GRADE 3 UNIT 5 OVERVIEW

Humpback Whales 101

Introduction

Humpback whales are highly intelligent marine mammals that depend on specific environmental conditions to survive. They migrate north to nutrient-rich waters of Alaska to feed during the summer, and south to tropical, but nutrient-poor, warm waters in winter to give birth and mate.

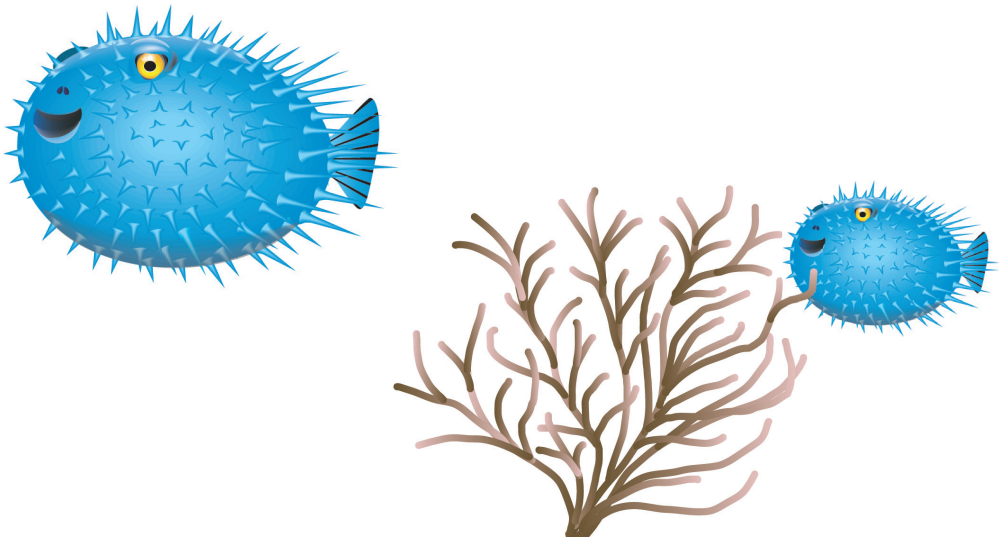
Humpback whales feed on huge amounts of small fish and plankton that are abundant in northern marine environments in spring and summer. Adult whales maintain a thick layer of insulating *blubber* under their skin that keeps internal body temperatures constant. Whales are not born with insulating blubber and would freeze in cold Alaskan waters, which may explain whale migration to tropical environments in winter to give birth, and thus perpetuate survival of the species.

Brainstorming the amazing adaptations these marine mammals have undergone over millions of years to survive in ocean environments, brings this unit to life for the students. They then imagine body feature changes that would be required for humans to adapt to similar environments.

Students also learn that humpback whales, like humans, are warm-blooded, give birth, engage in courtships, mate, nurse their young, and protect them from predators. Students study whale body features and crucial roles they play during migration, feeding, and mating.

The unit's main focus is on whale behavior while in the mating and nursing grounds in Hawai‘i. Like researchers, students follow the scientific inquiry process to answer questions.

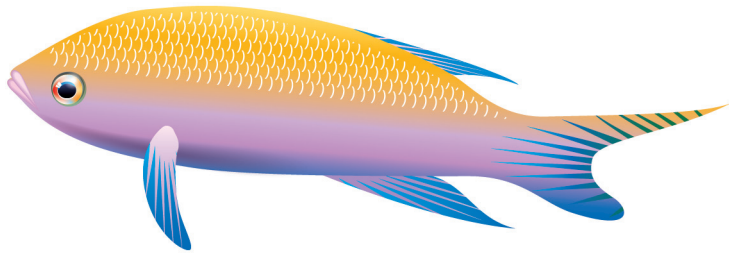
Through hands-on lab activities and fun games that complement lessons, students replicate the feeding behaviors of whales, and create bar graphs comparing the feeding styles of baleen and toothed whales. During review exercises, students engage in a game, pantomime whale behaviors and match photographs of whale flippers with descriptive cards.



At A Glance

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

ESSENTIAL QUESTIONS	HCPS III BENCHMARKS	LESSON, *Brief Summary,* Duration
How do the body structures of humpback whales allow them to function in a marine environment?	Science Standard 5: Life and Environmental Sciences: SC.3.5.1: Describe the relationship between structure and function in organisms. Language Arts Standard 6: Oral Communication: LA.3.6.1 Use oral language to obtain information, complete a task, and share ideas and personal opinions with others. Language Arts Standard 7: Oral Communication: LA.3.7.1 Add concrete details and specific facts to support and develop ideas when speaking Math Standard 3: Numbers and Operations MA 3.3.3 Estimate the results of whole-number computations	**Lesson 1: Anatomy of a Humpback Whale** Students brainstorm what features a marine mammal needs to survive in a marine environment. They role-play as humpback whales to learn about how whales are designed for life in the ocean. Students label the external body features on a diagram of a humpback whale, and create anatomically correct humpback whale models. Two 45-minute periods



