GRADE 4 UNIT 6 OVERVIEW

Beach Detectives

Introduction

In this unit, students will explore the sandy beach environment and the different organisms that live there. Students will then engage in a field trip to the sandy beach to investigate the different types of pollution that threaten this habitat.

Little research has been done concerning species of animals and plants dwelling in sandy beach habitat ecosystems. Typically, these habitats consist of upper (backshore), middle (foreshore), and lower (nearshore) beach zones. Sandy dune habitats in the upper beach zone face harsh environments: the middle zone (a shifting habitat) is where organisms live below the sand surface; and the lower zone harbors a variety of organisms that live in the shallow waters found there, depending on their location, in calm or turbulent beach environments.

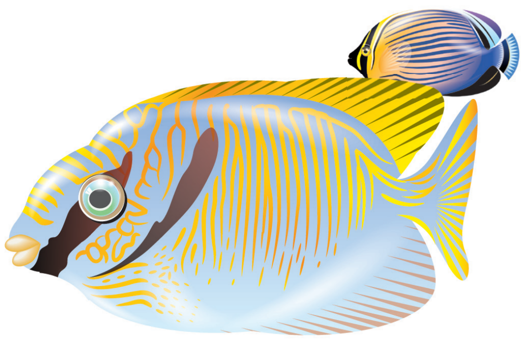
In this unit, students listen to concerns voiced by Claude the Crab that his habitat, and ultimately his life which depends on his habitat, are being threatened. Based on information provided by Claude, students embark on fact-finding searches to find supporting evidence for Claude's concerns by first pinpointing local beaches where Claude lives.

In detective investigations, seemingly insignificant details can yield vital evidence. Students study sand types from various Hawaiian island beaches, and find that sand is the result of weathering and erosion plus deposits of hard material left by once-living organisms. By examining sand particles, students make a testable hypothesis that infers the origin and make-up of Hawaiian beach sands.

Based on brainstorming reinforced by online searches, students identify pollution as a primary suspect in Claude's predicament. Students go on field trips to experience firsthand where Claude lives and note what they find and see, including trash. They clean up a beach site, assessing marine debris and trash left behind by humans. Students then contrast facts and inferences, write stories and poems about plants and animals they found at the beach, and theorize how marine debris and trash got there.

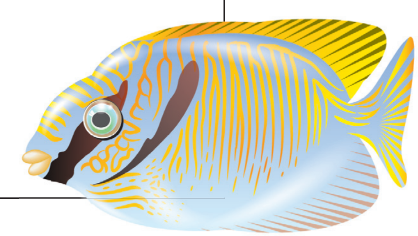
In culminating exercises, students demonstrate their knowledge of beach habitat ecosystems by writing a one-minute public service announcement, based on Claude's inquiries, that addresses pollution, habitats, beach organisms, and sand. They also write letters to manufacturers concerning food wrappings they found on the beach, and request replies outlining what these companies are doing to help curb trash pollution. They also share with others the effects of pollution on beaches and beach habitats, and float ideas that might help curb the use and dumping of harmful household chemicals and pesticides.

Each Lesson addresses HCPS III Benchmarks. The Lessons provide an opportunity for students to move toward mastery of the indicated benchmarks.



At A Glance

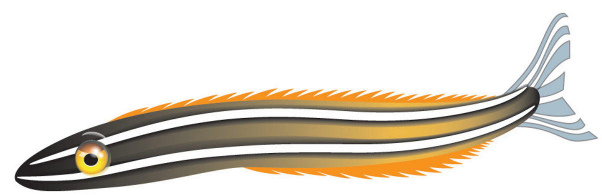
ESSENTIAL QUESTIONS	HCPS III BENCHMARKS	**LESSON,** Brief Summary, Duration
How are ecosystems and habitats defined? How is an organism's behavior determined by its environment? How do organisms survive in specific environments?	Science Standard 1: The Scientific Process: Scientific Investigation: SC 4.1.2 Differentiate between an observation and an inference Science Standard 3: Life and Environmental Sciences: Organisms and the Environment: SC 4.3.2 Describe how an organism's behavior is determined by its environment. Science Standard 5: Life and Environmental Sciences: Diversity, Genetics, and Evolution: SC 4.5.3 Describe how different organisms need specific environmental conditions to survive.	**Lesson 1: Beach Habitats "Scene of the Crime"** Students will first be introduced to the concept of an ecosystem and a habitat and the differences between them. Students study the kinds of organisms that live on their local beaches or coastal areas, and describe how they fit into an ecosystem. Students research an organism and its habitat, and then place a drawing of that organism on a cross section of the beach in the appropriate habitat. Students will then be introduced to Claude the Crab and a pollution problem. Two 45-minute periods
How is sand created? What is a testable hypothesis and an experimental procedure?	Science Standard 1: The Scientific Process: Scientific Investigation: SC 4.1.1 Describe a testable hypothesis and an experimental procedure. SC 4.1.2 Differentiate between an observation and an inference. Science Standard 8: Physical, Earth, and Space Science: Earth and Space Science: SC 4.8.1 Describe how slow processes sometimes shape and reshape the surface of the Earth. SC 4.8.2 Describe how fast processes (e.g., volcanoes, earthquakes) sometimes shape and reshape the surface of the Earth.	**Lesson 2: Hawaiian Beach Sands "Crime Scene Bio"** This lesson allows students to study samples of Hawaiian beach sand and trace them to their volcanic or biological origins. Students begin to think about how the slow processes of weathering and erosion that breakdown and transport material, as well as how fast processes like hot molten lava pouring into the ocean shatters to form certain types of sand. Two 45 minute periods

