GRADE 4 UNIT 4 OVERVIEW

Life and Times of Humpback Whales

Introduction

Humpback whales are highly intelligent marine mammals that depend on specific environmental conditions to survive. In the Northern Hemisphere, 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 large 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.

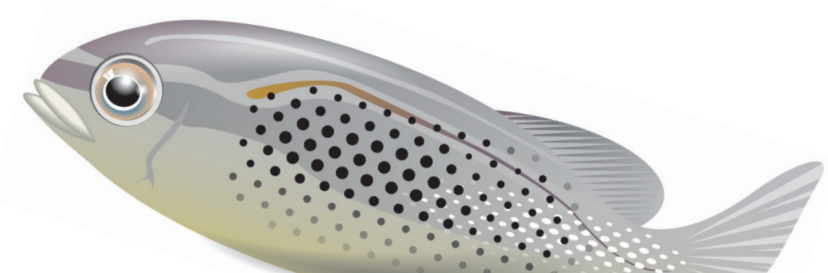
In this unit, students begin to understand more about whales by investigating the similarities and differences of whale fossils to their present day form. Using data compiled by marine scientists, students accurately plot whale migratory routes on maps, and pinpoint sites where whales feed in Alaska, and give birth and mate in Hawai‘i. They also study the adaptability of whale body features, and the crucial roles these features play in their summer and winter environments as well as during migration. Students also note the feeding and behavioral dissimilarities displayed by different whale types in these environments.

Under the teacher’s guidance and through Internet searches, students discover that humpback whales, like humans, are warm-blooded, give birth, engage in courtships, mate, nurse and protect their young from predators.

Through hands-on lab activities and fun games that complement the lessons, students duplicate the feeding behaviors of whales, and construct charts and bar graphs comparing the feeding styles of baleen and toothed whales.

Male whales use vocal sounds (whale songs) to communicate. After listening to recorded whale songs, students view computer-generated spectrographs, construct graphs to diagram these sounds, and create lyrics for whale song phrases.

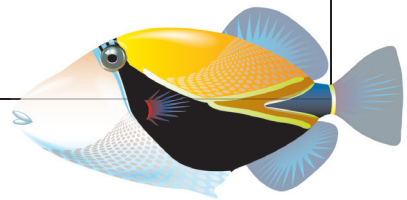
As part of the culminating exercises, students write creative stories about the life and times of a humpback whale, from the perspective of a whale or a whale researcher. The stories also address the potentially damaging effects natural events, and human- and technology-induced noise pollution have on whale behaviors, and suggest measures to minimize their occurrences.

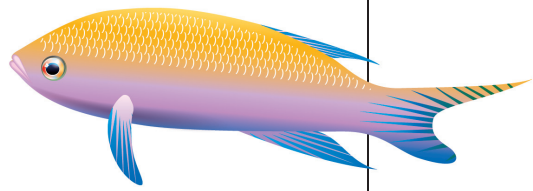


At A Glance

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
What is a fossil? How did whales evolve from land to sea animals?	Science Standard 1: The Scientific Process: SC.4.1.2 Differentiate between an observation and an inference Science Standard 5: Life and Environmental Sciences: SC.4.5.1 Compare fossils and living things. Language Arts Standard 2 Reading: LA.4.2.2 Use organizational patterns (e.g., sequential, cause and effect) to access and understand information.	**Lesson 1: Where did the Whales Come From?** Students investigate information about the development of today's whales during the last 60 million years. The readings take students from the whale's early terrestrial ancestors to the aquatic mammals of today. Two 60 minute periods
Why do humpback whales migrate between Alaska and Hawai'i each year? Why do humpback whales need both Hawaiian and Alaskan environments to survive?	Science Standard 3: Life and Environmental Sciences: SC.4.3.2: Describe how an organism's behavior is determined by its environment. Science Standard 5: Life and Environmental Sciences: SC.4.5.3: Describe how different organisms need specific environmental conditions to survive. Social Studies Standard 7: Geography: World In Spatial Terms SS 4.7.2 Collect, organize, and analyze data to interpret and construct geographic representations Math Standard 8: Geometry and Spatial Sense: MA.4.8.1: Use ordered pairs to plot points on a coordinate grid.	**Lesson 2: A Humpback Whale's World** Students participate in an interactive brainstorming activity to discuss their prior knowledge about humpback whales with their classmates. Students plot the migration route of a humpback whale on a map, locate the areas whales feed, mate and give birth, and compare the features of the humpback's Hawaiian and Alaskan environments. The whales visit Hawai'i in the winter, therefore it is best, if possible, to do this lesson during the period of November to April. Three 45-minute periods



