Have each student group present their island stage, and prediction of Loihi. Have students describe every aspect of their poster.
13. Ask the class whether the stages that the student groups have developed are in-line with each other. If they are not, ask why and how it can be resolved.

**Assessments**

Poster development
Ability to accurately describe the poster & justify drawing based on knowledge from lesson

**Resources**

- The College of Exploration. ([http://mm.coexploration.org](http://mm.coexploration.org)).
- National Geographic EdNet ([http://www.ngsednet.org](http://www.ngsednet.org)).
- National Geographic Xpeditions ([http://www.nationalgeographic.com/xpeditions]).
- Ocean Explorer ([http://oceanexplorer.noaa.gov](http://oceanexplorer.noaa.gov)).
- SOEST Pacific Islands Benthic Habitat Mapping Center ([http://www.soest.hawaii.edu/pibhmc/pibhmc_mhi.htm](http://www.soest.hawaii.edu/pibhmc/pibhmc_mhi.htm)).
Extension Activities
If there is additional time, select several islands from the Northwestern Hawaiian Islands group, and have students provide a brief description of these islands. Have students prepare a written report that assigns each island to an appropriate stage and provides an explanation for their classification.

Art Connections
Art is a strong component of this lesson. It is at the teacher’s discretion to how much art is involved in the poster making process. Aside from markers and crayons, sponged paint can give the illusion of billowing volcanic eruptions, and glitter pens can create the illusion of volcanic glass spewing from the lava.
**Northwestern Hawaiian Islands**

**Concepts**
Movement of water around the Pacific and throughout the world is important for the marine life in the NWHI.

**HCPS III Benchmarks**
- SC.8.1.1.
- SC.8.1.2.
- SC.8.2.2.
- SC.8.8.4.
- SC.8.8.6.
- SC.8.8.7.

**Duration**
40 minutes

**Source Material**
PRISM

**Vocabulary**
- Climate
- Coriolis Effect
- Current
- Deep circulation
- El Niño
- Gyre
- High-pressure system
- Low-pressure system
- Surface circulation
- Weather

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**Ocean Currents**

**Summary**
Students will learn what causes ocean currents and how they play a role in distributing marine debris and pollution around the world. They will also learn what causes the Coriolis Effect and El Niño.

**Objectives**
- Students will be able to identify the environmental causes of ocean currents.
- Students will be able to explain the effects of ocean currents on climate and weather.

**Materials**

**For each student dyad:**
- 1 rectangular plastic bin or baking dish (approx. 5-8 inches tall)
- Warm water to fill half of the container
- 4 ice cubes colored with food dye

**For each student:**
- 1 copy of “Ocean Currents Lab” worksheet
- Writing utensil

**Making Connections**
Students will draw upon personal experiences of hearing about or experiencing the effects of El Niño and how the weather differs from one year to the next and so on. Students may also recognize marine debris they have seen on the beach, and how foreign materials made its way to Hawaii.

**Teacher Prep for Activity**
Prepare color-dyed ice cubes by mixing food dye into the water used to make the ice cubes. Allow ample time for water to freeze prior to activity. Make one copy of “Ocean Currents Lab” worksheet for each student. If time is limited, fill container with warm water prior to activity start.

**Background**
**Currents** are continuous streams of seawater that circulate through the ocean. Some are short-lived and small, while others are vast flows that take centuries to complete the circumference of the globe. Currents are caused by winds, water temperature, gravity, and variations in water density in different parts of the ocean. There are two distinct current systems in the ocean: **surface circulation**, which stirs the relatively thin upper layer of the sea; and, **deep circulation**, which sweeps along the deep sea floor.
The dominant pattern of surface circulation is the **gyre**, a well-organized, circular flow. Five enormous gyres spin in subtropical waters, two in both the Atlantic and Pacific Oceans, and one in the Indian Ocean. Smaller polar gyres stir the northern Atlantic and Pacific. A surface current circles endlessly around Antarctica.

These gyres are made up of currents set in motion by winds and gravity, and steered by the placement of the continents and the rotation of the Earth. Wind is an important cause of surface currents. Winds and gravity start water moving, but the currents that form do not flow parallel to the wind or straight down the steepest surface. Rather, the currents move at an angle to the force that generates them, a phenomenon called the **Coriolis Effect**. The Coriolis Effect occurs because the Earth’s surface rotates faster at the equator than at the poles.

Most importantly, ocean currents affect climate, weather, and the Earth’s atmosphere. **Weather** is the local state of the atmosphere over a short time span and **climate** is the general condition of the atmosphere over time. Global warming and **El Niño** are climatic conditions because they may persist over long periods of time. Although the atmosphere can influence ocean currents by wind-driven circulation, ocean currents may affect the atmosphere through **high** and **low pressure systems** and the storage of heat in the water as compared to the atmosphere.

