Marine Skulls Cart

Lawrence Hall of Science

This activity outline was developed for use in a variety of informal venues. By design, it provides the content, pedagogy and strategy necessary for implementation by both the novice and experienced informal educator. It is expected that this outline will be adapted and improved upon by the user. We welcome your feedback!

Synopsis of the Activity

Visitors interact with skulls of several marine animals to explore similarities and differences between the animals and how and what they eat.

Audience

This activity is designed for the general public. It can be appropriate and challenging for all ages and audiences. It is best executed for small groups of visitors**.**

Setting

This activity works well as a cart anywhere in an informal science setting.

Activity Goals

Learners will be more aware of and more interested in the structure of marine animals' skulls and/or jaws.
Learners will develop the ability to predict what the animal likely eats by observing the shape of its mouth and teeth.
Learners will gain a greater appreciation for the diversity of marine organisms and their feeding mechanisms.

Concepts

- Different marine animals eat different things in different ways.
- What an animal might have eaten when it was alive can be determined in part by observing its skull and teeth.
- Differences exist between the skulls and teeth of mammals, bony fish, and cartilaginous fish, and similarities exist within each classification.

Ocean Literacy Principles

Some of the following Principles will be more relevant to different audiences, depending on their prior knowledge and the direction of the conversation between the audience and the facilitator.

5. The ocean supports a great diversity of life and ecosystems.
    a. Ocean life ranges in size from the smallest virus to the largest animal that has lived on Earth, the blue whale.
    c. 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.

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d. 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.
e. 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.

Materials
Animal skulls/jaws: shark, dolphin, sea lion, moray eel, wolf eel, skate, rockfish or other bony fish
Plastic animal models corresponding to the animal skulls/jaws on display
Photographs of animals

Prep Section Make sure that all of the materials (skulls, models, etc.) are present in the cart.

Procedure and Set-up
Arrange the skulls and jaws on top of the cart randomly to allow visitors to make their own groupings. Keep models and photographs of animals to the side and ready for use.

Guiding Questions
What do you notice about this skull? These teeth?
How are the skulls similar? How is [this one] like [that one]? How are they different?
How would you group these skulls?
Why would you group these together? What clues (or evidence) did you use to place them together?
What sort of food do you think this animal might eat? Why? What about the skull/teeth leads you to think that?
Which of these animals (models or photos) matches that skull? What was your evidence?

Activity Description
The series of activities described below can be presented in almost any order and can be repeated, or cycled through as new visitors approach. Facilitators should gauge the areas of interest and knowledge level of visitors and help them to select activities that will relate to and be of interest to them. You may start the interaction with the sorting activity and spend five minutes discussing the similarities a visitor sees in the mammal skulls, then move into what animals eat, then into the differences between mammals and all the other animals.

1. Interacting with the Skulls
Invite visitors to look at and touch the animal skulls and jaws that have been set out on the Marine Skulls Cart. Tell visitors that all these objects came from different ocean animals. Once they have had time to look over some of the objects initiate a conversation with them about the objects they are touching. Use the following questions and tasks to get the conversation started if needed. Remember to encourage visitors to ask their own questions as well as invite them to respond to each others' comments and questions.

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- Go ahead and pick up anything on the cart you find interesting. What is interesting about it to you?
- As you look at the skulls, think of a question or two about the animal that you would want to know more about.
- Try to come up with some questions about what you see or touch.
- How would you describe what the object looks and feels like?
- What do you notice about it? What do you wonder about?
- Do you have an idea about what that object might be?
- What would you call all these things on the cart?

Note: You will likely need to mention to younger visitors that skulls are the "head bones" of animals and that these are all from kinds of animals that are living in the oceans today (not dinosaurs).

- As visitors offer suggestions about what the objects might be, ask them what evidence they used to make that decision.

Potential key ideas to discuss during the initial interactions:
Skulls help to protect the brain of animals.
Skulls and jaws from different animals look very different, but they have some things in common.
Teeth from different animals look very different.

