Kids on the Beach

Overview

Kids on the Beach is a hands-on program that has students doing real science and investigating the nearshore marine environment! Over the course of four days you will explore the Salish Sea and issues affecting it. This program is designed for you to do one 30 min activity a day.

Contents

Background

What is an Estuary?
An Estuary is a semi-enclosed body of water where salt water from the ocean is diluted by freshwater from the land.

What is a Habitat?
A habitat is the home of an animal or a plant.

What is the Padilla Bay Reserve?
The Padilla Bay Reserve is one of 29 sites in the National Estuarine Research Reserve system established to protect coastal areas for long-term research, monitoring, education, and stewardship. Padilla Bay Reserve is the only Research Reserve in Washington State.

Why is Padilla Bay important?
Padilla Bay is in the heart of the Salish Sea. It has more than 8,000 acres of eelgrass; it's the second largest eelgrass meadow on North America's Pacific Coast.

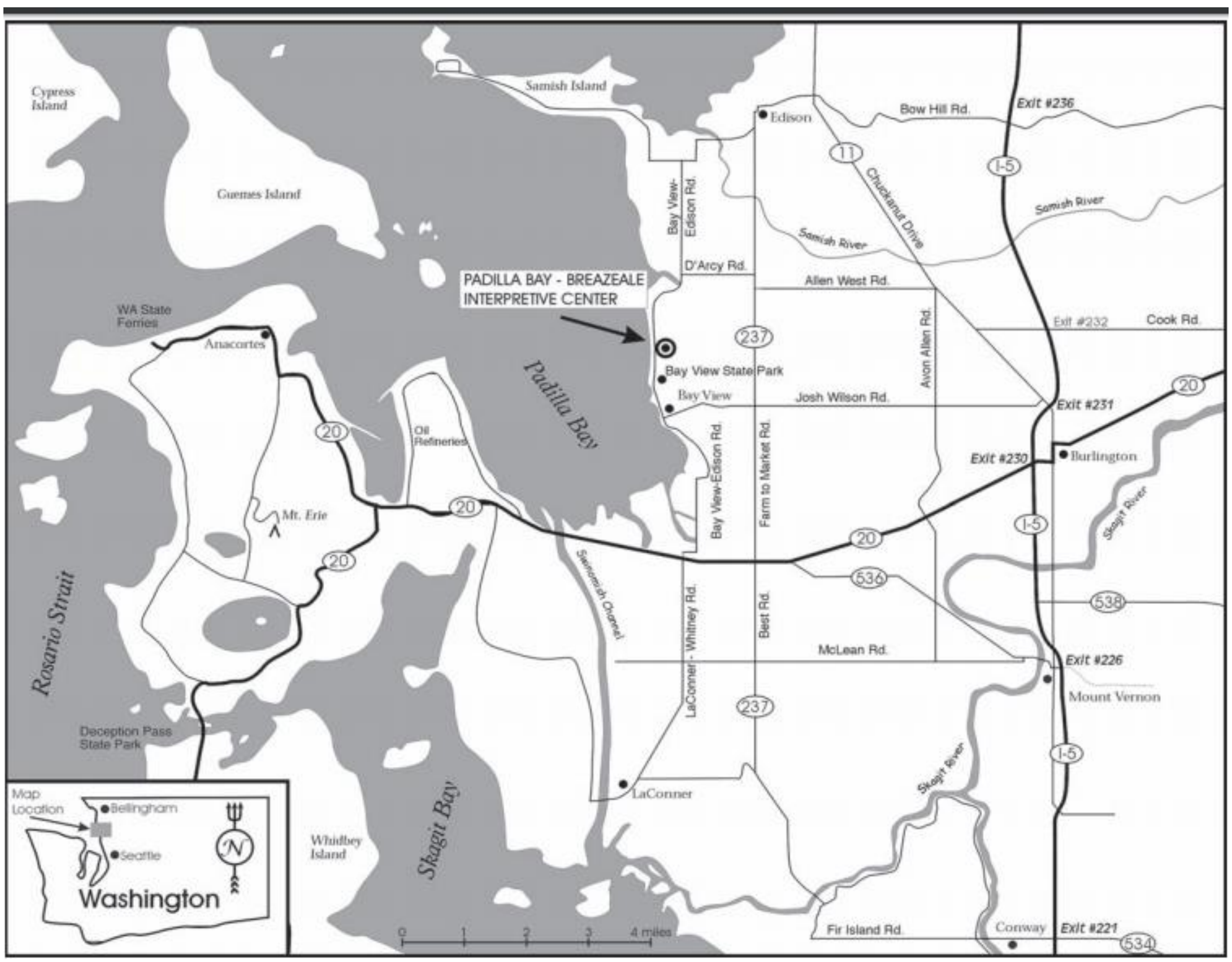
What is the Salish Sea?
The Salish Sea is an inland sea that encompasses Puget Sound, the San Juan Islands and the waters inside of Vancouver Island, BC. The area spans from Olympia, Washington in the south to the Campbell River, British Columbia in the north.

Why is eelgrass important?
Eelgrass is used as a nursery habitat for juvenile salmon, crab, and herring. It also provides critical habitat for waterfowl and marine birds.

Vocab

Estuary: a place where freshwater mixes with salty sea water. All of the Salish Sea is an estuary.
Salish Sea-The Salish Sea is an inland sea that encompasses Puget Sound, the San Juan Islands and the waters off of Vancouver, BC.
Plankton- plants or animals floating in the water, usually microscopic.
Phytoplankton- free-floating plants in water; often microscopic.
Zooplankton- free-floating animals in water; often microscopic.
Diatoms-Diatoms are a single-celled algae which has a cell wall of silica (glass-like structure). Like other algae they photosynthesize.
Microscopic- too small to see without a microscope.
Detritus- dead rotting stuff. The compost of the estuary!
Filter feeder- an animal, such as a clam or oyster that strains food from the water.
Photosynthesis- the process in which plants and some other organisms use sunlight to create food from carbon dioxide and water.
Algae- a type of plant without a true stem, roots or leaves; mostly lives in water.
Food Chain- the transfer of energy (food) from plants to animals, and maybe then to other animals.
Food Web- overlapping and connecting food chains.
Eelgrass- a type of grass that grows in the water.
Copepods- type of zooplankton (microscopic animal), the animal plankton from sponge bob is modeled after.
Watershed- the area of land that drains into a body of water like a river or bay.