**Vocabulary**

- **Climate** – the composite or generally prevailing weather conditions of a region, as temperature, air pressure, humidity, precipitation, sunshine, cloudiness, and winds, throughout the year, averaged over a series of years
- **Coriolis Effect** – the apparent deflection of a body of motion with respect to the earth, as seen by an observer on the earth, attributed to a fictional force but actually caused by the rotation of the earth and appearing as a deflection to the right in the Northern Hemisphere and a deflection to the left in the Southern Hemisphere
- **Current** – a large portion of air, large body of water, etc., moving in a certain direction
- **Deep circulation** – currents that flow in the deep ocean
- **El Niño** – a warming of the ocean surface off the western coast of South America that occurs every 4-12 years when upwelling of cold, nutrient-rich water does not occur - causing die-offs of plankton and fish and affects Pacific jet stream winds, altering storm tracts and creating unusual weather patterns in various parts of the world
- **Gyre** – a ring-like system of ocean currents rotating clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere
- **High-pressure system** – created by an uneven cooling on the ground that causes the hot air to rise and spread out, and eventually causing the air to cool and sink back to the ground
- **Low-pressure system** – generally caused by air becoming less dense as a result of heating
- **Surface circulation** – currents that flow on the surface of the ocean
- **Weather** – the state of the atmosphere with respect to wind, temperature, cloudiness, moisture, pressure, etc.
Procedure

1. Begin the activity by introducing the “world ocean.”
   a. Rather than the five oceans that are commonly referred to (Pacific, Atlantic, Southern, Indian, and Arctic), the world is one big ocean because they are all connected.

2. Ask students where they think the water would be warmer – near the equator or near the poles.
   a. Students should know the water is warmer near the equator, complimenting the tropical climate.

3. Explain that the class will perform an experiment to demonstrate how the colder waters near the poles and the warmer waters near the equator mix together and move to create ocean currents.
   *(Elapsed time check: 15 minutes)*

4. Divide the class into dyads or triples and hand out the Ocean Currents Lab worksheet to each student.

5. The students in each group should fill a clear rectangular container with warm tap water to represent the warm water near the equator.

6. Ask students what they predict will happen if colder water is introduced into the system.

7. Instruct students to place one (colored) ice cube at each end of the container, representing the cold water near the poles.
   a. Watch for students who do not regularly follow directions, as their data may be skewed if they place ice cubes in other areas other than the polar ends of the container.

8. Allow students to observe that the cold (colored) water sinks and moves along the bottom of the container toward the warmer water in the center.
   *(Elapsed time check: 30 minutes)*

9. Have students complete the rest of the worksheet and answer the concluding questions by extrapolating their lab findings and applying it to real-life situations.

Assessments

Lab observations
Completion of “Ocean Currents Lab” worksheet

Resources

National Geographic Xpeditions (http://www.nationalgeographic.com/xpeditions).

Extension Activities

If time and supplies permits, allow students to add more ice cubes at the poles to determine how this changes the “ocean.” It might be beneficial to have different colored ice cubes for this extension.

Culture Connections

Students may investigate current movements further by researching how the Polynesians used ocean currents to navigate the Pacific and land upon the Hawaiian Islands.
Ocean Currents Lab

Problem (What are we studying?):

Question (What are we going to figure out?):

Hypothesis (What is our best guess?):

Methods (What steps are we taking to solve our question?):

Observations (What are we seeing, hearing, feeling?):
Results (What did we find out?):

Discussion (What do these results mean?):

Conclusion (Questions to answer about the lab):

1. How would oceans affect the Earth’s weather? Think about weather at the equator compared to the weather at the poles.

2. Why is it important to study ocean currents? Think about how plants, animals, and humans use ocean currents.
Species Diversity

Summary
Students will learn about the diversity of species in the Northwestern Hawaiian Islands and how their existence may be threatened by environmental changes. They will also learn why diversity is important in an ecosystem.

Objectives
- Students will be able to determine why the diversity in the NWHI is unparalleled by anywhere else in the world.
- Students will be able to explain the necessity of diversity in an ecosystem such as the NWHI.

Materials
For each group of four students:
1 poster paper
1 “NWHI Species List” handout
writing utensils

For each student:
1 “A Global Treasure” article
1 “The Last Best Place” article

Making Connections
Although students may not have personally seen many of the species, because they are centralized in the NWHI, they may be able to draw upon knowledge and prior experience with similar species that are found in the main Hawaiian Islands. Having resource books on the NWHI available will help students to connect to these species.

Teacher Prep for Activity
Make one copy of “A Global Treasure” and “The Last Best Place” article for each student. Borrow books on the NWHI to provide as visual resources in the classroom. A recommended list of books can be found the Resources section of this lesson.

Background
The Northwestern Hawaiian Islands, a Marine National Monument, include the northern 75% of the Hawaiian archipelago. In this two million acre expanse, coral reefs, atolls, small islands, seamounts, banks, and shoals exist. There is an abundance of sea birds and large apex ocean predators. This coral reef habitat supports approximately 7,000 marine species, 25% that are endemic – existing nowhere else on Earth.
The 14 million seabirds that nest in the NWHI, as well as the Hawaiian monk seals and green sea turtles all rely on healthy land and sea habitats, and a balance of species diversity. The **biomass** of marine life in the NWHI is three times greater than that of the main Hawaiian Islands. NWHI coral reefs have more **apex predators**, such as sharks and ulua. Their presence in large numbers suggests that the ecosystem is healthy, since there needs to be an adequate number of species to support them (as prey). In contrast, the main Hawaiian Islands’ ecosystem consists mostly of low-level carnivores and herbivores. The absence of apex predators is attributed mostly to overfishing.