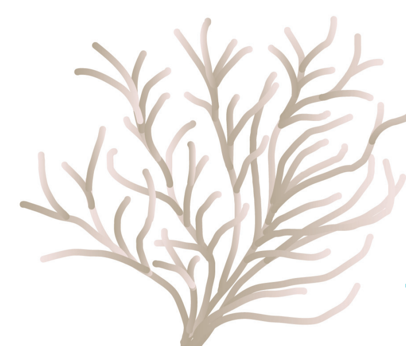


ESSENTIAL QUESTIONS	**HCPS III BENCHMARKS**	**LESSON,** Brief Summary, Duration
How is pollution and the sources of pollution defined?	Science Standard 1: The Scientific Process: Scientific Investigation: SC 4.1.2 Differentiate between an observation and an inference Standard 2: The Scientific Process: Nature Of Science: SC 4.2.1 Describe how the use of technology has influenced the economy, demography, and environment of Hawaiʻi.	**Lesson 3: Pollution "The Suspect"** This lesson engages students in considering sources of pollution for Hawaiʻi's beaches beginning with a story about Claude the Crab, and a pollution problem. Students examine maps of the local field trip site (Claude's Home), and hypothesize about the point source pollution and the many sources of non-point source pollution. Two 45 minute periods
How do we conduct science investigations safely? Why do organisms need specific environments to survive?	Science Standard 1: The Scientific Process: Scientific Investigation: SC 4.1.2 Differentiate between an observation and an inference Science Standard 5: Life and Environmental Sciences: Diversity, Genetics, and Evolution: SC 4.5.3 Describe how different organisms need specific environmental conditions to survive.	**Lesson 4: Life at the Beach "Examining the Crime Scene"** The fourth and fifth lessons are actual field trip experiences and data collection and can be done on the same field trip. In this lesson, students learn important safety rules about the beach, and about interacting with organisms on the beach. Then they take a field trip to the beach, and make a series of observations about the water, wind, weather, and animal and human activity, and consider what conditions are necessary for survival. During a transect, students identify life at the beach in different zones of habitation. One 140-minute session broken into several flexible categories, depending on needs and travel time.
What types of marine pollution did we identify? What are the sources of this pollution? How does it impact the organisms found there? How has technology impacted this marine environment?	Science Standard 1: The Scientific Process: Scientific Investigation: SC 4.1.2 Differentiate between an observation and inference. Science Standard 2: The Scientific Process: Nature of Science: SC 4.2.1 Describe how the use of technology has influenced the economy, demography, and environment of Hawaiʻi.	**Lesson 5: Trash Hounds "Crime Scene Conclusions"** The fourth and fifth lessons are actual field trip experiences. In this lesson, students clean up a beach site, make observations about the quantity and type of marine debris, and infer from where the debris came. They then tell a *cradle-to-grave* story describing how the trash might have landed on the beach. One 45 minute period on the beach

ESSENTIAL QUESTIONS	HCPS III BENCHMARKS	**LESSON,** Brief Summary, Duration
What is pollution? How is an organism's behavior determined by its environment? How do organisms survive in specific environments? How is sand created?	Science Standard 1: The Scientific Process: Scientific Investigation: SC 4.1.2 Differentiate between an observation and inference. Science Standard 5: Life and Environmental Sciences: Diversity, Genetics, and Evolution: SC 4.5.3 Describe how different organisms need specific environmental conditions to survive. Science Standard 8: Physical, Earth, and Space Science: Earth and Space Science: SC 4.8.1 Describe how slow processes sometime shape and reshape the surface of the Earth. Standard 4: Writing: Conventions and Skills: LA 4.4.1 Write in a variety of of grade appropriate formats for a variety of purposes and audiences.	**Culminating Lesson: "Crime Scene Report"** Now it's time for the students to put together all of the information that they gathered throughout this investigation. Students will demonstrate their knowledge of beach ecosystems by writing a crime scene report about beach ecosystems that addresses beach habitats "the scene of the crime", pollution including trash "the suspect", beach organisms and sand" examining the crime scene." The crime scene report should be done as a response to Claude the Crab's initial inquiries and the evidence they gathered on their beach field trips. One 45 minute period

**HCPS III Benchmarks from the Hawai'i Department of Education, from Website: http://doe.k12.hi.us/standards/index.htm*



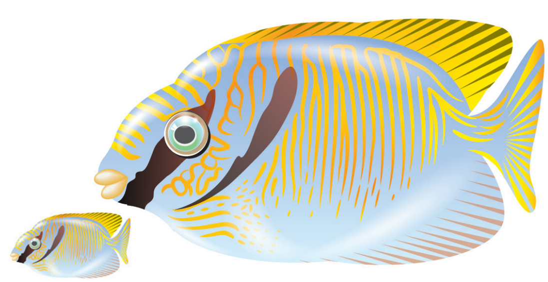


Benchmark Rubric

I. HCPS III Benchmarks*

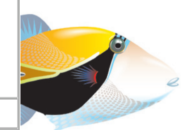
Below is a general Benchmark Rubric. Within each lesson, there are other assessment tools and additional rubrics specific to the performance tasks of each lesson topic.

Topic		Scientific Inquiry	
Benchmark SC.4.1.1		Describe a testable hypothesis and an experimental procedure	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Create a testable hypothesis and an experimental procedure to test it	Describe a testable hypothesis and an experimental procedure	Identify, with assistance, a testable hypothesis and an experimental procedure	Recognize, with assistance, a testable hypothesis or an experimental procedure
Topic		Scientific Knowledge	
Benchmark SC.4.1.2		Differentiate between an observation and an inference	
Rubric			
Advanced	Proficient	Partially Proficient	Novice
Explain the difference between an observation and an inference and give examples	Differentiate between an observation and an inference	Provide examples of observations and inferences	Define an observation and an inference
Topic		Science, Technology, and Society	
Benchmark SC.4.2.1		Describe how the use of technology has influenced the economy, demography, and environment of Hawai‘i	
Rubric			
Advanced	Proficient	Partially Proficient	Novice
Explain how the use of technology has influenced the economy, demography, and environment of Hawai‘i and suggest ways to conserve the environment	Describe how the use of technology has influenced the economy, demography, and environment of Hawai‘i	Give examples of how the use of technology has influenced the economy, demography, and environment of Hawai‘i	Recognize that the use of technology has influenced the economy, demography, and environment of Hawai‘i
Topic		Interdependence	
Benchmark SC.4.3.2		Describe how an organism’s behavior is determined by its environment	
Rubric			
Advanced	Proficient	Partially Proficient	Novice

