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## Marine Mammal Commission: Education Curriculum Lesson Plan Outline for High School Students

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### SLIDES

1. Cover slide
  - a. Brief introduction
2. Today we'll be learning about marine mammals like these. Can anyone name the characteristics that they all share?
3. Characteristics of marine mammals
  - a. Breathe air through lungs, usually have hair, produce milk, and give live birth.
  - b. *Marine* mammals are those that rely on the ocean for most, if not all, of their life.
  - c. Marine mammals as a group are quite diverse in terms of morphology, physiology, and more. There are around 129 species of marine mammals!
4. Marine mammals are classified into four different groups: pinnipeds, the sea otters / polar bears, sirenians, and cetaceans.
5. These categories are based on evolutionary history. Scientists can use genetic analyses and fossils to reconstruct the 'tree of life' for marine mammals.
  - a. The family Ursidae, the bear family, and Mustelidae, the family that includes sea otters, are very closely related to the pinniped families.
6. Using these techniques, we know that the closest relative to the whales is the hippopotamus, and that cetaceans are actually part of the group Artiodactyla, the group containing even-toed ungulates like camels and deer. Notice that the species in italics are based on fossil specimens that 'fill the gaps' in the phylogeny between the cetaceans and hippo.
7. Seals, Sea Lions, and Walruses
  - a. There are 33 species of pinnipeds – the name for seals, sea lions, and walruses.
  - b. 'Pinnipeds' refers to these animals being 'fin-footed' from the Latin 'pinna' (fin) and 'pedis' (foot).
  - c. Pinnipeds are carnivorous and semi-aquatic as they spend a lot of time on shore. They are usually found in cold climates, although they are globally distributed.
8. How do you tell the difference between a seal and a sea lion?
  - a. Seals: small flippers, crawl on their bellies, and don't have visible ear flaps
  - b. Sea Lions: large flippers, 'walk' on land, and have visible ear flaps
9. Seal v Sea Lion
  - a. Left image: Seal – no visible ear flaps

- i. This is actually a photo of a Hawaiian monk seal, an endangered species only found in the Hawaiian Islands. There used to be a Caribbean monk seal, as well, but it has gone extinct.
  - b. Right image: Sea lion – visible ear flaps, ‘walking’, large flippers
10. Walruses
  - a. Walruses can weigh more than 4000 pounds and their tusks are made of ivory that can reach 1 meter long!
  - b. While otters have fur, cetaceans and pinnipeds use blubber, which is a thick layer of fat to help keep them warm in cold water.
    - i. **Optional activity:** Show how blubber works. (NOAA activity:[https://www.afsc.noaa.gov/education/activities/PDFs/NFS\\_K-6\\_Sept2013\\_Act5.1\\_BlubberMitt.pdf](https://www.afsc.noaa.gov/education/activities/PDFs/NFS_K-6_Sept2013_Act5.1_BlubberMitt.pdf))
11. Pinnipeds, especially walruses, have very sensitive whiskers or ‘vibrissae’ that have ten times the innervation as terrestrial mammals. This allows them to sense vibrations in the water as they search for food or avoid predators.
12. Polar Bear
  - a. There are two kinds of marine mammals that you might not expect – polar bears and sea otters.
13. They are the largest land carnivores in the world. They eat other marine mammals like ringed and bearded seals, which are ice-dependent.
14. How might climate change affect polar bears?
  - a. If the ice melts, it becomes harder for them to find food because they have to swim long distances between ice flows that support their prey.
15. Sea otters
  - a. Sea otters have very thick fur which keeps them warm in cold water – it is actually the thickest in the animal kingdom.
  - b. They are the smallest marine mammals and live in coastal waters, mostly in kelp beds.
  - c. To keep from drifting apart while they sleep, sea otters sometimes sleep holding paws.
16. Sea Otters- Tool Use
  - a. Sea otters are able to use tools – rocks – to open shellfish!
17. Sea otters are also keystone species, or *a species that has a disproportionate effect on its ecosystem relative to its abundance*.
  - a. Along the Pacific Northwest coast, kelp forests are regulated by the grazing effects of sea urchins. If there are no sea otters, the urchins overgraze the kelp and cause a phase shift in the ecosystem. If there are sea otters in abundance, they prey on the urchins, which in turn do not eat as much kelp. Ultimately, this maintains the kelp ecosystem.
18. How does this dynamic change if you were to add killer whales to the system?
  - a. Killer whales prey on sea otters, so adding them to the system could result in a decrease in the population of sea otters and a cascading effect down the food web. As sea otter abundance is reduced, sea urchin abundance could increase, and kelp might be reduced.