ESSENTIAL QUESTIONS	HCPS III BENCHMARKS	LESSON, *Brief Summary,* Duration
How are the feeding methods of baleen and toothed whales similar and different?	Science Standard 1: The Scientific Process: SC.3.1.1 Pose a question and develop a hypothesis based on observations SC. 3.1.2 Safely collect and analyze data to answer a question. Science Standard 4: Life and Environmental Sciences: SC.3.4.1 Compare distinct structures of living things that help them to survive. Science Standard 5: Life and Environmental Sciences: SC.3.5.1 Describe the relationship between structure and function in organisms. Math Standard 11 Data Analysis, Statistics, and Probability: MA.3.11.1 Pose questions, collect data using surveys, and organize the data into tables and graphs. Math Standard 12 Data Analysis, Statistics, and Probability: MA 3.12.1 Interpret data (e.g. tallies, chart, tables, bar graphs, line plots) and state what the representation shows about the set of data	**Lesson 2: Whale Feast Feeding Discovery Lab** Students work in cooperative groups and participate in a hands-on lab activity simulating the feeding methods of various cetaceans. Students construct a chart and bar graph to compare the feeding styles of baleen and toothed whales, and write a conclusion to complete the lab activity. Two 45-minute periods
Why do humpback whales need to migrate between Alaska and Hawai'i? What are the behaviors of humpback whales in the Hawaiian breeding and nursery grounds during the winter months?	Language Arts Standard 1: Reading: LA.3.1.3 Use new grade-appropriate vocabulary, including homophones and homographs, introduced in stories, informational texts, word study, and reading.	**Lesson 3: Humpback Whale Behaviors** Students learn about the behaviors of humpback whales in the Hawaiian breeding and nursery grounds. Students then create their own interpretation of humpback behaviors. They also study the different structures of humpback whales that help them survive in their different environments. Two 45-minute periods

ESSENTIAL QUESTIONS	HCPS III BENCHMARKS	LESSON, *Brief Summary,* Duration
How do scientists identify and study individual humpback whales?	Science Standard 1: The Scientific Process: SC. 3.1.2 Safely collect and analyze data to answer a question	**Lesson 4: Be a Whale Researcher** Students distinguish observations from inferences. In studying the behaviors of humpback whales in the Hawaiian breeding and nursery grounds, as well as the Alaskan feeding grounds, students will be able to use inquiry to interpret these humpback behaviors. Students will then match fluke photographs like whale researchers to practice their observation skills, and make their own whale fluke designs. One 45-minute period

* *"Hawai'i Content & Performance Standards III Database." Hawai'i Department of Education. June 2007. Department of Education. 17 Dec. 2007..*

Benchmark Rubric

I. HCPS III Benchmarks*

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

Topic		**Scientific Inquiry**	
Benchmark SC.3.1.1		Pose a question and develop a hypothesis based on observations	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Pose a question and develop a hypothesis based on logical inferences and observations	Pose a question and develop a hypothesis based on observations	Pose a question or develop a hypothesis partially based on observations	With assistance, pose a question or develop a hypothesis

Topic		**Scientific Inquiry**	
Benchmark SC.3.1.2		Safely collect and analyze data to answer a question	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Summarize and share analysis of data collected safely to answer a question	Safely collect and analyze data to answer a question	With assistance, safely collect and analyze data	With assistance, safely collect data and attempt to analyze data

Topic		**Cells, Tissues, Organs, and Organ Systems**	
Benchmark SC.3.4.1		Compare distinct structures of living things that help them to survive	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Group living things by the distinct structures that help them to survive and provide justification for the grouping	Compare distinct structures of living things that help them to survive	Describe a few ways in which distinct structures of living things help them to survive	Name distinct structures of living things that help them to survive

Topic		**Unity and Diversity**	
Benchmark SC.3.5.1		Describe the relationship between structure and function in organisms	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Classify the structures of organisms according to their function	Describe the relationship between structure and function in organisms	Identify the relationship between structure and function in an organism	Recall that structures in organisms are related to the functions they perform

Topic		**Estimation**	
Benchmark MA.3.3.3		Estimate the results of whole-number computations	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Consistently make appropriate estimates of the results of whole-number computations using an estimation strategy	Usually make appropriate estimates of the results of whole-number computations using an estimation strategy	Sometimes make appropriate estimates of the results of whole-number computations using an estimation strategy	Rarely make appropriate estimates of the results of whole-number computations using an estimation strategy

Topic		Data Collection and Representation	
Benchmark MA.3.11.1		Pose questions, collect data using surveys, and organize the data into tables and graphs	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Pose meaningful questions, collect data using surveys, and effectively and accurately organize the data into tables and graphs	Pose questions, collect data using surveys, and organize the data into tables and graphs, with no significant errors	Pose questions, collect data using surveys, and organize the data into tables and graphs, with a few significant errors	Pose questions, collect data using surveys, and organize the data into tables and graphs, with many significant errors