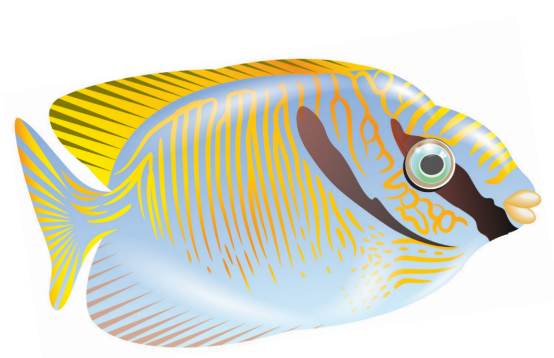


Explain and give examples of how different organisms' behaviors are determined by their environments	Describe how an organism's behavior is determined by its environment	Identify a way that an organism's behavior is influenced by its environment	Recognize that an organism's behavior is influenced by its environment

Topic		Unity and Diversity	
Benchmark SC.4.5.3		Describe how different organisms need specific environmental conditions to survive	
Rubric			
Advanced	Proficient	Partially Proficient	Novice
Explain why different organisms need specific environmental conditions to survive	Describe how different organisms need specific environmental conditions to survive	List specific environmental conditions that organisms need to survive	Recall that organisms need specific environmental conditions to survive
Topic		Forces that Shape the Earth	
Benchmark SC.4.8.1		Describe how slow processes sometimes shape and reshape the surface of the Earth	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Use evidence to explain how slow processes have shaped and reshaped the surface of the Earth	Describe how the shaping and reshaping of the Earth's land surface is sometimes due to slow processes	Provide examples of the shaping and reshaping of the Earth's land surface due to slow processes	Recognize that the shaping and reshaping of the Earth's land surface is sometimes due to slow processes



Topic		Forces that Shape the Earth	
Benchmark SC.4.8.2		Describe how fast processes (e.g., volcanoes, earthquakes) sometimes shape and reshape the surface of the Earth	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Use evidence to explain how fast processes have shaped and reshaped the surface of the Earth	Describe how the shaping and reshaping of the Earth's land surface is sometimes due to fast processes	Provide examples of the shaping and reshaping of the Earth's land surface due to fast processes	Recognize that the shaping and reshaping of the Earth's land surface is sometimes due to fast processes



Topic		Range of Writing	
Benchmark LA.4.4.1		Write in a variety of grade-appropriate formats for a variety of purposes and audiences, such as: • narratives that follow a plot and describe a setting and characters • poems that provide insight into why the topic is memorable • responses to literature • reports that focus on a central question and incorporate summaries from research • accounts based on personal experience that have a clear focus and supporting details • pieces to reflect on learning and to solve problems	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Insightfully adapt writing to grade-appropriate formats for a variety of purposes and audiences	Adapt writing to grade-appropriate formats for a variety of purposes and audiences	Write with some adaptation to grade-appropriate formats for a variety of purposes and audiences	Write with little adaptation to grade-appropriate formats for a variety of purposes and audiences

II. General Learner Outcomes*

Below is a list of the HIDOE General Learner Outcomes (GLOs). Each Unit of the Lessons from the Sea Curriculum addresses the GLOs. Within some lessons, there is more specific mention of individual GLOs with specific pertinence.

I. Self-directed Learner. (The ability to be responsible for one's own learning.)
II. Community Contributor. (The understanding that it is essential for human beings to work together.)
III. Complex Thinker. (The ability to demonstrate critical thinking and problem solving.)
IV. Quality Producer. (The ability to recognize and produce quality performance and quality products.)
V. Effective Communicator. (The ability to communicate effectively.)
VI. Effective and Ethical User of Technology. (The ability to use a variety of technologies effectively and ethically.)

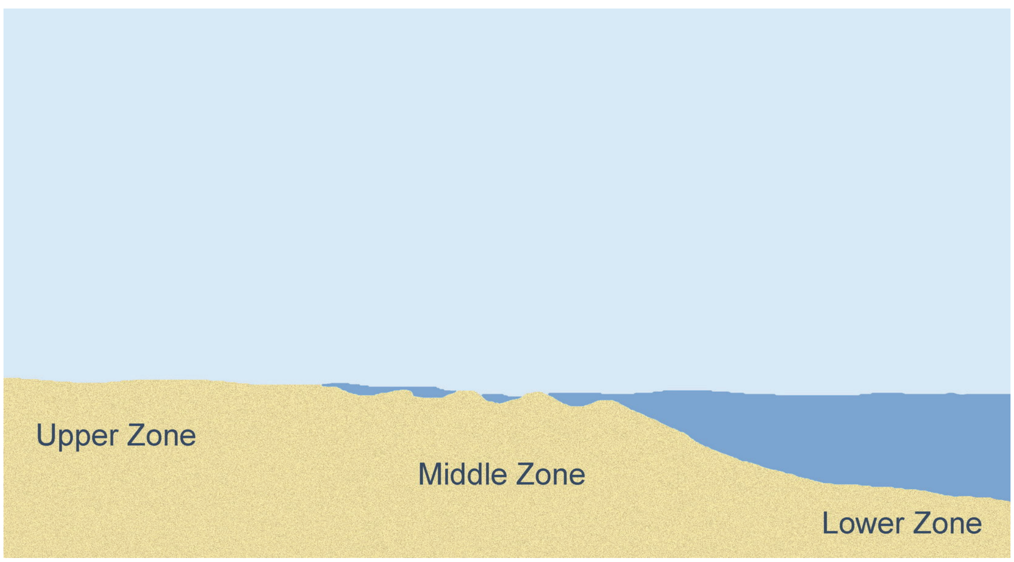
**HCPS III Benchmarks and General Learner Outcomes are from the Hawai'i Department of Education's Website:* http://doe.k12.hi.us/standards/index.htm.