ESSENTIAL QUESTIONS	HCPS III BENCHMARKS	LESSON, Brief Summary, Duration
Why might humpback whales sing? How do scientists study whale songs? How do human activities create noise pollution that may affect the behavior of humpback whales?	Science Standard 1: The Scientific Process: SC.4.1.2 Differentiate between an observation and an inference. Science Standard 3: Life and Environmental Sciences: SC.4.3.2 Describe how an organism's behavior is determined by its environment. Science Standard 2: The Scientific Process: SC.4.2.1: Describe how the use of technology has influenced the economy, demography, and environment of Hawai'i Math Standard 11: Data Analysis, Statistics, and Probability: MA.4.11.2: Label the parts of a graph (e.g., axes, scale, legend, title). Language Arts Standard 4: Writing LA.4.4.1 Range of Writing: Write in a variety of grade-appropriate formats for a variety of purposes and audiences. Fine Arts Standard 2: Music: FA.4.2.6 Compare and contrast musical styles from two or more cultures.	**Lesson 3: Harmonizing with Humpbacks** Students analyze popular and classical songs to understand how people use music to communicate, and then view a PowerPoint about humpback whale songs. Students construct a graph to diagram real whale song sounds, and create lyrics for whale song phrases. In addition, students will examine ways scientists capture whale songs and human sources of noise pollution in whale habitats. Two 45-minute periods 
What major events occur during each stage of a humpback whale's life cycle? How is humpback whale survival impacted by natural and human activities?	Science Standard 3: Life and Environmental Sciences: SC 4.3.2 Describe how an organism's behavior is determined by its environment. Science Standard 2: The Scientific Process: SC.4.2.1 Describe how the use of technology has influenced the economy, demography, and environment of Hawai'i. Language Arts Standard 4: Writing: LA.4.4.1 Write in a variety of grade-appropriate formats for a variety of purposes and audiences	**Culminating Lesson: The Life Cycle of Humpback Whales** Students play a board game in small groups to learn about events that occur in each stage of the humpback whale life cycle, including natural and human-caused threats. Students write a creative story about the life and times of a humpback whale as the culminating experience for the unit. Two 45-minute periods

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

Benchmark Rubric

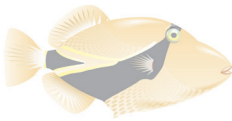
I. HCPS III Benchmarks*

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

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		Biological Evolution	
Benchmark SC.4.5.1		Compare fossils and living things	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Compare, and use evidence to explain, the relationship between fossils and living things	Compare fossils and living things, describing their similarities and differences	Identify the connection between fossils and living things	Recall that there is a connection between fossils and living things

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		Understanding Text Structures	
Benchmark LA.4.2.2		Use organizational patterns (e.g., sequential, cause and effect) to access and understand information	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Use organizational patterns to access and understand complex information, in a highly effective way	Use organizational patterns to access and understand information	Use organizational patterns in a way that gives limited access to and/or understanding of information	Use organizational patterns in a way that does not help access and understand information
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

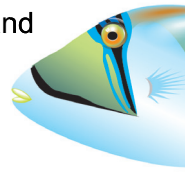
Topic		How the Arts Shape and Reflect Culture	
Benchmark FA.4.2.6		Compare and contrast musical styles from two or more cultures	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Compare and contrast musical styles from two or more cultures, in great detail	Compare and contrast musical styles from two or more cultures, in detail	Compare and contrast musical styles from two or more cultures, in some detail	Compare and contrast musical styles from two or more cultures, in minimal detail
Topic		World In Spatial Terms	
Benchmark SS.4.7.2		Collect, organize, and analyze data to interpret and construct geographic representations	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Collect, organize, and analyze data to interpret and construct geographic representations, with accuracy	Collect, organize, and analyze data to interpret and construct geographic representations, with no significant errors	Collect, organize, and analyze data to interpret and construct geographic representations, with a few significant errors	Collect, organize, and analyze data to interpret and construct geographic representations, with many significant errors
Topic		Coordinate Geometry	
Benchmark MA.4.8.1		Use ordered pairs to plot points on a coordinate grid	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Use ordered pairs to plot points on a coordinate grid, with accuracy	Use ordered pairs to plot points on a coordinate grid, with no significant errors	Use ordered pairs to plot points on a coordinate grid, with a few significant errors	Use ordered pairs to plot points on a coordinate grid, with many significant errors
Topic		Data Collection and Representation	
Benchmark MA.4.11.2		Label the parts of a graph (e.g., axes, scale, legend, title)	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Effectively label the parts of a graph	Sufficiently label the parts of a graph	Label the parts of a graph, with a few omissions or errors	Label the parts of a graph, with significant omissions or errors



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 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.