The NWHI have one of the highest rates of endemism in the Pacific for marine and terrestrial species. Researchers have estimated that these islands are home to many species found nowhere else on Earth, including: 12 species of plants, 7 land mollusks, 64 arthropods, and 4 land birds. The species’ distribution and habitat requirements make them very fragile and extremely susceptible to predation, over-harvesting, and being out-competed by alien species.

Overfishing or fishing pressure has reduced many nearshore fish populations in the main Hawaiian Islands to dangerously low fish resource levels, where they are unable to replenish themselves. The loss of traditional controls on fishing in the last 200 years, combined with pressures of a growing human population, coastal development, habitat loss, invasive species, and the use of modern technology have all contributed to decreased fish populations.

**Vocabulary**

- **Apex predator** – animals that feed at the top of the food chain
- **Biomass** – total weight of living things in a defined area
- **Endemic** – unique to an area

**Procedure**

1. Start the lesson by having students read the article, “A Global Treasure” and note what are the important facts that the article pointed to.
   a. Students are encouraged to highlight, underline, and make notes of important phrases or identify words they are not familiar with.
2. Next, have the students read “The Last Best Place” article and take notes.
3. Review what the students read and took notes on. Write the important points on the board, so that they remember what they read. *(Elapsed time check: 20 minutes)*
4. Review the concepts of a food chain.
   a. Producer – organisms that use energy from the sun to produce their own food
   b. Consumer – animals that get their energy by feeding on plants or other animals
   c. Decomposer – organisms that help to break down plant and animal matter into nutrients that producers need to grow
5. Explain to students that they will create a food chain with the organisms provided on the NWHI Species List handout.
6. Allow students to refer to online or reference book information to determine what the animals consume to produce energy.
7. Regroup the class and go over the groups’ food chains. Have students critique other groups’ food chains to discuss what is a producer, consumer, or decomposer.
8. If only a short time permits, ask students what would happen if one level of the food chain were eliminated.
Partnerships for Reform through Investigative Science and Math

- Answer: the food chain would end and the organisms would die because one food source would vanish. The level below would over-populate and its food source would become scarce. The level above would have no food source, and thus perish.

9. If more time permits, cross out four organisms on each group’s NWHI Species List (variable by group), and have them create another food chain.
   - Ask students if the food chain would change without these organisms and how.

10. Conduct a class discussion on why species diversity is important to the NWHI and all other ecosystems.
   - Answer: increased food sources provide more opportunities for diverse niches of consumers, and thus less competition for foraging.
   - Answer: invasive species alter the natural balance of species diversity, as it has a more competitive nature and may harm endemic and native species that are not adapted to competition.

Assessments
Notes and questions on articles
Food chain development
Discussion participation

Resources
NOAA Navigating Change Curriculum
Northwestern Hawaiian Islands Marine National Monument – A Citizen’s Guide

Culture Connections
If time permits, have students investigate how past human disturbance has affected the species diversity in the NWHI and why it was important for the NWHI to become a Marine National Monument. Also, students may investigate the extreme measures that human researchers must take prior to their arrival on any NWHI (i.e., freezing clothes prior to kill invasive species, buying new shoes, etc.).
NWHI Species List

Hawaiian Monk Seal

Ahi
Limu
Mano
Laysan Finch
Ulua
Honu
Great Frigatebird
Naupaka
Laysan Duck
Nihoa Palm
Black-Footed Albatross
Tube Coral
Nihoa Finch
Octopus
Humpback Whale
Coral Shrimp
Spinner Dolphin
Simple Collector Crab
Algae
A GLOBAL TREASURE

Beyond the main eight populated islands of Hawai‘i lie a string of tiny islands, atolls, shoals, and banks spanning 1,200 miles of the Pacific Ocean, the world’s largest body of water. Hundreds of miles northwest of Kaua‘i, places like Nihoa, Laysan, Pearl and Hermes, and Kure comprise the little known, rarely visited Northwestern Hawaiian Islands (NWHI). Seen from space, the area’s shallow waters appear as a string of turquoise jewels in an empty and dark blue vastness.

Thanks to their isolation, these 4,500 square miles of wild coral reefs are among the healthiest and most extensive in the world. This marine wilderness is home to the highly endangered Hawaiian monk seal, the world’s second most endangered seal, and uninhabited sandy islets provide the nesting grounds for 90 percent of Hawai‘i’s threatened green sea turtles. Though land areas are limited, over 14 million seabirds nest here and this is the only home for four endangered land birds.

The marine habitats of the NWHI contain features not found in the main Hawaiian Islands, such as coral atolls, and nurture thriving populations of many species once abundant in the main Hawaiian Islands, but rarely found today. Large predatory fish such as jacks, Hawaiian grouper, and sharks are nearly fifteen times as numerous in the shallow waters of NWHI compared to the heavily fished main Hawaiian Islands. Many sought after aquarium species, now rare in the main Hawaiian Islands, are much more common on these reefs as well.

Globally the NWHI are a natural and cultural treasure of outstanding scientific, conservation and aesthetic value. The steps we take in preserving these last undisturbed environments are gifts we give to our children’s children, and help in sustaining the ocean’s bounty that supports us today.