Science Background for the Teacher

Note: Bolded words found within this section are defined in the *Science Background for the Teacher Glossary*. The footnotes refer to the references found in the *Science Background for Teacher - Bibliography* at the end of this section.

Describe the physical conditions of a Hawaiian sandy beach habitat, and the unique adaptations of the plants and animals that are found there.[2] (Lesson 1)

Sandy beach habitats can be divided into three zones: the upper zone, middle zone, and the lower beach zone. The upper zone, or backshore, lies above the high tide mark, also known as the **wrack line.** Wind tends to be the major physical force in this area, piling sand into small mounds and dunes. The dunes of the upper zone in sandy beach habitats are a harsh environment with little freshwater, lots of wind, high soil pH (alkalinity), occasional salt spray, and intense sun. Animal life in this zone is scarce and consists mainly of terrestrial visitors such as feral cats and mongoose. On isolated sandy beach habitats such as those at *Ka'ena Point, moli,* or Layson albatross come to nest among the many species of plants that grow among the dunes. The plants that are commonly found there have adapted to the harsh conditions by being **halophytic,** or salt tolerant. They also have creeping stems and roots that allow them to spread out and grow low to the ground, anchoring in the sand. To retain water, many plants have waxy coatings or hairs on their leaves. Others are succulent-like, producing thick leaves capable of holding moisture. In Hawai'i, common plants found in this zone include beach morning glory (*pōhuehue*), beach naupaka (*naupaka kahakai*), *nehe*, and *hinahina.* For additional information concerning plants found in this zone, see http://www.state.hi.us/dlnr/dofaw/nars/kaena/kaenafr.html



The middle sandy beach zone, or foreshore, can be characterized as a shifting habitat. It lies below the wrack line, but above the low tide line. Wave action moves the sand and does not allow much to live on the surface. Little research has been conducted in the middle sandy beach habitats in Hawai'i. In many cases a typical middle sandy beach habitat can be described as the surface of the sand *seeming* quite barren. However, one only needs to dig a little to find an abundance of life below. The **infauna,** species that live *in* the sand, are adapted to the middle zone of the sandy beach habitat. On a typical beach in Hawai'i, one might see Ghost crabs that scurry back and forth with the waves in the middle zone in search of food and constructing burrows just above the wave zone in the upper zone to hide in; and Mole crabs (or turtle crabs) that bury themselves in the sand in the wave zone (back end first) exposing only their antennae to capture small food particles. Clams and annelid worms are more permanent members of the infauna in the lower part of the sandy middle zone. The clams use strong foot muscles to bury themselves into the sand, and filter water through siphons that protrude through the surface of the sandy beach. It is common to see the small holes of the siphons bubbling when the tide recedes. Other visitors of the middle beach zone include the Hawaiian sea turtle and Monk seal. It is common to see these marine animals haul themselves out of the water to bask on the beach, nest, or pup. Because little research has been done in these areas, it is likely that observations will vary from beach to beach.

As with the middle sandy beach habitat, there is little research on the lower sandy beach habitats, or nearshore of Hawaiʻi. However, a typical lower sandy beach zone can be described as being constantly submerged. This zone is small compared to the upper and middle zones, and varies greatly depending on the type of beach. Exposed high energy beaches, such as Sandy and *Mōkapu* beaches, do not have much living in the lower zone because of the constant wave action. In more protected beaches, such as those in *Hanauma Bay* or *Kāneʻohe Bay*, schooling fish, gobies, and flounders can be seen in the shallows. Common schooling fish include species of mullet (*ʻamaʻama*), goatfish (*weke ʻā*), and flagtails (*aʻholeʻhole*). Porcupine pufferfish are active predators on shellfish and crabs, and often visit this zone in search of their next meal. Small mounds of sand are usually a sign of a goby burrow. Many gobies share their burrow with shrimps; this type of relationship is considered a **mutualism.** On rare occasions, one may see baby sharks swimming in the protected shallows of the low sandy beach zone. Observations, however, are likely to vary by site.

Describe different kinds of sand on Hawaiian beaches, what they are made up of, and where they might be found.[3] (Lesson 2)

The sand that makes up the beaches in Hawaiʻi originates from a number of different sources. Red and black sands result from volcanic rock eroding into smaller and smaller fragments over time through the process of **weathering** and **mechanical erosion.** Red sand beaches are rare but are the result of erosion of volcanic rock that is rich in iron, giving the sand its characteristic red color. *Kaihalulu* beach in *Maui* is an example of a red sand beach. Some black sand beaches that result from erosion of volcanic rock are not true black sand beaches when compared to obsidian sand beaches found at *Punaluʻu, Hoʻokena*, and *Kealakekua* beaches on the island of Hawaiʻi. Obsidian black sand beaches form when lava enters the ocean and is rapidly cooled to form black glass. The glass explodes due to the rapid cooling and fragments are distributed onto the shoreline. Over time these fragments become eroded with wave action into fine grains, producing the black sand of obsidian beaches. Olivine, or green sand beaches, are formed under the same process but the green minerals of Olivine are formed, which is the first mineral formed in volcanic rock formation. The olivine minerals explode into fragments that erode into sand grains to form green sand beaches.