What is a fossil? How are they formed? [1] (Lesson 1)

Fossils are preserved remains of plants and animals that lived thousands to millions of years ago. The oldest fossils are approximately 600-million-years old, although some bacteria may have lived as long as 3-billion-years ago. Not all former life is preserved through fossilization. In fact, the vast majority of dead organisms are broken down by living organisms and decay until there is nothing left. The most likely organisms to be preserved as fossils are aquatic organisms with hard parts like teeth, bony skeletons, or shells. The process of **fossilization** requires a combination of conditions, and generally takes place in several phases:

- Phase 1 – **Death:** An organism, for example a fish, dies and sinks to the bottom of the ocean where its soft, fleshy parts are eaten by scavengers and microorganisms. After a few weeks, all that remains is the bony skeleton.

- Phase 2 – **Deposition:** After several months, the skeleton becomes covered with silt and sand. These layers continue to build and provide a shield around the skeleton, which protects it from being damaged. Layers continue to build, and after a few hundred years the skeleton is several feet beneath the surface.

- Phase 3 – **Permineralization:** The chemicals that make up the skeleton gradually undergo a series of changes. As the skeleton slowly decays, water carrying dissolved minerals passes through it and replaces the chemicals in the skeleton with rock-like minerals (such as calcite, iron, or silica). These minerals take the shape of the original skeleton, but have changed its composition and made it heavier (i.e., more dense). The skeleton loses its original color, and is now essentially made of rock.

- Phase 4 – **Erosion:** Over millions of years, as the plates of the Earth's crust move and shift, the fossil may be brought closer to the surface. Erosion from waves, wind, rain, or ice can wash away the layers of sediment above the fossil to bring it very near the surface.

- Phase 5 – **Exposure:** Finally, the fossil becomes exposed, either because of some natural event (like a landslide or Earthquake), or because it was dug up by a paleontologist studying the fossil record.

The above process is generally referred to as permineralization, but there are numerous other ways that fossils can be formed as well. Some examples of other fossilization processes include **impression formation,** in which the imprint of an organism is preserved in silt or clay without preservation of the animal itself; **amber preservation,** in which organisms (usually insects) are encased in the hard resin of a tree; and **freezing,** in which an entire organism is preserved under snow and/or ice.

What can scientists learn from fossils? [2] (Lesson 1)

Fossils can tell us a variety of things depending on what kind of organism they are from, and how they were preserved. For instance, amber fossils provide a wealth of information about the anatomy of an organism, since amber usually preserves organisms completely intact without any disintegration of organs, muscles, and coloring. Bones, and other hard parts that are preserved through permineralization, can also tell us a great deal about the soft anatomy of organisms. For instance, the areas where muscles were attached to bone can leave helpful clues about the size, shape, and function of those muscles and various organs. The cavities and channels in skulls can provide information about brain size, intelligence, and behavior of organisms as well. Fossils can also be used to tell a great deal about their surroundings and the environmental conditions of the Earth during the time in which the fossilized animals lived. For instance, the shape of

land and seas are constantly changing over the course of time. Many places that are dry land now were once underwater, and vice versa.
Finally, fossils record the succession of living things throughout the course of natural history, and therefore, tell us how different groups have changed or evolved over time. Various methods can be used to determine the age of a fossil, and they, therefore, tell us what organisms looked like and how they might have behaved throughout the course of the Earth's history. Fossils are the only direct record of what has occurred in the natural world in the course of time on an evolutionary scale.

How do scientists know how old a fossil is? [3] (Lesson 1)

Scientists use a variety of methods to determine the age of fossils, but the two main methods are relative dating and radiometric (or radioisotope dating).

To understand **relative dating,** first recall that fossils are most commonly found in **sedimentary rocks,** which form from the silt and mud that settle on the bottom of seas, lakes, and wetlands. New layers of sediment fall over the older ones and compress them into rock. In places where the water level constantly rises and falls, sedimentary rock will be deposited in many layers called **strata.** Over time, some of these layers may erode away to reveal more ancient strata that had previously been buried. **Relative dating** estimates the age of a fossil based on its position within these strata, and deeper layers of strata are generally assumed to be older than shallower layers.