THE NORTHEASTERN HAWAIIAN ISLANDS
The Last Best Place:  
Terrestrial Environments

Although some of the Northwestern Hawaiian Islands (NWHI) were decimated by introduced mammals (rabbits, in the case of Laysan), other islets and atolls have been relatively untouched by humans. As a result, robust seabird populations and healthy insect and plant communities can still be found, and in places that were heavily impacted, seabird and plant populations are now on the mend. Nihoa Island is one of the most biologically pristine islands in the Pacific, and probably most closely represents the original island appearance and native species found before humans arrived in the Hawaiian Islands.

These islands provide breeding sites for all but three of Hawaii’s 22 species of seabirds such as the grey-backed tern, short-tailed albatross, and the red-tailed tropicbird. Millions of central Pacific seabirds congregate on these islands to breed. They nest in burrows and cliffs, on the ground, and in trees and shrubs. For some species, these tiny specks of land provide their only breeding site.

More than 99 percent of the world’s Laysan albatrosses and 98 percent of the world’s black-footed albatrosses return to the NWHI each year to reproduce. For species such as Bonin petrels and Tristram’s storm-petrels, these predator-free islands provide the last safe nesting places since islands in other parts of the Pacific are becoming 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 (the Nihoa finch, Nihoa millerbird, and Laysan finch) and the world’s rarest duck – the Laysan duck – are found on these islands.

The plants of the NWHI are primarily coastal strand species of the Pacific that can tolerate high salt levels, periodic drought, and intense sun. Most have seeds capable of dispersing in seawater. Some plants evolved into new species, and six endemic plants are listed under the Endangered Species Act, including the endangered fan palm Pritchardia remota found only on Nihoa. A similar palm went extinct during the rabbit plague on Laysan Island, and in recent years an alien grasshopper has attacked Nihoa’s palms.

The first entomologists (insect scientists) visited Laysan Island in 1893, and upon numerous subsequent visits, identified at least 75 native species, including 15 found only on Laysan. The arthropods and land snails are the least understood components of the terrestrial ecosystems, but studies continue to improve our knowledge. At least 35 species of endemic insects and spiders, and six species of endemic land snails have been identified at Nihoa Island. Unfortunately, positive discoveries are at times offset by negative ones – as many as 125 species of alien insects and spiders have also been found, and some of these, particularly ants, are extremely destructive. Considered “ecosystem busters,” introduced ants have the ability to displace native species, and even affect the survival of ground nesting seabirds.
Coral Reef Health and Marine Debris

Summary
Students will learn about the importance of the extensive coral reefs in the Northwestern Hawaiian Islands and the impeding threats to coral reefs around the world. They will increase their knowledge about legislative efforts to protect this natural resource. They will also learn why marine debris is one of the greatest threats in the Northwestern Hawaiian Islands.

Objectives
- Students will be able to explain the interdependence existing in a coral reef ecosystem.
- Students will be able to describe the current efforts to protect coral reef health.
- Students will be able to describe the marine debris currently degrading the world’s oceans.
- Students will be able to explain the threat of marine debris to the NWHI’s species.

Materials
For the class:
Finding Nemo DVD (with Bonus Features)
TV or AV system with DVD player
Mobile lab (or computer and Internet access for all students)
Color printer

For each group of four to six students:
Poster paper
Writing utensils

Making Connections
Although students may not be familiar with the NWHI coral reefs, the use of the Finding Nemo DVD and the Great Barrier Reef can be used to bridge a knowledge gap. Most students are familiar with this Disney movie, and can relate to the diverse environment below sea level.

Teacher Prep for Activity
Borrow the Finding Nemo DVD with bonus material. Connect the DVD player to the TV or AV system. Secure the mobile computer lab, school computer lab, or 1 computer for each group for the class period. Connect a printer to the computers for picture printing.

Northwestern Hawaiian Islands

Concepts
Coral reef health and marine debris are major issues in the lower eight Hawaiian Islands, but it is also a problem in the NWHI.

HCPS III Benchmarks
SC.8.2.1.
SC.8.5.1.
SS.8.5.1.

Duration
135 minutes OR
3 x 45 minutes

Source Material
PRISM

Vocabulary
Bolus
Coral bleaching
Marine debris
Phytoplankton
Pollutants
Symbiosis
Zooxanthellae
Background
Coral reefs are complex communities of plants and animals. The coral colonies that grow next to and on top of each other form the basis for this community, providing food, shelter, and diverse living spaces for many plants and animals.

Coral reefs provide valuable material for the sandy islands and islets. This is a support system for millions of seabirds, sea turtles, monk seals, and land-based endemic plants and insects. Variations in coral species dominance occur and some types of coral are restricted to the center of the chain. The coral reefs offer a variety of habitat types, including fore and back reefs, lagoons, coral flats, banks, and shoals.

Corals play a dual role for producers and carnivores. The producers of the coral community include microscopic phytoplankton and larger algae that use the energy from sunlight to convert water and carbon dioxide into sugar through photosynthesis. The producers are the basis of the food chain, providing food for herbivores, such as turtles and parrotfish, that live on the reef. Carnivores, such as moray eels, monk seals, and sharks prey on the herbivores, which helps keep the population balanced.