Topic		Data Interpretation	
Benchmark MA.3.12.1		Interpret data (e.g., tallies, chart, tables, bar graphs, line plots) and state what the representation shows about the set of data	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Interpret data and state what the representation shows about the set of data, with accuracy	Interpret data and state what the representation shows about the set of data, with no significant errors	Interpret data and state what the representation shows about the set of data, with a few significant errors	Interpret data and state what the representation shows about the set of data, with many significant errors

Topic		Vocabulary and Concept Development	
Benchmark LA.3.1.3		Use new grade-appropriate vocabulary, including homophones and homographs, introduced in stories, informational texts, word study, and reading	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Use new grade-appropriate vocabulary, including homophones and homographs, with precision, fluency, and accuracy	Use new grade-appropriate vocabulary, including homophones and homographs, with no significant errors	Use new grade-appropriate vocabulary, including homophones and homographs, with difficulty and a few significant and/or many minor errors	Use new grade-appropriate vocabulary, including homophones and homographs, with great difficulty and/or many significant errors

Topic		Discussion and Presentation	
Benchmark LA.3.6.1		Use oral language to obtain information, complete a task, and share ideas and personal opinions with others	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Use creative oral language to obtain information, complete a task, and share ideas and personal opinions with others, in a highly effective way	Use oral language to obtain information, complete a task, and share ideas and personal opinions with others	Use typical oral language that sometimes aids in obtaining information, completing a task, or sharing ideas and personal opinions with others	Use inappropriate oral language that does not aid in obtaining information, completing a task, or sharing ideas and personal opinions with others

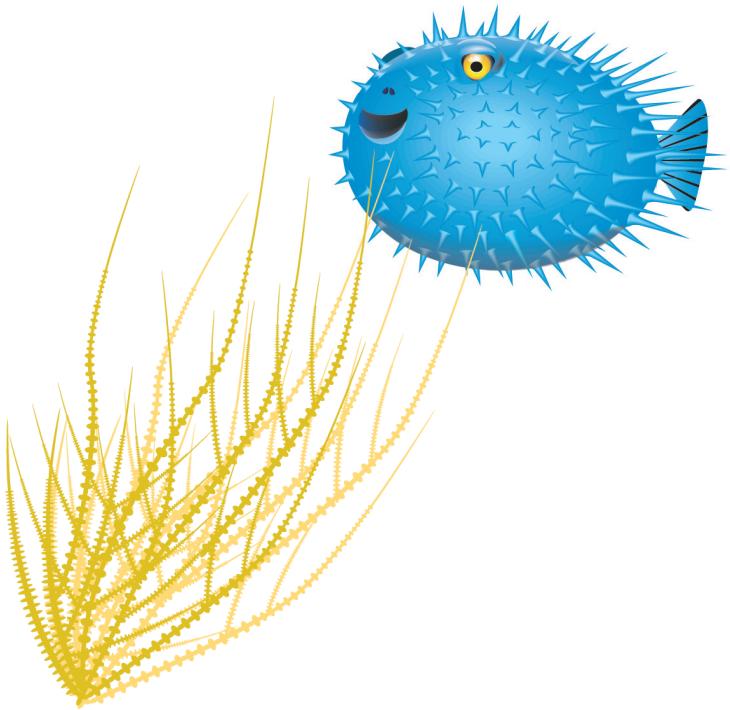
Topic		Meaning	
Benchmark LA.3.7.1		Add concrete details and specific facts to support and develop ideas when speaking	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Add concrete details and specific facts to support and develop ideas when speaking, in a highly effective way	Add concrete details and specific facts to support and develop ideas when speaking	Add obvious or trivial details and facts that partially support and develop ideas when speaking	Add vague details and irrelevant facts that do not support and develop ideas when speaking

II. General Learner Outcomes*

Below is a list of the Hawai'i Department of Education (HIDOE) General Learner Outcomes (GLOs). Each Unit of the Lessons from the Sea Curriculum addresses the GLOs.

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.)

* *"Hawai'i Content & Performance Standards III Database." Hawai'i Department of Education. June 2007. Department of Education. 17 Dec. 2007.*



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 the Teacher Bibliography* at the end of this section.

What are Whales?[1] (Lesson 1 and Lesson 2)

Whales, dolphins, and porpoises belong to the taxonomic order *Cetacea*, which is further divided into **Mysticetes** (baleen whales) and **Odontocetes** (toothed whales). All cetaceans are aquatic mammals that are endothermic (warm blooded, able to internally regulate their body temperature), and possess a four-chambered heart, lungs for breathing air, body hair (only when they are very young), and mammary glands (for nursing young).

