Using Sampling to Determine the Species Composition of an Ecosystem

A middle school science lesson based on the research of Lacee Sherman on NOAA Ship Oscar Dyson in conjunction with the scientists from the Midwater Assessment and Conservation Engineering (MACE) group of the Alaska Fisheries Science Center in Seattle, Washington. (Note: A real ecosystem is much broader than what is represented in this lesson; to sample a real ecosystem, many different sampling gears would be used.)

Subject (Focus/Topic):	This lesson addresses how sampling can be a valid source of collecting data in the oceans.
Grade Level:	7th Grade.
Average Learning Time:	Two 50-minute class periods.
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LESSON PLAN DESCRIPTION

Lesson Summary (Overview/Purpose)

Students will use sampling to learn the species composition of different marine environments.

Overall Concept (Big Idea/Essential Question)

Students often think that in order to collect accurate data, every object must be accounted for. This lab activity will help the students to realize that having a consistent sampling technique and multiple trials can be used in situations when not every item/ object is able to be measured.

Specific Concepts (Key Concepts)

Students will practice the following: sampling techniques:

- writing and following procedures
- collecting data
- identifying species
- reporting results

Focus Questions (Specific Questions)

1. How many samples should be taken in order to get an accurate count of each species?
2. Is it better to focus on one sampling location and collect a large amount of data, or is it better to take a few samples from multiple locations?
3. How can data be combined to increase sample size for a more accurate species composition?

Objectives/Learning Goals

- Given a species identification guide, students will be able to identify all species with 90% accuracy.
- As a class, students will get accurate percentages for their species composition +/- 3% per species.

Background Information

Students will need to understand how to make data tables to collect information in a consistent manner. They will need to be able to follow instructions and work together in groups. Students should understand that sampling in the ocean is especially important because there is no practical way to count every fish in the ocean, and that sampling can be an accurate way to estimate things that cannot be known in another way. Students will also learn about the benefits of ecosystems that have a large amount of biodiversity.

Common Misconceptions/Preconceptions

Students may not understand why many trials of an experiment are necessary. This activity will show them that the larger the number of trials, the closer they get to the actual species composition of each tub.

Teaching Materials

Appended Resources (AR's)

Non-interactive, printed materials inserted into this document after the Lesson Plan Description.

- **Species Identification Chart** – pages with photo and description of each species
- **Species Pictures** – pages with photos of each species, without descriptive text

Digital Resources (DR's)

Interactive, electronic files created by the Teacher-At-Sea to support this lesson.

- None

Physical Items

Items used in the classroom to facilitate learning, especially during activities:

- copies of the **Species Identification Chart** (1 per group)
- 3 medium sized tubs or buckets
- 3 colors (light colors recommended) of printer paper (1 per tub) that will be used to print the species pictures
- copies of **Species Pictures** (100 species pictures x 3 tubs, each on a different paper color)
- student notebooks or paper for data collection

