9-12 Meet the Locals Activity

South Carolina Aquarium

Overview

Focus Question
How do we know which bottlenose dolphins are local to the Charleston area? Why do dolphins make a good sentinel species?

Activity Synopsis
Students will learn about different bottlenose dolphin populations in Charleston, SC, called stocks. Students will match dorsal fin photos to identify dolphins. Students will learn how dolphins are sentinel species.

Time Frame
One 60 minute session

Objectives
The learner will be able to:
- Define marine mammal stock
- Explain the difference between migratory and residential marine mammals
- Understand what constitutes a sentinel species
- Match Charleston area residential bottlenose dolphins through photo identification

Key Terms
- Dorsal fin
- Marine mammal
- Migratory
- Photo identification
- Residential
- Sentinel species
- Stock (biology)
- Toothed whale
- Vertebrate

Teacher Key Terms
- Indicator species
- Odontoceti
- Site fidelity
- Sustainable

Standards

South Carolina College- and Career-Ready Science Standards 2021

Biology: B-LS2-1, B-LS2-2, B-LS2-7, B-LS2-8, B-LS4-6

* Bold standards are the main standards addressed in this activity

2014 Academic Standards and Performance Indicators for Science

Biology: H.B.1A.1, **H.B.1A.4**, H.B.1A.6, H.B.1A.7, **H.B.1A.8**, H.B.6A.2, H.B.6C.1, H.B.6D.1

* Bold standards are the main standards addressed in this activity

South Carolina College- and Career-Ready Science Standards 2021

<u>**Biology Performance Expectations**</u>
B-LS2-1 Use mathematical and/or computational representations to support explanations of biotic and abiotic factors that affect carrying capacity of ecosystems at different scales.
B-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
B-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on biodiversity and ecosystem health.
B-LS2-8 Evaluate evidence for the role of group behavior on individual and species' chances to survive and reproduce.
B-LS4-6 Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

2014 Academic Standards and Performance Indicators for Science

<u>**Biology Performance Indicators**</u>
H.B.1A.1 Ask questions to (1) generate hypotheses for scientific investigations, (2) refine models, explanations, or designs, or (3) extend the results of investigations or challenge scientific arguments or claims.
H.B.1A.4 Analyze and interpret data from informational texts and data collected from investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to (1) reveal patterns and construct meaning, (2) support or refute hypotheses, explanations, claims, or designs, or (3) evaluate the strength of conclusions.
H.B.1A.6 Construct explanations of phenomena using (1) primary or secondary scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams.
H.B.1A.7 Construct and analyze scientific arguments to support claims, explanations, or designs using evidence and valid reasoning from observations, data, or informational texts.
H.B.1A.8 Obtain and evaluate scientific information to (1) answer questions, (2) explain or describe phenomena, (3) develop models, (4) evaluate hypotheses, explanations, claims, or designs or (5) identify and/or fill gaps in knowledge. Communicate using the conventions and expectations of scientific writing or oral presentations by (1) evaluating grade-appropriate primary or secondary scientific literature, or (2) reporting the results of student experimental investigations.
H.B.6A.2   Use mathematical and computational thinking to support claims that limiting factors affect the number of individuals that an ecosystem can support.
H.B.6C.1 Construct scientific arguments to support claims that the changes in the biotic and abiotic components of various ecosystems over time affect the ability of an ecosystem to maintain homeostasis.
H.B.6D.1 Design solutions to reduce the impact of human activity on the biodiversity of an ecosystem.

Background

Key Points
Key Points will give you the main information you should know to teach the activity.

- **Marine mammals** are endothermic (warm blooded) **vertebrate** animals that give live birth, breath through lungs, have hair and feed young with milk.
- The bottlenose dolphin (*Tursiops truncatus*) is the most common dolphin species found off the east coast of the US.
- A **stock** is group of animals of the same species that interbreed and occupy the same geographical area. Marine mammal breeding populations are divided into stocks.
- **Residential** animals exhibit high **site fidelity**, meaning they stay in the same geographic location.
- **Migratory** animals move seasonally for mating and/or feeding grounds.
- Some marine mammals, like bottlenose dolphins, exhibit both residential and migratory lifestyles.