Location



The Great Plankton Race

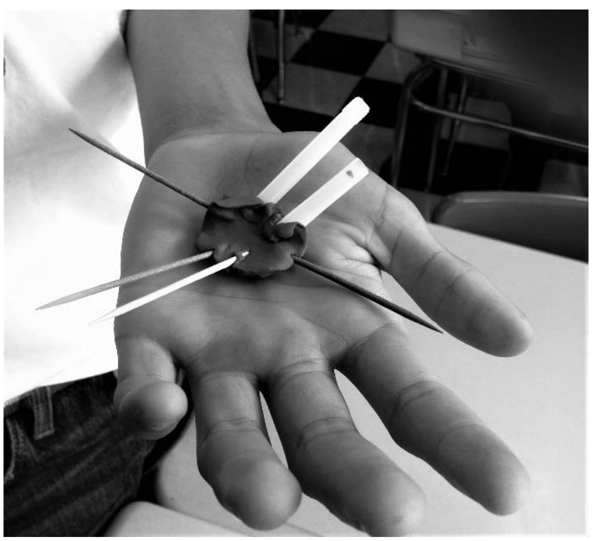
Adapted from the COSEE's "The Great Plankton Race" lesson plan

Background

The word **plankton** is from the Greek word for "wandering". They are organisms that drift or wander the oceans at the mercy of the currents. Plankton can't move against currents. Some planktonic organisms can be large (like jellyfish), but most are small enough that they must be viewed under a microscope. The plankton that photosynthesize are called **phytoplankton**. Plankton that eat other plankton are called **zooplankton**. All Plankton must avoid sinking. Phytoplankton need sunlight for photosynthesis, so they must stay within the **photic zone** (the top 200m of water column). Zooplankton depend on phytoplankton and other zooplankton for food, so they must avoid sinking as well. Plankton avoid sinking by increasing their surface area and/or decreasing their **density**. Flattened bodies, spines, and other body projections slow sinking by adding surface area without increasing density. Some plankton resist sinking by forming chains. The use of low-density substances like oil or fat helps increase **buoyancy** and can serve as food reserves. While plankton are too weak to swim against a current, many do swim vertically each day. Great numbers of zooplankton commute up to the surface at night and back down each day. Migrating plankton can take advantage of more food near the surface at night when predators can't see as well.

Activity

Construct a model plankton using your choice of materials. Using things like corks, tooth picks, paper clips, coins, string, and rubber bands work well. It is a good idea to try lots of different types of materials. Your goal is to produce a creature as close to neutrally buoyant (doesn't sink or float) as possible. Construct your plankton to be roughly the size of a golf ball. Use a bucket, dishpan, soda bottle, or your kitchen sink to test your model. Your plankton should float just below the water's surface but not sink to the bottom.



Check your understanding

1. Why would plankton want to go up in the water column?

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2. Why would plankton want to go down in the water column?

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3. If plankton cannot swim against the current, how do they move within the water column?

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4. Draw a picture of your plankton model.

5. Describe its features. What materials did you use to build your model?

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6. Test your plankton in water three times. Record your observations below. If your model sinks, record the time it takes to reach the bottom.

Trial 1: (sec)	**Trial 2: (sec)**	**Trial 3: (sec)**

7. What is the average time to reach the bottom? **((Trail 1)+(Trial 2)+(Trial 3)) / 3 =**

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8. Describe how well your plankton performed the test.

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9. This race was performed in freshwater. How would the performance of your plankton be different in saltwater? Why?

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10. This race was performed in room temperature water. How would the performance of your plankton be different in very cold water?

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In very hot water?

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Why?

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11. What factors, other than buoyancy, influence the evolution of plankton’s external features?

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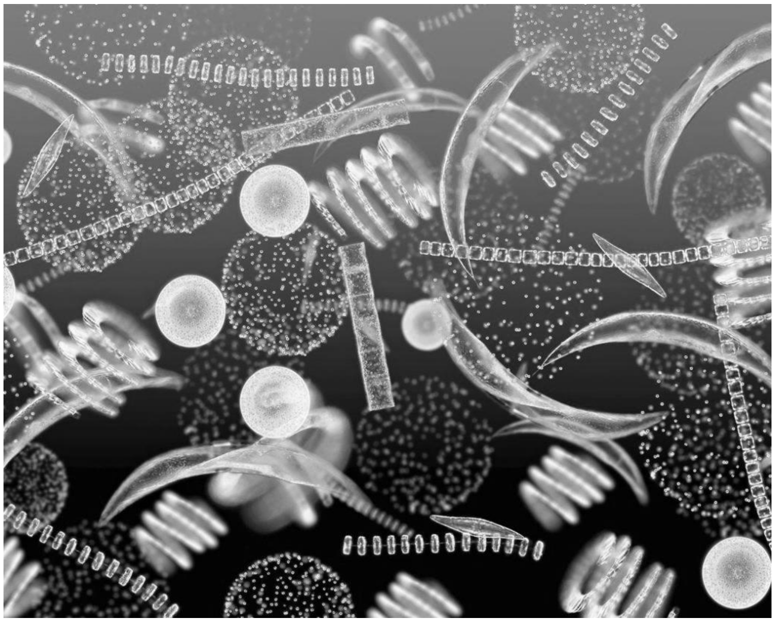
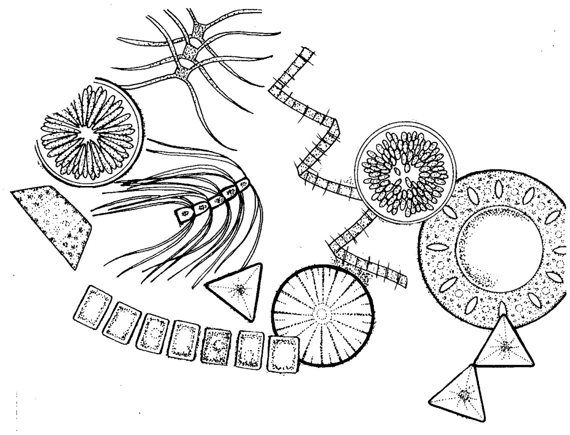
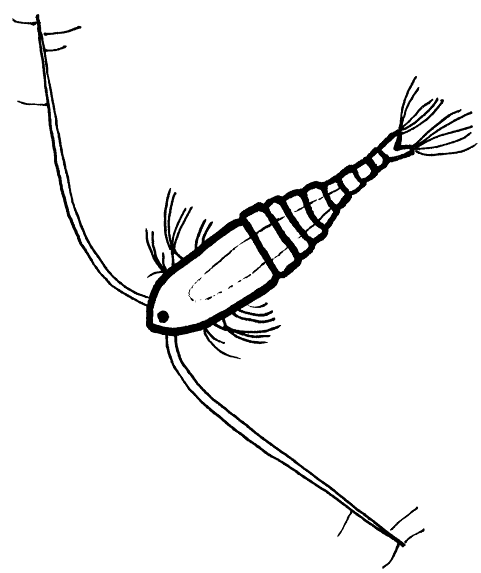
Plankton images

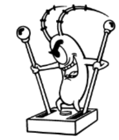
Phytoplankton image and drawing of diatoms (a type of phytoplankton that produces up to 50% of the oxygen on Earth!)





Zooplankton image and a drawing of a copepod (a type of zooplankton fish really like to eat—Plankton from SpongeBob is based off of a copepod)





How to Catch a Fish

Adapted from the Smithsonian's "How to Catch a Fish" lesson plan

Background

Adding or removing any animal from an ecosystem can cause big changes to the entire food web and change how healthy an ecosystem is. When animals are removed more quickly than they can reproduce, the animal can go extinct. Sometimes an animal won't go completely extinct, but will become what scientists call "functionally extinct." This means that there are still some of the animals in the ecosystem, but that there are so few of them that they cannot do their job. If the animal is a predator that eats other animals, when it is functionally extinct, it won't be able to eat enough of the other animals to keep the prey population low. If the animal that goes functionally extinct is a prey species, there won't be enough of them for the predators to eat.

As humans have gotten better at designing fishing equipment, humans have been able to catch more fish in a shorter amount of time. Scientists are worried that this fishing equipment is allowing us to take too many fish out of estuaries and the oceans. One of the big problems with commercial fishing is something called bycatch. Bycatch is anything that you did not mean to catch. In this activity we will look at how bycatch might affect an estuary's food web.