Dolphins, porpoises, and some whales (like the sperm whale and the beaked whale) are considered toothed whales. They use their sharp, pointed teeth to catch fish and other types of prey, and swallow them whole. Toothed whales are generally smaller than baleen whales and have a single blowhole from which to breathe. **Echolocation** is also a characteristic of toothed whales, and is used as a way of seeing what is in front of them in low visibility, such as hidden prey. Sounds are produced by the whale's forehead (or melon), and bounce off objects in front of them; this is called an echo. The echo is then received in the lower jaw of the whale for interpretation. Echolocation is extremely sensitive and in some species is thought to be superior to sight.

Baleen whales (like the humpback, blue, gray, right, and fin whale) do not possess the ability to echolocate. Baleen whales have two blowholes arranged side-by-side and are generally larger than toothed whales. Instead of teeth, baleen whales have plates of **baleen** attached to their upper jaw, which is made of the same protein as human fingernails, and is strong and flexible. Baleen plates are arranged close together and are wide where they attach to the gum line, tapering into a fringe that forms a curtain hanging down inside the whale's mouth. Baleen whales feed by swimming through the water with their mouth open to filter out small fish and plankton that get stuck in the baleen. They use their tongues to wipe the baleen clean, swallowing the captured food.

The humpback whale (*Megaptera novaeangliae*), common in Hawaiian waters during the winter and early spring, can grow to be 15–16 meters (approx. 50 ft) in length. They are distinguished from other baleen whales by their long pectoral flippers, apparent throat grooves, dark body coloring with patchy white undersides, deeply notched tail fluke, and the presence of a small hump just anterior (in front of) to the dorsal fin (top fin). They are the most surface active of the baleen whales, and it is common to see them lunge out of the water or breach, or slap the surface of the water with their flukes and flippers. They are also very vocal animals. Only the males sing, producing individual songs that can last up to 20 minutes and be repeated over many hours. Singing is most common during the breeding season, but some songs have been recorded while they are in their feeding grounds. Researchers are not sure why male humpbacks sing, but think it may be a way to attract females, or a way to communicate their presence to other whales.

What are some body features of humpback whales that help them survive in the marine environment?[2] (Lesson 1)

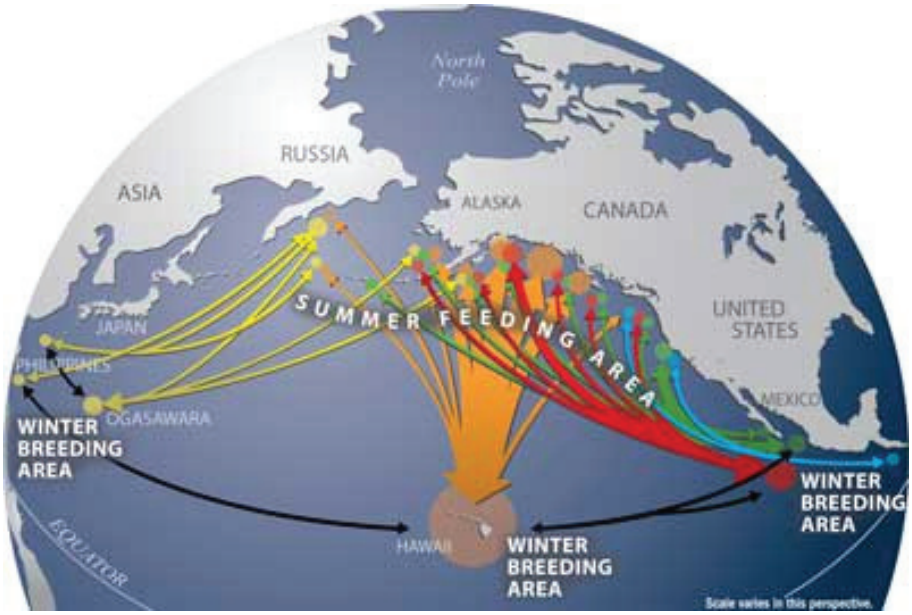
Humpback whales are warm-blooded, air-breathing mammals that spend their entire lives in the marine environment. They must be capable of holding their breath for long periods of time in order to dive, and that means possessing large lungs that can withstand changes in pressure. Humpbacks can dive down to 120 meters (~360 feet), and hold their breath for up to 30 minutes, although they typically dive for approximately 6–10 minutes before surfacing. Their nostrils, or blowholes, are located on the top of their head for easy breathing just at the surface of the water.

Being warm-blooded, whales must constantly maintain their internal body temperature above that of the surrounding waters. Whales do this by maintaining a thick layer of insulating **blubber** just under their skin. They must eat enough food in the winter months to maintain their blubber. Their average food intake per day amounts to approximately one ton of krill, their food of choice.

To reduce the amount of energy used for swimming, humpbacks are streamlined in shape, making it easier to glide through the water. They possess long powerful tail flukes to help them swim and dive. Their pectoral flippers are also quite long compared to other baleen whales species, and may also aid in swimming.

