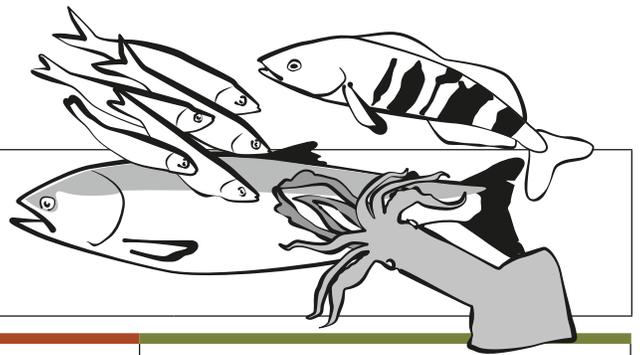


LESSON FOUR

What do fur seals eat?



Subject Area(s): Life science

Grade Levels: K-6

Presentation – 10 minutes
Activities – variable

Lesson Topics:	Marine mammal and northern fur seal diets, scat and stomach analysis.	Focus Questions	<ul style="list-style-type: none"> • How do scientists study what fur seals eat if they eat at sea? • Why do we want to know what fur seals eat?
Learning Objectives:	Students will: <ul style="list-style-type: none"> • learn what fur seals eat • identify fur seal scat contents • learn two ways scientists determine what fur seals eat • summarize lunch contents • explain why it is so hard to study what marine mammals eat 	Key words:	diet, prey, ecosystem, scat, food habits

ACTIVITIES		ALASKA STANDARDS			
		Math	Science	Minutes	Grades
Activity 4.1	Make a Food Chain		SC3.2	15	K–2
Activity 4.2	Lunch Box Detective	K.CC.4–6; K.MD.3 1.MD.7 2.MD.9–10 5.MD.4	SA1.1–1.2 SA2.1	15	K–2
Activity 4.3	Scat Detective	K.CC.4–6; K.MD.3 1.MD.7 2.MD.9–10 3.MD.4 3.MD.6 4.MD.6 5.MD.4	(3–6) SA1.1–1.2 SC2.1 SG2.1	30	3–6
Activity 4.4	Microworlds: What do Marine Mammals Eat?			15	K–6

Targeted Alaska Grade Level Expectations (GLEs)

Science as Inquiry and Process

SA1 Students develop an understanding of the processes of science used to investigate problems, design and conduct repeatable scientific investigations, and defend scientific arguments.

SA2 Students develop an understanding that the processes of science require integrity, logical reasoning, skepticism, openness, communication, and peer review.

Concepts of Life Science

SC2 Students develop an understanding of the structure, function, behavior,

development, life cycles, and diversity of living organisms.

SC3 Students develop an understanding that all organisms are linked to each other and their physical environments through the transfer and transformation of matter and energy.

Science and Technology

SE1 Students develop an understanding of how scientific knowledge and technology are used in making decisions about issues, innovations, and responses to problems and everyday events.

SE2 Students develop an understanding that solving problems involves different ways of thinking, perspectives, and curiosity that lead to the exploration of multiple paths that are analyzed using scientific, technological, and social merits.

History and Nature of Science

SG2 Students develop an understanding that the advancement of scientific knowledge embraces innovation and requires empirical evidence, repeatable investigations, logical arguments, and critical review in striving for the best possible explanations of the natural world.

Laaqudaᖅ: The Northern Fur Seal

Lesson 4:

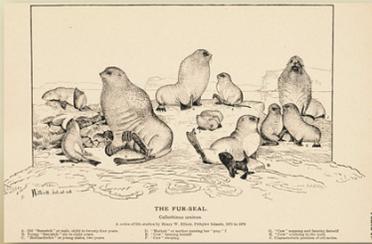
What do fur seals eat?



© Thomas Stream Northern Fur Seal

Lesson 4 gives an overview of what fur seals eat when they are at the rookery, traditional knowledge, and current scientific methods of studying fur seal food habits.

What will you learn?



- How do fur seals find their food?
- What do fur seals eat?

Lesson 4: What do fur seals eat?

1

Image: Henry Wood Elliott illustration, The Fur Seal, University of Washington Library.

How do they find their food?

■ Foraging: searching and hunting for food



- Forage for food at sea by diving
- Dive as deep as 200 meters (650 feet) to find fish and squid
- Detect prey by sight and by feeling vibrations with whiskers

Lesson 4: What do fur seals eat?

2

Fur seals find their food by foraging and diving while at sea. Most fur seals feed at night when fish and squid move closer to the surface. Fur seals large eyes are well suited for seeing underwater and in low light conditions. Their whiskers detect vibrations caused by prey moving in the water and they can hear very well.

Listen to sounds created by sea creatures at Discovery of Sound in the Sea. www.dosits.org/audio/interactive

Photo: Paul Hillman, NOAA Ocean Media Center

What do fur seals eat?

- Diet depends on what is available
- As fish populations change, so does fur seal diet
- Smaller fur seals eat smaller fish, larger seals eat larger fish
- Humans and seals eat some of the same fish



Lesson 4: What do fur seals eat?

3

Fur seals eat different fish in different places. The scat from St. Paul Island and St. George Island contain mostly pollock. Other prey species are squid, herring, salmon, and atka mackerel.

It is important to note that seals and humans are consuming the same species of fish and squid.

Photos: NOAA/AFSC website (http://www.afsc.noaa.gov/ABL/MSI/msi_sae_psf.htm)

When do adult males eat?

- Adult males do not eat on the rookery
- Fast from 3 days to 2 months depending on how long the male holds its territory
- Lose 32% of body fat while defending a territory on the rookery



Lesson 4: What do fur seals eat?

4

When do the different age groups eat?

Adult males on the rookery do not leave to eat; they fast for the whole time they are on the rookery. If a male left its territory to feed at sea, another male would move in and take over his territory. Males spend most of the winter feeding and gaining weight for the breeding season.

During the summer, non-territorial males and non-breeding males alternate between time on shore to rest and time at sea to feed.

Photos: thin male — Pam Goddard, www.thalassa-education.com
inset — Mikhail Shlemov (Russian photographer) via Vladimir Burkanov, NMML/AFSC/NMFS/NOAA

When do adult females eat?

- Once on the rookery, females do not go to sea to feed until they have nursed their newborn pup for a week
- Females alternate 1-3 days of nursing with 4-10 days of feeding at sea until the pup is weaned



Lesson 4: What do fur seals eat?

5

The pup is nursed for about 4 months before it weans and starts feeding itself.

As the nursing pup gets older and needs more milk, the female goes out for a longer time to feed.

Females from different rookeries eat different fish and feed in different areas.

Photo: Jeremy Sterling, NMML/AFSC/NMFS/NOAA

What & when do pups eat?



- The pup drinks its mother's milk for the first 4 months
 - Milk is 49% fat, 37% water, 11% protein
 - Pups nurse for 1-3 days, then go without food for 4-10 days while their mothers are at sea feeding
 - Pups learn to eat fish and squid when they leave the rookery at 4 months



Lesson 4: What do fur seals eat?

6

Pups stay with their mom for one week after they are born, nursing every day. After the first week, the female goes out to sea to feed and to produce more milk; during that time, the pup stays in the rookery and fasts.

The female alternates feeding trips with one to three day visits ashore to nurse the pup.

After four months, the pup weans itself by leaving its mother; then it learns to hunt and feed itself.

Photo: nursing pup — Pam Goddard, www.thalassa-education.com

Traditional Knowledge



- Pribilof fur seals used to eat more seal-fish (Northern smoothtongue)
- Fur seals from different rookeries eat different fish
- Fur seal meat may taste different depending on the diet of the fur seal
- Sea lions taste different than fur seals



Lesson 4: What do fur seals eat?

7

Northern smoothtongue (*Leuroglossus schmidti*), also known as smoothtongue, was called seal-fish by the Unangan because the seals ate these fish. Elders in the Pribilof Islands told stories that the fur seals ate more seal-fish in the past.

An elder from St. George Island who moved to St. Paul Island said that fur seals from St. George Island tasted different (better) than the fur seals from St. Paul Island. Many years later, scientists studying the diet of seals from the different islands and different rookeries found that the diet of fur seals from St. George contained more squid and salmon than the diet of fur seals from St. Paul Island.

Food habits studies of fur seals have also confirmed that fur seals from different rookeries tend to eat different food.

Source of traditional knowledge: Aquilina Lestenkof and St. Paul community members

Photo: Richard Hibpshman, REFM/AFSC/NMFS/NOAA

How do we know?



- Traditional knowledge of fur seal food habits has been confirmed by scat collections
- Analysis of stomachs and intestines
- Analysis of fur, whiskers, and blood
- Observe nursing pups



Lesson 4: What do fur seals eat?

8

Historically, fur seals were killed for scientific purposes. Scientists collected stomachs from these seals to learn about their diets. Since the 1970s fur seals have not been killed for science.

Today fur seal diet information is collected while the seals are on the rookery.

- Scientists collect seal scat (poop), then wash it through sieves to find bones and squid beaks in the scat. These are identified to find out what fur seals eat.
- Bones and beaks are also measured to determine the size of fish and squid that the seals eat.
- Fur seal throw up (spew) large bones and squid beaks that cannot pass through the digestive tract. Scientists examine spews to identify fish and squid that are eaten.
- Stomachs and intestines from harvested animals are examined to see their contents.
- Chemical and fatty acid analyses of fur, whiskers and blood can provide information on the types of food that fur seals eat.

Photos: Paul Hillman, NOAA Ocean Media Center

Summary



- Fur seals eat different types of fish and squid
- Breeding males don't eat while on land
- Females alternate feeding trips at sea with visits to the rookery to feed their pups
- Pups drink milk for the first 4 months



Make A Food Chain

OBJECTIVE

Students will learn about marine food chains and where humans fit into a food chain.