2. Free Sort

Invite visitors to sort the skulls using any common characteristics they notice. As the visitors sort, ask them to share with everyone:

- As you look at the skulls and jaws, think of a question or two about the animals that you want to know more about.
- Try to come up with some questions about what you see or touch.
- Why did you place these items together?
- What characteristics did you use to sort?
- What do you notice about any one of these skulls?
- Do you see any other skull that is similar?
- Can you find two skulls that are similar? Why did you choose those two?
- Can any item be placed in more than one category?
- What do you have questions about? Can we figure this out together? What other information would we need to answer that question?

Potential key ideas to discuss during the free sort depending on how the visitor sorted the skulls:
• Some of the skulls are from bony fish (moray eels, wolf eel and rockfish)
• Some of the skulls are from cartilaginous fish (skates and shark)
• Some of the skulls are from mammals (dolphin and sea lion)
• Differences exist between the skulls and teeth of mammals, bony fish, and cartilaginous fish, and similarities exist within each classification.

3. Guided Sorts: comparing similar types of organisms

Sample questions for each type of animal:

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Eels: Ask visitors to observe the eel skulls.

- As you look at the skulls, think of a question or two about the animal that you would want to know more about.
  - Try to come up with some questions about what you see or touch.
  - What do you notice about the eel skulls?
  - How are they the same?
  - How are they different?

Call attention to the teeth and jaws.

- Where are the teeth?
- Do you think we can tell what they eat by looking at the teeth and jaws?
- How does looking at the teeth and jaws help us figure it out?

Potential key ideas

• The wolf eel is called an eel, but it isn't a true eel. It has a large pectoral fin and a separate tail fin. True eels like the moray eel have their dorsal and anal fins combined with their tail fin. Sometimes as with the moral eel, true eels don't have any pectoral or pelvic fins.
• Wolf eels have strong jaws, canines and crushing molars to eat hard shelled prey like clams. Their jaws are massive which allows them to have more muscle attachments and the strength to crunch hard-shelled prey.
• Moray eels have very sharp teeth for catching fish. They have an extra set of jaws in their mouth that helps them to swallow food. Their jaws are slender which allow them to enter narrow crevices to hide and chase fish.

Cartilaginous Fish:

- What differences do you see in the shark and skate jaws?
- How are the teeth of the two jaws similar?
- How are they different?
- What can we tell about what they eat by looking at the teeth and jaws?

Potential key ideas

• The skate has rounded teeth and the shark has very sharp, serrated teeth.
• The skate uses its flat, crushing teeth to eat hard-shelled prey, like snails
• Sharks use their sharp teeth to eat fish or marine mammals.
• Both sharks and skates teeth are actually the skin with scales growing into the mouth.
• We can find shark and skate teeth because they routinely shed or lose them and they become fossilized.
• The jaws of sharks and skates are not connected to their skulls, so they are not found together.

Mammals:

- As you look at the skulls, think of a question or two about the animal that you would want to know more about.
  - Try to come up with some questions about what you see or touch.
- Compare the dolphin and sea lion skulls.
- How are the dolphin and sea lion skulls the same?

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- How are they different?
- Can you find where the nose of the sea lion was?
- What about the nose of the dolphin?
- Where is your nose?
- How might the placement of the nose help the organism survive in the ocean?
- What do you notice about the teeth?
- How are the teeth different?
- Looking at the teeth, what do you think this animal ate? Why?

Potential key ideas

• Both marine mammals have a very strong skull with large eye sockets.
• The dolphin has its nostrils on the top of its head, while the sea lion has it on the front of its face.
• Dolphins can come to the surface and quickly take a breath without even slowing down their swimming. They just skim the surface with the top of their head.
• The dolphin is adapted to a totally aquatic way of life, and the sea lion has adaptations for both the water and the land.
• Dolphin teeth are all identical - conical and sharp for catching and eating fish whole.
• Sea lions have sharp canine teeth for fighting each other and for catching fish. Some seals eat other seals and even penguins.