Many things such as pollution, global warming, over-fishing, and tourism have contributed to the damage to coral reefs worldwide. Also, natural events such as El Nino weather patterns and hurricanes also cause reef damage. If the current rate persists, many of the world’s coral reefs could be completely destroyed in the next 30 years. Another troubling threat is coral bleaching. Coral polyps sometimes eject the zooxanthellae living inside them, where they usually have a relationship in the form of symbiosis. When this happens, the coral loses its primary food source and basically dies of starvation and turns white.

Marine debris can originate from the land as well as the ocean. Land-based marine debris can be from landfills, beach litter, storm drains, streams and rivers. Some examples of marine debris are: plastics (i.e., bottles, fishing line, 6-pack can holders, etc.), aluminum (i.e., cans, foil), and other materials (i.e., fishing line, food wrappers, cigarette butts, tires). Marine debris that originates from the sea stems from fishing boats, recreational boaters and fishers, and offshore oil rigs. Most of the debris in the water today comes from a sea origin.

More than just degrading the physical appearance of an area, marine debris affects coral reef health, and can cause serious damage to coral and marine animals. Fishing lines drag against coral and break it apart, and marine animals accidentally ingest debris that resembles prey or get caught in fishing nets until starvation or suffocation.

A common activity to determine how marine debris negatively impacts marine and shoreline animals includes an observation of an albatross bolus. An albatross, a local bird in the Northwestern Hawaiian Islands, like many birds, regurgitates a bolus to feed to its young that are still in the nest. The amounts of marine debris found in the albatross bolus can indicate the health of the marine environment immediately around the albatross.

Less obvious forms of marine debris pollutants include: chemicals, hazardous wastes, pesticides, and fertilizers. These pollutants escape the land by way of storm drains and run-off water. These pollutants can have adverse effects on the marine environment’s pH, nitrogen concentration, and it increases the amount of poisons in the water.

By increasing education and awareness about marine debris, the amount and adversity of the debris can be decreased and potentially avoided altogether.
Vocabulary

**Bolus** – fat, cigar-shaped mass that is regurgitated by some types of seabirds and contains indigestible materials (e.g., plastics, squid beaks)

**Coral bleaching** – the loss of the coral’s primary food source and the coral dies of starvation, turning white

**Marine debris** – Human-made solid material that is dumped or washed into the marine environment

**Phytoplankton** – microscopic algae

**Pollutants** – waste material that pollutes water, air, or land.

**Symbiosis** – a relationship between two separate organisms in which they live together to the benefit of at least one of the organisms

**Zooxanthellae** – microscopic, unicelled algae, thought to be the “building block” of the coral reef

Procedure

1. Introduce the lesson by linking the NWHI coral reefs to the Great Barrier Reef seen in Disney’s Finding Nemo.
   a. Most students have seen Finding Nemo and are familiar with the characters.

2. Play the “Exploring the Reef” bonus section by Jean-Michel Cousteau on the Finding Nemo DVD.

3. Ask the students what they learned from the segment, or if they have any questions about what Jean-Michel Cousteau was discussing.
   *(Elapsed time check: 15 minutes)*

4. Explain to the class that they will create informational posters about specific themes that relate to coral reef health and protection.
   a. Coral bleaching
   b. Climate change and coral reef health
   c. Marine debris
   d. Standard tourism and ecotourism in coral reefs
   e. U.S. government’s efforts to protect reefs

5. Students will choose their topic, and thus be placed into groups by their choice. They will conduct research on this topic and present their findings to the class in the form of a poster.

6. Give student groups some guidelines of what they are to present:
   a. What is the topic?
   b. How does this topic affect coral reefs?
   c. Is this a beneficial or detrimental change to coral reefs?
   d. How do the terms of “preservation,” “conservation” and “restoration” apply to this topic?
   e. What is the group’s suggestion on how to care for coral reef health?

7. Give the student groups time to research the topic and be available to answer questions and guide students.
   *(Elapsed time check: 90 minutes)*
8. During the next 45-minute session, give students the time to present their poster and time to ask questions of the presenting group by the audience.

**Assessments**
- Group collaboration
- Ability to research
- Poster preparation and presentation

**Resources**
National Geographic Xpeditions (http://www.nationalgeographic.com/xpeditions).

**Extension Activities**
Bolus Dissection – More information can be found in *Navigating Change* (Unit 4, Activity 3)

**Culture Connections**
If time permits, have students investigate the role that coral reefs played in traditional Hawaiian culture. What importance did Native Hawaiians place on the coral reef ecosystem? Did they recognize the benefit of a healthy coral reef ecosystem?
Partnerships for Reform through Investigative Science and Math

Northwestern Hawaiian Islands

Concepts
Nihoa and Mokumanamana Islands are important to the Hawaiian culture. Much correlation between the Hawaiian Islands and Polynesia has been found in the NWHI.

HCPS III Benchmarks
SC.8.2.1.
SS.8.2.2.

Duration
90 minutes
2 x 45 minutes

Source Material
PRISM

Vocabulary
Polynesian Triangle
Radiocarbon dating

Cultural Ties to the NWHI

Summary
Students will learn about the cultural value and anthropological wealth of the NWHI. No knowledge base of the NWHI would be complete without an understanding of the longstanding history that the NWHI have with Native Hawaiians and their deep traditions.