TIME REQUIRED

15 minutes

BACKGROUND

Animals that eat other organisms are part of a food chain.

MATERIALS

- Worksheets with pictures:
 - ◆ Sun
 - ◆ Phytoplankton
 - ◆ Zooplankton
 - ◆ Small fish
 - ◆ Larger fish
 - ◆ Fur Seal
 - ◆ Harbor seal
 - ◆ Baleen whale
 - ◆ Killer whale
 - ◆ Human
- Optional – used stuffed animals instead of, or with, the cards

PROCEDURE

- Ask if students know what a food chain is. Describe how a food chain shows how energy is passed from one organism to another (or, another way to say it is “when an animal eats another animal and that animal is eaten by another animal”). Ask kids to talk about simple food chains that they know about (cat eats mouse eats grain seed, which gets its energy from the sun). Emphasize that plants make their own energy from the sun, and the sun is at the beginning of a food chain.
- Working with a group of five to six students, have them choose pictures from the worksheet. Line them up in order: sun, phytoplankton, zooplankton, small fish, larger fish, seal. Explain that phytoplank are tiny plants in the ocean that get their energy from the sun and zooplankton are tiny animals, and that the sun is at the beginning of a marine food chain.
- Repeat this exercise a few times, with different animals. Have the students line themselves up in the correct order. Sing a song about food chains – one option is a song that is adapted from a song called “Slippery Fish” (<http://www.youtube.com/watch?v=g67pk7gXJLo&feature=related>)

Big round sun, big round sun, shining on the water,
Big round sun, big round sun, shining on the water,
Big round sun, big round sun, GULP GULP GULP!
Oh no, it’s been eaten by a.....

Plankton, plankton, floating in the water....

Zooplankton, zooplankton, wiggling in the water...

Small fish, small fish, slipping in the water....

Larger fish, larger fish, swimming in the water....

Fur seal, fur seal, flying through the water....

Sea lion, sea lion, playing in the water....

And so on.

- Examples of food chains that you can make:
 - ◆ Sun, phytoplankton, zooplankton, small fish, fur seal
 - ◆ Sun, phytoplankton, zooplankton, baleen whale
 - ◆ Sun, phytoplankton, zooplankton, small fish, large fish, killer whale
 - ◆ Sun, phytoplankton, zooplankton, small fish, fur seal, person
 - ◆ Sun, phytoplankton, zooplankton, small fish, large fish, person

DISCUSSION

Discuss what all the food chains have in common (they all start with sun, phytoplankton, zooplankton)

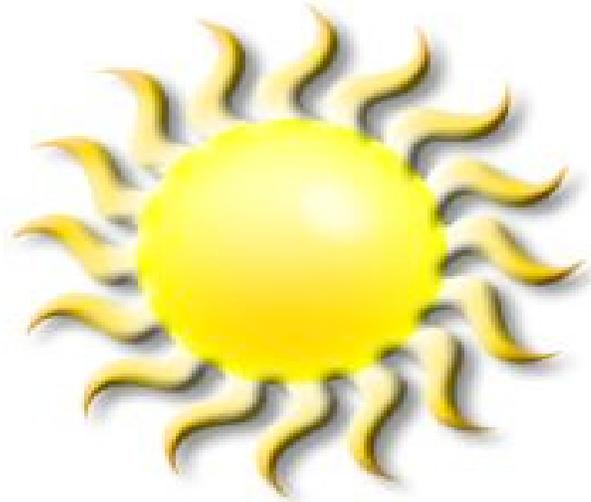
Discuss what might happen if the phytoplankton or zooplankton disappeared.

The other animals wouldn't have enough to eat.

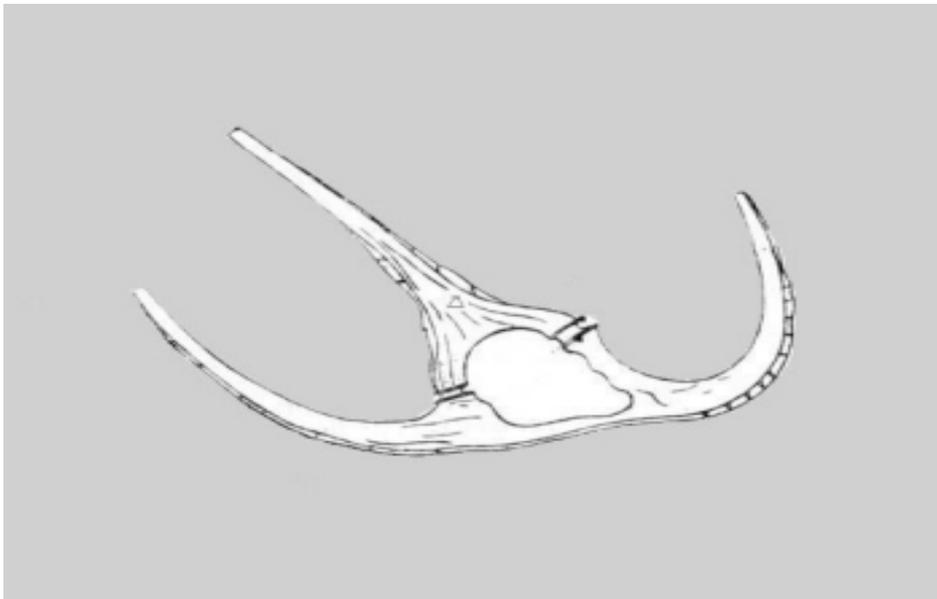
EXTENSION

Optional individual activity: make several copies of the food chain cards, mix them up and lay them on a table. Ask students to make their own food chains, and explain them to you.

- Optional extension: make a food chain of each student’s favorite food.
 - ◆ Example: if the favorite food is macaroni and cheese, talk about what macaroni is made from (wheat) and where cheese comes from (milk, from a cow), and then draw a food chain:
 - Macaroni: Sun, wheat (which is made into pasta), STUDENT
 - Cheese: Sun, plants, cow (makes milk which is made into cheese), STUDENT



Sun



phytoplankton



zooplankton



Pacific sand lance



salmon



northern fur seal



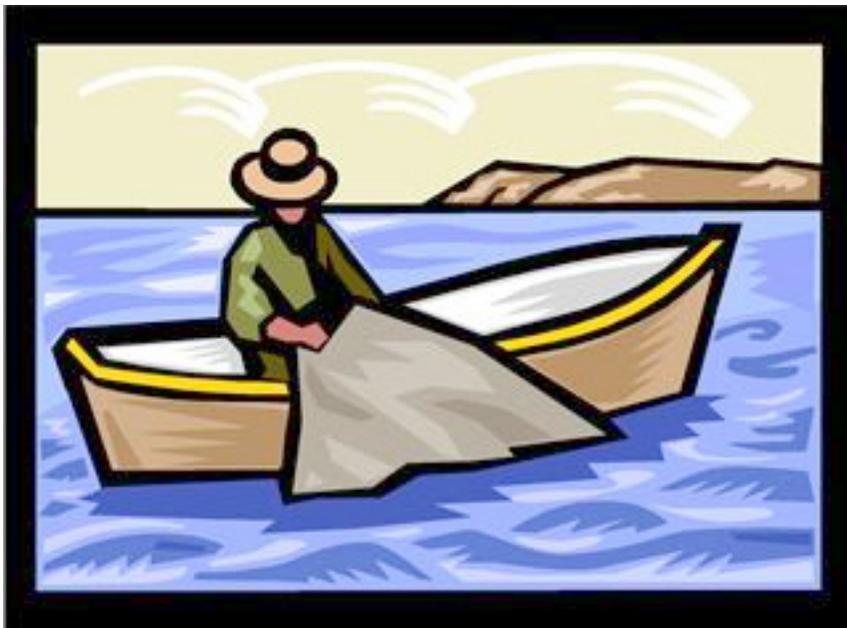
harbor seal



killer whales



humpback (baleen) whales



human

Lunch Box Detective

OBJECTIVE

Students will learn how to create a frequency of occurrence graph using food from student lunch bags.

TIME REQUIRED

15 minutes

BACKGROUND

In this activity, students use lunches (either actual or created with paper images) to categorize and graph the contents. The activity prompts them to think about what kind of information they can obtain by looking at lunches much like a scientist would obtain by looking at fur seal scats.

MATERIALS

- Sack lunches
- Plastic bags
- Multi-colored Post-It notes (small)

PROCEDURES

GRADE LEVEL K-2

- Ask students to bring in a sack lunch the following day or make up your own sack lunches with plastic bags and the images provided below.
- Looking at what is inside the students' lunches is similar to looking at the fur seal scats.

Make a prediction chart.

1. Draw an X and Y-axis on a white board or poster paper.
2. Have the students predict the contents of the lunches.
3. Create four to six categories for lunch items. Examples: sandwiches, fruit, vegetables, sweets, drink, other.
4. Without looking at the lunches, ask students to raise their hand if they think an item is going to be in their lunch. Plot the data.

Analyze and plot the lunch data.

1. Create categories on the X-axis for lunch items using the categories the class chose.
2. Have each student empty his/her lunch bag on his/her desk.

3. Categorize the lunch items into groups; for example: fruit, sandwich, vegetable, sweets...
4. Make a bar chart of the lunch items.
 - a. For each lunch item ask students to raise their hands if the item is in their lunch.
 - b. Count the number of lunches with the item. Note: students may have more than one item from a category; only record the presence of an item, not the number of items in each lunch. You are trying to figure out how many lunches contain items from a category not the number of times the item occurs.

Compare the predictions to the actual results.

NOTE: If you have Post-It pads of different colors, you can use the colors to represent the food categories and have each student put up one Post-it note for each type of food in their lunch, creating a bar graph on the board.

Example:

green = vegetable
red = fruit
purple = sweet
yellow = sandwich

The students use the Post-It notes to plot their data on the classroom bar chart.