- b. \*\*If there is time, here is a wonderful video about keystone species and trophic cascades, with a focus on Robert Payne's research and sea otters. <https://www.youtube.com/watch?v=hRGg5it5FMI>
- 19. Manatees
  - a. What kind of marine mammal is a manatee? (Sirenian)
  - b. Manatees are often called 'sea cows' because they feed on seagrasses.
- 20. You can find manatees around Florida and the eastern USA, where their populations have recovered in recent years thanks to the Endangered Species Act and Marine Mammal Protection Act, which we will cover later. The USFWS estimated that there were now over 13,000 manatees in the region as of 2016.
- 21. Cetaceans can be broken up into two groups.
  - a. Odontocetes: whales and dolphins that have teeth. These are highly social and smaller than the other group.
  - b. Mysticetes: whales that have baleen plates to filter feed. These are usually much larger than odontocetes.
- 22. Dolphins
  - a. There are over 80 species of cetaceans and 44 species of dolphin in the world.
  - b. As you probably know, cetaceans are incredibly intelligent animals – they are self-aware, very social, can use tools, communicate extensively, and even have different dialects within species.
- 23. Dolphins have very good hearing – some species rely heavily on this sense, like those that live in dark, murky rivers.
  - a. This is the Amazon river dolphin, a species we still know very little about.
- 24. Toothed Whales
  - a. This whale has teeth- the sperm whale. It feeds primarily on giant squid in the deep-sea! It is actually the deepest-diving marine mammal, swimming down to depths of over 3000 feet.
- 25. Sperm Whale Teeth
  - a. Does anyone know how to figure out the age of a tree?
  - b. Just like trees, whale teeth lay down layers of growth that we can count to figure out the age of a whale. You can actually do the same thing with the ear wax within whale ears as well.
  - c. Sperm whales have teeth that can weigh over 2 pounds each. They are useful, but not required to eat squid; some sperm whales have been found without teeth and yet were well fed.
- 26. Baleen Whales
  - a. This is a humpback whale, a baleen whale.
  - b. Does anyone know what baleen is made out of?
- 27. Baleen
  - a. Baleen is made out of keratin, the same material that your fingernails and hair are made out of.
  - b. Baleen whales take enormous mouthfuls of water and then they shoot the water back out of their mouth through the baleen, which has tiny cracks for water to go through. Only the tiny fish and krill stay inside and get