Objectives
- Students will be able to explain the importance of Nihoa and Mokumanamana Islands to the Native Hawaiian culture
- Students will be able to argue the importance of the United States’ claim of the NWHI

Materials
For class:
Use of mobile lab or computers, printer and software
Use of art supplies (poster paper, coloring utensils)

For each student:
1 copy of the translated Kumulipo
1 copy of the “Remote Island Holds Mysteries” article
1 copy of “The Race to Necker” article

Making Connections
The Kumulipo – the creation chant of the Native Hawaiians, calls upon knowledge of the coral species, as the chant explains that all life originated from the coral polyp. After learning about the coral reef community in the previous lesson, students will feel more connected to the Kumulipo and the rationale as to why the Native Hawaiian community reveres the NWHI.

Teacher Prep for Activity
Download and make copies of the translated Kumulipo for each student. A translated copy of the Kumulipo can be found at: http://www.edithkanakaolefoundation.org/projects/kumulipo/index.htm. Make copies of the “Remote Island Holds Mysteries” article and “The Race to Necker” article for each student.

Background
The Northwestern Hawaiian Islands have an important place in Native Hawaiian culture. The anthropological value of these islands have created strong theories of the Polynesian migration and piece together much of the unwritten history of pre-contact times.
The NWHI were explored and colonized by Native Hawaiians, long before European contact. Nihoa and Mokumanamana Islands, the two closest to the main Hawaiian Islands, have archaeological sites, which suggest agricultural and religious practices, in addition to habitation. According to data collection by world-renown archaeologist, Dr. Kenneth Emory and the Tanager Expedition, radiocarbon dating ages these sites back to 1000 AD to 1700 AD. The religious sites on Nihoa and Mokumanamana lie on the Tropic of Cancer, which is parallel to those religious sites on the Marquesas Islands – on the Tropic of Capricorn. Dr. Emory’s connection between the two island nations allowed for theories to develop about the Polynesian migration and the **Polynesian Triangle**.

There are 52 cultural sites on Mokumanamana and 88 cultural sites on Nihoa. Currently, the National and State Register list these two islands as culturally and historically significant for Historic Places. The U.S. Fish and Wildlife Service also protect these islands. The NWHI have also been recommended to be listed as a Natural and Cultural (Mixed) Site on the UNESCO World Heritage List, due to its natural importance to the Hawaiian ecosystem as well as its cultural importance to Native Hawaiians and worldwide cultural history.

**Vocabulary**

**Polynesian Triangle** – The region of the Pacific Ocean anchored by three island groups: Hawai’i, Easter Island (Rapa ʻNui) and New Zealand (Aotearoa), often used as a simple way to define what constitutes Polynesia

**Radiocarbon dating** – Radiometric dating method that uses the naturally occurring radioisotope carbon-14 to determine the age of carbonaceous materials up to about 58,000 to 62,000 years.

**Procedure**

1. Introduce the lesson with the *Kumulipo*. Explain to students that this is the creation chant of the Native Hawaiians.
   a. Rather than instigating a discussion on creationism, explain that this investigation will be more critical for the scientific aspect, and how this chant can relate to the NWHI investigation.
2. Have students read the translated version of the *Kumulipo* aloud, with each individual reading one stanza and going around the room.
   a. Continue this until approximately line 51 or until each person had read 2 lines
3. Stop the reading and ask the class, What is this chant saying? What is so important about the species that it calls upon? What order does this chant call upon the species?
   a. Students should answer that the origin was the coral polyp and the species began to become more developed and diverse.
4. Ask the students, What connection does this chant have with what they have been studying about the NWHI?
   a. This suggests that the NWHI is the origin – alike the coral polyp, and more life developed as the island chain proceeded south.

*(Elapsed time check: 20 minutes)*

5. Next, pass out the “Remote Island Holds Mysteries” article. Have the class read the article together, with each student reading one paragraph.
6. Ask the students what they learned from reading this article. Prompt with questions such as:
   a. What is Kekuewa Kikiloi?
b. What is Kikiloi doing in the NWHI?
c. What is important about Mokumanamana Island?
d. Why is it important?

7. Explain to the class that they will be investigating the anthropological importance of Necker and Mokumanamana Islands.

8. In the next class, they will work in teams of 3-4 to uncover information on one of the following topics:
   a. Tananger Expedition
   b. Polynesian migration
   c. Polynesian Triangle
   d. Kekuewa Kikiloi’s current research
   e. Native Hawaiian settlement in the NWHI
   f. U.S. acquisition of the NWHI

9. Encourage students to find their teammates and topic, and begin investigation before the next class. They will be given only 20 minutes to collaborate in the next class.

(Elapsed time check: 45 minutes)

10. In the second session, have students investigate their topic and develop their presentation for 20 minutes.
   a. Allow students access to the Internet and book resources.
   b. Presentation can be in an oral, audio, or visual form. Allow students the opportunity to use PowerPoint, iMovie, or other software to create the presentation.