DISCUSSION

- How close was your prediction to the actual data?
- What information can you gather from looking at lunches like this?
- What items are the most frequently found (e.g. most lunches had a sandwich)?
- What was the least frequently found item?
- Think about how this activity might be different if you wanted to see what an animal eats.

EXTENSION

Within a category, have students graph the different items to see how frequently they were found (e.g. apples, pears, oranges within the "fruit" category).

ACTIVITY 4.2

EXAMPLE

Lunch Box Detective

LUNCH #1
sandwich
apple
orange
cookie

LUNCH #2
sandwich
sandwich
carrots
celery
radishes

LUNCH #3
sandwich
carrots
broccoli
apple

LUNCH #4
sandwich
pear
orange

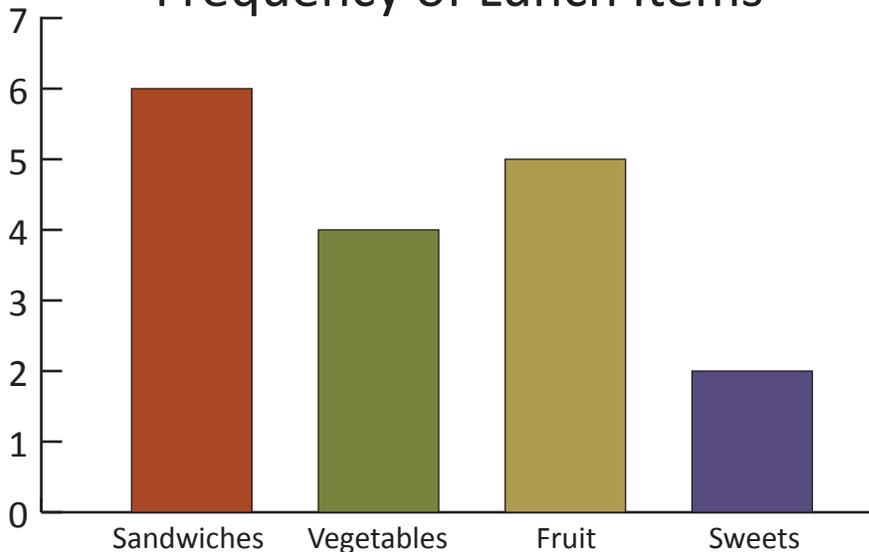
LUNCH #5
sandwich
sandwich
carrots

LUNCH #6
sandwich
mango
candy

LUNCH #7
celery
carrots
apple

Total # of Lunches	7
Lunch Item	# of lunches with item
Sandwiches	6
Vegetables	4
Fruit	5
Sweets	2

Frequency of Lunch Items



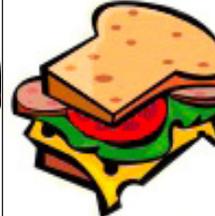
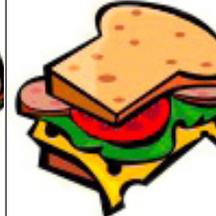
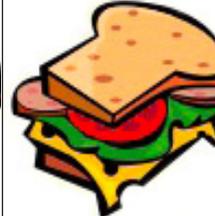
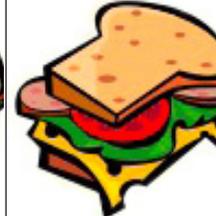
ACTIVITY 4.2 LUNCH IMAGES

Lunch Box Detective

 JUICE	 JUICE	 JUICE	 JUICE	 JUICE	 JUICE
 COOKIE	 COOKIE	 COOKIE	 COOKIE	 COOKIE	 COOKIE
 CARROT	 CARROT	 CARROT	 CARROT	 CARROT	 CARROT
 PEAR	 PEAR	 PEAR	 PEAR	 PEAR	 PEAR
 APPLE	 APPLE	 APPLE	 APPLE	 APPLE	 APPLE
 ORANGE	 ORANGE	 ORANGE	 ORANGE	 ORANGE	 ORANGE

ACTIVITY 4.2 LUNCH IMAGES

Lunch Box Detective

					
BANANA	BANANA	BANANA	BANANA	BANANA	BANANA
					
SANDWICH	SANDWICH	SANDWICH	SANDWICH	SANDWICH	SANDWICH
					
SANDWICH	SANDWICH	SANDWICH	SANDWICH	SANDWICH	SANDWICH
					
HOT DOG	HOT DOG	HOT DOG	MILK	MILK	MILK
					
MILK	MILK	MILK	MILK	MILK	MILK
					
WATER	WATER	WATER	WATER	WATER	WATER

Scat Detective

OBJECTIVE

Students will examine scats, tally the data, and produce frequency histograms.

TIME REQUIREMENT

30 minutes

BACKGROUND

Fur seals eat many different types of fish and sometimes they eat birds. One of the ways scientists study fur seal food habits is by examining their scat. (Scat is also called feces or poop.) Each summer, scat is collected from the rookery, frozen, and then shipped back to the lab for further examination. After all of the organic material has been washed away the bony parts of the fur seal's prey is left behind. Many of the bony or hard parts can be traced back to a specific species of fish, squid, or octopus. The parts that survive traveling through the digestive tract of a fur seal are:

- otoliths (fish earbones)
- vertebrae (fish bones)
- eye lens
- squid or octopus beaks (mouth parts)

By using extensive reference collections located at the Alaska Fisheries Science Center, scientists are able to identify species of fish, squid, or octopus that the bones, otoliths, lenses, or beak come from. We call the scientists Scat Detectives.

MATERIALS

- Images of prey items—Appendix II
- Plastic or cloth bags, envelopes
- Otolith, bone, and fish reference keys

PROCEDURE

Preparing the scats

This should be completed at least one day before you teach the lesson.

1. Print several single sided copies of the otoliths/beaks and bones. Sixty percent of your images should be pollock bones or otoliths. If you have access to a laminating machine, laminate the images of otoliths/beaks and bones before proceeding.
2. Cut out the individual images and mix them up.

3. Obtain enough bags or envelopes for each student or pair of students to have one bag. Number each bag. If you are feeling really ambitious, label each prey item that goes into the bag with the same number. This allows you to have the same data from year to year.
4. Fill the bags with the different prey items. Remember that pollock is the most frequently consumed prey item. Almost all of the scats should have pollock otoliths or bones in them.
5. Distribute the bags around the classroom to simulate a rookery.
6. Have the students find a scat and open it up.

Analyze the data using a frequency histogram

1. Using the reference keys, ask the students to identify the bones, otoliths, and beaks in their bags.
2. Complete Worksheet 4.3.1
3. Have each student graph the result for his or her bag. The x-axis should be the species and the y-axis is the frequency or total number of items for that species.
4. Now consolidate the data for the class and make another graph.

DISCUSSION

Did all of the scats have the same species? How were the individual scats different from the class total? Why do you think the seals would eat different prey?

EXTEND AND EXPLORE

Research the species on the reference keys and answer some of the following questions. A good place to start is FishBase, www.fishbase.org.

1. Where is the species found?
2. How big does it get? How many would a fur seal have to eat to fill up?
3. Is the species commercially harvested in Alaska or off the West Coast? If yes, what time of the year is it harvested? What size fish are the fishermen targeting?

NOTE: It takes time to cut out all of the images and put them in bags. Start the preparation for this activity one or two days before you plan on teaching it. Save it for future years

Student Name: _____

Scat Bag #: _____

Place a tally mark for each item that is present in your bag.

Species Name	bones	otoliths or beaks	Total
walleye pollock			
Pacific cod			
Atka mackerel			
Pacific herring			
Pacific sand lance			
Northern smoothtongue			
coho salmon			
squid			

Class Total

Total # of scat bags: _____

Species Name	# bones	# otoliths or beaks	Total
walleye pollock			
Pacific cod			
Atka mackerel			
Pacific herring			
Pacific sand lance			
Northern smoothtongue			
coho salmon			
squid			

ACTIVITY 4.3 **TEACHER KEY 4.3.1** Scat Detective—Frequency Data*Student Name: Sample DataScat Bag #: 32

Place a tally mark for each item that is present in your bag.

Species Name	bones	otoliths or beaks	Total
walleye pollock			
Pacific cod			
Atka mackerel			
Pacific herring			
Pacific sand lance			
Northern smoothtongue			
coho salmon			
squid			