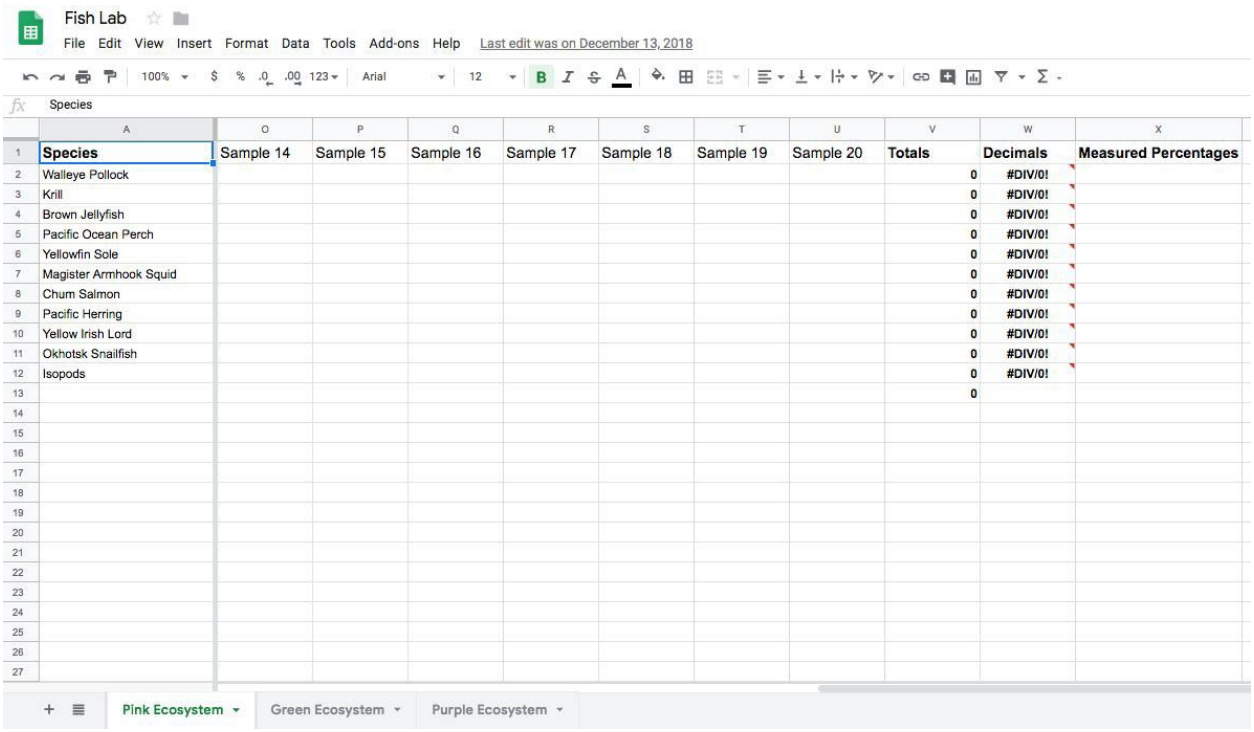
Technical Requirements

Any connectivity, software, hardware, or A/V equipment needed to teach this lesson:

- Spreadsheet such as Google Sheets or Excel for inputting data, although a white board or paper can be used if the technology is not available

Teacher Preparation

Teachers will need to make one copy of the Species Identification Guide per group of students and print out 100 pictures of the species per tub (3 recommended). Print out the 100 pictures per tub and crumble them into a paper snowball and put in one of the tubs. Repeat for the other tubs using a different color of paper (so the kids can keep them separated). Species compositions should be different for each tub and do not tell students the exact numbers, but make sure that you know them and write them down. You can adjust them how you like depending on the emphasis that you would like to teach during the lesson. It is recommended to have one tub that is very biodiverse and has some of every species in different amounts with pollock still being the dominant species. Have another tub with just pollock and jellyfish, and the third tub with mostly pollock and jellyfish, including a few other species in there.



	A	O	P	Q	R	S	T	U	V	W	X
1	**Species**	Sample 14	Sample 15	Sample 16	Sample 17	Sample 18	Sample 19	Sample 20	**Totals**	**Decimals**	**Measured Percentages**
2	Walleye Pollock								0	#DIV/0!	
3	Krill								0	#DIV/0!	
4	Brown Jellyfish								0	#DIV/0!	
5	Pacific Ocean Perch								0	#DIV/0!	
6	Yellowfin Sole								0	#DIV/0!	
7	Magister Armhook Squid								0	#DIV/0!	
8	Chum Salmon								0	#DIV/0!	
9	Pacific Herring								0	#DIV/0!	
10	Yellow Irish Lord								0	#DIV/0!	
11	Okhotsk Snailfish								0	#DIV/0!	
12	Isopods								0	#DIV/0!	
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Figure 1: Sample data table spreadsheet

Students will need a place to make a data table and record their data. Teachers will also want to set up a digital spreadsheet where students from each group can add their own data. It is recommended to have the spreadsheet calculate totals and averages, or have the students calculate these on their own.

Keywords

- Sampling
- Species Composition
- Trials
- Biodiversity

Anticipatory Set (Optional)

After students review blog posts or participate in a lesson on biodiversity in the ocean, they will be ready to complete this hands-on activity.