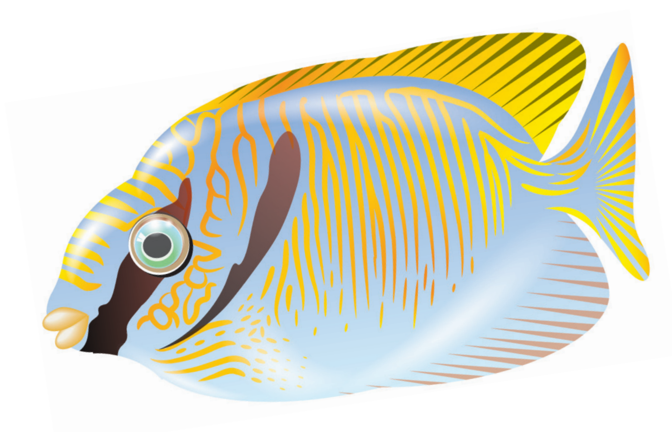
White sands are the small particulate remnants of coral skeletons, skeletons of animals that incorporate calcium carbonate into their shells or protective structures, and calcareous and coralline algae. White sand beaches are more common on older islands, such as *Lanikai* beach on *Oʻahu* and *Hanalei Bay* beach on *Kauaʻi*. Both have had extensive growth of coral reef structures and enough time for the dynamic processes of mechanical and biological erosion (**bioerosion**) to occur on the reefs, causing coral fragments to be broken off during storms or other disturbances. These fragments then roll back and forth with the waves, a form of mechanical erosion, slowly eroding into smaller and smaller particles that become sand. Animals that bore into coral, such as boring sponges, worms, and bivalves, as well as sea urchins and fish that graze on coral, break coral down through the bioerosion process. Parrot fish (*uhu*) are considered important bio-eroders on the reef. They use their fused jaws to break off pieces of live coral in order to digest the **zooxanthellae** that live inside the coral tissues. In the process, they finely grind the coral skeleton and deposit it back on the reef as a waste product. Estimates of the amount of sand produced by an individual parrotfish vary greatly by species, but are within the range of 20–1000 kg (44.09 – 2,204.62lbs.) per year. Other animals that contribute to the creation of white sands include many shelled animals, such as snails, oysters, and scallops that leave their shelled homes behind when they die. Also, other animals, such as sea urchins, have protective spines made of calcium carbonate that they leave behind when they die. These structures share the same fate as coral fragments, rolling with the waves and slowly eroding into sand particles. Calcareous algae, such as species of **Halimeda,** and coralline algae, such as the encrusting pink and red algae that cements reefs together, also leave behind their calcium carbonate structures that erode to become sand particles over time. For additional information concerning the origins of sands in Hawaiʻi, see http://Hawaii.gov/dlnr/occl/Sand/BeachSand.pdf

Give examples of point and non-point source pollution that can be found in Hawai‘i and describe the impacts it has on the marine environment. What type of pollution is marine debris?[1] (Lesson 3)

Marine pollution comes in many different forms in Hawai‘i and is generally categorized based on where it originates. If the source of the pollution can be traced back to a specific place, it is called **point-source pollution.** Examples of point- source pollution include municipal sewage treatment discharge, air pollution from the smoke stacks of industrial refineries, and agricultural waste discharge being pumped into nearby bodies of water like streams or wetlands.

There are a few examples of point-source pollution affecting the coastal waters of Hawai‘i. The Hawaiian Electric Company Kahe Point Energy Plant thermal discharge pipe off Electric Beach in *Nānākuli*, *O‘ahu* is an example of point-source **thermal pollution.** The energy plant pumps in ocean water to cool the six operating generators that produce electric power for the island of *O‘ahu*, similar to how a car radiator cycles water around the engine to keep the engine from overheating. The **effluent,** or outfall, of this water is 5–6 °C warmer than ambient seawater temperatures. Until the mid 1970s, this effluent was discharged directly onto the coral reef. During the summer, the effluent would elicit coral bleaching and cause great decreases in coral cover. Once the effluent was diverted to discharge 250 meters (820 ft.) offshore, the reef recovered and coral cover actually improved as coral began settling on the pipe structure. Now the pipe hosts a healthy coral reef community, and has become a popular diving destination. Monitoring has been conducted at permanent sites around the outfall for the past 20 years to record the changes in coral coverage as a result of the effluent and the pipe. For more information, see http://cramp.wcc.Hawaii.edu/LT_Montoring_files/lt_study_sites_Oahu_Kahe_Point.htm

A different kind of point-source pollution from a municipal sewage spill occurred in March 2006 and resulted in the largest sewage spill the Hawaiian Islands had ever seen. A sewer main in *Waikīkī* ruptured due to overflow from heavy rains, and began pumping raw sewage onto the streets of *Waikīkī*. Municipal workers purposely diverted the leak into *Waikīkī's* Ala Wai Canal to divert sewage away from homes and businesses. More than 48 million gallons of raw sewage spilled into the Ala Wai Canal over a five-day period, closing the canal and nearby beaches. The sewage spill drastically reduced the water quality of the surrounding beaches by introducing an abundance of bacteria and nutrients into the waters. Excess nutrients are harmful because they allow invasive algae to overgrow and smother corals, and harmful bacteria may jeopardize the health of fish and other sea life and result in mortality. Unfortunately, sewage spills are recurrent in Hawai‘i. On the windward side of *O‘ahu*, heavy rains frequently cause pipes to leak and dump raw sewage into *Kailua* and *Kāne‘ohe Bay* multiple times throughout the winter rainy season. For more information concerning beach water quality, see http://www.surfrider.org/waterquality.asp and http://www.wcc.Hawaii.edu/water/Windward%20Beaches/windwardbeaches01.htm



The source of point-source pollution is identifiable, and in some municipal, industrial, and agricultural practices, practically unavoidable, such as the Kahe power plant example previously described. The United States Environmental Protection Agency (EPA) has developed the National Pollutant Discharge Elimination System (NPDES) in an effort to monitor, control, and regulate the amount of point-source pollution entering the natural environment from these sources. Businesses and municipalities that discharge any form of waste must obtain permits from the NPDES program to do so, and are subject to inspections and permit renewal. The permits regulate the amount of waste discharged according to a variety of variables. For more information concerning this program, see http://cfpub.epa.gov/npdes/