Class Total

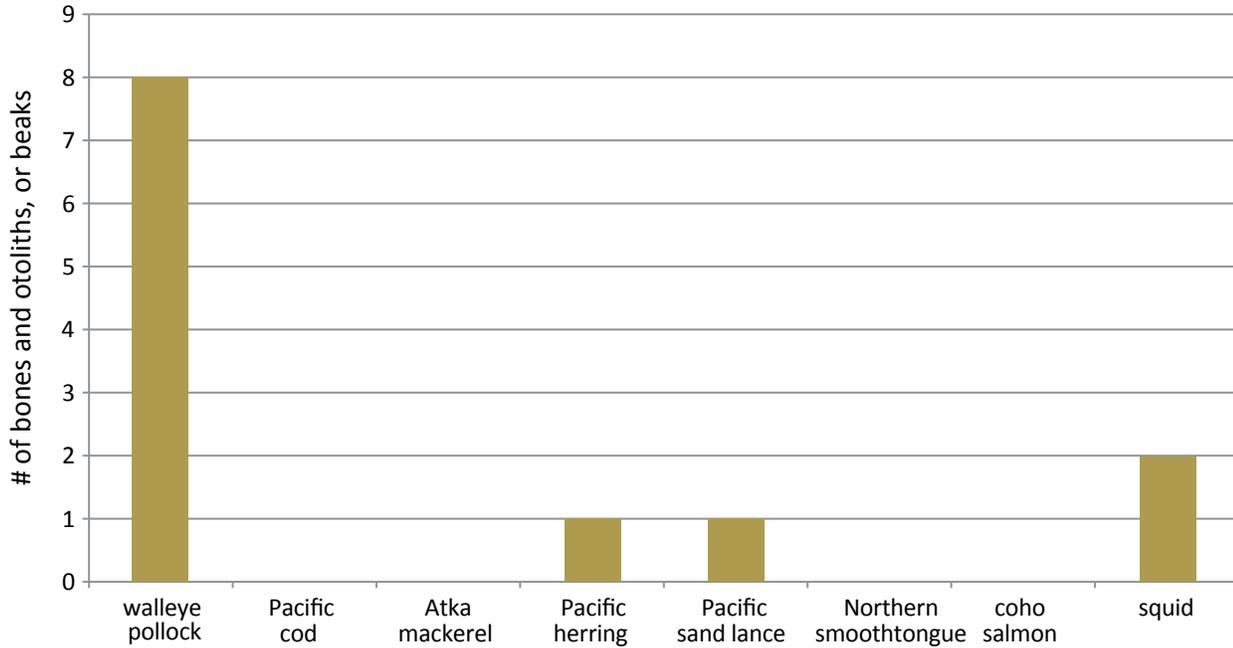
Total # of scat bags: 10

Species Name	# bones	# otoliths or beaks	Total
walleye pollock	42	28	70
Pacific cod	5	2	7
Atka mackerel	3	4	7
Pacific herring	6	2	8
Pacific sand lance	5	3	8
Northern smoothtongue	3	3	6
coho salmon	2	1	3
squid		15	15

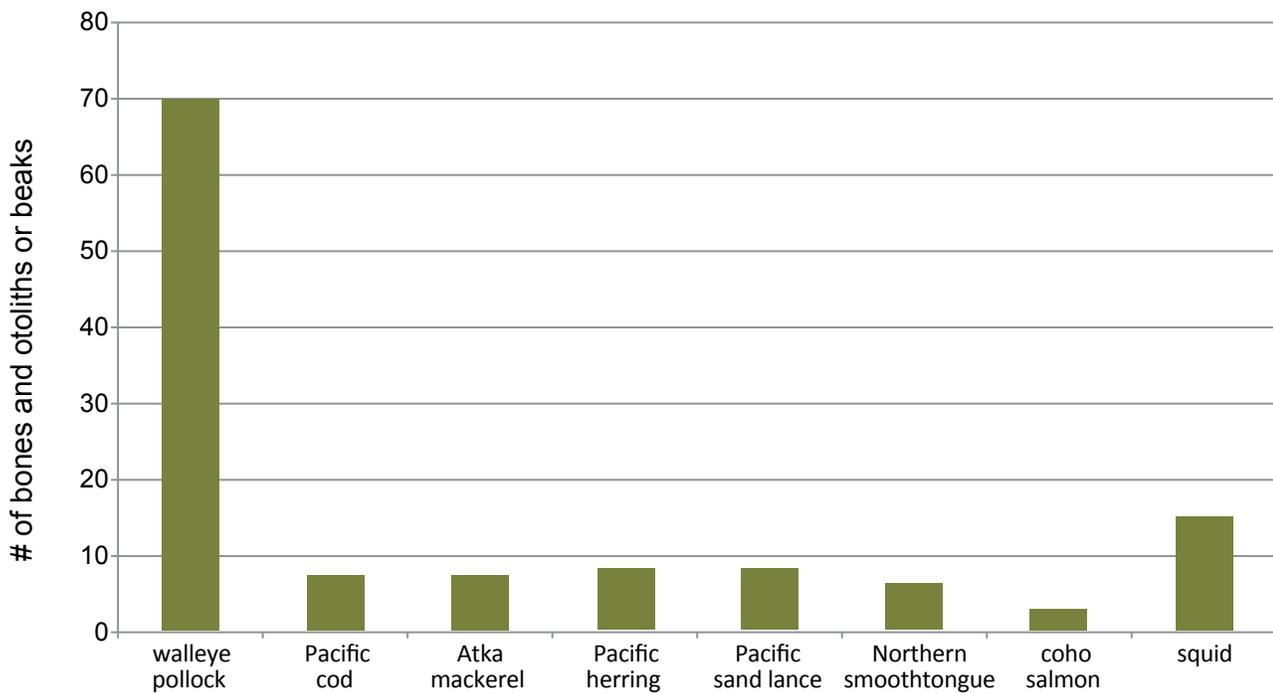
* Sample, answers will vary

Sample Data

Scat #32



Class Total



* Sample, answers will vary



squid



walleye pollock (*Theragra chalcogramma*)



Pacific cod (*Gadus macrocephalus*)



northern smoothtongue (*Leuroglossus schmidti*)



Pacific herring (*Clupea pallasii*)



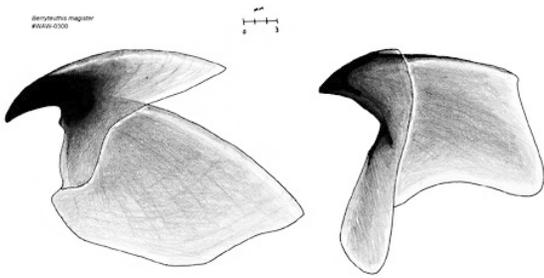
coho salmon (*Oncorhynchus kisutch*)



Pacific sand lance (*Ammodytes hexapterus*)



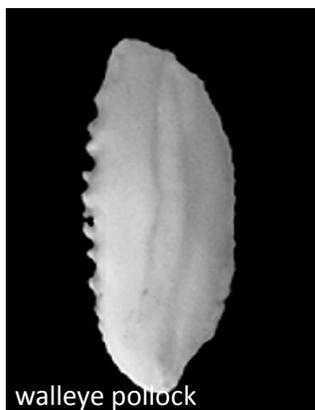
Atka mackerel (*Pleurogramma monopterygius*)



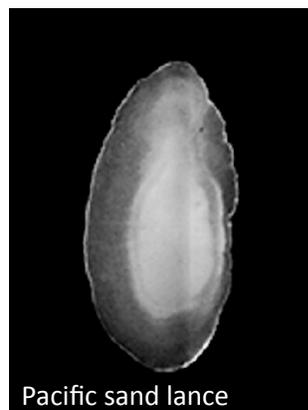
squid beak



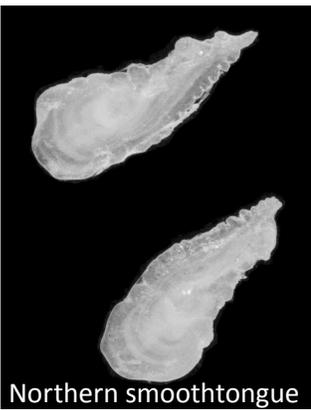
Pacific cod
Gadus macrocephalus



walleye pollock
Theragra chalcogramma



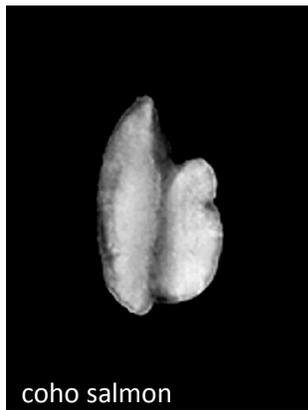
Pacific sand lance
Ammodytes hexapterus



Northern smoothtongue
Leuroglossus schmidti



Pacific herring
Clupea pallasii



coho salmon
Oncorhynchus kisutch



Atka mackerel
Pleurogramma monopterygius

ACTIVITY 4.3

REFERENCE KEY

Scat Detective



Pacific cod
Gadus macrocephalus



Pacific cod
Gadus macrocephalus



walleye pollock
Theragra chalcogramma



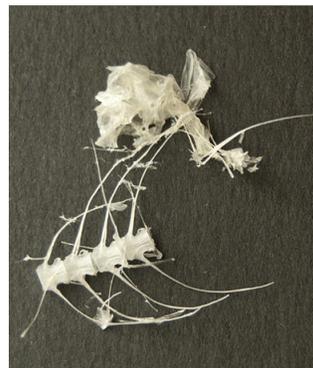
walleye pollock
Theragra chalcogramma



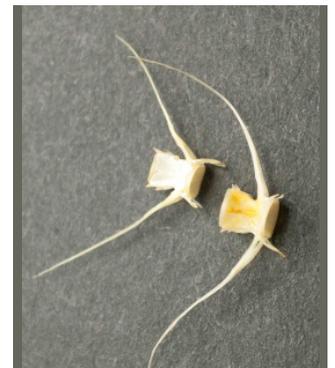
walleye pollock
Theragra chalcogramma



Northern Smoothtongue
Leuroglossus schmidti



Northern Smoothtongue
Leuroglossus schmidti



Pacific herring
Clupea pallasii



Pacific herring
Clupea pallasii



Pacific herring
Clupea pallasii



Pacific sand lance
Ammodytes hexapterus



Pacific sand lance
Ammodytes hexapterus



coho salmon
Oncorhynchus kisutch



coho salmon
Oncorhynchus kisutch



Atka mackerel
Pleurogramma monoptyerygius



Atka mackerel
Pleurogramma monoptyerygius

Microworlds: What do Marine Mammals Eat?

OBJECTIVE

Students will learn why it is difficult to study what marine mammals eat.

learn why population is declining
changes in diet could indicate changes in ecosystem

TIME REQUIRED

15 minutes

RESOURCES

NOAA Microworlds: What do Marine Mammals Eat?
DVD or website
http://www.youtube.com/watch?v=Ntu_x9Jkrxl

BACKGROUND

Fur seals spend most of their lives at sea. When they are on land they do not eat. Scientists have used many different ways to study fur seal food habits. This video of Dr. Tony Orr from the Alaska Fisheries Science Center's National Marine Mammal Lab explains how Tony studies what fur seals eat.