Another way to understand this dating process is to imagine that, after reading your newspaper every day, you stack it in a pile to be recycled. If you were to go back through that pile of papers and find a grocery list between the June 29th and June 30th newspaper, you would have a pretty good idea of when you wrote the grocery list. In this case, your newspapers would be just like the layers of sediment that make up the strata in the fossil record.

Of course the strata do not have dates written on them like newspapers do, so how do we know the age of a specific layer of strata? Scientists use **radiometric dating** to determine **absolute** ages for fossils (meaning that fossil age is given in years instead of relative terms). Igneous (volcanic) rocks surrounding fossils contain various elements, such as carbon, uranium, and others, that accumulated when the rocks were formed. Each of these elements exists in a variety of different forms called **isotopes,** and each isotope has a consistent rate of decay that is unaffected by temperature, pressure, or other environmental variables. The rate at which an isotope decays is called its **half-life,** and refers to the number of years it takes for 50% of the original isotope to break down. For instance, an isotope called carbon-14 has a half-life of 5,600 years. By measuring the amount of carbon-14 in the rock above or below a fossil, scientists can estimate how long ago the fossilized organism died. For older fossils, researchers must use an isotope with a longer half-life, such as uranium-238, with a half-life of 4.5 billion years.

What did scientists learn about whales from fossils? [4] (Lesson 1)

Fossil remains indicate that whales (including dolphins and porpoises) evolved from hoofed land animals called ungulates or artiodactyls. Present-day representatives of this group include cows, sheep, pigs, deer, and camels. Scientists have discovered several lines of evidence supporting the theory that whales evolved from land mammals. First, the fossil record shows that the earliest mammals were terrestrial (land) animals, and they first appeared around 200 million years ago (MYA) at a time when there were no marine mammals in existence. Indeed, the first whale-like mammals did not appear until around 50 MYA.

Several transitional fossils have also been found that link whales to terrestrial mammals. **Transitional fossils** are those that have some traits in common with an older organism, and other traits similar to more recent organisms, indicating an evolutionary link between the older and newer group. These transitional fossils show terrestrial animals that appear to have slowly started spending more and more time in the sea, and often showed adaptations for living on both land and

sea. Over time, their physical characteristics became more suited for aquatic living, and they eventually lost nearly all externally visible similarities to their terrestrial ancestor.

There are several other lines of evidence for whale evolution in addition to the fossil record, and you can even see evidence of their terrestrial ancestry by looking at the skeletons of modern-day whales. For instance, the forelimbs (or flippers) of modern whales are made up of the same skeletal elements as cats, dogs, and humans. If you could look inside a whale's front flippers, you would see that it has bones very similar to the bones that make up your lower arm, wrist, and hand. Whales even have **finger bones** within those flippers. All whale species also have several vestigial structures that are commonly found in terrestrial mammals, but serve no purpose in whales. **Vestigial (ves-TIJ-eeal) structures** are those that are reduced in form or function because they no longer serve the purpose for which they originally evolved. For instance, many modern whales have skeletal remnants of hind legs. These leg bones are very reduced in size and usually entirely contained within the musculature of the whale (i.e., they are not externally visible), although they can sometimes be seen externally in sperm whales. All whales also have a small number of muscles devoted to nonexistent external ears. In land mammals, these muscles are useful for turning large, mobile ears for directional hearing, but in whales, which lack external ears, they are useless. All of these things support the idea that whales, like all mammals, evolved from a single terrestrial ancestor.

What are some of the theories about the evolution of whales? [5] (Lesson 1)

Some terrestrial mammals began spending more and more of their time in the sea starting approximately 60 MYA. It is assumed that this move was a way of taking advantage of the rich food sources of the ocean compared to land, but it may also have had to do with a decrease in other large predator populations. Before this time, reptiles had been the dominant animal group, and any mammal attempting to enter the sea may have been eaten fairly quickly by one of many predatory aquatic reptiles. However, the end of the Cretaceous Period (approx.65 MYA) marked a mass extinction of reptiles and dinosaurs, which appears to have opened the door for mammals to expand their range into the sea. Several examples of transitional fossils or intermediates between land mammals and modern whales have been found in the fossil record, and it took approximately 10-15 million years to make the full transition to whales. A few of the main intermediate organisms are described below. To see images of these whales, refer to PowerPoint "Whale Evolution" associated with Lesson 1 of this unit.