11. Have student groups present their topic to the rest of the class and allow time for questions.

**Assessments**
Group work
Project presentation

**Resources**
Edith Kanaka‘ole Foundation (http://www.edithkanakaolefoundation.org/projects/kumulipo/index.htm)
Hawaii Tribune Herald. (Access to “Remote Island Holds Mysteries” article)
National Oceanic and Atmospheric Administration (www.noaa.gov)

**Extension Activities**
An excursion to the Mokupapapa Discovery Center in Downtown Hilo would make for a wonderful wrap-up to this curriculum, as it will delve deeper into the natural and cultural resources of the NWHI with trained staff and educational advisors. To set up an appointment, contact the Mokupapapa Discovery Center.
Remote island holds mysteries

By AUDREY McAVOY

HONOLULU — Researchers on a rare expedition to a now uninhabited rocky outpost north of the main Hawaiian islands found a partially finished human stone carving and the remnants of what may be a craftsman’s workshop.

The findings at the remote Mokumanamana Island, about 460 miles northwest of Honolulu, were part of the most extensive archaeological survey of the tiny outcrop in 85 years. University of Hawaii anthropology doctoral student Kekeuwea Kikiloi spent 18 days on the 46-acre island along with Aan Raymond, a U.S. Fish and Wildlife Service archaeologist.

The inhospitable island lacks fresh water, trees that would provide cover, and is continually buffeted by wind. It’s frequented by seabirds, but is otherwise desolate save for the ruins of ancient heiau, or shrines, that line the top of a ridge running along the spine of the island.

“It’s somewhat of an archaeological mystery as to how people survived on this island in the past and constructed these huge monuments,” Kikiloi said.

The newly discovered carving resembles other stone figures found on Mokumanamana during a trip to the island sponsored by Hawaii’s provisional government shortly after the U.S.-backed overthrow of the Hawaiian monarchy in 1893.

That expedition brought several figures to the main islands, most of which are now at the Bishop Museum in Honolulu.

Kikiloi said it’s not clear what the images were used for but they’re unlike any other objects in the Hawaiian islands. In general in Hawaiian tradition, he said, images are often used as a focal point during prayer and worship of gods.

The partially unfinished figure found on this trip has a blank face, as though the artist didn’t get around to carving facial features. It also appears that its left arm has broken off.

The workshop was far from the heiau. Raymond said someone may have been working on the figure to take to a heiau and would have done so if it was finished.

“It’s unclear when humans lived on the island or if they had a long-term settlement there,” Kikiloi said.

But Kikiloi said coral objects on nearby Nihoa Island, which he believes was a staging ground for the construction Mokumanamana’s heiau, date to the 1500s.

Mokumanamana has an unusually high concentration of heiau — at least 34 on just 46 acres.

Kikiloi believes Hawaiians built the shrines there because Mokumanamana was considered the gateway to the afterlife. He said he plans to address this theory in his doctoral dissertation.

Mokumanamana lies on the Tropic of Cancer. This means the sun — which represents life and death in Hawaiian tradition — goes directly over the island on the summer solstice, the longest day of the year.
The Race to Necker
In 1894, two ships left Honolulu Harbor on a most urgent and unlikely mission to the Northwest Hawaiian Islands.

STORY BY RON WILLIAMS, JR.

At 5:10 p.m. on May 25th, 1894, the steamer Iwaihoku quietly pulled out of Honolulu Harbor. She had arrived only that morning, made swift and secret preparations, and promptly left. Although the crew tried to slip away unnoticed, that was nearly impossible with the heightened sense of anxiety around town. Under normal circumstances the hurried departure of a ship might not have aroused much suspicion. But circumstances in the Honolulu of 1894 were anything but normal.

Just sixteen months prior, in January 1893, a critical moment in Hawaii’s history had occurred. A small group of mostly American and European businessmen, backed by US Minister John L. Stevens, had overthrown the Kingdom of Hawaii. They had chosen missionary descendant and former politician Sanford B. Dole to lead a provisional government, but they had no intention of actually running the country; instead, they sent a treaty to the United States proposing immediate annexation. President Grover Cleveland, however, was not receptive; he dismissed the treaty and called for an investigation that later declared the coup an “act of war” and Minister Stevens complicit.
The Race to Necker

Few knew that when the steamer胡otu hastily departed Honolulu Harbor in 1894, it was headed for Necker, a remote isletment in the Northwest Hawaiian Islands. Even fewer knew why the provisional government of Hawaii would be interested in this barren speck of rock, a place with no beach, no protected anchorage, no resources and no strategic value. Still, the provisional government’s Minister of the Interior, James A. King (below), explained the Kohala on its simple but crucial mission: To set foot on Necker Island before the British did.

Things got complicated for the newly declared provisional government. New US Minister to Hawaii Albert Willis arrived in Honolulu with orders to negotiate the reinstatement of Queen Lili‘uokalani. Some believed that Willis had authorization to use force. Rumors spread—some of them true—that both the annexationists and supporters of the Kingdom of Hawaii were gearing up for a possible military conflict. Throughout the early part of 1894, the newspapers had reported that groups of mercenaries had offered to sail to Hawaii and defend the teetering provisional government.

People in Honolulu were keeping close tabs on everything and everybody, and so, when a steamer mysteriously pulled into port and shipped out in a matter of hours, the tense town filled with gossip.

When the next morning’s papers came off the press, the whispers became a roar. All the papers suggested that a secret mission on behalf of the provisional government was under way; the Hawaii Holomua wrote specifically that the aim of the operation was to suppress an insurrection among Japanese laborers on one of the Islands’ plantations. The Hawaiian-language newspaper Ka Makana added to the general mystery by reporting that “Kapena Kimi, Kuhina Nahualua” (Capt. James A. King, minister of the interior) had been seen boarding the Iwalam with “he mau pa”—guns—and “he pahuale”—a flagpole.