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- Some marine mammal populations can be studied through **photo identification** (ID). Photo identification of dolphins uses high resolution photos of their **dorsal fins** to record unique markings.
- The Charleston area bottlenose dolphins have been studied for over 20 years with photo identification.
- The parts of a dolphin's dorsal fin that are used in Photo ID are the leading edge, trailing edge, upper third, middle third and lower third.
- **Sentinel species** are species that provide us with early warning signs in regards to human health.
- The Charleston area bottlenose dolphin populations are perfect examples of a sentinel species showing us toxin levels specific to different areas in Charleston.

Detailed Information

Detailed Information gives more in-depth background to increase your knowledge, in case you want to expand the activity or you are asked detailed questions by students.

Marine mammals can be found in all of the world's oceans and in all types of water. They are **vertebrates** (have a backbone) with the following characteristics:

- Warm-blooded
- Breath air
- Give live birth
- Nurse young with milk
- Have hair

What separates marine mammals from other mammals is that they live in or by the ocean.

Marine mammals are endothermic or warm-blooded. This means that their body temperature is kept at a constant and not controlled by its environment. They are air breathers, using a lungs to breathe. Some species of marine mammals have a blow hole/s, an adaptation that allows them to breathe more efficiently at the surface of the water. Marine mammals have internal fertilization, resulting in a baby through live birth that was nourished by a placenta while in the womb. Mother marine mammals will nurse their young and take care of them for up to a few years depending on the species. All marine mammals live in the ocean with a few exceptions, such as the river dolphins. Some species, like the bottlenose dolphin, also have the ability to live in brackish water, where salt and fresh water mix. Some marine mammals like those within the order Carnivora have hair for their entire life, while others like order Cetacea may only have hair as a newborn that quickly falls out.

Taxonomy

Marine mammals include animals from three orders: Cetacea, Carnivora, Sirenia. The order Cetacea includes the whales, dolphins and porpoises which includes about 89 living species. This order is divided into two suborders: Mysticeti and **Odontoceti**. Mysticeti are baleen whales such as humpback and North Atlantic right whales. Odontoceti are **toothed whales** such as dolphins and orcas. Order Carnivora is divided into many suborders including over 280 placental mammal species. Two of the Carnivora suborders have marine mammals including about 35 species. Those are Pinnipedia or 'flipper-footed' that includes seals and sea lions and Fissipedia or 'paw/pad-footed' including polar bears and sea otters. The order Sirenia or 'sea cows' is comprised of two aquatic, herbivorous families, the Dugongs and Manatees, and there are just 4 living species.

Bottlenose Dolphins (*Tursiops truncatus*)

Bottlenose dolphins are in the Order Cetacea, Suborder Odontoceti. The bottlenose dolphin is the most common dolphin species found off the east coast of the US. Bottlenose dolphins are found in tropical to temperate waters around the world and are found in the Pacific, Atlantic, and Indian Oceans. Since they have a global habitat and usually live off the coast, this species has been extensively studied.

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Bottlenose dolphin range (light blue) from Voices in the Sea

Bottlenose dolphins use echolocation to locate their prey and use their sharp cone-shaped teeth to feed primarily on fish. They have been known to strand feed in South Carolina, which is a feeding method where they case fish onto the beach and then carefully come onshore to grab the fish before sliding back into the water. This feeding method can be dangerous because of the possibility of getting stuck on land.

Marine Mammal Stocks

Marine mammal populations are divided into groups called **stocks**. A stock is group of animals of the same species that interbreed and that occupy the same geographical area. Sixty-one stocks of bottlenose dolphins have been identified in US waters. Five stocks along the Atlantic Coast are labeled depleted. This means the stock populations are deemed below its optimum **sustainable** number by a governing body, as in the State or Secretary of Commerce. If the population number is below the sustainable number, the population will have a hard time increasing and may end up critically endangered or even extinct.

As of 2018, there are five bottlenose dolphin stocks off the coast of South Carolina:
- Residential:
    o Northern South Carolina Estuarine
    o Charleston Estuarine *(this activity will focus only on this stock)*
    o Southern South Carolina – Northern Georgia Estuarine
    o South Carolina – Georgia Coastal
- Migratory:
    o Southern Migratory

Of these five stocks, only one is comprised of **migratory** animals, the other four stocks have **residential dolphins**. Residential bottlenose dolphins exhibit high **site fidelity**, meaning they stay in the same geographic area. This means these stocks are found in their territory year-round. They may move seasonally within their area but they do not migrate. Since residential stocks remain in the same area year round they provide an excellent way to study this species.