The last shore-dwelling ancestor of modern whales appears to have been a deer-like animal called ***Indohyus*** that lived approximately 48 MYA. Similarities in the skull and ear bones of ***Indohyus*** and today's whales show a close family ancestry.

The next known transition organism in the sequence is ***Pakicetus***, which is known only from skull fragments. ***Pakicetus*** lived approximately 52 MYA, and shows teeth somewhat similar to ***Sinonyx,*** but the molars have become more pointed like those of modern whales. These pointier teeth are an adaptation for catching fish, more indicative of an aquatic lifestyle. ***Pakicetus*** did not have a water-adapted inner ear, and its nostrils were still located at the front of the head (i.e., it did not have a blowhole).

Ambulocetus lived approximately 50 MYA, and is one of the best examples of a transitional form between whales and terrestrial animals. ***Ambulocetus*** lacked a blowhole, but otherwise had a skull and tooth structure very similar to modern whales. Its spine moved up and down for swimming the way that modern whales do, but its four legs were still functional enough that it was probably able to walk on land in the same way that sea lions do today. This animal is best described as being an amphibious (using both land and sea), sea lion-sized animal that swam and ate fish, but was still somewhat connected to the terrestrial environment.

The ***Rodhocetus*** lived around 46 MYA, and shows a further progression toward the traits of modern whales. It had developed a powerful tail for swimming, and a more flexible spine for tail movements. Therefore, this is the earliest known mammal to swim predominantly using its tail for propulsion rather than its legs. ***Rodhocetus*** still appears to have

legs strong enough to move on land, but they were shorter and probably even less useful than those of ***Ambulocetus*** before it. ***Rodhocetus*** also showed that the nostrils moved back along the snout to a point directly above the canine teeth, and therefore is the first example of blowhole evolution.

Another transitional or intermediate fossil organism is ***Basilosaurus,*** which lived between 35 and 45 MYA. This was a very large (approx.15 meters or 50 ft long), serpentine animal that was originally thought to be the remains of a sea serpent. ***Basilosaurus*** had a very small pelvic girdle and hind limb bones that were far too small to bear the animal's weight on land. Its vertebral column shares characteristics of whales with tail flukes (fins), but flukes contain no bone, and are therefore unlikely to fossilize. The nostrils had fused into a large single blowhole that had migrated further back on the head from that of ***Rodhocetus.***

Finally, the ***Dorudon*** lived approximately 40 MYA, during the same period as ***Basilosaurus,*** and is the most likely ancestor to modern whales. Like ***Basilosaurus, Dorudon*** was fully aquatic and lacked large enough limbs to move around on land. It was much smaller (approximately 4–5 meters or 15 ft) than ***Basilosaurus.*** Despite its similarity to modern whales, ***Dorudon*** lacked the capability to use underwater sounds to locate objects (echolocation) as modern whales can.

How are toothed and baleen whales different? What is a humpback whale?[6] (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 or 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 in their feeding grounds. Researchers aren't 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? [7] (Lesson 2)

Humpback whales are warm-blooded, air-breathing mammals that spend their entire lives in the marine environment. They possess large lungs that can withstand changes in pressure to enable them to hold their breath for long periods of time in order to dive. Humpbacks can dive down to 120 meters (approx. 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 about 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 behaviors? [8] (Lesson 2)

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.

Near the coast of Alaska in the spring and summer months for example, the weather is mild and the waters are teeming with the humpbacks primary food source of small schooling fish, krill, and other plankton. Humpbacks feed extensively in these 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.

Since winters in the Polar regions of the oceans are severe, and food availability decreases dramatically, 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 more information on the Hawaiian Islands Humpback Whale National Marine Sanctuary visit http://Hawaiihumpbackwhale.noaa.gov/

There are (now) Northern Hemisphere whales (e.g. they live North of the equator) in the Arabia Sea, off Oman and Pakistan, and therefore their migration to the North is blocked by land masses. Since they apparently find enough food to survive year round, and yet the conditions are also acceptable for mating and calving, they don't have to migrate. But no one is really sure how this situation came into being, however, they are apparently more genetically similar to Southern Hemisphere humpbacks, and so one theory might be that they moved into the area during a period of glaciation, as that would tend to bring Northern and Southern populations closer together (and maybe even overlap on occasion), and then when the glaciers retreated, this small population remained above the equator. For more information visit http://www.iucnredlist.org/apps/redlist/details/132835/0

What are some of the methods that researchers use to study humpback whales? [9] (Lesson 3)

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 PCBs, toxic environmental pollutants which tend to accumulate in animal tissues 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 (70 miles) in a day. At this pace, humpbacks can reach their feeding grounds in Alaska in as little as 39 days. For more information on different migratory routes of humpbacks visit http://www.fakr.noaa.gov/newsreleases/2007/humpbacks101007.htm.