- eaten. They are some of the biggest animals on the planet, but they eat large quantities of tiny organisms.
28. Does anyone know what type of whale this is? Hint: it is the largest whale on earth, and the largest animal to ever exist on earth.
    - a. Blue Whale- an endangered whale that can be up to 30 meters long and weigh 300,000 lbs!
  29. Whales like humpbacks and blue whales sing underwater. Listen to them here- [http://hawaiihumpbackwhale.noaa.gov/explore/sounds/whale\\_song.mp3](http://hawaiihumpbackwhale.noaa.gov/explore/sounds/whale_song.mp3)
    - a. Whale song is used to communicate across vast distances.
  30. Some whales also produce sound to locate prey, much like bats, through echolocation. Killer whales are an example of a species that uses echolocation to locate fish and other marine mammals.
    - a. As you can see, there are many kinds of marine mammals that live all over the world.
    - b. Unfortunately, they face lots of challenges.
  31. Why do we need to protect marine mammals?
    - a. One reason is due to interactions with fishing gear.
    - b. Sometimes fishermen use traps and other gear to catch fish and shellfish, like crabs. Other times, they use enormous net called purse seines that scoop up entire schools of fish.
    - c. But sometimes whales and other animals can swim into the ropes attached to those traps, or even into fishing nets themselves, and get tangled.
    - d. This makes it hard for them to swim, and in US waters alone up to 80% of all whales show some evidence of being entangled in fishing gear or other marine debris at some point in their lives.
  32. What is bycatch?
    - a. Does anyone know what the term bycatch means?
      - i. Any animal that gets accidentally caught when fishermen are trying to catch something else is called bycatch.
      - ii. Bycatch is the biggest threat to marine mammals. Over 600,000 marine mammals are caught as bycatch every year!
      - iii. Check out this video from NOAA, the National Oceanic and Atmospheric Administration, to learn more. NOAA is a government agency that is responsible for taking care of our fisheries:  
<https://www.youtube.com/watch?v=xz8q6uHSdmg&feature=youtu.be>
  33. The vaquita is one example of a marine mammal affected by bycatch.
    - a. It is the smallest known porpoise on earth.
  34. It is endemic to the northern Gulf of California – endemic means that you can only find them there, nowhere else.
  35. There are currently less than thirty individuals that are still alive. Vaquita have experienced a 95% decline in just two decades, making them the most critically endangered marine mammal in the world.

36. Their decline is directly attributable to bycatch interactions. Vaquita get entangled and die in the illegal gill nets that fishermen use to catch the highly valuable totoaba.
37. The totoaba is a bony fish, which is also critically endangered, that is targeted for its swim bladder, the organ that regulates its buoyancy. The swim bladders are transported to Asia where they are sold under the guise of being medicinally valuable. There is no scientific evidence to support these claims.
  - a. For more information, check out this video if there is time:  
<http://vaquitafilm.com/>
38. How can we avoid entanglement?
  - a. The challenge: we need to continue providing seafood to our local communities while preventing marine mammal mortality and injury.
  - b. In groups of three, take five minutes to come up with some solutions, then elect a spokesperson to share with the class.
39. Some options that have been developed are to –
  - a. Reduce the number of vertical lines in the water column by using sinking ropes.
  - b. Put more traps on each line to reduce the number of vertical floating lines.
  - c. Reduce the amount of time ropes are in the water column.
    - i. Use galvanic time-release links. These are links that that degrade in sea water within a predictable amount of time, so you can tie ropes to them in a coil and, after, for example, 24 hours, the link will dissolve and the buoy will float to the surface for retrieval.
  - d. Use ropeless fishing technology that is in development.
40. Ocean Noise
  - a. So we just learned about animals getting caught in fishing gear, but why else do they need our help?
  - b. Ocean noise is an issue of growing concern. It can alter behavior, cause stress, and even cause physical injury in some cases.
  - c. Why would ocean noise be an issue for marine mammals like whales in particular?
    - i. Because whales communicate over long distances with each other, ocean noise can make it harder for them to find one another for important behaviors like mating.
    - ii. Thankfully, our country has put laws in place to help protect marine mammals from these, and other, threats.
41. The Marine Mammal Protection Act:
  - a. The Marine Mammal Protection Act went into effect in October 1972 in partial response to growing concerns among scientists and the general public that certain species and populations of marine mammals were in danger of extinction or depletion as a result of human activities.
42. MMPA (continued)
  - a. The MMPA was the first act in the USA to use an *ecosystem-based approach* to management.
  - b. The MMPA prohibits the ‘taking’ of marine mammals, defined as the hunting, killing, capturing, and/or harassing of any marine mammal.

- c. The MMPA does provide for exceptions (e.g. wildlife photography, Naval operations, construction).

43. MMPA (continued)

- a. The mandate of the MMPA is carried out by three primary agencies – NOAA, which is responsible for pinnipeds and cetaceans, USFWS, which is responsible for sea otters, walruses, polar bears, and manatees, and the Marine Mammal Commission, which is responsible for oversight of all federal activities impacting marine mammals. The Marine Mammal Commission was actually created by the MMPA!

44. Thanks for listening! Feel free to visit our website or follow us on Twitter for the latest scientific information on marine mammals.