Lesson Procedure

Day 1

1. Begin by asking students probing questions: How many different marine species can you think of? How many different marine species have been discovered so far? How could we find out exactly how many fish are in the ocean? Have them discuss in groups or as a class.

2. Explain to the students that sampling is an effective method to help and learn things that may not be able to be measured exactly. Give examples of sampling, such as taking a handful of Skittles and trying to estimate how many of each color would be in a large bag. Explain that the more separate handfuls we examine, even after returning the original Skittles, the closer we will get to knowing the correct color composition of that entire bag.

3. Have students read the lesson objective: *Determine the species composition of different marine environments by sampling*. Lead them to the knowledge that they will be trying to find the percentage of each species in each tub (environment).

4. Explain that there are three different marine ecosystems represented in the classroom, each by a tub containing a different color of paper. They will be collecting samples by following a sampling procedure, make a data table for each color tub, and try to collect three trials from each tub, adding their data to their data tables.

5. Sampling procedure includes:
    a. Sending one student to the tub, reaching one hand into the tub and grabbing as many pieces of crumpled paper as possible (like the claw arcade game), and then doing the same thing with the other hand. This will be one sample (all samples will probably have different amounts, and this is desired because it is more realistic when fishing).
    b. The student bringing the sample back to his/her group and the group sorting and identifying each organism using the Species Identification Chart and recording their data.
    c. Re-crumpling the papers into balls and returning them to the correct tub before gently shaking it up and collecting another sample.

6. Students will probably be able to collect 4-5 total samples the first day. Close the lesson by asking students to share observations and any challenges that they may be facing.

Day 2

1. Begin the lesson by asking students to share observations from the previous day. Remind them of the sampling procedure and the goal for each group to collect three samples from each tub.
2. Allow students to continue sampling and walk around asking groups to share with you what they are learning/noticing about each tub.
3. With about 15 minutes left in class, have one student per group start to compile their group's data into a spreadsheet (Google Sheets is great because they can all work on the same one at the same time). If the spreadsheet is set to calculate the average number per species then you may use that, or have students calculate the average number of each species from all of the groups. Once students know the class average for each species, you should tell them the correct numbers to see how close they were able to get.
4. Close this lesson by asking students to reflect on their data and how accurate they were as a class. Why were they more successful with certain species or certain environments than with others? Were there species that were not accurately represented? Why would sampling be useful in the oceans?

Assessment and Evaluation

Classes can be evaluated based off of how close their measured species compositions compare to the actual species compositions set by the teacher. Students should be able to calculate the species composition +/- 3% accuracy for each species.

Standards

Next Generation Science Standards (NGSS) or State Science Standards Addressed

- MS-LS2-3 Ecosystems: Interactions, Energy, and Dynamics
    - Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- MS-LS2-4 Ecosystems: Interactions, Energy, and Dynamics
    - Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Science and Engineering Practices:

- Obtaining, Evaluating and Communicating Information
- Planning and Carrying Out Investigations
- Using Mathematics and Computational Thinking

Ocean Literacy Principles Addressed

- 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 provides a vast living space with diverse and unique ecosystems from the surface through the water column and down to, and below, the seafloor. Most of the living space on Earth is in the ocean.
- 7e Use of mathematical models is an essential part of understanding the ocean system. Models help us understand the complexity of the ocean and its interactions with Earth's interior, atmosphere, climate, and land masses.

Additional Resources

- https://teacheratsea.noaa.gov/#/2018/Lacee*Sherman/blogs

SPECIES IDENTIFICATION CHART

Adult Walleye Pollock

Common Name: Walleye Pollock

Scientific Name: *Gadus chalcogrammus*

Identifying Features: 3 Dorsal Fins, large eyes

Ecological Importance: Polllock influence the euphausiid populations and are food to many larger marine species, and humans.

Interesting Facts: Walleye pollock produces the largest catch by volume of any single species inhabiting the 200-mile U.S. Exclusive Economic Zone.

Common Name: Krill

Scientific Name: Euphausiidae (Family)

Identifying Features: 1-2 centimeters in length on average. They look similar to very small shrimp, and often swim in schools.