Where do humpback whales migrate? What are their feeding and mating behaviors?[3] (Lesson 2 and Lesson 3)

Humpback whales are **migratory** animals, traveling up to 5,000 kilometers (3,000 miles) from their feeding grounds in the cold waters of the Polar regions in spring and summer months, to their breeding grounds in the warm waters of tropical regions of the oceans in fall and winter months. During the spring and summer months, the Polar regions produce an abundance of food including krill, plankton, and small fish for the whales to feed on, but in the winter, food becomes scarce, and the waters become too cold and harsh. Humpbacks travel to the calm, protected waters of the tropics during the winter, and it is here that they calve and breed. The whales typically do not actively feed during their stay in the tropics as the waters are **oligotrophic** and contain little food.



Humpbacks feed extensively in Alaskan waters to fatten up before their journey to the tropics. Humpback whales employ group tactics and feed in small pods. Bubble netting is one such example of group feeding behavior. Multiple whales dive under a school of fish or thick bloom of plankton or krill and circle around below, blowing bubbles that float up around the school and form a bubble-net to keep the fish from escaping. The whales then swim in a spiral within the bubble-net with their mouths open, swallowing the large amount of food that has been trapped within the net. They also work in groups to herd large schools of small fish, like anchovy or sardines, by swimming around the school, closing in from every angle so that the fish form a tight, dense ball. They may also use their powerful flippers and fins to slap the school, stunning the fish and disabling them. The whales then swim through the ball with their mouths open to swallow as many fish as they can. Groups of whales are also known to swim in V-formation through a thick bloom, or school of fish, to maximize the catch of each whale. When swimming in a V, the prey missed by the whale in the front of the V will be consumed by the whales behind it.

Before winter begins, humpback whales migrate south to the tropical regions of the ocean like the Caribbean Sea, Mexico, and the Hawaiian Islands. Tropical waters tend to have much less food available to the whales, and they do not feed while in the tropics. Their main purpose during this time is to give birth and breed. Females usually start the journey before the males, so that they can give birth and begin nursing their young. Once the males arrive, breeding behaviors begin. Courtship behaviors between males and females include close body contact like rubbing, stroking, and patting. If a female accepts a male, he will stay with her during the breeding season and is called an escort. It is common in Hawai'i to see a female whale, her calf, and a male escort swimming together. Competition and aggressive behavior can, and usually does, ensue when another male tries to replace the current escort. While direct contact is usually not made, males will lunge toward each other, thrash their tail flukes, and slap the water with their fins and flukes to demonstrate dominance.

While humpbacks are found in all regions of the ocean both in the northern and southern hemispheres, the Hawaiian Islands support the only National Marine Sanctuary for humpback whales. It is estimated that as many as 10,000 whales travel from the Gulf of Alaska to visit the Hawaiian Islands every winter, starting in November and lasting through May. For additional information on the Hawaiian Islands Humpback Whale National Marine Sanctuary, visit http://hawaiihumpbackwhale.noaa.gov/

How do scientists identify and study humpback whales?[4] (Lesson 4)

Humpback whales have characteristic colorings of white patches on their tail flukes and flippers, as well as unique notches and serrations. By taking pictures of these parts of individual whales, researchers have been able to keep track of many individuals over the years. Non-invasive observations from research vessels have allowed researchers to gain insight into humpback whale movements, reproductive success, survival, and behavior as they age.

In conjunction with visual identification and monitoring, tissue samples, or **biopsies** of humpback whales have been taken from thousands of these individuals. From biopsy samples, researchers can determine health and life history characteristics, like whether the animal is pregnant, the levels of contaminants, like mercury and Polychlorinated Biphenyls (PCBs), present in the animal, and the genetic diversity present among populations.

Other methods have been developed to locate individuals and track their diving patterns and movements both on short and long-time scales. These include:

Radio transmitters: These instruments are attached to the whale through suction cups or small, shallow darts that are secured to the dermal layer of the animal. Radio transmitters send beeps that are recorded by a receiver. They are used to indicate the presence, or absence of individuals within groups, or when visibly identifying the individual is difficult.

Geographic time depth recorders: These tags record light levels and surface water temperatures between dives. They also have clocks that allow the researchers to estimate when the animals are most surface active. Latitude and longitude of the animal's location can also be estimated using temperature, time, and light level data.