Materials

- Attached readings and chart
- Plankton - Sprinkles or rice
- Baby target fish - Small pasta
- Target fish - Large pasta
- Sharks - Goldfish crackers, small pretzels, or a similar food
- A cup or small bowl and a plate
- A net - strainer, colander, or basket with holes

Instructions

1. What do you know about different types of fishing methods? Write down the methods you can think of. Can you think of benefits of each method? What about drawbacks?

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2. Look at the "Fishing Gear and Technology - Advantages and Disadvantages" page. Are there types of fishing you hadn't heard of before? Choose three fishing methods and fill out the advantages and disadvantages from the perspective of the fisher and from the perspective of the fish. (Look at the chart for an example of how to set yours up.)
3. Read the handout "A Net Loss: The Effects of Bycatch."

4. Fill your cup with a mixture of the different foods.
   a) Sprinkles or rice = Plankton
   b) Small pasta (like macaroni) = juvenile (young) target fish
   c) Larger pasta = adult target fish (these are the ones we want to catch)
   d) Goldfish/Pretzels/etc. = sharks
5. Using a colander, strainer, or something else with holes. as your 'net', dump the contents of your cup into the net. (Do this over the plate or bowl so you don't make a mess!) Shake the net a bit then count and record the number of each species that remain in your net after sifting under Trial 1.
6. Put all your species back in the cup and repeat step 5 for Trial 2 and Trial 3. Did you get the same results?

	Trial 1	Trial 2	Trial 3
Plankton			
Juvenile Fish			
*Target Fish			
Sharks			

*Target Fish are what you want to get!

7. Think about or talk about the following questions:

   a) Did you catch species other than the target fish? If so what?

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   b) If you had bycatch, how do you think it will affect the ecosystem in the future? Will those species be able to reproduce?

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   c) If you had sharks as bycatch, how will removing the predator effect the rest of the ecosystem?

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   d) If you had juvenile (young) fish as bycatch, how will removing these fish before they can reproduce affect the ecosystem?

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Fill in this chart for three fishing methods:

	FROM THE PERSPECTIVE OF THE FISH		FROM THE PERSPECTIVE OF THE FISHER	
FISHING METHOD	Advantages	Disadvantages	Advantages	Disadvantages
Gillnets				
Longlines				
Bottom Trawls				
Midwater Trawls				
Traps (Pots)				
Purse Seines				
Hookas				
Spearguns				
Hook and Line				

Fishing Gear and Technology - Advantages and Disadvantages

Gillnets
Kept at the desired depth by floats or weights, these long nets trap and entangle fish, turtles and marine mammals as the lines move with the current or the boat to which they are attached.

Longlines
These lines with baited hooks are kept at the desired depth by spaced floats (for drift longlines) or held to the bottom with weights (bottom longlines).

Bottom Trawls
Bag-shaped nets are held open at one end by long horizontal beams, or planers, and dragged along the ocean bottom to catch fish and shrimp.

Midwater Trawls
Large bag-shaped nets, open at one end, are towed by a boat to catch fish between the surface and the bottom.

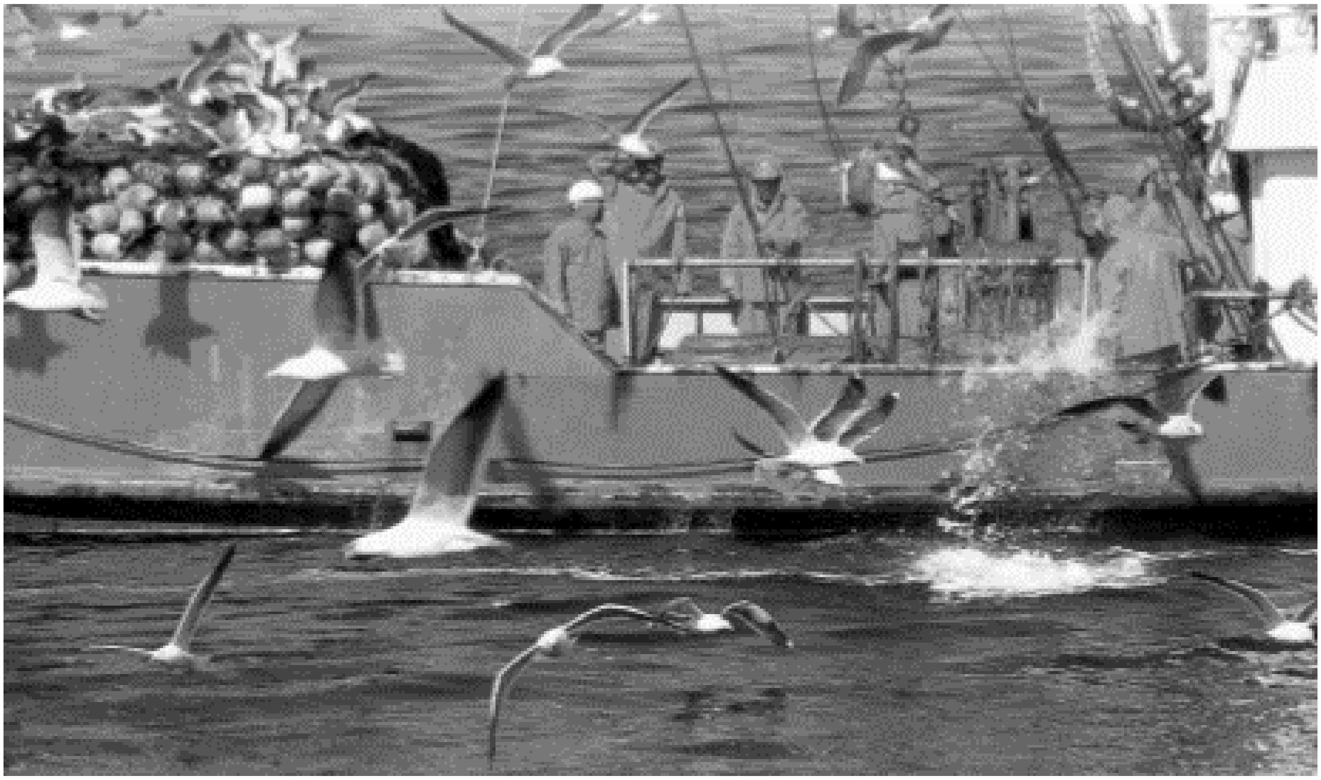
Traps (Pots)
These are cages and baskets made of wood, wicker, metal rods, wire netting or other materials for catching fish and crustaceans that enter through one or more openings. The traps are set at the bottom and connected to ropes attached to buoys on the surface.

Purse Seines
Large nets surround fish and are drawn closed at the bottom, like a purse, preventing fish from diving to escape.

Hookas
Using hoses and compressors, divers use this method to collect such species as lobster and sea cucumbers from the ocean floor.

Spearguns
These are guns whose ammunition is spears rather than bullets. They are used to shoot fish one at a time. Generally, they are used only by recreational fishers and by small-scale artisanal fishers. Spearguns can be used in conjunction with the hooka method.

Hook and Line
This is a fishing rod with one line and one hook.



What is bycatch?
Commercial fishing boats generally intend to target only a few commercially valuable species, but the gear and fishing technologies they use often catch much more than just these specific marine animals. More than 25 percent of all species caught are not used. These unwanted animals are dumped back into the ocean, dead or dying.