MATERIALS

- NOAA Microworlds: What do Marine Mammals Eat? DVD or website

PROCEDURES

Watch "What do marine mammals eat?"

DISCUSSION

Discuss or write about the following.

- Why is it so hard to study what marine mammals eat?

instruments are expensive: underwater video cameras, satellite tags

marine mammals move quickly: very hard to follow under water, dive to great depths

marine mammals eat underwater: do not bring food to the surface, feed at night or in deep water

In the video Tony mentions he studies northern fur seal food habits by using scats, spews, and hair.

- What are different ways scientists study northern fur seals diets?
 - DNA from scat
 - animal tissue (whiskers, blood, hair, blubber)
- Why is it so important to know what they eat?
 - fishing pressure
 - competing with humans for food

Microworlds: What do Marine Mammals Eat?

1. Name three reasons why it is hard to study what marine mammals eat.

2. Describe methods that scientists use to study northern fur seal diets.

3. Why is it important to know what northern fur seals eat?

Microworlds: What do Marine Mammals Eat?

1. Name three reasons why it is hard to study what marine mammals eat.

Marine mammals feed underwater. It is hard to see what they eat.

Putting cameras on the animals is very expensive.

The environment where they eat is often deep and dark.

2. Describe methods that scientists use to study northern fur seal diets.

Radio and satellite tags.

Scat analysis. DNA from scat.

Animals tissue: blubber, hair, whiskers, blood

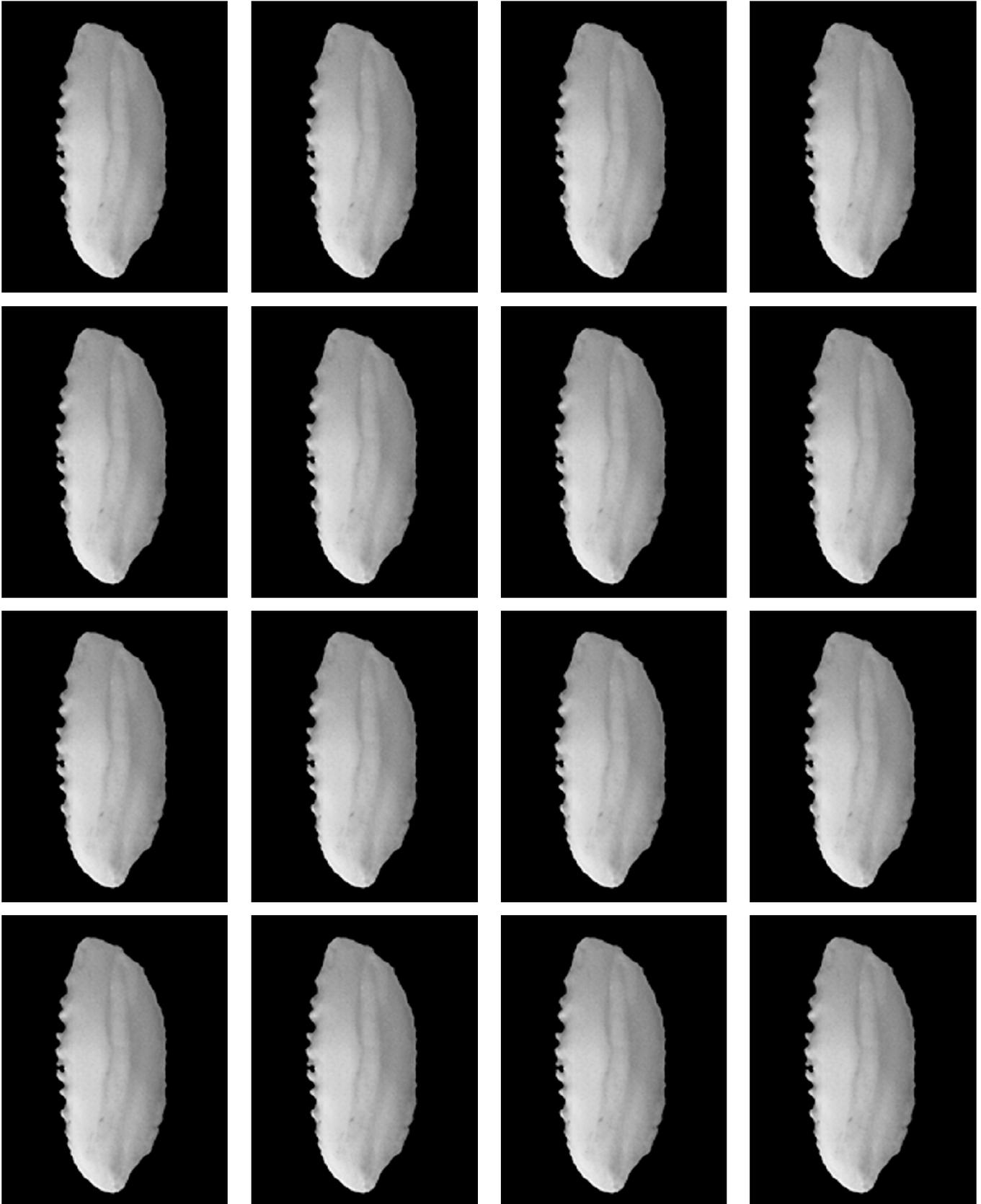
3. Why is it important to know what northern fur seals eat?

Northern fur seals compete with humans for the same fish.

The northern fur seal population is declining. Scientists need to figure out why the population is not stable.

Northern fur seals are part of a complex ecosystem. Changes in the fur seals diet could indicate changes in the larger ecosystem.

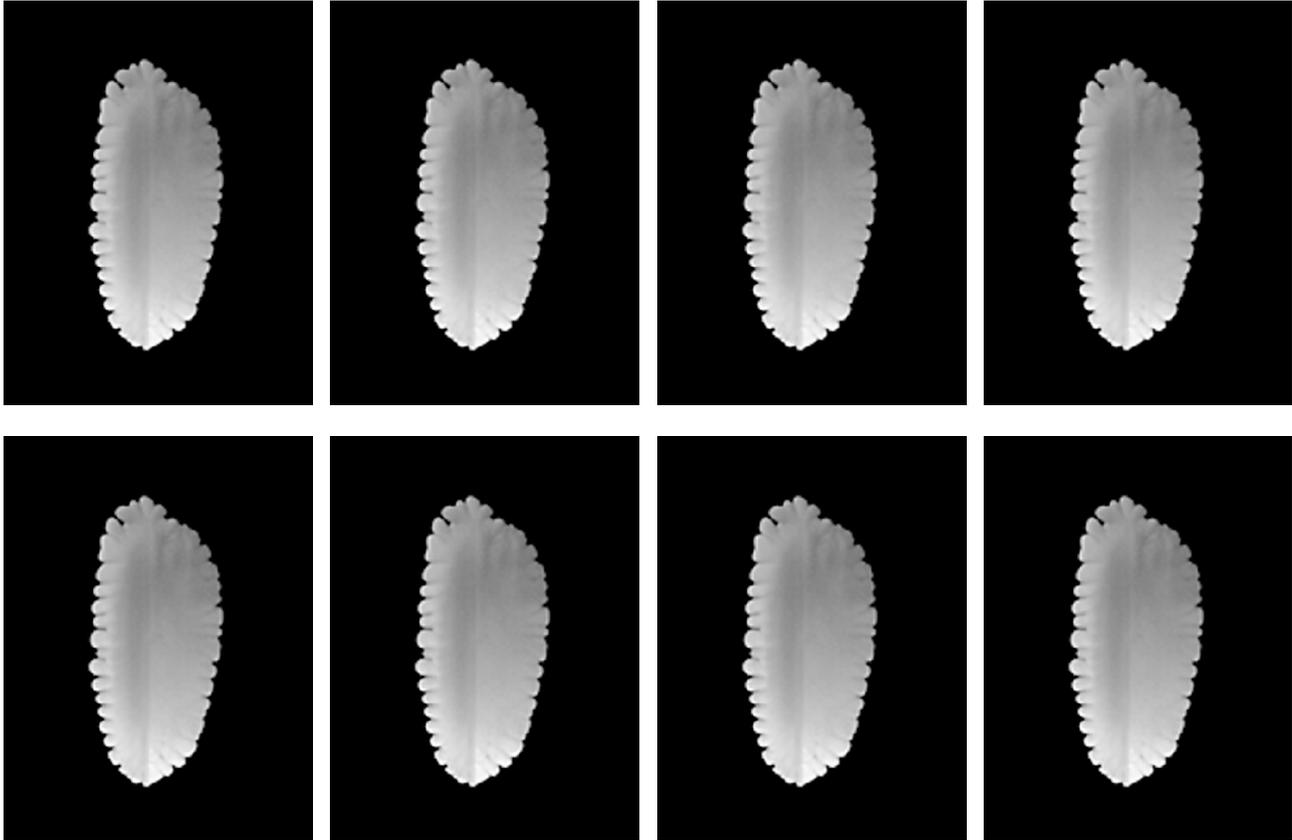
walleye pollock, *Theragra chalcogramma*