What tools do scientists use to study whale songs? [10] (Lesson 3)

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 **spectrographs** (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 about 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? [11] (Lesson 3)

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 can 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 more information about this program 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 intensity of this sonar is in the 180–240 decibel range. This is equivalent in air to being 7 meters (20 feet) away from a rocket at takeoff. A large percentage of marine mammal carcasses being collected from beach strandings show signs of hearing damage, showing evidence that many mammals that strand may be doing so in response to hearing damage. Many recorded mass strandings 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. Strandings have also been documented 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

amber preservation: process of fossil preservation in which organisms (usually insects) are encased in the hard resin of a tree.
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.
deposition: part of the fossilization process in which a dead organism is gradually buried by silt and sand and compressed.
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.
erosion: the washing away of layers of sediment (by waves, wind, rain, or ice) that often brings a fossil nearer to the Earth's surface.
exposure: the uncovering of a fossil, either from a natural event (like a landslide or Earthquake) or because it was dug up by a paleontologist studying the fossil record.
fossilzation: the creation of a fossil from the remains of a dead organism. Can take place through a number of different methods, the most common of which is permineralization.
fossils: the preserved, mineralized remains of plants and animals that lived thousands to millions of years ago.
freezing: a mechanism of fossilization in which an entire organism is preserved through under snow and/or ice.
half-life: the rate at which an isotope decays. It refers to the number of years it takes for 50% of the original isotope to break down.
hydrophone: an instrument used to record sound underwater.
impression formation: a mechanism of fossilization in which the imprint of an organism is preserved in silt or clay without preservation of the animal itself.
isotopes: a specific type of a common element (such as carbon-14 or uranium-238) that has a consistent rate of decay and can therefore be used for dating rocks or fossils.
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.
permineralization: part of the fossilization process in which chemicals that make up the skeleton are gradually replaced by rock-like minerals (such as calcite, iron, or silica).
radiometric dating: the measurement of isotope decay in a rock or fossil that allows the age of that fossil to be determined on an absolute scale (as opposed to a relative scale).
relative dating: estimation of a fossil's age based on its position within the strata record. Deeper layers of strata are generally assumed to be older than shallower layers.
sedimentary rocks: rocks formed from the silt and mud that settle on the bottom of seas, lakes, and wetlands, leading to the formation of strata.
spectrograph: a visual reproduction of sound waves and frequencies.
strata: layers of sedimentary rock that can be compared in order to determine the age of fossils through relative dating.
transitional fossils: fossils that have some traits in common with an older organism and other traits similar to more recent organisms, indicating an evolutionary link between the older and newer group.
vestigial structures: structures that are reduced in form or function because they no longer serve the purpose for which they originally evolved.

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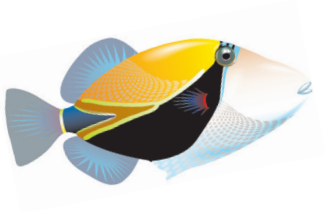

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NOAA Resources

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:

- SPLASH Research and related lessons
- "Discover Marine Mammals" activity book developed in collaboration with NOAA and Project WET
- "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

Humpback Whale NMS

- Beautiful images and video of the sanctuary http://Hawaiihumpbackwhale.noaa.gov/imagery/welcome.html
- Images and video of entanglements http://Hawaiihumpbackwhale.noaa.gov/res/entanglement.html http://Hawaiihumpbackwhale.noaa.gov/res/cases0809.html
- Images of habitat mapping in the sanctuary http://Hawaiihumpbackwhale.noaa.gov/documents/maps.html
- Any images and video of other research on the sanctuary http://Hawaiihumpbackwhale.noaa.gov/science/splashinfo.html http://Hawaiihumpbackwhale.noaa.gov/science/permittedresearch.html http://Hawaiihumpbackwhale.noaa.gov/science/otherresearch.html
- Images of NOAA scientists and staff at work from OMAO and NOAA Corps http://www.soest.Hawaii.edu/pibhmc/pibhmc_cruise-catalog.htm http://oceanexplorer.noaa.gov/gallery/technology/technology_collection.html
- Audio of whale calls picked up from HARP http://www.dolphin-institute.org/our_research/whale_research/whalesong.htm http://www.whaletrust.org/research/research_humpback_whale_song.shtml

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.
5c. Some major groups are found exclusively in the ocean. The diversity of major groups of organisms is much greater in the ocean than on land.
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.