What species are affected and how?
As bycatch, marine animals become waste. Marine mammals, including dolphins, whales, seals and sea lions, as well as sharks and sea turtles fall victim when entangled in nets intended for tuna, pollock, cod and other fish. Baited hooks from longlines, splayed out for miles behind boats, attract seabirds, such as albatrosses and petrels, which often get hooked and dragged underwater, where they drown. Shrimp trawling is especially devastating when it comes to bycatch. For every pound of wild shrimp caught, an average of eight pounds of bycatch is discarded. Juveniles of many commercially fished species are routinely caught and discarded as bycatch, destroying their future reproduction potential. Some bycatch species are valuable food sources; nevertheless, if they are not the target species, they become waste. Boats seeking halibut discard cod as bycatch, and boats seeking cod discard halibut.

<u>Shell Shocked</u>

Adapted from the Shape of Life's "Shell Shocked" lesson

Background

Few things in nature are as beautiful and fascinating as seashells, with their graceful spirals, marvelous shapes, and dazzling colors. However, the handsome homes of snails (gastropods) are built at a great cost. Creating a shell requires a huge investment of energy and building materials, so there must be a big payoff for the snail. That payoff, of course, is protection. Snails build their expensive shells not for beauty, but to defend their soft bodies against the sharp claws of hungry crabs and lobsters, and the strong jaws of predatory fish.

Here are some good shell designs and traits for thwarting predators:

- **Thick walls** – stout, heavy armor is the most basic defense, but costly to build
- **Protrusions** – spikes and spines, flanges and fronds: these extensions are an economical way to distance claws and jaws from the central cockpit where the soft animal resides; they also make for an uncomfortable mouthful
- **High Spires** – the shells of most snails are twisted, but some are "flat" coils whereas others spiral out to a tall point like soft-serve ice cream; the latter are harder to swallow and also put some distance between the attacker and the wider part of the shell that houses the snail
- **Narrow Aperture** – the shell's opening is the place most vulnerable to attacks; a slit-like opening is tougher for predators to infiltrate
- **Long Siphonal Canal** – Many snails' possess a siphon, a snorkel that sticks out into the water through a siphonal canal in the shell. They use the siphon to bring water in over their gills and also to taste the water. A long, slender siphonal canal is less vulnerable to entry by predators, and also permits the snail to burrow without suffocating
- **Thickened aperture margins** – the outer rim or "lip" of the aperture is especially vulnerable to the shell breaking grip of attackers; the thicker the better

Study the armor from different species of gastropods in the images. Photos are actual size. Grade each one A, B, C, D, or F (A is good, F is bad) on each of the six defensive traits on the report card:

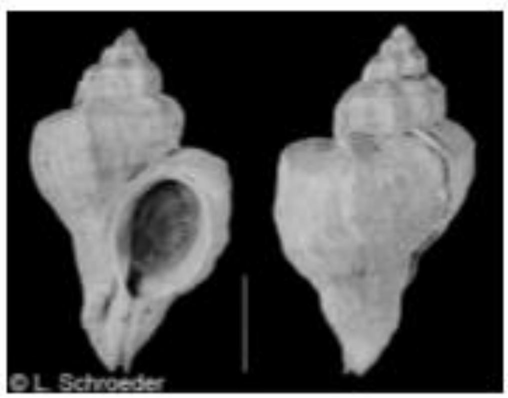
Species	Shell Size	Shell Thickness	Protrusions	High Spire	Long Canal	Thickened Margins	Narrow Aperture
Japanese Oyster Drill Whelk	Up to 5 cm						
Black Turban	Up to 2.5 cm						
Queen Conch	Up to 30 cm						
Tiger Cowrie	Up to 15 cm						
Lattered Olive	Up to 9 cm						
Common Auger	Up to 4 cm						
Venus Comb Murex	Up to 15 cm						
Oregon Triton	Up to 15 cm						
Silvery Top Shell	Up to 3 cm						
Mud Snail (*Batillaria*)	Up to 5 cm						
Lewis's Moon Snail	Up to 14 cm						
Pinto Abalone	Up to 18 cm						

Shell Thickness:

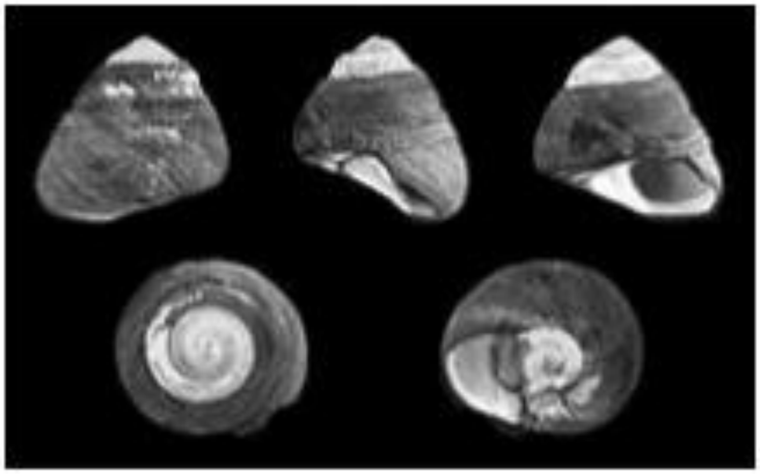
Thin:

Medium:

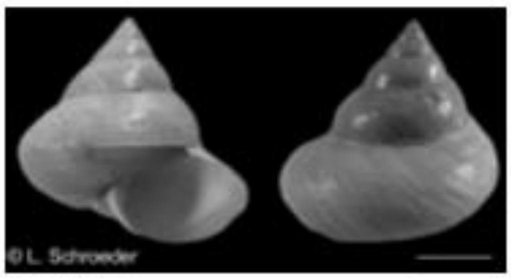
Thick:

Japanese Oyster Drill Whelk – 

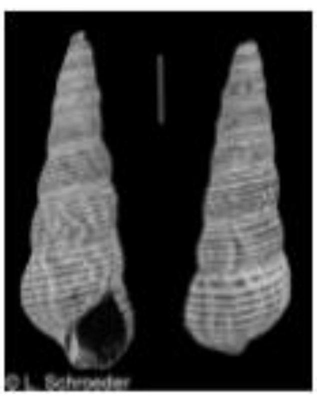
Black Turban -



Silvery Top Shell -

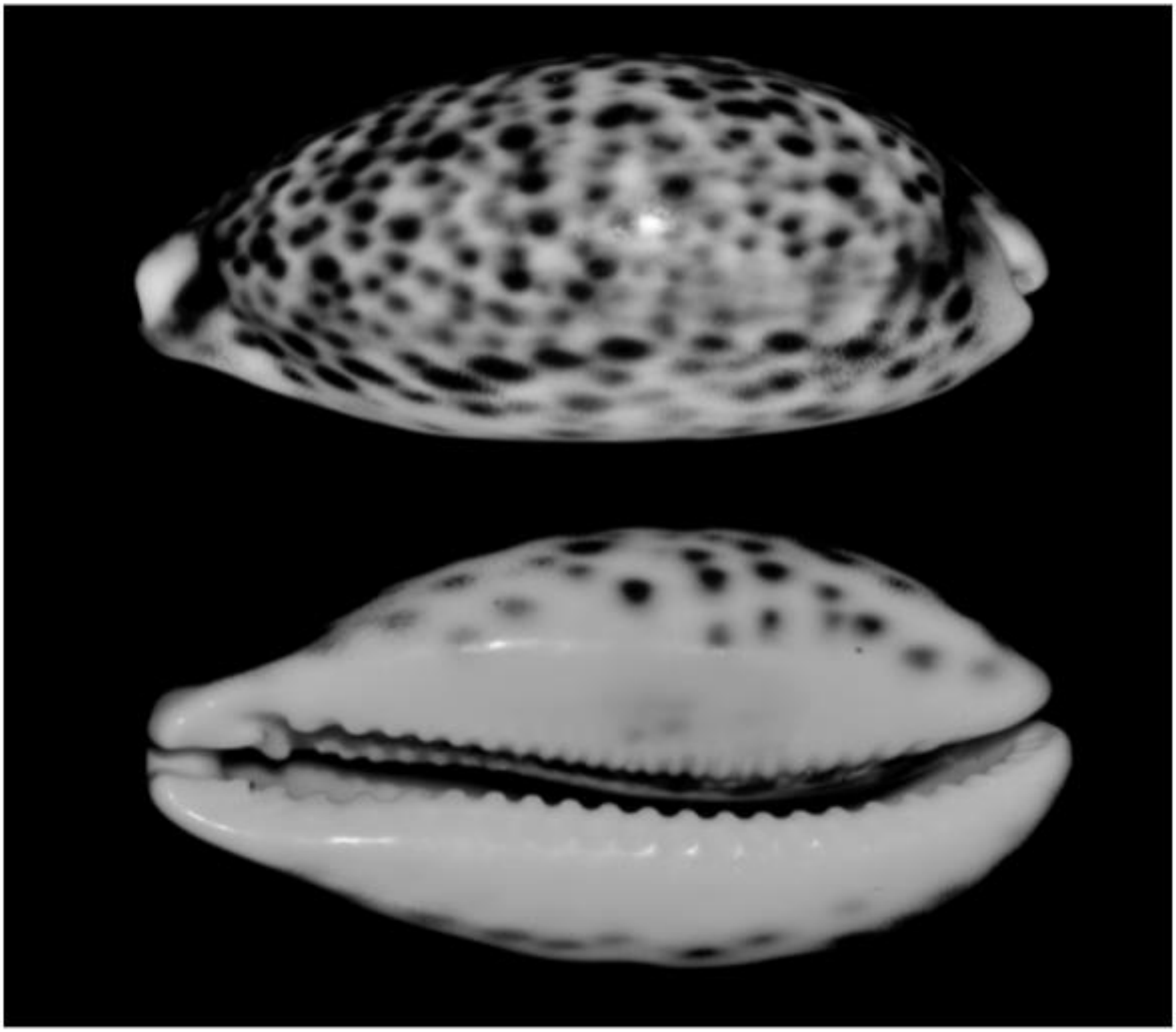


Mud Snail -

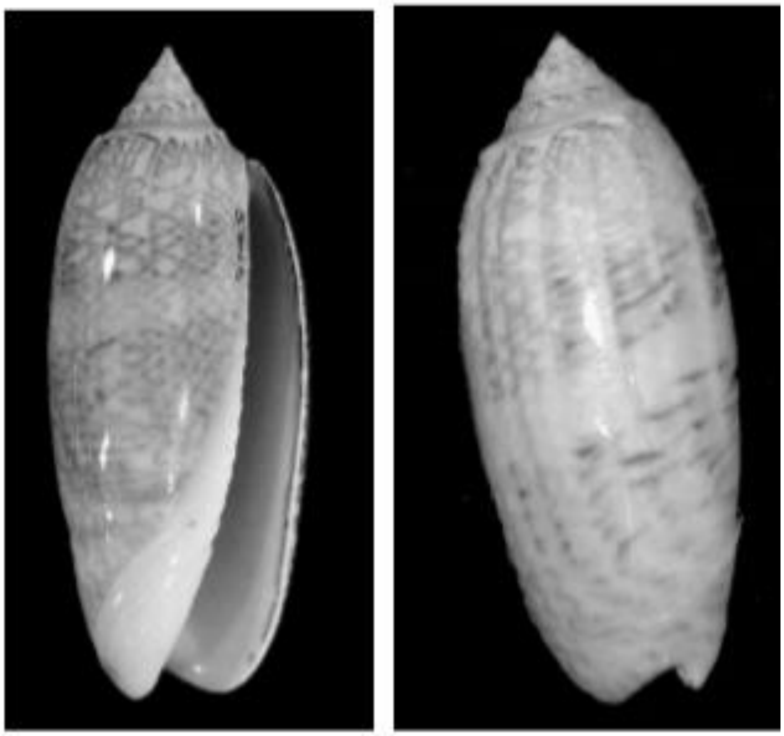


Queen Conch-

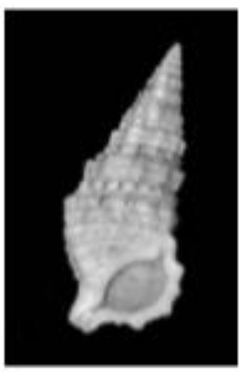
Tiger Cowrie-



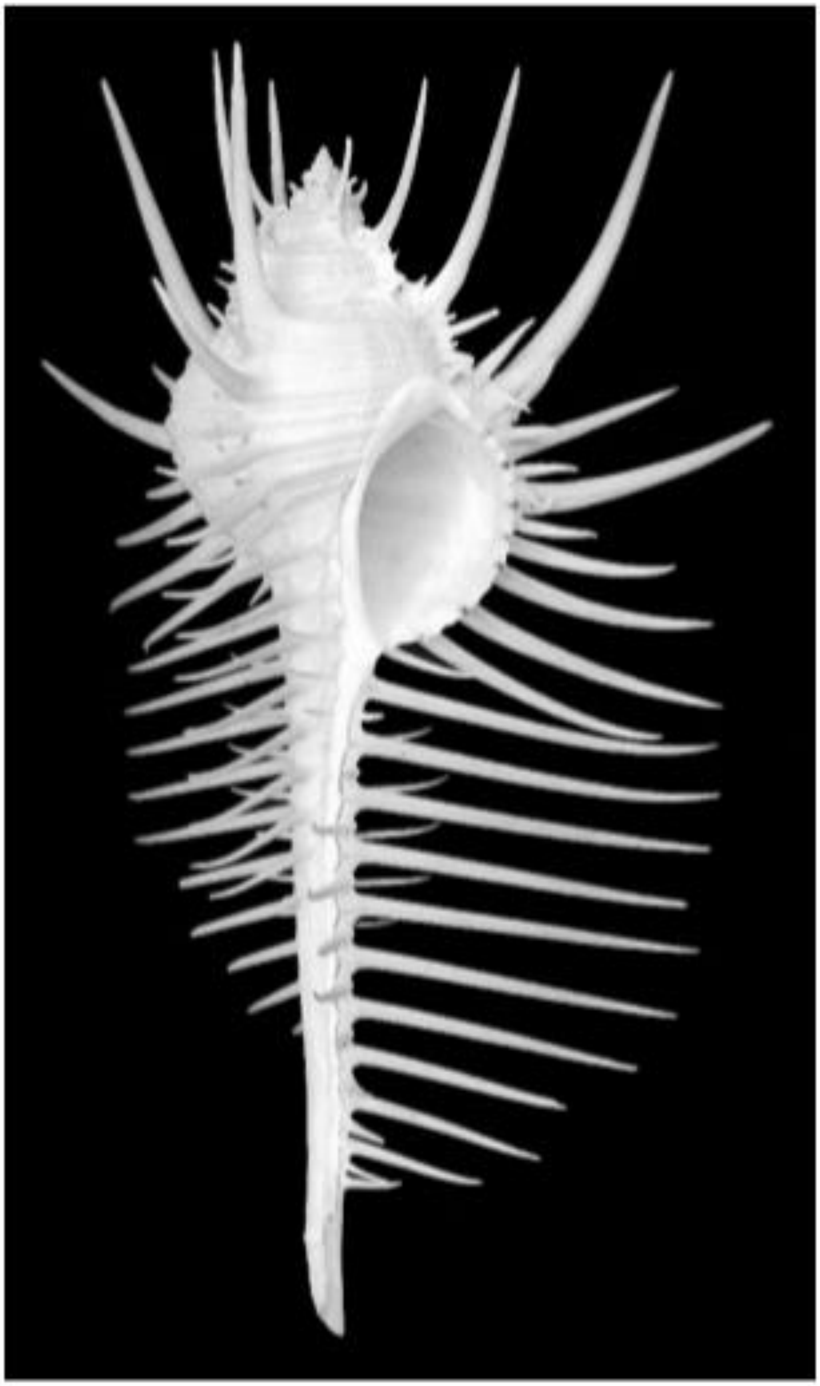
Lattered Olive -



Common Auger -



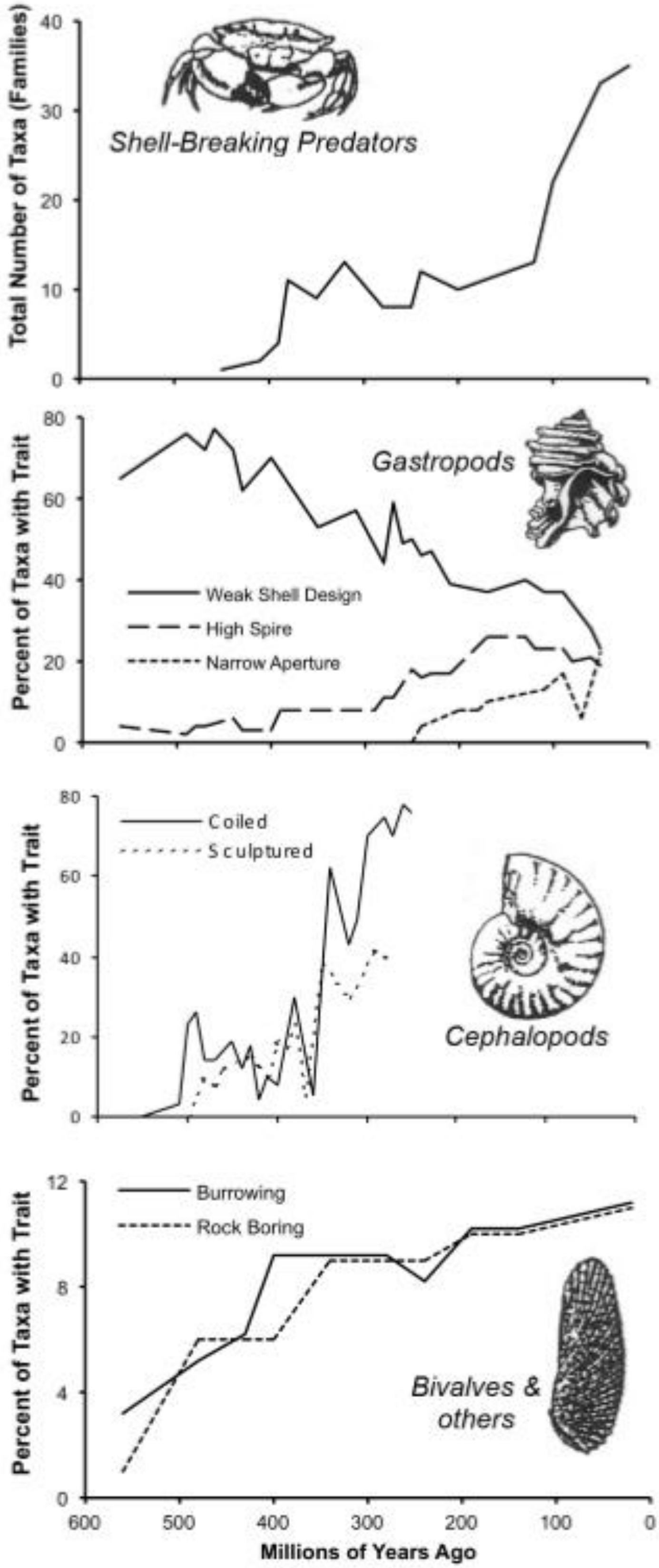
Venus Comb Murex-



Oregon Triton-

Lewis's Moon Snail-

Pinto Abalone-


Total Number of Taxa (Families)
Shell-Breaking Predators
Percent of Taxa with Trait
Gastropods
Weak Shell Design
High Spire
Narrow Aperture
Coiled
Sculptured
Cephalopods
Burrowing
Rock Boring
Bivalves & others
Millions of Years Ago
600
500
400
300
200
100
0

One nice thing about seashells is that they preserve well as fossils. So do the hard claws, jaws, and teeth of shell-breaking predators. Geerat Vermeij (say "ver-MAY") is probably the paleontologist who has done the most careful surveys of fossilized seashells. His renowned studies are especially remarkable because he's been blind since birth. He collected all his data (tons of it) by studying the fossils with his hands! The graphs on page 3 show data from Vermeij's research. All four graphs share the same x-axis at the very bottom: Vermeij studied fossils spanning over 500 million years! Analyze the graphs carefully and answer the following questions. The first graph (Shell-breaking Predators) shows the number of fossilized predators that had claws or jaws powerful enough to break seashells.

How long ago did predators first develop shell-breaking traits? Since then, what has happened to the frequency of these traits in the fossil record?