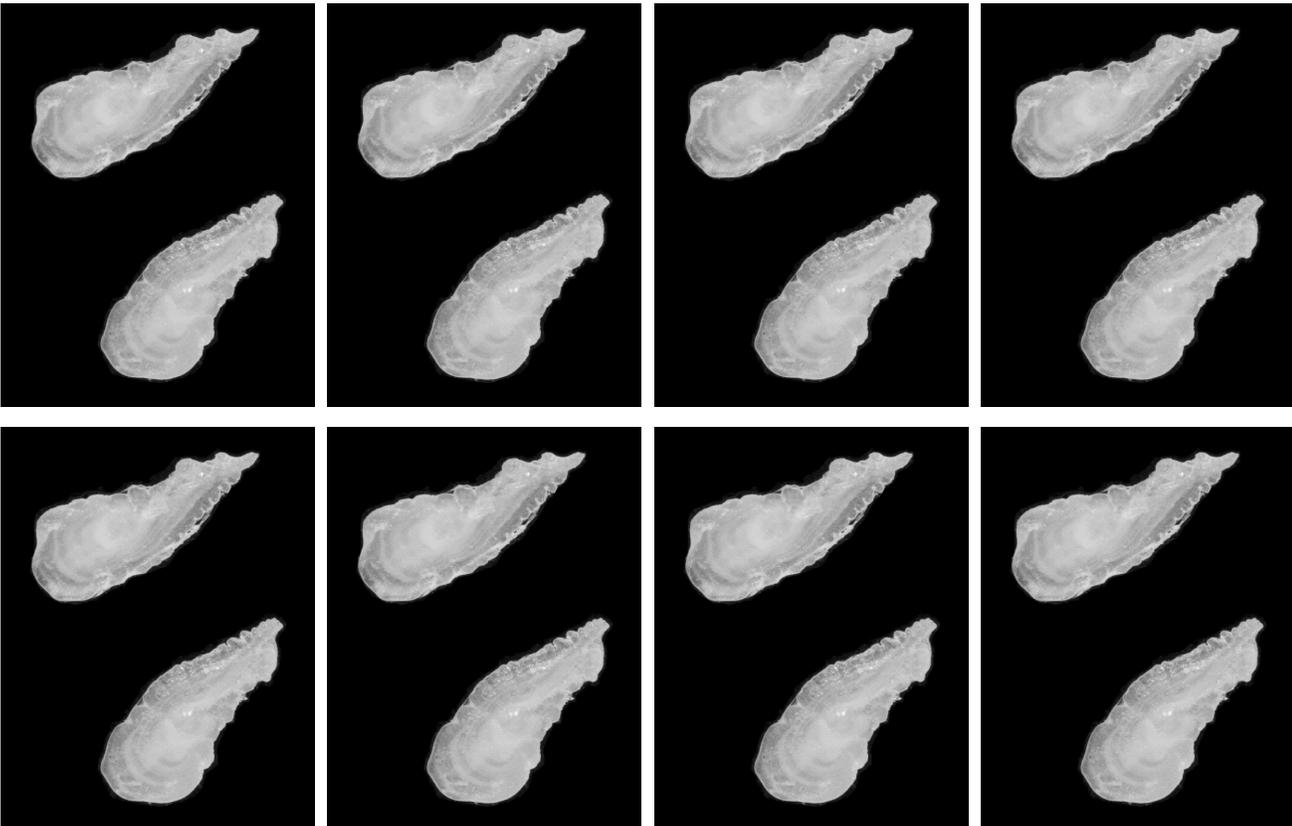
APPENDIX II

SCAT DETECTIVE IMAGES

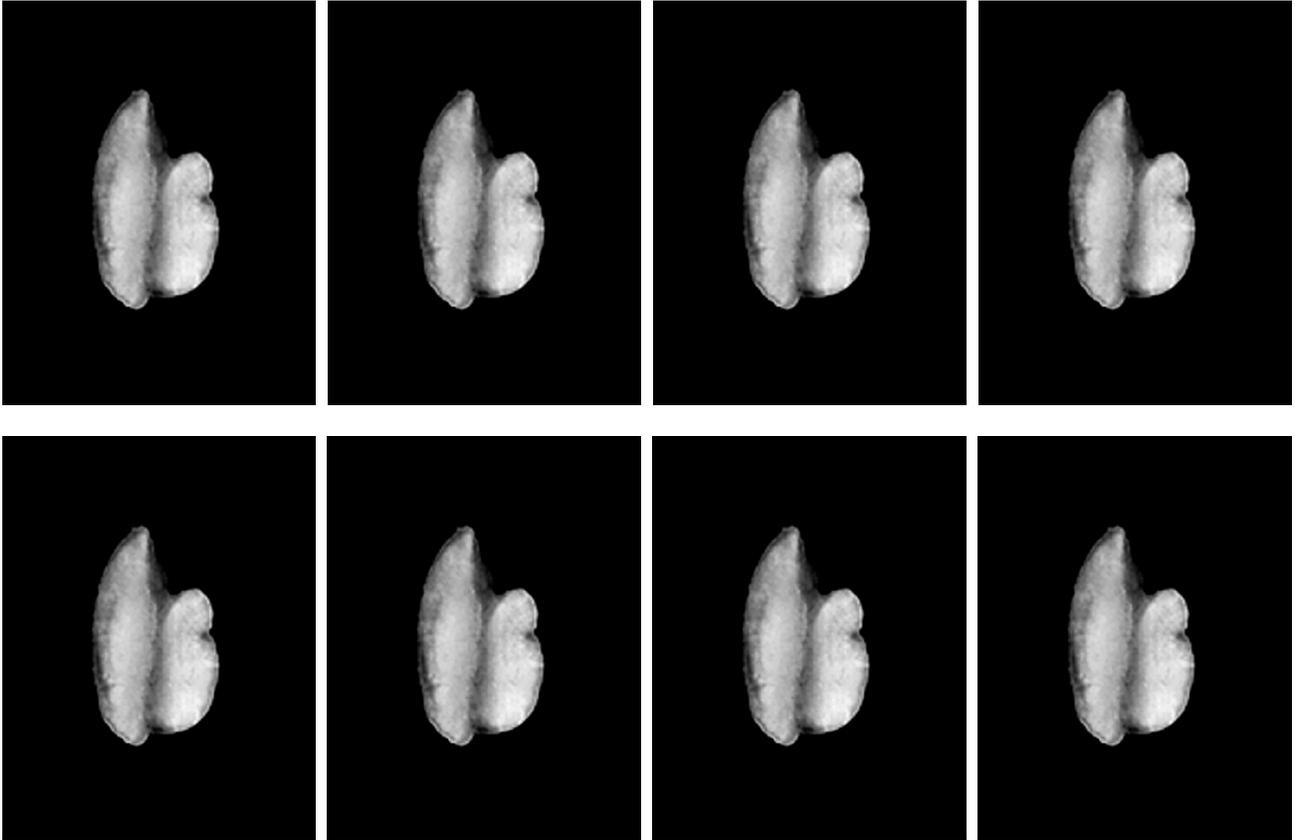
Pacific cod, *Gadus macrocephalus*



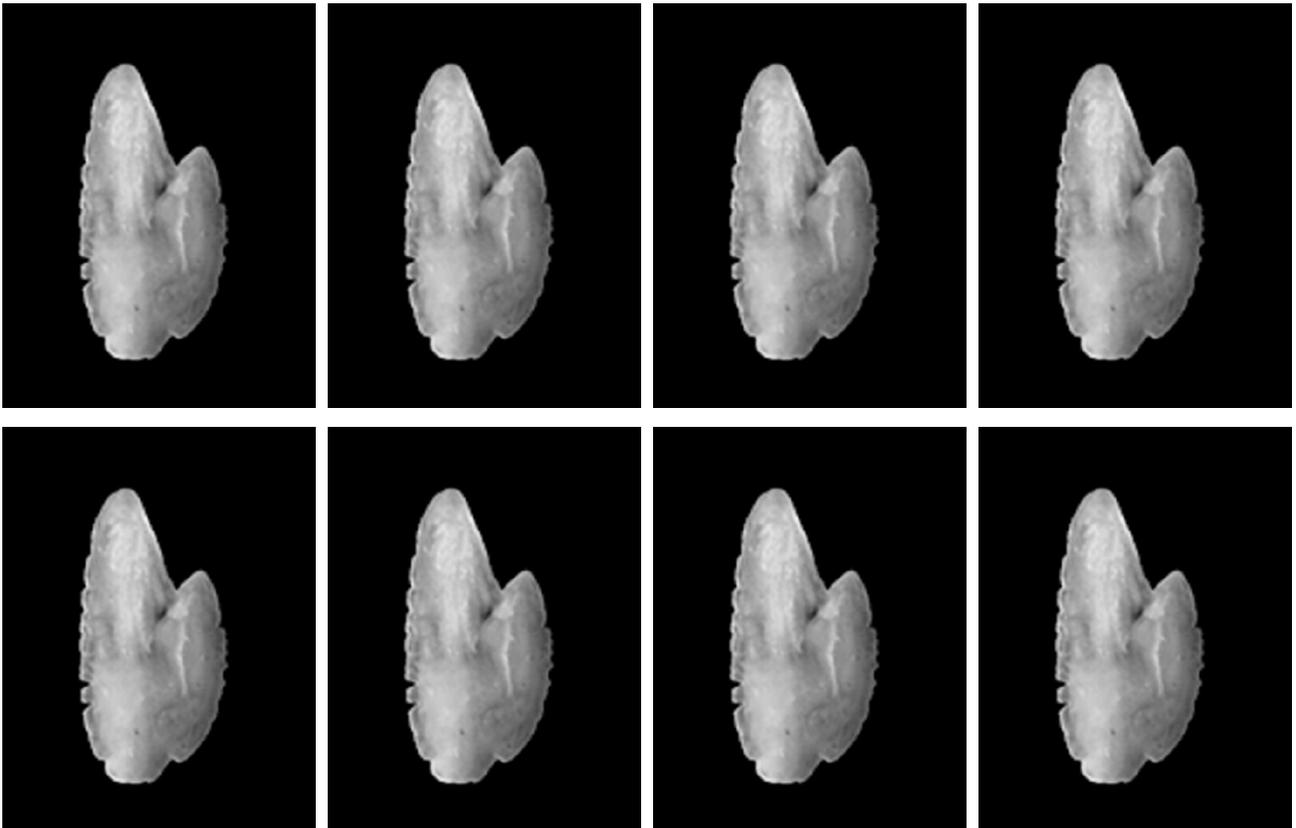
Northern smoothtongue, *Leuroglossus schmidti*