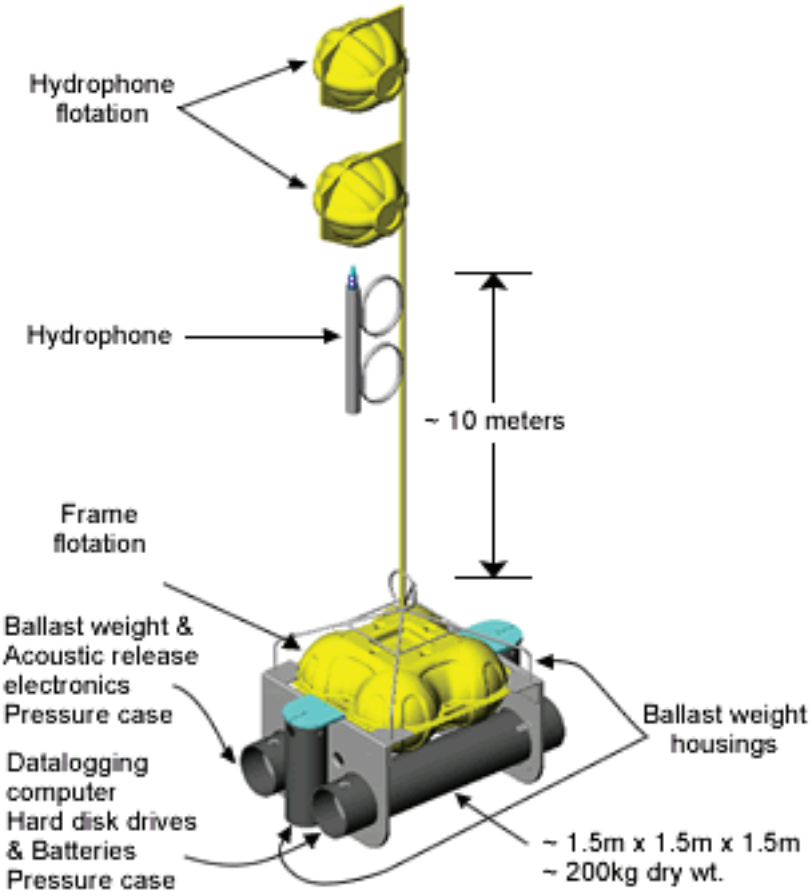
Satellite linked transmitters: These transmitters allow scientists to track individuals over long time periods by recording the global position of the animal as well as depth while diving. For humpback whales, these tags have provided valuable information on the **migratory** routes and traveling speeds and times between Alaska and Hawai'i. The path of many whales leaving the Hawaiian Islands is to travel northwest up to Russia through the Aleutian Islands and over to Alaska via the Bering Sea. Others travel a straight northeast route up to Alaska. During their long distance travels, whales can cover 110 kilometers (68.35 miles) in a day. At this pace, humpbacks can reach their feeding grounds in Alaska in as little as 39 days. For additional information concerning different migratory routes of humpbacks, visit http://www.fakr.noaa.gov/newsreleases/2007/humpbacks101007.htm

What tools do scientists use to study whale songs? (Lesson 2)

The U.S. Navy was the first to record whale songs in the 1950s by using underwater listening devices called **hydrophones**. These are still the main instruments used to listen to, and record, whale songs today. Computer programs have been developed to help deconstruct the complex vocalizations made by male humpback whales. These **bioacoustic** software programs create spectographs (visual representations of the sounds) that allow researchers to visualize the composition and patterns of individual songs. Researchers record an individual's song, and keep track of that individual over many years in order to better understand the reasons behind the vocalizations.

Scientists have been analyzing songs since the 1970s, and have discovered that patterns exist. For example, the basic structure of a whale song consists of a series of sounds or units, repeated in patterns over time called phrases. Each phrase is then repeated several times to comprise a theme. A complete song lasts from 8–15 minutes, and has a total of approximately 5–7 themes that are repeated during the song. The song can also be repeated and may go on for several hours. Over the years, the song of individuals slightly changes, but it is interesting to note that interacting populations of humpbacks share essentially the same song. Different populations have completely different songs; for example, the North Pacific population has a completely different song than the South Pacific population.

Only males sing, usually alone and much more frequently in breeding grounds, although singing can also be heard in feeding grounds. Hypotheses exist as to why whales sing, but researchers do not know the absolute reason. It is thought that males sing as a way to communicate their location to other males, or to attract females.



What human activities cause underwater noise pollution that may affect the behavior of humpback whales?[6] (Lesson 2)

Marine mammals use sound to navigate, find food, find mates, and communicate with each other. Human-produced underwater noise pollution is thought to disrupt any, or all of these vital functions. The physical effects of intense noise pollution include hemorrhaging of the brain, lungs, inner ear, and eyes, causing severe impairment in acoustic communication and other essential behaviors. Our knowledge of the biology of marine mammals is still growing although very little is known about the hearing capabilities of cetaceans. Current research at the Marine Mammal Research Program at the Hawai'i Institute of Marine Biology is attempting to characterize the hearing frequency ranges of these animals to better understand how **anthropogenic** underwater noise pollution might affect them. For additional information, visit http://www.hawaii.edu/mmrp/search.htm

Below is a list of sources of anthropogenic noise pollution that are thought to be detrimental to marine mammals causing any, or all the physical damage previously described.