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.

7. The ocean is largely unexplored

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.

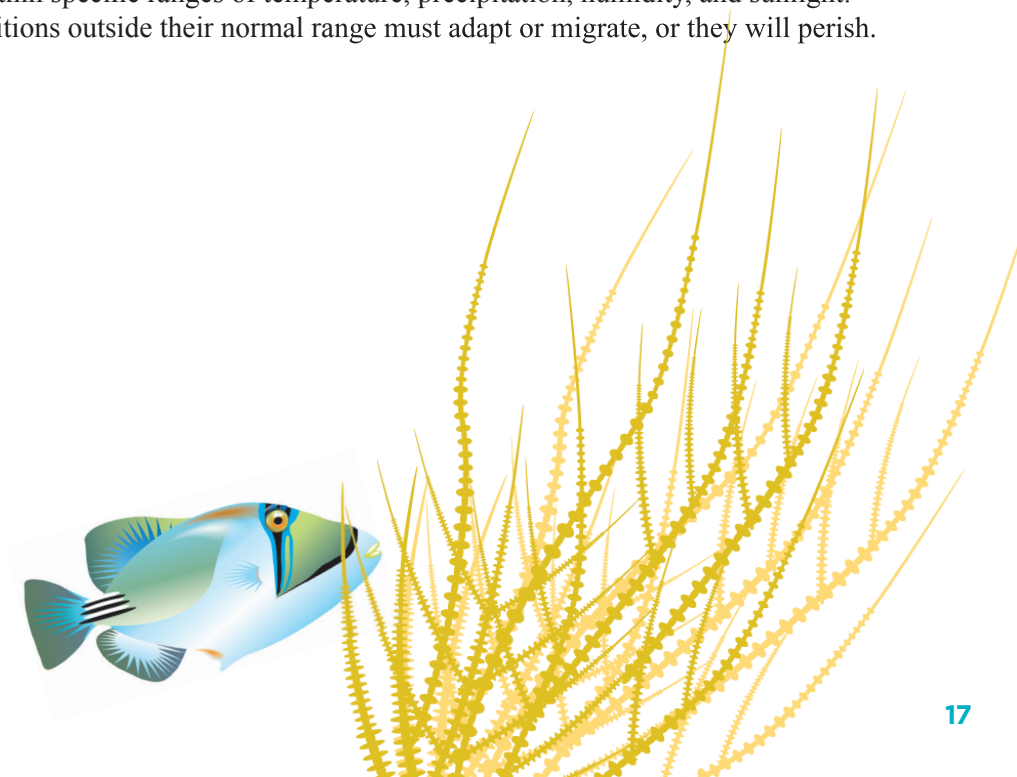
Lesson 1: 5a. 5c.
Lesson 2: 5a. 5c. 5d. 5f. 5e.
Lesson 3: 5a. 5d. 7d. 6e.
Lesson 4: 5a. 5c. 5d. 5e. 5f. 6e.

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 2: 3a
Lesson 4: 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 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