In addition to point source, another more common and more variable source of pollution originates from numerous diffuse sources that cannot be attributed to specific points, such as discharge pipes or smoke stacks. These types of pollution are collectively termed **non-point source pollution.** Examples of non-point source pollution includes trash, or **marine debris,** that finds its way in the ocean or gets washed ashore, and runoff from a rain event that washes sediments, chemicals, and nutrients from construction sites, and residential, industrial, and agricultural areas. The polluted runoff

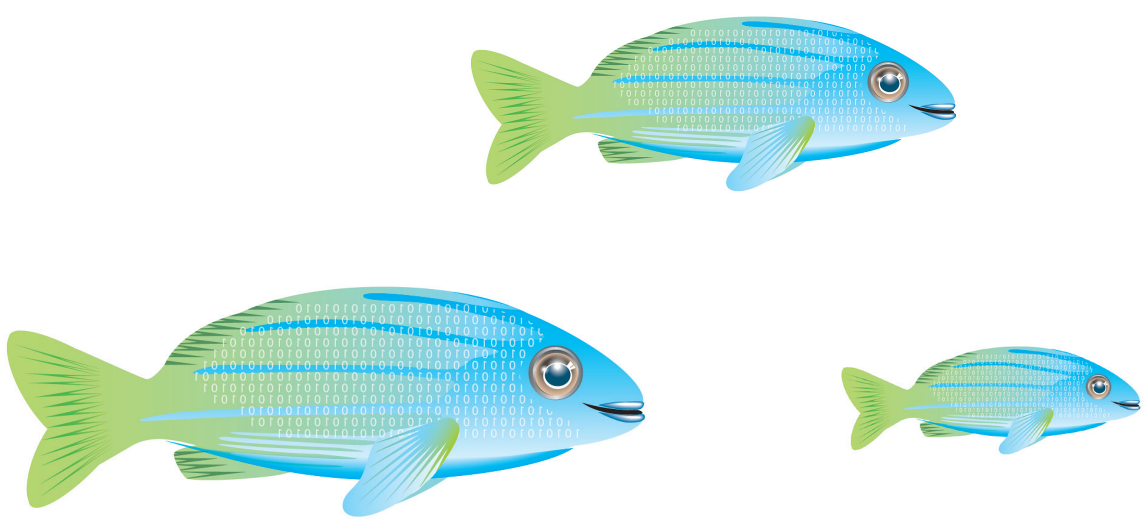
flows into storm drains and/or streams that eventually make their way to the ocean. These sources of pollution cannot be traced back to a specific point. Therefore, it is difficult for the EPA to regulate this type of pollution because it originates from the everyday activities of citizens in neighborhoods, businesses, and farms. Examples of the effects of non-point source pollution on waterways and beaches include an increase in the abundance of pathogens from the fecal waste of wild animals, farm animals, and household pets that get washed off the land after a rain event and enter our recreational waters. This may result in human health concerns if the recreational waters are not tested and monitored and properly managed. Sediments that runoff from construction sites or heavily grazed farm lands can alter stream flow, decrease water clarity, clog fish gills, and influence the availability of healthy aquatic habitat. Sediments that are deposited on a coral reef limit access to sunlight by smothering the coral or reducing water clarity. This can result in severe coral mortality across the whole reef. Additional examples of non-point source pollution and a great fact sheet are presented in http://www.soest.Hawaii.edu/SEAGRANT/communication/publications.php in the section entitled *Nonpoint Education for Municipal Officials (NEMO) fact sheets.*

Non-point sources of pollution affecting the coastal waters of Hawai‘i are varied. For example, as a result of the activities of individuals improperly disposing of trash and refuse, and recreational and commercial fishing practices whereby nets, buoys, and other types of fishing gear are abandoned at sea, marine debris is a huge problem to marine life in the Hawaiian Islands. The problem is even more severe in the Northwestern Hawaiian Islands because they are home to numerous species of marine life and are refuges for many **endemic** species only found in Hawai‘i.

Because of their location in the North Pacific gyre, a large slow ocean current, the islands accumulate on average about 53 tons of debris per year. Hawaiian sea turtles, Monk seals, Laysan albatross, and many other types of marine life can become entangled in abandoned fishing gear, affecting their ability to swim or fly. Accidental ingestion occurs when trash is mistaken for food, which has no nutritional value, but can clog the digestive tracks of animals that ingest it. Over time, these animals starve as the amount of trash in their guts increases. For the Albatross on Midway Atoll, up to 40% of the mortality rates are attributed to trash ingestion. Since 1996, NOAA’s Marine Debris Removal Program has removed 563 tons of debris from the Northwestern Hawaiian Islands. For additional information, see http://marinedebris.noaa.gov/projects/removal_nwhi.html.

Science Background Glossary for the Teacher

bioerosion: the biological process of erosion due to fish grazing, boring organisms and other biotic factors that break up the reef into smaller particles.
effluent: outflow of liquid.
endemic: organisms only occurring within a particular region or locality.
erosion: the breaking down and transport of material.
halophytic: plants that are salt tolerant and able to grow in salty soil.
infauna: organisms that live within the sand.
marine debris: trash and abandoned fishing gear floating in the ocean or washed ashore.
mechanical erosion: erosion due to movement and wear and tear of material from wave action, winds, water transport, etc.
mutualism: a relationship between two organisms that results in a positive interaction for both involved.
non-point source pollution: pollution that originates from many diffuse sources.
point-source pollution: pollution that can be traced to a specific source.
sand: broken down rock or organic material that lines beaches.
thermal pollution: pollution that negatively impacts the temperature of the environment.
weathering: the physical process of wind and precipitation breaking down rock into smaller particles.
wrack line: the area of the beach along the high tide line where debris is likely to collect.
zooxanthellae: single-celled algae that live in a symbiotic relationship with their host.