Ecological Importance: Krill are a very important food source for many fish and also larger marine mammals such as whales.

Interesting Facts: They are filter feeders and eat zooplankton and phytoplankton, which makes them omnivores.

Chrysaora melanaster

Common Name: Northern Sea Nettle, Brown Jellyfish

Scientific Name: *Chrysaora melanaster*

Identifying Features: 16 lines from the center of the bell to the outer edges of the bell. Large range in sizes, from very small to very large.

Interesting Facts: Jellyfish may become a problem for the Bering Sea in the future because they reproduce in large numbers and they can dominate an entire environment easily.

Pacific Ocean Perch

Common Name: Pacific Ocean Perch

Scientific Name: Sebastes alutus

Identifying Features: Bright to light red with brown blotches dorsally near fins, large spines on dorsal and anal fins, knob on lower jaw

Ecological Importance: delicious

Interesting Facts: Pacific Ocean Perch are a type of Rockfish. Pacific Ocean Perch have a swim bladder similar to that of pollock, so they reflect similar acoustic signals and can sometimes be acoustically confused for pollock if no sample is taken in a specific area.

Yellowfin Sole

Common Name: Yellowfin Sole

Scientific Name: *Limanda aspera*

Identifying Features: Black line between body and dorsal and ventral fins, fins may appear yellow in color

Ecological Importance: Yellowfin sole are benthic (live and feed on the ocean floor).

Interesting Facts: Yellowfin sole grow slowly and may be 10.5 years old by the time they reach 30 cm in length.

Magister Armhook Squid

Common Name: Magister Armhook Squid

Scientific Name: *Berryteuthis magister*

Identifying Features: 8 tentacles and two larger feeding arms, dark red in color, but white when damaged

Ecological Importance: Prey on fishes and other squid

Interesting Facts: These are the most abundant squid found in the waters of Alaska.

Chum Salmon on the conveyer belt with pollock

Common Name: Chum Salmon

Scientific Name: *Oncorhynchus keta*

Identifying Features: Metallic dark blue on the top and silvery on the sides

Ecological Importance: Chum Salmon have adapted to live in saltwater and freshwater. They mainly eat copepods, fishes, squid, mollusks and tunicates.

Interesting Facts: Chum salmon eggs are hatched in freshwater rivers and streams. They then travel downstream to live most of their life in the ocean. When it is time, Chum Salmon spawn (reproduce) in the same freshwater stream they hatched in. Once a salmon spawns, they die.

Pacific Herring

Common Name: Pacific Herring

Scientific Name: Clupea pallasii

Identifying Features: Large scales that are shiny silver along the sides and shiny blue along the top of the fish. Tail has a fork and there is only one dorsal fin.

Ecological Importance: Eat phytoplankton and zooplankton. Herring and their eggs are eaten by fish, birds, marine mammals, and humans.

Interesting Facts: Herring eggs (roe) are considered a traditional delicacy in Japan called kazunoko.

Yellow Irish Lord

Common Name: Yellow Irish Lord

Scientific Name: *Hemilepidotus jordani*

Identifying Features: Yellowish tan to dark brown, white to yellow bottom, and yellow gill membranes

Ecological Importance: Since they are usually found close the ocean floor, they regularly eat things like fish eggs, isopods and amphipods, worms, and small fishes.

Interesting Facts: There is another species of Sculpin that is similar called a Red Irish Lord.

Common Name: *Okhotsk Snailfish*

Scientific Name: Liparis ochotensis

Identifying Features: Large head with small bumps on it, elongated body with eel-like tail.

Ecological Importance: Unknown

Interesting Facts: They are benthic species, which means they live near the Ocean floor. They also have a “suction cup” like device on their underside near their head.

Common Name: Isopods

Scientific Name: Exact species unknown

Identifying Features: Flat body with antennae, paired legs, and a red/orange belly.

Ecological Importance:. These are a parasite and actually attach themselves to other marine species.

Interesting Facts: These are often known as the “cockroaches of the sea”.

SPECIES PICTURES