3. Guided Sorts: compare and contrast different groups of organisms

Mammals and fish:

- How are the mammal skulls similar to each other?
- How are they different from the fish skulls?
- How are the fish skulls similar to each other?

Potential key ideas:

• Generally, mammals have more different kinds of teeth than fish do. Dolphins are an exception since they have evolved more to the marine environment than seals and sea lions have and in turn have more fishlike adaptations.

Boney and Cartilaginous Fish:

Have visitors compare the shark and skate jaws to the eel skulls.

- What do you notice?
- How are they different?

Potential key ideas:

• These two jaws represent two classes of fish, e.g. those with a boney skeleton vs. a cartilaginous skeleton.
• Bony fish have the skull connected to the upper jaw and both the skull and jaws are present.
• Cartilaginous fish do not have the skull and upper jaw connected.
• Cartilaginous fish have a very small, cartilaginous skull that is not usually collected or fossilized.
• Often, even the jaws of cartilaginous fish are not fossilized, instead scientists collect fossilized teeth and then make a jaw for the teeth to fit into.

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4. Skull identification

Introduce the animal models and photographs and encourage visitors to match the animal models to the skulls to determine which skull belongs to which animal. This works especially well with younger visitors (5 and under). *Note: If you start with this activity, visitors will often leave after each animal has been identified.*

Related Activities/Extensions/Modifications

Use animal models and pictures to:

• Make inferences about and discuss locomotion - how different animals get around in (and out of) the water.

• What information can we get about locomotion by looking at the body shape or skull?

• Discuss habitat and counter-shading. What information can we get about where an animal lives by looking at its color?

Additional Resources

Books and field guides with additional information about the animals represented on the cart are interesting and helpful for the visitors to find additional information that they can share with each other and the facilitator. Posters and videos playing in the back ground are also engaging and provide the opportunity for continued conversations about the organisms in their habitat.

Background

Sea lions

Male sea lions have a sagittal crest on their skull where the large jaw muscles attach. This is an adaptation for male-to-male competition for defending their harems in the water. Sea lions are one of only a few seals and sea lions that have an aquatic territory. Their territories are found from the Channel Islands south into Mexico.

Sea lions have sharp teeth for catching and hanging onto slippery fish. Their canines are also used in male-to-male competition. Sea lion males always have larger canines for competition and defense than the sea lion females.

Sea lions (Otariidae) are different from seals (Phocidae). Sea lions belong to the 'eared seal' group; they have external ear flaps, whereas seals belong to the 'true seal' group and they only have an opening through which they hear. Also, sea lions can rotate their front and rear flippers allowing them to "walk" and climb on rocks, and are the ones often seen in circuses. Seals cannot 'walk' on their flippers–they 'inchworm' along the land. Seals, sea lions and walruses are grouped together and known as Pinnipeds. They are all carnivorous mammals. There are different views about the evolution of the seals and sea lions as follows: 1) they all evolved from a common bear-like ancestor and diverged from one another about 25 million years ago or 2) they all evolved separately about 20 million years ago with the seals evolving from otter-like ancestors and the sea lions from a bear-like ancestor. Sea lions and bear skulls are remarkably similar.

California sea lions tend to feed alone or in small groups unless there is a large quantity

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of food. Foods eaten include: cephalopods, anchovies, herring, Pacific whiting, rockfish, hake, salmon, squid and octopuses (Riedman, 1990). California sea lions feed on fish and squid near the ocean surface down to 80 feet but can dive to depths greater than 500 feet.

Dolphins
Dolphin skulls are very streamlined. Their elongated snout and jaws (called the rostrum), with lots and lots of cone-shaped teeth allow them to capture and eat fish, octopus, and squid whole. Unlike seals and sea lions that have their noses on the front of their face like a dog, the nasal pathways of dolphins (and other whales) open to the top of the skull. The placement of their nostrils on the top of their head allows them to take in breaths very quickly, with only the top of their head breaking the water. This is an adaptation to a completely aquatic life style.