Dolphin Photo Identification (ID)

Photo identification is when a high quality photo is taken of an animal and it is cataloged into a database. Photo ID is a noninvasive identification method for cetaceans. It started in the 1970's and has become an established way of identifying individual cetaceans by either photographing the animal's **dorsal fin** or fluke (tail) depending on the species. When photo identifying a dolphin, each dorsal fin has a unique blend of markings, scars, notches, and other characteristics that make easier to identify an individual. The parts of a dorsal fin are the leading edge, trailing edge, upper third, middle third and lower third.

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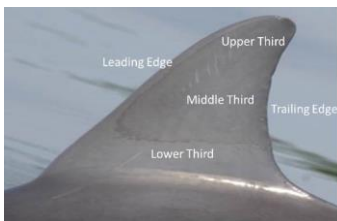
Photos are kept in a database that can analyze the dorsal fin markings and match it to an established animal or create a new entry if needed. There are many long standing photo identification programs around the world. Here in Charleston, SC the photo ID program of the bottlenose dolphins began in 1994 using a system names FinBase. Through this type of research, scientists can study the life history of individuals but also of the entire population.

This activity is focus on the Charleston Estuarine System Stock (CESS). Over the last two decades of photo identification of bottlenose dolphins in the CESS, 300 – 900 individual dolphins have been observed and photographed. The highest abundance is observed during the summer months while winter brings the lowest numbers. Due to this, researchers believe that there are around 300 resident bottlenose dolphins in the CESS. Interestingly through years of research and health examinations, less than half of the CESS bottlenose dolphins are considered healthy individuals.

Sentinel Species

A **sentinel species** is similar to an **indicator species** in that both provide warning signs regarding health. The difference between the two terms is that a sentinel species usually gives warning in regards to human health, whereas an indicator species helps researchers evaluate the health of an ecosystem. One of the most common sentinel species examples is the canary in the coalmine. In the early 20th century, miners would bring canaries into the coalmine as they have a higher sensitivity to carbon monoxide. If a canary acted strange or even died, the miners would know it was no longer safe for them to be in the mines. Due to this early detection method, miners would have enough time to leave the mine before the gas concentration became fatal to the workers.

Now there are many animals and plants that serve as sentinel species within their habitats. Honeybees, amphibians, marine mammals, daphnia and even lichens are just a few types of sentinel species. Some characteristics of a sentinel species is that they are widespread and abundant, easily handled or observed, have a measurable response to the hazards in question and whose habitat overlaps with the range studied. Typically, a sentinel species is identified by characteristics of the hazard, i.e. does the hazard live in stored fat? If yes, then an animal with a thick fat reserve could serve as a sentinel species. Or does the hazard biomagnify in the food chain? If yes, then an apex predator would be an ideal sentinel species. Biomagnification refers to toxin moving within a food chain. The toxin magnifies in strength as it climbs higher up the food chain. Therefore, the apex, or top, predator of the food chain would carry the heaviest toxin load because all of the toxins from its prey and its prey's prey are combined within the apex predator. The toxin concentration has a positive relationship with the trophic (food chain) level; as one increases so does the other.

Some consider marine mammals to be sentinel species against toxins since they do have a thick fat layer, they are typically apex predators, they are widespread, and have a long life expectancy. The bottlenose dolphin, specifically the population around Charleston, have been labeled sentinel species as they can raise an early alarm against biomagnified toxins found within the food web.

Procedure

Materials

- Activity Presentation
- Dolphin Photo Cards
- Meet the Locals Worksheet (one per student)
- Writing utensil
- 8 Computers/Ipads with Internet (one per group)
- Clue Cards and Answer Key (for Teacher only)

Procedure

1. Give each student a Meet the Locals Worksheet.

2. Go through the Activity Presentation slides 1-9 to learn about Charleston local bottlenose dolphins.
   - Bottlenose dolphin information
   - Photo ID
   - Where do they live?
   - Bottlenose dolphin stocks – residential and migratory, estuarine and coastal
   - Charleston Estuarine System Stock (CESS)
   - Sentinel species

3. As prompted in the presentation, have students individually respond to the first journal prompt on their worksheet: Why is it important to know the local dolphins of an area and where they live (slide 10, Worksheet #1)?