Still, few knew the Iwalam’s true destination, and those who did weren’t talking. The Hawaiian Star quoted Attorney General William O. Smith as saying, “I can say nothing of the Iwalam’s mission further than she has gone to one of the westward islands and will return in a few days.” If rumors around town were wild, the truth was perhaps even more bizarre.

Less than an hour after the departure of the Iwalam, the British cruiser HMS Champion also left Honolulu Harbor. British officials had spread word that the twenty-two-gun warship was headed out for target practice. Yet instead of heading east to the usual firing areas, the ship marked a course west-northwest, similar to that of the Iwalam. Adding to the intrigue, one of the men aboard the Champion had arrived in Honolulu only the day before from Victoria, British Columbia and had been shuttling around town in secrecy. This mysterious visitor had immediately gone to see the acting British vice-counsel, P.M. Swamy. The two had
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Cultural Ties to the NWHI

The Race to Necker

On a secret trip to Hawai‘i in 1893, Fleming had studied maps and survey titles and concluded that a tiny, 46-acre volcanic island called Necker Island had been long uninhabited and officially left unclaimed by the Hawaiian kingdom. It was therefore still up for grabs. If a ship from the Royal Navy could sail to Necker and claim it for Britain, the empire would have its cable way station.

The British government was initially wary about such an aggressive land grab, fearing it could push the United States to annex Hawai‘i. They tried first to negotiate a purchase or lease of the needed territory but to no avail. Upon receiving inquiries from the British regarding Necker, the provisional government of Hawai‘i publicly declared its ownership of the island.

Privately, however, they rushed to research whether their claim was true. Their investigation unearthed some interesting facts. Several Hawaiian monarchs, including Ka‘ahumanu, had visited Mokumanamana (the Hawaiian name for Necker, literally “branching island”), but there were no records of official land grants or territorial claims. An 1857 expedition sponsored by King Kamehameha IV, Alexander Liholiho, and led by William Faty had explored the northwest islands and indeed taken possession of several, including Laysan and Lisiansky, in the name of the Hawaiian kingdom. No such claim had been made for Necker.

With this enterprise, a foreigner pushing the issue and their claim in doubt, the provisional government took no chances. Capt. King knew that despite the rebuffing of the initial British offer, Fleming would not be easily deterred. Now these secretive men were in town preparing...something...and time seemed to be of the essence. They needed to be decisive; they needed a ship.

They contacted the Inter-Island Steamship Co. and chartered the Iwalihi. The ship was out to sea at the time but due back shortly. Upon return the Iwalihi’s crew was in port only minutes before it was quietly given its new assignment; indeed, the race was on!

By nightfall on May 25, both the Iwalihi and the Champion had left port and were out of contact; those on land would have to simply wait for word of the outcome. Nuepeka Ka Oiaio reprinted, in Hawaiian, a May 11 column from a Canadian newspaper that reported on the British plans for a Pacific telegraph cable.


Back in the waters off O‘ahu on that
May 25 evening, the two competitors were steaming toward their goal. The distance from Honolulu to Necker is 460 miles, and not many were giving the old Hawaiian freight steamer much of a chance against a sophisticated modern cruiser from the world's most powerful navy. But while the *iwalani* was a much less sophisticated and technically slower ship, she had the advantage of being lighter and more maneuverable among the reefs that dotted the journey.

Nearly seven hours after leaving Honolulu, the ship reached Kauai. Bearing southeast, the *iwalani* sailed for another eighteen hours until passing Niihoa, 150 miles west of Necker. Sailing on through the night, the eager crew sighted Necker at 9 a.m. on the 26th. The *iwalani*'s log states: "... arrived at the island and dropped anchor in eighteen fathoms of water."

But they needed to actually set foot atop this imposing island with its sheer cliffs and document their landing. A camera had been brought along for just that purpose. They lowered a skiff loaded with "His Excellency Capt. J.A. King, Captain Freeman, C.B. Norton and nine sailors."

After a difficult landing, the successful culmination of the mission was recorded next: "A hard climb up a rugged cliff 260 feet high was made, when Minister J.A. King hoisted the Hawaiian flag, read the proclamation and took possession of the island. The crew remained on Necker for only a few hours before heading back.

When the familiar whistle of the *iwalani* was heard in Honolulu around 7 p.m. on Thursday May 29, a number of people rushed down to the wharf. Dole and the provisional government cabinet arrived to meet Capt. King and congratulate him. The newspapers mercilessly teased the massive British ship and its crew; the *Hawaii Hoherana* joked that Capt. King, with his rifle, had "bored a hole in the Champion, and that the wreck was hanging at the end of a stern-line from the *iwalani*."

Later the British government would insist that the *Champion* had stopped just past Kauai; her intended destination all along. (International embarrassment notwithstanding. Fleming would eventually have his cable; the first section, from San Francisco to Honolulu, was laid in 1902.) While the facts of the British ship's true destination are disputed to this day, some Honolulu families still recount stories celebrating the *iwalani*... and *ka hieha iā Necker*—the race to Necker.