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The next three graphs (Gastropods, Cephalopods, and Bivalves) show three different groups of soft-bodied, shell-making animals. Gastropods were snails that crept on the seafloor. Cephalopods were swimmers: By collecting gas inside their shells, they could float above the seafloor and swim! Bivalves have two hinged shells that open and close like a jewelry box. Modern bivalves include clams and oysters.

Over the past 500 million years, what gradually happened to the design of gastropod shells?

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A coiled shell gives a soft animal a bigger space to retreat into. "Sculptured" shells have ribs and ridges that reinforce the shell, or bumps and spines that make it hard to swallow. For cephalopods, what pattern do we see in the fossil record?

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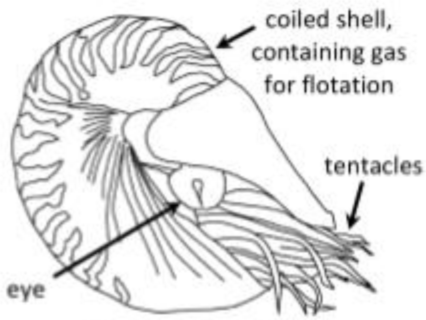

***Chambered Nautilus,
a modern cephalopod***

(NOTE: On the graph it looks like cephalopods suddenly went extinct 250 million years ago. This graph represents a group that went extinct 250 million years. Other groups continued. The ancestors of the squid and octopi won the day by evolving into the modern day animals. An exception is the living chambered nautilus, which has a squid-like body with eyes and arms, yet has kept its coiled shell and sluggish lifestyle.) Some modern bivalves – like clams – burrow into the seafloor. Others – like oysters – do not. Over the past 500 million years, what trend do we see in such behaviors?