coho salmon, *Oncorhynchus kisutch*



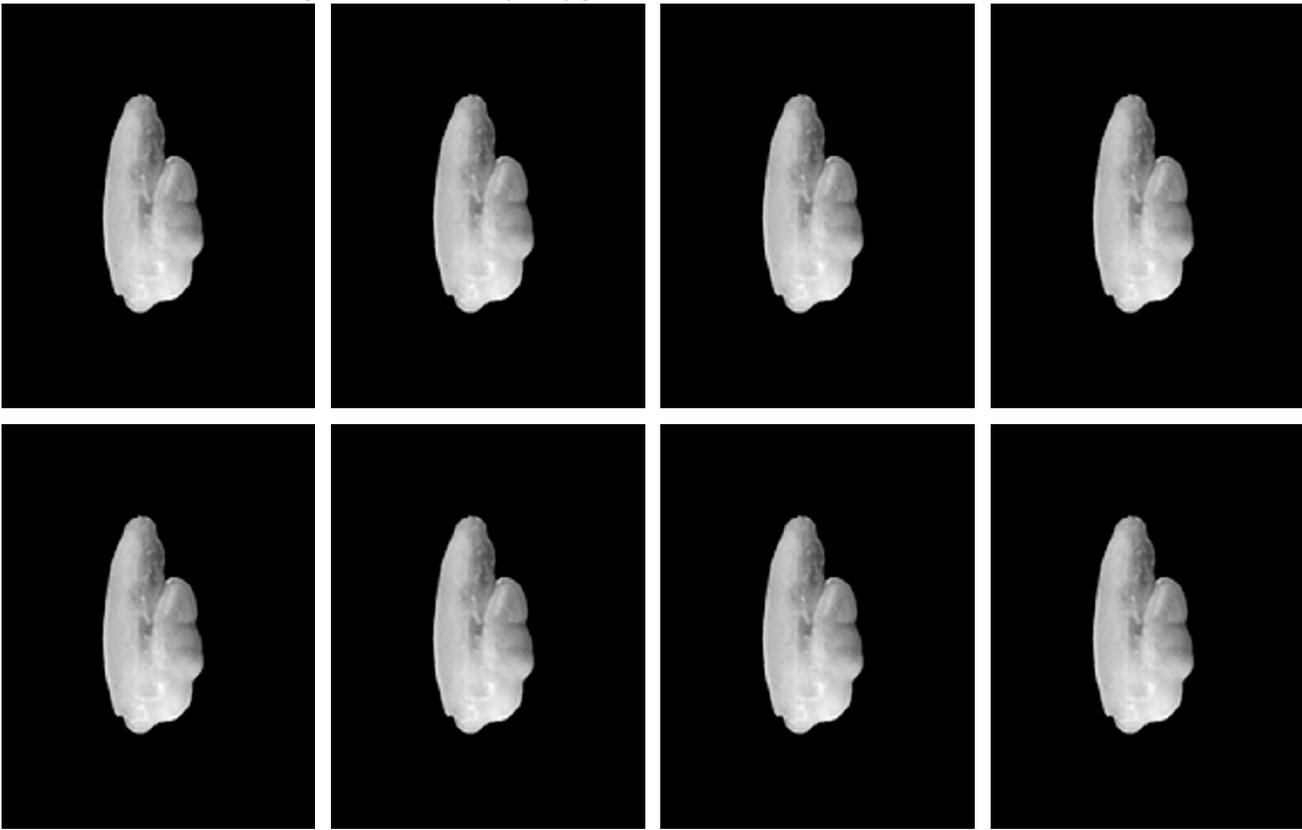
Pacific herring, *Clupea pallasii*



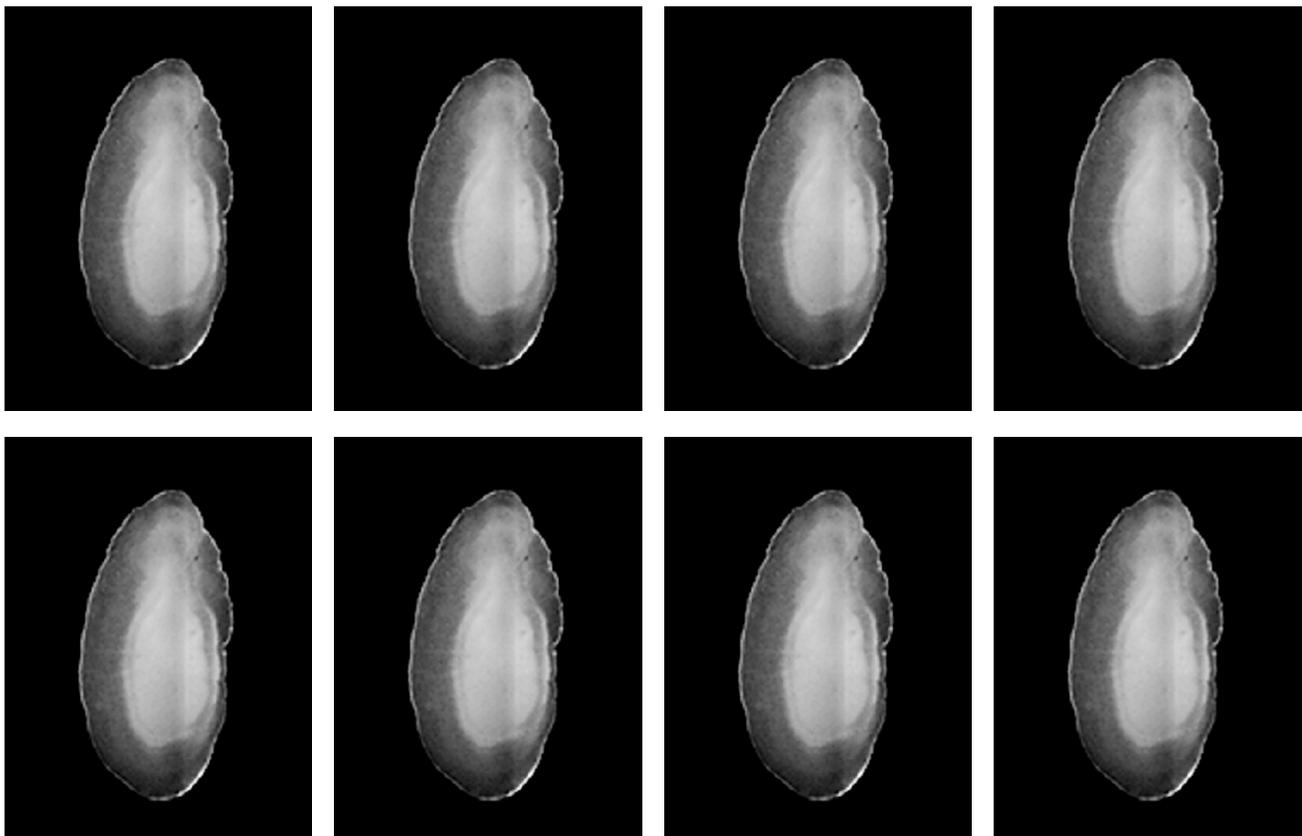
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SCAT DETECTIVE IMAGES