Science Background for Teachers - Bibliography

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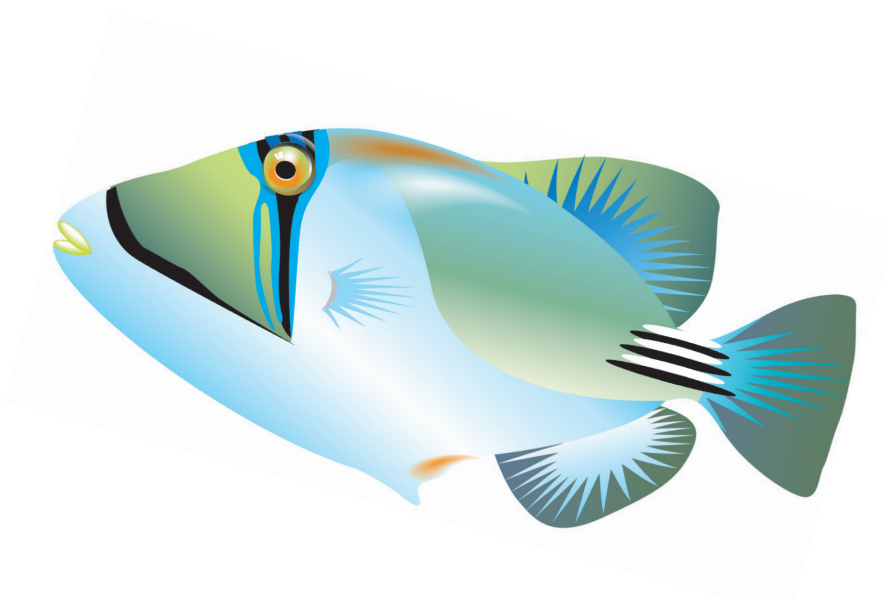

NOAA Resources

Below is a list of resources compiled by the Outreach Education Office of the National Oceanic and Atmospheric Administration. The science standards and the ocean literacy principles addressed in this unit were used as a guideline in selecting the following resources. To access the print resources listed below, contact NOAA's Outreach Education Office directly:

Outreach Unit
NOAA Office of Public and Constituent Affairs
1305 East West Highway #1W514
Silver Spring, MD 20910
Phone: (301) 713-1208
Email: NOAA-OUTREACH@noaa.gov
http://www.education.noaa.gov/

Resources:

Some resources you may find helpful:

National Ocean Service Education
http://oceanservice.noaa.gov/education/kits/pollution/

Marine Debris Resources: Marine Debris 101
http://marinedebris.noaa.gov/marinedebris101/resources_md101.html#activity

OCEAN LITERACY ESSENTIAL PRINCIPLES

2. The ocean and life in the ocean shape the features of the Earth
   2a. Many earth materials and geochemical cycles originate in the ocean. Many of the sedimentary rocks now exposed on land were formed in the ocean. Ocean life laid down the vast volume of siliceous and carbonate rocks.
   2c. Erosion- the wearing away of rock, soil and other biotic and abiotic earth materials- occurs in coastal areas as wind, waves, and currents in rivers and the ocean move sediments.
   2d. Sand consists of tiny bits of animals, plants, rocks and minerals. Most beach sand is eroded from land sources and carried to the coast by rivers, but sand is also eroded from coastal sources by surf. Sand is redistributed by waves and coastal currents seasonally.
   2e. Tectonic activity, sea level changes, and force of waves influence the physical structure and landforms of the coast.

5. The ocean supports a great diversity of life and ecosystems.
   5a. Ocean life ranges in size from the smallest virus to the largest animal that has lived on Earth, the blue whale.
   5d. Ocean biology provides many unique examples of life cycles, adaptations and important relationships among organisms (symbiosis, predator-prey dynamics and energy transfer) that do not occur on land.
   5e. The ocean is three-dimensional, offering vast living space and diverse habitats from the surface through the water column to the seafloor. Most of the living space on Earth is in the ocean.
   5f. Ocean habitats are defined by environmental factors. Due to interactions of abiotic factors such as salinity, temperature, oxygen, pH, light, nutrients, pressure, substrate and circulation, ocean life is not evenly distributed temporally or spatially, i.e. it is "patchy". Some regions of the ocean support more diverse and abundant life than anywhere on Earth, while much of the ocean is considered a desert.
   5h. Tides, waves and predation cause vertical zonation patterns along the shore, influencing the distribution and diversity of organisms.

6. The ocean and humans are inextricably interconnected.
   6e. Humans affect the ocean in a variety of ways. Laws, regulations and resource management affect what is taken out and put into the ocean. Human development and activity leads to pollution (point source, non-point source, and noise pollution) and physical modifications (changes to beaches, shores and rivers). In addition, humans have removed most of the large vertebrates from the ocean.

Lesson 1: 5a.5d.5e.5f. 5h. 6e.
Lesson 2: 2a. 2c. 2d. 2e.
Lesson 3: 5f. 6e.
Lesson 4: 5a. 5e. 5f.
Lesson 5: 5a. 5e. 5f. 6e.
Final : 2d. 5a. 5e. 5f. 5h. 6e.

CLIMATE LITERACY ESSENTIAL PRINCIPLES

There is no appropriate alignment of Climate Literacy Essential Principles to the unit lessons.

NOAA Marine Science Career - Case Studies

Kris McElwee

Pacific Islands Marine Debris Coordinator

Do you want to help clean our beaches and oceans for a living? Kris McElwee is the Pacific Islands Marine Debris Coordinator. Kris took some time to share with us how she became involved in protecting the health of our oceans, saving our marine ecosystems, and teaching others how they can help clean up our oceans and beaches.

How did you first become interested in ocean health and marine debris? I have always been interested in water. Growing up I used to enjoy swimming in lakes and being a lifeguard. One summer I took a high school training program on the science of freshwater pollution. It was many years after that when I began to work in a marine-related field. After completing my service in the Peace Corps I decided to go back to school, to study marine resource management. As a graduate student, I worked at an international aquaculture research program. I then moved to Hawai'i and began working with NOAA, to directly improve the health of our ocean, by helping to clean up marine debris.