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What do you think prompted all these changes in the bodies and behaviors of gastropods, cephalopods, and bivalves over the past 500 million years? Back up your hypothesis with evidence from the four graphs.

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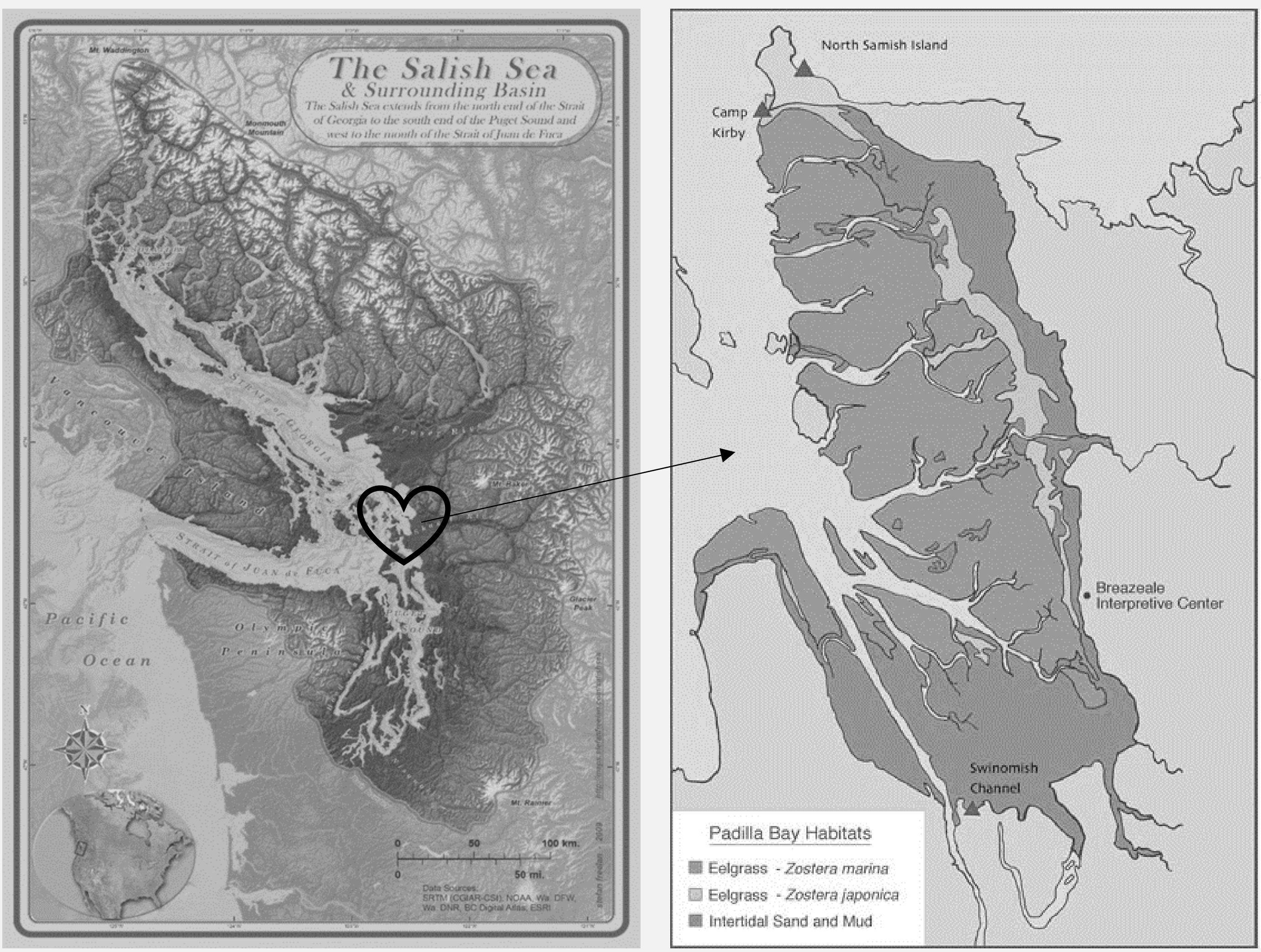
Hot on the trail of the *Batillaria* mud snail!

Featured scientists: Madison McKay and Roger Fuller *Padilla Bay National Estuarine Research Reserve*

Where can we find *Batillaria* mud snails?

Padilla Bay is located in the heart of the Salish Sea, and it holds more than 8,000 acres of eelgrass—the second largest on North America's Pacific Coast. Eelgrass is used as a nursery by juvenile salmon, crab, and herring. It also provides critical habitat for waterfowl and marine birds.

When traveling to Padilla Bay the mud snails may not be the first thing you notice, but once you've noticed them—you won't stop. Currently there up to 5 billion snails in Padilla Bay!



Scientific name: *Batillaria attramentaria*

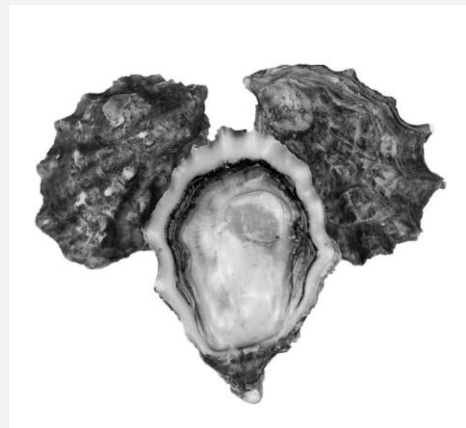
What do they look like?

They range from brown to gray in color, have a spiral-conical shell shape, and are about the size of a pen cap. Their coloring blends in perfectly with the mudflats that cover the entire bay in stinky, sticky mud!

Where did they come from?

The mud snails are an invasive species brought here in the 1920s from Japan, most likely having hitched a ride with Pacific oysters that were shipped here for farming.

Although they have been here for almost 100 years, little is known about their impact on Padilla Bay's ecosystem. In order to get a better sense of *Batillaria*'s ecological role, scientists Madi McKay and Roger Fuller set out to investigate.



Pacific oyster

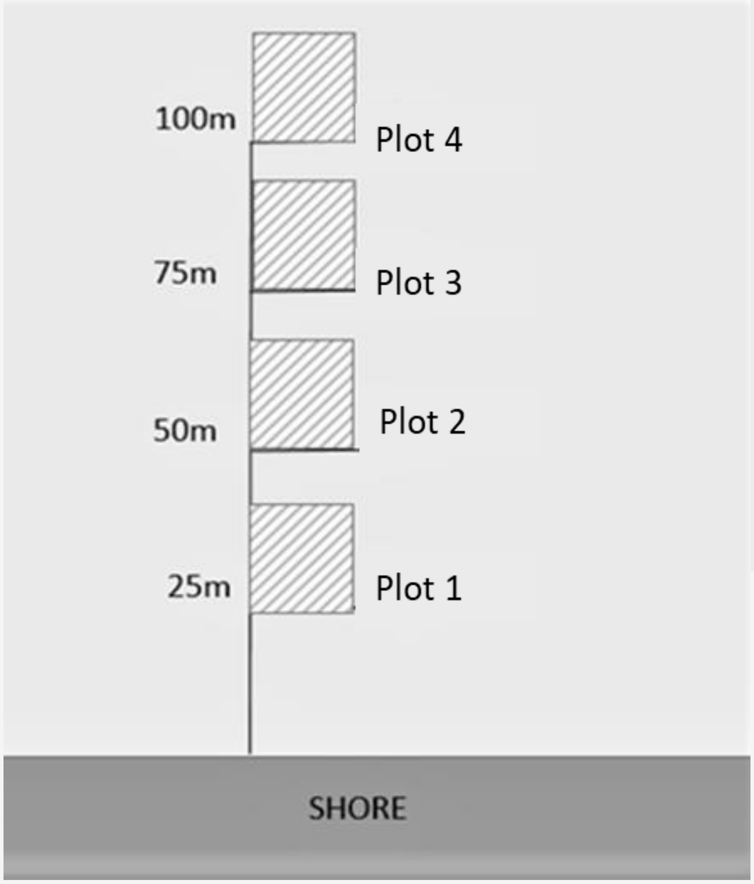
Top: Western sandpiper eating algae

Bottom: Hairy shore crab

What do we know?