Low Frequency Active Sonar (LFAS): This type of high-intensity sonar was designed by the military to track and detect submarines and other covert machines that operate underwater. The frequency of this sonar is in the 180–240 decibel range. This is equivalent in air to being 6.1 meters (20 feet) away from a rocket at takeoff. A large percentage of marine mammal carcasses being collected from being stranded on the beach show signs of hearing damage, evidence that many mammals that become stranded may be doing so in response to hearing damage. Many recordings of mass marine mammals being stranded have occurred during naval testing of LFAS.

Air guns: Air guns are used for underwater exploration and monitoring of oil reserves as well as geophysical research, and often operate for long periods of time, producing frequent bursts. Sperm whales and blue whales that were located as far away as 370 kilometers (230 miles) from the air gun reportedly stopped vocalizing for up to 36 hours in response to the noise. There is documentation of these mammals becoming stranded in close vicinity to these machines.

Shipping: Cargo ships produce constant low frequency noises from their propellers that fall within the same frequency range that many whales use to communicate over long distances. The effects of shipping noise are hard to quantify because shipping vessels are very frequent in the world's oceans. Some scientists, however, are concerned that interference from shipping noise could have large scale population level effects in the ability of individuals to communicate with each other over long distances.

Science Background for the Teacher Glossary

anthropogenic: an effect or objects resulting from human activities (ex. air pollution).
baleen: the internal feeding structure of baleen whales composed of a protein similar to human fingernails that hangs from the upper jaws of the whale's mouth; functions to sieve through water and trap small food particles.
bioacoustic: sound production and reception in animals.

biopsies: small tissue samples collected from living organisms.
blubber: the fat of marine mammals used for insulation.
echolocation: the ability of animals to examine their surroundings using sound waves they produce that bounce off objects and are received back and interpreted.
endothermic: describes organisms that are capable of maintaining an internal body temperature that is independent of the surrounding environment.
hydrophone: an instrument used to record sound underwater.
migratory: an animal that moves from one place to another.
mysticetes: the taxonomic order given to baleen whales.
odontocetes: the taxonomic order given to toothed whales.
oligotrophic: waters that are characterized as having few suspended nutrients.

Science Background for the Teacher- Bibliography

[1-6] ***Science background information condensed and/or compiled from the following sources:***

1: Cetacean research and rescue Unit. (2007). Humpback Whale. Retrieved October 28, 2007, from http://www.crru.org.uk/education/factfiles/hback.htm
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2: Enchanted Learning. (2007). What is a whale? Retrieved October 28, 2007, from www.enchantedlearning.com/subjects/whales/allabout/

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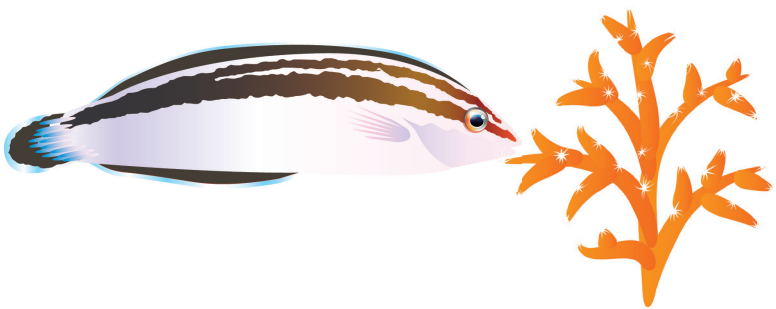
5: Whale Trust. (2007). *Humpback whale song.* Retrieved October 30, 2007, from http://www.whaletrust.org/whale_song.html

6: Green, M. (2004). *Effects of underwater noise pollution in Marine mammals.* Retrieved October 30, 2007, from, http://www.oceanmammalinst.org/underwaternoise.html



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:

- **SPLASH (Structures of Population, Levels of Abundance and Status of Humpback Whales) Project information including research technique information are found at:** http://hawaiihumpbackwhale.noaa.gov/science/splashinfo.html

- **"Discover Marine Mammals" activity book developed in collaboration with NOAA and Project WET**

- **Images of Whales are found at:** http://hawaiihumpbackwhale.noaa.gov/imagery/welcome.html

- **Images of habitat mapping in the Humpback Whale sanctuary can be found at:** http://hawaiihumpbackwhale.noaa.gov/documents/maps.html

- **"Understanding Threats to Humpback Whales" kid's page and "Protecting Hawai'i's Ocean Treasures" newspaper insert, both found at:** http://hawaiihumpbackwhale.noaa.gov/kids_page.html

- **NOAA Fisheries "The Kid's Times" found at** http://www.nmfs.noaa.gov/pr/education/turtles.htm and http://www.nmfs.noaa.gov/pr/education/whales.htm

OCEAN LITERACY ESSENTIAL PRINCIPLES

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.