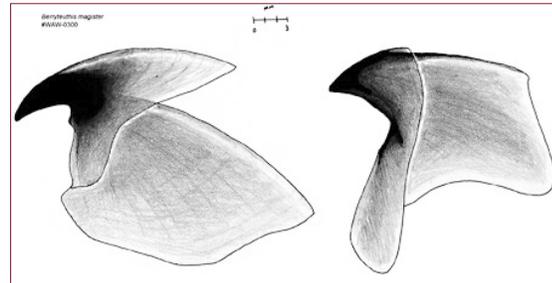
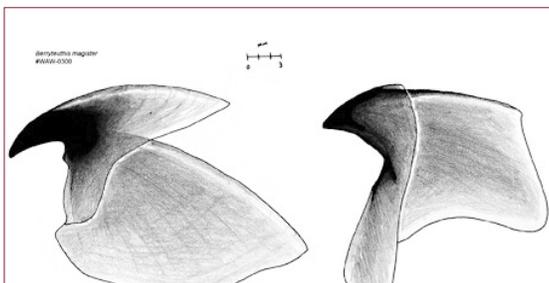
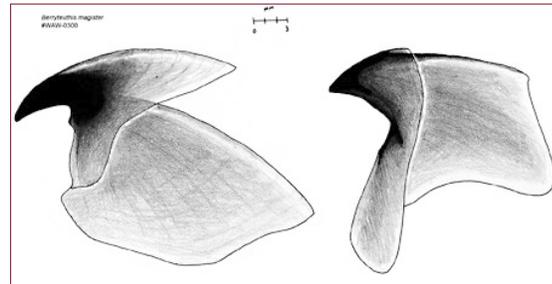
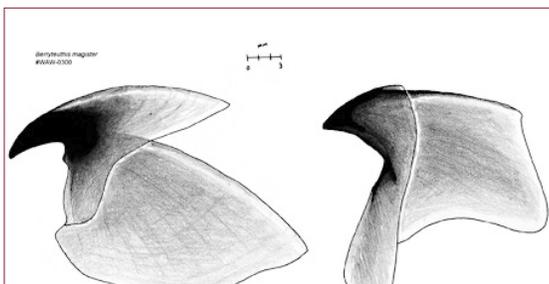
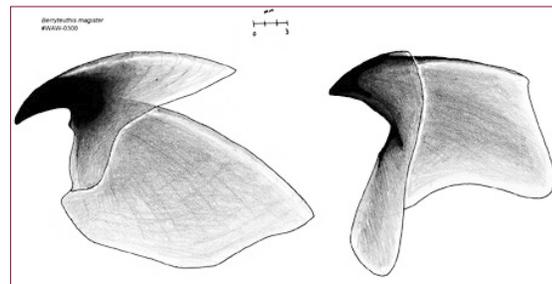
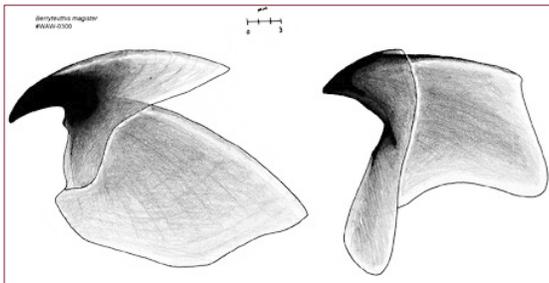
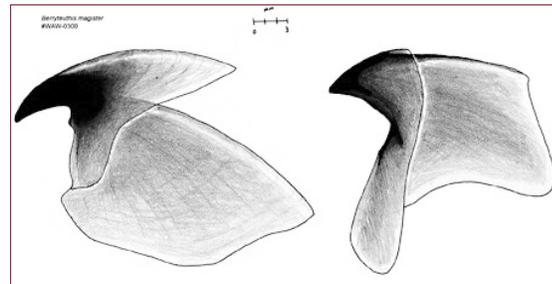
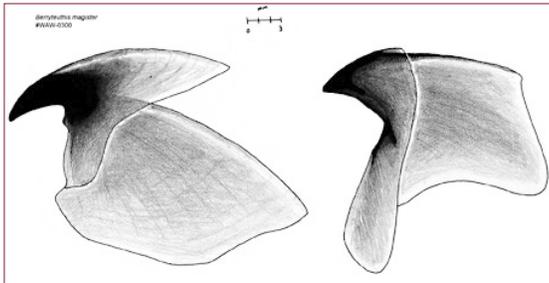
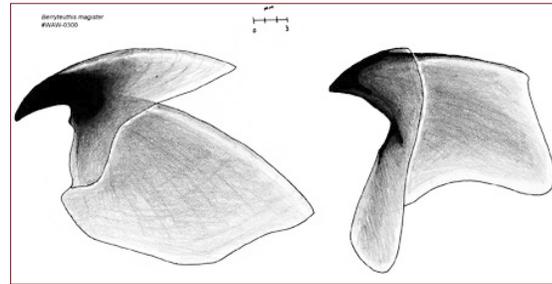
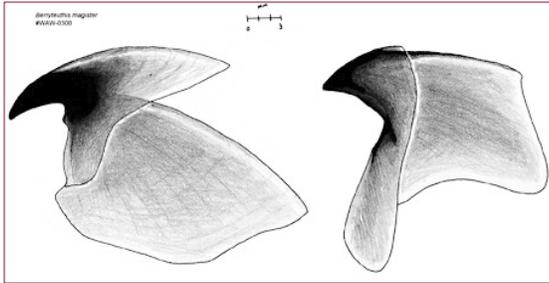
Atka mackerel, *Pleurogramma monopterygius*



Pacific sand lance, *Ammodytes hexapterus*



squid, *Berryteuthis magister*



APPENDIX II

SCAT DETECTIVE IMAGES

walleye pollock *Theragra chalcogramma*



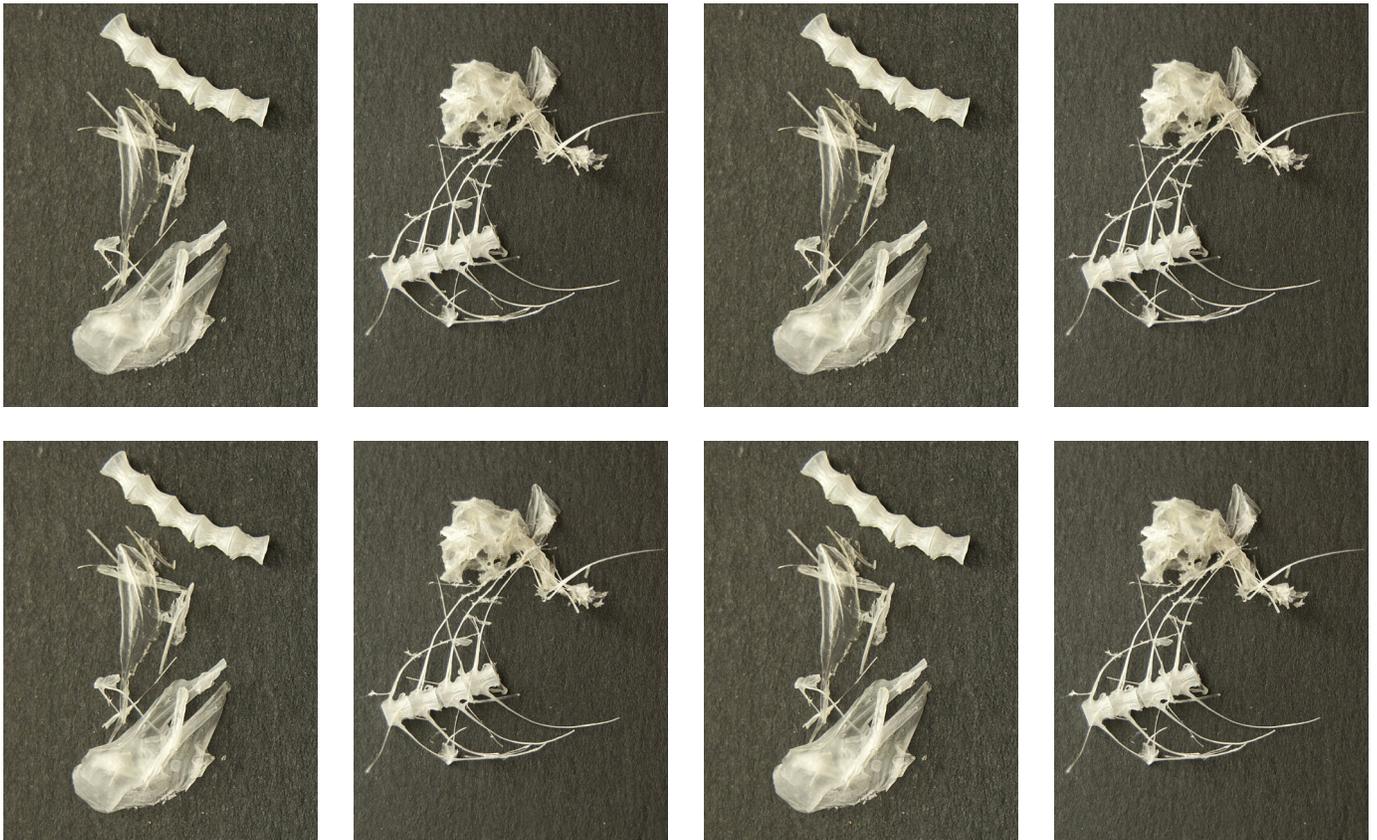
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SCAT DETECTIVE IMAGES

Pacific cod, *Gadus macrocephalus*



Northern Smoothtongue, *Leuroglossus schmidtii*



APPENDIX II

SCAT DETECTIVE IMAGES

Pacific herring, *Clupea pallasii*



Pacific sand lance, *Ammodytes hexapterus*



APPENDIX II

SCAT DETECTIVE IMAGES

coho salmon *Oncorhynchus kisutch*



Atka mackerel, *Pleurogramma monopterygius*



Lesson 4 Activity 4.3: Scat detective

Bag-stomach game

Fish Image Sources

squid beak (*Berryteuthis magister*)

NOAA/NMFS/AFSC/NMML

<http://www.afsc.noaa.gov/Quarterly/amj2011/divrptsNMML1.htm>

squid (*Berryteuthis magister*)

NOAA/Alaska Fisheries Science Center/Multimedia Gallery

<http://access.afsc.noaa.gov/MultimediaGallery/details.php>

walleye pollock (*Theragra chalcogramma*)

NOAA/Alaska Fisheries Science Center/Age and Growth

http://www.afsc.noaa.gov/refm/age/age_pollock.htm

Pacific cod (*Gadus macrocephalus*)

NOAA/Alaska Fisheries Science Center image database

http://www.afsc.noaa.gov/race/media/photo_gallery/fish_files/Pacific_cod.htm

Pacific sand fish (*Trichodon trichodon*)

NOAA/Alaska Fisheries Science Center image database

http://www.afsc.noaa.gov/race/media/photo_gallery/fish_files/Pacific_sandfish.htm

Pacific herring (*Clupea pallasii*)

USGS/Alaska Science Center

Field Guide to Identifying Kittlitz's Murrelet Forage Fish

Mayumi Arimitsu and John Piatt

USGS-ASC, 3100 National Park Rd, Juneau, Alaska 99801

marimitsu@usgs.gov

Pacific sand lance (*Ammodytes hexapterus*)

NOAA/Alaska Fisheries Science Center/Auke Bay Lab

http://alaska.usgs.gov/science/biology/seabirds_foragefish/foragefish/Aleutian/images.php

coho salmon (*Oncorhynchus kisutch*)

NOAA/Northeast Fisheries Science Center

<http://www.nefsc.noaa.gov/faq/fishfaq2c.html>

Atka mackerel (*Pleurogramma monopterygius*)

NOAA/Alaska Fisheries Science Center image database

http://www.afsc.noaa.gov/RACE/media/photo_gallery/fish_files/Atka_mackerel.htm

Otolith Image Source

Harvey, James T., Thomas R. Loughlin, Michael A. Perez, and Dion S. Oxman. 2000. Relationship between fish size and otolith length for 63 species of fishes from the eastern north Pacific Ocean. NOAA Tech Report 150.

Bone Image Source

Pam Goddard, Thalassa Education