Marine debris has become a topic of great public interest, and I'm happy to be involved in finding solutions. It's given me the opportunity to combine the two things I'm most interested in, science and policy. Most days I work in an office, but still manage to meet with people all over the world through conference calls to places like America Samoa, Guam, Commonwealth of the Northern Mariana Islands (CNMI), Washington D.C., Seattle, and Korea. About once a year, I get to go on a research vessel out to sea for three or four weeks. The coolest thing I have been a part of was a marine debris removal trip in the Northwestern Hawaiian Islands. I worked every day on small boats and hauled nets onboard. It was hard work, but the benefit to the coral reefs, monk seals, and sea turtles was obvious and immediate.

What kinds of marine debris are most common in Hawai‘i and what can people do to help?

The best part of marine debris removal is that everyone can help. Beach cleanup is a type of immediate and gratifying work that really does make a difference. You can help by picking up and throwing out a few pieces of debris (litter) every time you go to the beach. The most common types of debris we find are cigarette butts, bottle caps, lids, food wrappers and containers. Debris like fishing nets and lines are some of the most dangerous types of debris for animals because they can get tangled up in them. If we make good choices about reducing the amount of waste we create, recycle plastics, and reuse materials, we can make a big difference. By serving as good examples, you can encourage your family and friends to do those things too.

What can students do to get involved in your field?

There are many ways to get involved in marine debris management. If you are interested in helping reduce our impact on the environment, you should take advantage of internships, independent learning, and networks (friends of friends and people you meet). There is no degree in marine debris, so you will need a broad education with science, policy and social science. Don’t be afraid to ask questions of adults who have a career you are interested in.

Glossary of Cooperative Learning Techniques

In an effort to maximize student engagement and learning, the NOAA Sea Earth and Atmosphere curricular resources were designed using cooperative learning techniques. This guide defines the expectations for implementation of each technique.

What is Cooperative Learning?

Cooperative learning may be broadly defined as any classroom learning situation in which students of all levels of performance work together in structured groups toward a shared or common goal. According to Johnson, Johnson and Holubc, (1994): "Cooperative learning is the instructional use of small groups through which students work together to maximize their own and each other's learning." In classrooms where collaboration is practiced, students pursue learning in groups of varying size: negotiating, initiating, planning and evaluating together. Rather than working as individuals in competition with every other individual in the classroom, students are given the responsibility of creating a learning community where all students participate in significant and meaningful ways. Cooperative learning requires that students work together to achieve goals which they could not achieve individually.

Jigsaw

To Jigsaw materials refers to the use of a strategy in which each student on a team receives only a piece of the material that is to be learned in which that student becomes the "expert." Once the material is learned each member of the team takes a turn teaching the other members their assigned content. This type of dynamic makes the students rely on the other members of their team to learn all of the material.

Think-Pair-Share

This four-step discussion strategy incorporates wait time and aspects of cooperative learning. Students (and teachers) learn to LISTEN while a question is posed, THINK (without raising hands) of a response, PAIR with a neighbor to discuss responses, and SHARE their responses with the whole class. Time limits and transition cues help the discussion move smoothly. Students are able to rehearse responses mentally and verbally, and all students have an opportunity to talk.

Numbered Heads

This structure is useful for quickly reviewing objective material in a fun way. The students in each team are numbered (each team might have 4 students numbered 1, 2, 3, 4). Students coach each other on material to be mastered. Teachers pose a question and call a number. Only the students with that number are eligible to answer and earn points for their team, building both individual accountability and positive interdependence.

KWL Chart

A pre-assessment tool consisting of three vertical columns. Students list what they "**K**now" about a topic. What they "**W**ant" to know about a topic. The last column students share what they have "**L**earned" about a topic.

KWL CHART

Be sure to bullet your list.

Use content words only (nouns, verbs, names of people and places, dates, numbers, etc.).

WHAT DO I KNOW?	WHAT DO I WANT TO KNOW? *or* WHAT DO I WANT TO SOLVE?	WHAT HAVE I LEARNED?
•		•

Role Cards

Assign students to cooperative learning groups. Once students are in their groups the teacher will hand out premade role cards that will help each member of the group contribute to the completion of the given task. Before roles are assigned, the teacher should explain and model the task as well as the individual roles for students so that they know and understand how his/her individual role will contribute to the success of the group completing the task. When this technique is used, taking on a different role will aid in student proficiency.

Example of role cards:

Role Card #1

Facilitator:

Makes certain that everyone contributes and keeps the group on task.

Role Card #2

Recorder:

Keeps notes on important thoughts expressed in the group. Writes final summary.

Role Card #3

Reporter:

Shares summary of group with large group. Speaks for the group, not just a personal view.

Role Card #4

Materials Manager:

Picks up, distributes, collects, turns in, or puts away materials. Manages materials in the group during work.

Role Card #5

Time Keeper:

Keeps track of time and reminds groups how much time is left.

Role Card #6

Checker:

Checks for accuracy and clarity of thinking during discussions. May also check written work and keeps track of group point scores.

Round Table

Round table can be used for brainstorming, reviewing, or practicing while also serving as a team builder. Students sit in teams of 3 or more, with one piece of paper and one pencil. The teacher asks a question which has multiple answers. Students take turns writing one answer on the paper, then passing the paper and pencil clockwise to the next person. When time is called, teams with the most correct answers are recognized. Teams reflect on their strategies and consider ways they could improve.

Three-Step Interview

This involves structured group activity with students. Using interviews/listening techniques that have been modeled; one student interviews another about an announced topic. Once time is up, students switch roles as interviewer and interviewee. Pairs then join to form groups of four. Students take turns introducing their pair partners and sharing what the pair partners had to say. This structure can be used as a team builder, and also for opinion questions, predicting, evaluation, sharing book reports, etc.

Venn Diagram

A diagram using circles to represent sets, with the position and overlap of the circles comparing and contrasting the relationships between two given pieces of information.