7. The ocean is largely unexplored.
   - 7a. The ocean is the last and largest unexplored place on Earth- less than 5% of it has been explored. This is the great frontier for the next generation's explorers and researchers, where they will find great opportunities for inquiry and investigation.
   - 7b. Understanding the ocean is more than a matter of curiosity. Exploration, inquiry and study are required to better understand ocean systems and processes.
   - 7d. New technologies, sensors and tools are expanding our ability to explore the ocean. Ocean scientists are relying more and more on satellites, drifters, buoys, subsea observatories and unmanned submersibles.
   - 7f. Ocean exploration is truly interdisciplinary. It requires close collaboration among biologists, chemists, climatologists, computer programmers, engineers, geologists, meteorologists, and physicists, and new ways of thinking.

Lesson 1: 5a. 5d. 5e. 5f.
Lesson 2: 5a. 5d. 5e.
Lesson 3: 5a. 5d. 5e. 5f. 5h.
Lesson 4: 5a. 5d. 5e. 7a. 7b. 7d. 7f.

CLIMATE LITERACY ESSENTIAL PRINCIPLES

3. Life on Earth depends on, is shaped by, and affects climate.
   - 3a. Individual organisms survive within specific ranges of temperature, precipitation, humidity, and sunlight. Organisms exposed to climate conditions outside their normal range must adapt or migrate, or they will perish.

Lesson 3: 3a

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 aide 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

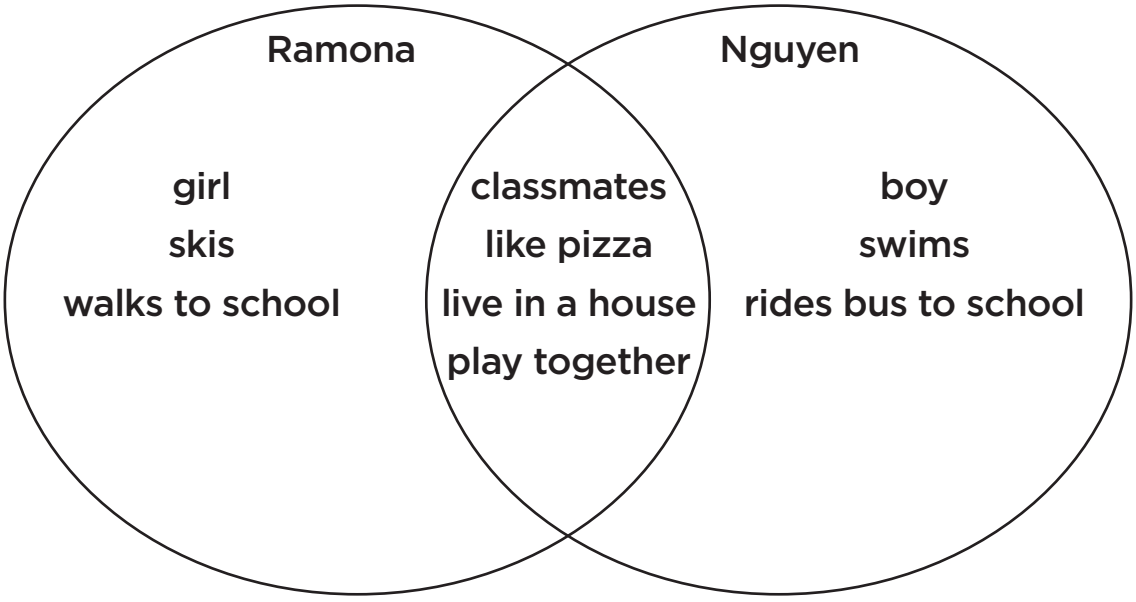
Round table can be used for brainstorming, reviewing, or practicing while also serving as a team builder. Students sit in teams of 3 or more, with one piece of paper and one pencil. The teacher asks a question which has multiple answers. Students take turns writing one answer on the paper, then passing 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.



References and Credits

From Lesson 1:
Suggested References for Teachers

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Whales: The Kids' Times. NOAA Fisheries: Office of Protected Resources Website:
http://www.nmfs.noaa.gov/pr/education/whales.htm
2. For more information on marine mammals:
Marine Mammal Education Web. NOAA Alaska Fisheries Science Center National Marine Mammal Laboratory Website:
http://www.afsc.noaa.gov/nmml/education/marinemammals.php

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http://www.marinemammalcenter.org/learning/education/teacher_resources/eatlikeawhale.asp
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From Lessons 3–4:
Suggested References for Teachers

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http://www.earthkam.ucsd.edu/public/educators/pdf/GeoImportandFactsLatAndLong.pdf

References and Resources Used by Writers (*Lesson 3)*

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2. Kaufman, G., & Forestell, P. (1986). Migration and Distribution, in *Hawai'i's Humpback Whales* (p.108). Aiea, HI: Island Heritage Publishing.
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3. Mann, J. (2000). *Cetacean Societies: Field Studies of Dolphins and Whales (pp. 180-181)*. Chicago, IL: University of Chicago Press.
4. *Whale Social Organization*. Retrieved September 28, 2007, from Whale Trust Website: http://www.whaletrust.org/whale_social_organization.html - yearling.

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