> **Commented [CL1]:** 1: RO: Reflective Observation

4. Go over the parts of a dorsal fin - leading edge, trailing edge, upper third, middle third and lower third (slide 11).

5. For the activity, break class into 8 groups and pass out 1 Dolphin Photo Card to each group. Have them record their Dolphin Card Number on their worksheet (Worksheet #2).

6. Student groups should use their Dolphin Photo Card to fill out their worksheet.
   - They should describe their dolphin's dorsal fin (Worksheet #3)
   - Each group will have to correctly identify the dolphin based on its unique dorsal fin using slide 12 in presentation. Record the Photo ID number on the worksheet (Worksheet #4).
   - The photo card will have 4 coordinates listed and the group will have to plug the coordinates into maps.google.com to find the dolphin's locations. Have the students record the locations on their worksheet as Cooper estuary, Stono estuary or coastal (Worksheet #5).

   > **Commented [CL2]:** 2: AC: Abstract Conceptualization

   - They should circle whether they have an estuarian dolphin, coastal dolphin or both (Worksheet #6)?
   - Once all groups have finished, the teacher will read each Clue Card that contains information about a real CESS bottlenose dolphin (can read them from answer key or from presentation slides 13-20). Groups will need to listen to the clues to figure out which dolphin they have and record the facts on their worksheet (Worksheet #7). Teacher may have to read the clues multiple times or leave the slides up for students to reference.

   > **Commented [CL3]:** 3: AE: Active Experimentation

      - Each clue is only used once. Make sure they pay close attention to the dorsal fin description and sighting locations to figure it out. Great lesson for auditory learning!

7. After hearing all the clues about the real CESS dolphins and as prompted in the presentation (slide 21), students will need define sentinel species and decide if these dolphins would make a good sentinel species for the Charleston area. They will need to defend their answers why or why not (hopefully all will agree that they do make good sentinel species). Have each student record their answers on their worksheet (Worksheet #8-9).

8. Have students turn in their worksheet for a grade.

9. Talk through why bottlenose dolphins are good sentinel species (slide 22).

10. Finish by watching this sentinel species news clip (slide 23).
    - https://www.live5news.com/2019/04/29/water-contamination-study-underway-concerns-grow-following-rise-dolphin-strandings/

   > **Commented [CL4]:** 4: CE: Concrete Experience

Follow-up Questions

- What other organisms are sentinel species?

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- Are sentinel species treated any differently by humans compared to non-sentinel species?
- If you were a politician, would knowledge of sentinel species help or hurt your campaign?

Assessment

The assessment will be grading the Meet the Locals Worksheet submitted at the end of class.

Scoring rubric out of 100 points

Explains importance of knowing dolphins:	**10 points**
Correctly copies Dolphin number:	**5 points**
Correctly describes fin:	**10 points**
Records correct Photo ID number:	**5 points**
Plots all 4 coordinates correctly:	**20 points (5 pts each)**
Circles correct location:	**5 points**
Fills out table with correct dolphin info:	**30 points (5 pts each)**
Correctly defines sentinel species:	**5 points**
Explains dolphins as sentinel species:	**10 points**

Cross-Curricular Extensions

STEAM Extension
Have students take a dolphin dorsal fin photo, trace it on to graph paper and turn it into a connect-the-dots graph by creating a table of coordinates that mirror the outline of the dorsal fin.

STEM Extension
Have students research how facial recognition software is helping conservation biology by identifying individual animals like dolphins. This article can be a good starting point: https://en.reset.org/blog/your-smartphones-face-recognition-software-now-being-used-identify-dolphins-11142018

Social Studies
Have students research about other sentinel species and report how their warnings may have changed laws or policies. An article on other sentinel species can be found at https://cen.acs.org/articles/95/i46/meet-the-sentinels.html

Resources

Teacher and Student Reference Websites

Dolphin Research Center
https://dolphins.org/
Information on dolphins.

NOAA Fisheries
https://www.fisheries.noaa.gov/species/common-bottlenose-dolphin
Information on the common bottlenose dolphin.

Worldatlas
https://www.worldatlas.com/articles/what-is-a-sentinel-species.html
Information on sentinel species.

Charleston Magazine

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https://charlestonmag.com/features/meet_the_locals
Articles on local dolphins in Charleston, SC