An important piece of information we know is that the snails graze on diatom (a microscopic algae) meadows that grow on the surface of the mud. Recently, it was discovered that shore birds, particularly sandpipers, also eat diatoms. In fact, up to 50% of their diet consists of these microscopic organisms! The local hairy shore crab also feeds on the algae. This suggest that the snails, sandpipers, and crabs are competing for the same food.

This insight led Madi McKay, who has a particular fondness for sandpipers and crabs, to take a closer look at *Batillaria attramentaria* to better understand this food web. Based on her observation she believes the snails found closer to the shore will be larger in size and more abundant than the ones found further from shore.



Left: Model of sampling plots.

Right, Above: Quadrat used at sampling plots. A quadrat is a portable frame, often with an internal grid. This one is gridded off into four sections.

Experimental design:

Madi and Roger set up an experiment to measure the population and distribution of *Batillaria* on the mud flats. They start by looking at 4 different plots (sites) at increasing distance from the shore. At each plot they record the number of *Batillaria* found and the length of the snails in each section of a quadrat. Then they calculate the mean number and the mean length of the total quadrat. This is done by adding up the four sections and dividing it by four. Below are the results:

Plot	Mean length of Batillaria (mm)	Number of Batillaria	Distance from shore (meters)
1	22.2	126	25
2	23.2	111	50
3	25.2	120	75
4	27.9	110	100

<u>Scientific Question:</u> Where along the shore are Batillaria the longest, where is it in the greatest concentrations?

<u>What is the hypothesis:</u> Find the hypothesis in the Research Background and underline it. A hypothesis is a proposed explanation for an observation, which can be tested with experimentation or other types of studies.

Hypothesis:

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What data will you graph to answer the question?
Independent variable:

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Dependent variable:

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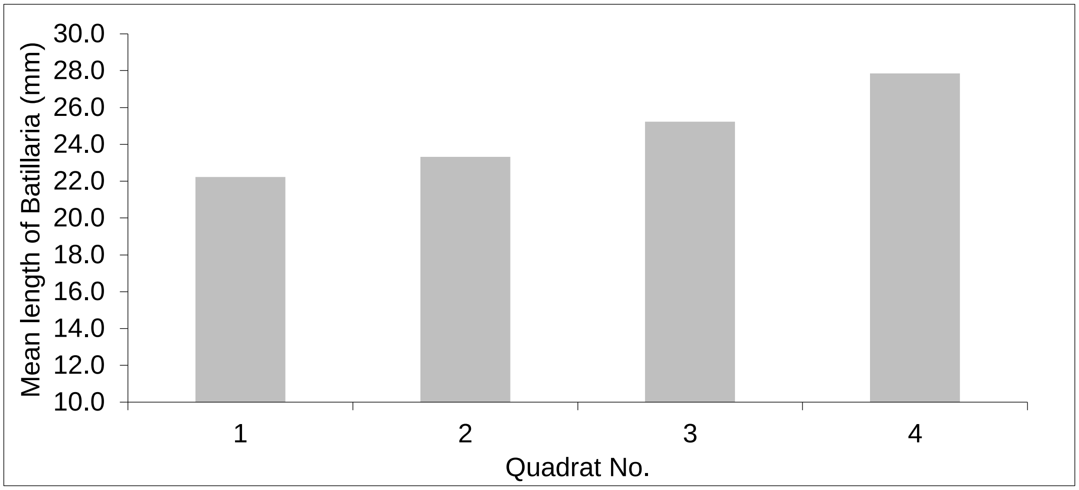
<u>Below is a graph of the mean length of Batillaria per quadrat (remember 1 is closest to the shore, and 4 is farthest from the shore):</u>



Are there any changes or trends differences you see in this graph? Draw arrows pointing out what you see, and write one sentence describing what you:

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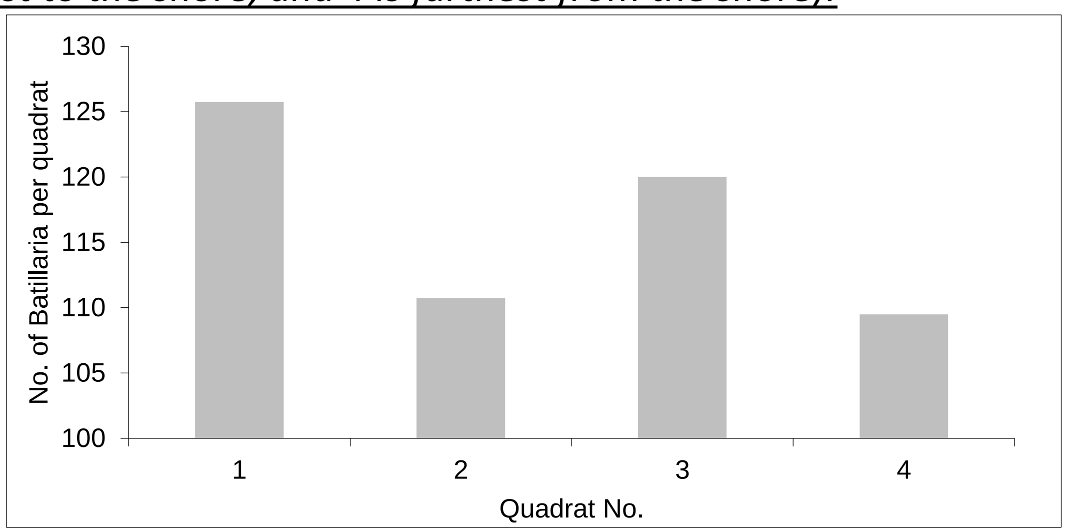
<u>Below is a graph of the number of Batillaria per quadrat (remember 1 is closest to the shore, and 4 is farthest from the shore):</u>



Are there any changes or trends differences you see in this graph? Draw arrows pointing out what you see, and write one sentence describing what you:

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Interpret the data:

Make a conclusion that answers the scientific question.

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What evidence was used to write your claim? Reference specific parts of the table or graph.

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Explain your reasoning and why the evidence supports your claim. Connect the data back to what you learned about how the distance from the shore may affect the number and size of the snails.

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Did the data support Madi's hypothesis? Use evidence to explain why or why not. If you feel the data was inconclusive, explain why.

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Your next steps as a scientist: Science is an ongoing process. What new question do you think should be investigated? What future data should be collected to answer your question?

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Northwest Straits Initiative
partners in marine conservation

Skagit County Marine Resources Committee

Padilla Bay National Estuarine Research Reserve

PUGET SOUND PARTNERSHIP

United States Environmental Protection Agency

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