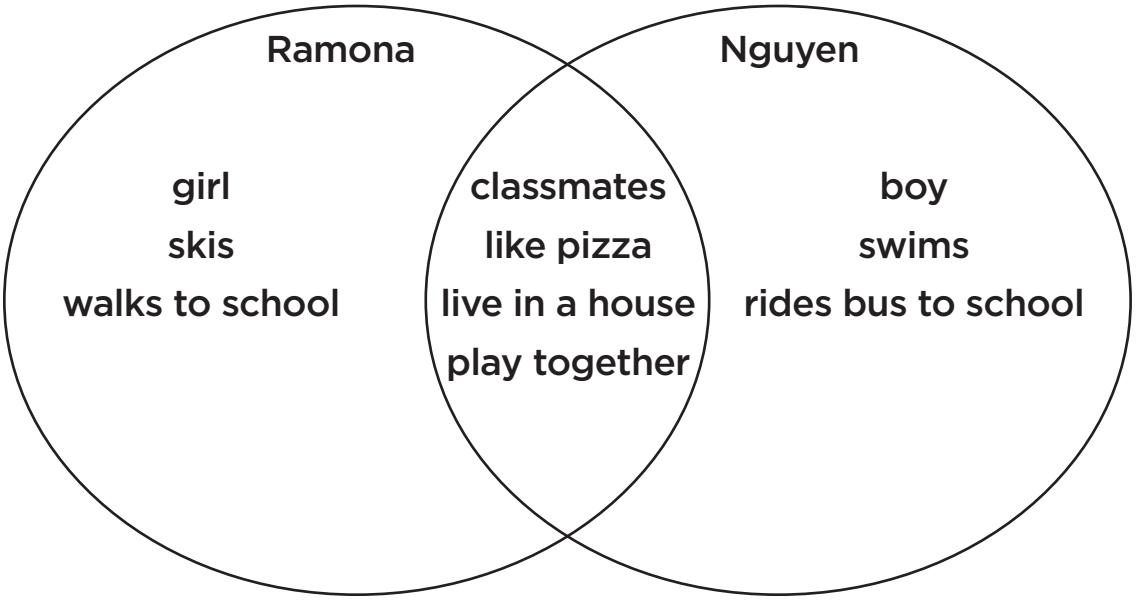
Round table can be used for brainstorming, reviewing, or practicing while also serving as a team builder. Students sit in teams of 3 or more, with one piece of paper and one pencil. The teacher asks a question which has multiple answers. Students take turns writing one answer on the paper, then passing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



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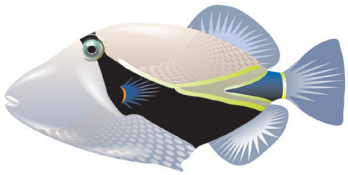
From Lesson 2:
References and Resources Used by Writers



1. *Important Facts about Latitude and Longitude*. Retrieved September 2, 2007, from ISS EarthKAM Website: http:// www.Earthkam.ucsd.edu/public/educators/pdf/GeoImportandFactsLatAndLong.pdf
2. Kaufman, G. & Forestell, P. (1986). Migration and Distribution, *Hawai'i's Humpback Whales* (p. 108). Aiea, HI: Island Heritage Publishing.
3. *Plotting Ordered Pairs*. Retrieved August 31, 2007, from Mathematics 'How To' **Library Website:** http://www.teacherschoice.com.au/Maths_Library/Coordinates/plotting_ordered_pairs.htm
4. *Science Background: Distribution & Migration*. Retrieved September 5, 2007, from National Geographic JASON Online Expedition Website: http://www.jasonproject.org/whales2001/about/migration.html This website no longer contains this online expedition. You may contact JASON Project for more info at www.jasonproject.org

From Lesson 3:
Suggested References for Teachers

1. http://www.fi.edu/fellows/fellow2/apr99/soundvib.html
   (A website with good explanation and visuals for sound waves, pitch, and amplitude.)
2. http://www.classiccat.net/
   (A web site to download free classical music.)
3. http://www.whalesong.net/
   (Web casting of live song of Hawai'i's humpback whales.)

References and Resources Used by Writers

1. Cronin-Jones, L. (1999). *The Florida Black Bear Curriculum Guide*. Defenders of Wildlife and Florida Fish and Wildlife Conservation Commission. (This activity is adapted from *Lesson Four: It's a Bear's Life*, pp. 45–64.)
2. Gabriele, C. et al. (2001). *Estimating the Mortality Rate of Humpback Whale Calves In the Central North Pacific Ocean*. Retrieved September 30, 2007, from U.S. Department of the Interior National Park Service Website: http://www.nps.gov/glba/naturescience/upload/Gabriele_2001_CalfMortalityCanJZoolApr2001.pdf.
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.

Student Readings

***SAFE ACCESS: Teachers need to take responsibility for student Internet use. Please make sure that you follow the DOE and school guidelines, IAUP's (Internet Acceptable Use Policy) signed prior to Internet use of a collection of whale songs for the teacher to play throughout the unit as desired.

From Lesson 4:
Suggested References for Teachers

1. Hawaiian Islands Humpback Whale National Marine Sanctuary Website: http://Hawaiihumpbackwhale.noaa.gov/Welcome.html
2. International Whaling Commission Website: http://www.iwcoffice.org/commission/iwcmain.htm
3. Steele, K. (2007). *Ideas for Teaching Writing.* Retrieved October 18, 2007, from Kim's Corner for Teacher Talk Website: http://www.kimskorner4teachertalk.com/writing/menu.html