Although it may appear that whales and dolphins have their eyes almost on the sides of their head, it is thought that they are actually able to see forward with both eyes. They are able to do this because the positions of their eyes are so far out and their rostrum is so narrow.

Wolf eel
Wolf eels are not true eels but belong to a group called the wolf fishes. (True eels have no pelvic and sometimes no pectoral fins, and their dorsal and anal fins are fused with the tail fin forming one continuous fin.) These fish are equipped with massively powerful jaws, large crushing teeth, and very tough skin around the mouth. These features allow them to eat hard-shelled or spiny prey such as clams, snails, crabs, and sea urchins. Most species have strong canines and molars for digging out and crushing clams and other hard-shelled prey. They feed on sedentary prey, including very slow moving fish and don't chase fish into crevices.

Sometimes divers can hear wolf eels crunching snails and sea urchins underwater. Divers have even been known to make lasting friendships with wolf eels by providing them with choice food items to eat.

Moray Eel
Moray eels are true eels and have their dorsal and anal fins fused with their tail fin. They are known to chase fish into tight crevices. Their jaws grab and lock tight and then they tie themselves into a knot and pull their head with the fish through the knot. This allows them to tear off pieces of flesh with their very sharp teeth. It has also been discovered recently that moray eels have a second set of toothed jaws located in their throat. These jaws project forward into the mouth and help to drag prey into their throats so they can swallow it. Many fish are known to have grinding plates or jaws on the roof of their mouth, but the moray can actually drag prey from the mouth into the throat with them. This discovery reminded the researchers of the *Alien* movies. Morays have very slender skulls which allows them to enter tight crevices as they chase fish.

Shark
The jaws and teeth of sharks are not connected to the skull (as other vertebrates skulls

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and jaws are). The cartilaginous jaws do not fossilize as easily as does bone and the shark skull is also very small in comparison to similarly sized mammals. Loose teeth are found much more often than whole jaws because they are made of denticles (scales) and they become fossilized. The teeth of sharks are actually the scales on the skin, which grow into the mouth. Stingray stingers and the "saws" on saw sharks are actually denticles, too. Sharks have large teeth for holding and cutting prey or snagging fish. The jaws of the shark project forward and they are actually able to create a vacuum to suck food in as they are grabbing and slashing prey. Pushing water quickly out of their gills creates the vacuum in their mouth as it does with most boney fish.

Skate

Skates are cartilaginous fish with flat bodies and both eyes on top of their head. Their pectoral fins are shaped like large wings and their gills and mouth are located on the underside of their body. Skates use their small rounded teeth for grinding food between the two plates. They eat hermit and other crabs, clams, shrimp and small fish. Skates, like other shark relatives can locate prey with a sense organ that detects weak electrical signals from the prey, even if it is hiding under the sand. They trap their prey under their "wings" and can also create suction on the sandy bottom with their gills to help capture prey.

Skates and rays (stingrays) look very similar, but are in different orders of cartilaginous fish. One of the differences between skates and rays is that skates have a thicker tail with no spine (stinger) and rays often have a thin tail with a spine at the base or midway down the tail. There are torpedo rays in most oceans that have no stinger but are electric.

Vocabulary

Predator - any organism that exists by killing and eating other organisms
Prey - an animal hunted or seized for food
Classify/Classification - To arrange or organize according to class or category. The systematic grouping of organisms into categories on the basis of evolutionary or structural relationships between them; taxonomy
Cartilaginous - having a skeleton composed either entirely or mainly of cartilage, as vertebrates of the class Chondrichthyes, which includes the sharks, skates and rays
Cartilage - a firm, elastic, flexible type of connective tissue of a translucent whitish or yellowish color
Osteichthyes - a class of fish having a skeleton composed of bone in addition to cartilage
Chondrichthyes - cartilaginous fishes; a class comprising cartilaginous fishes with well-developed jaws and including the sharks, skates and rays
Adaptation - any alteration in the structure or function of an organism or any of its parts that results from natural selection and by which the organism becomes better fitted to survive and multiply in its environment.

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