



Northwest Association of Networked Ocean Observing Systems (NANOOS)

Habitat, Habitat, Have to Have a Habitat!

INTRODUCTION:

The coastal ocean of the Pacific Northwest (PNW) is a very dynamic place. The water conditions, and hence the water column habitat for organisms living in the coastal ocean, are temporally and spatially variable. Upwelling and downwelling favorable winds, the interaction of waters along the continental shelf with topography and freshwater input (e.g., Columbia River, Strait of Juan de Fuca, etc), the branching of the North Pacific Current southward to form the northern extent of the California Current System, as well as the large-scale physical and biological variability due to El Niño Southern Oscillation (ENSO) and longer-term multi decadal cycles all control the dynamics of PNW oceanic waters. These factors are important to the ecosystem structure and function of the water column habitat of the Pacific Northwest. Understanding how these factors interact to influence the productivity of our coastal environment is important for resource managers aiming to protect biodiversity and fisheries stock.

Water column habitats can be difficult to access and monitor. Researchers and resource managers are working together in the PNW to build a comprehensive ocean observing system. Using such tools as moored buoys affixed with a variety of sensors, autonomous underwater vehicles, satellite information, and research cruises, we are gaining a better understanding of the dynamics of the coastal ocean. This information will help us to better understand, protect and conserve the marine environment in the PNW.

In this activity, students will role play as different organisms attempting to feed within a changing coastal ocean. A Pacific Northwest marine food chain (algae, copepods, herring, salmon, sea lion) is used as the basis of this game. Students will play through 4 scenarios, each time changing atmospheric conditions that alter the water habitat.

OBJECTIVES:

Students will:

- Develop an understanding that the ocean is dynamic
- Investigate, through role play, how different ocean conditions may impact organisms at different trophic levels

MATERIALS:

- Plastic Beads
- Plastic sandwich bags
- 20 1m long pieces of yarn
 - 1 red

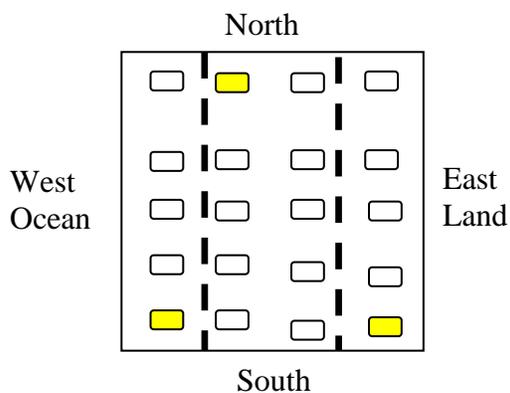
- 2 yellow
- 6 green
- 11 blue
- Masking tape (bright color)
- Clock or stopwatch
- Broom (to clean up beads)
- Print-outs:
 - Animal cards (print duplex so that “Action Card” is on one side and “Fact Card is on the other; cut-out cards)
 - Desk buoy/habitat conditions signs (on cardstock, print duplex)
 - Wall signs (print and cut out)

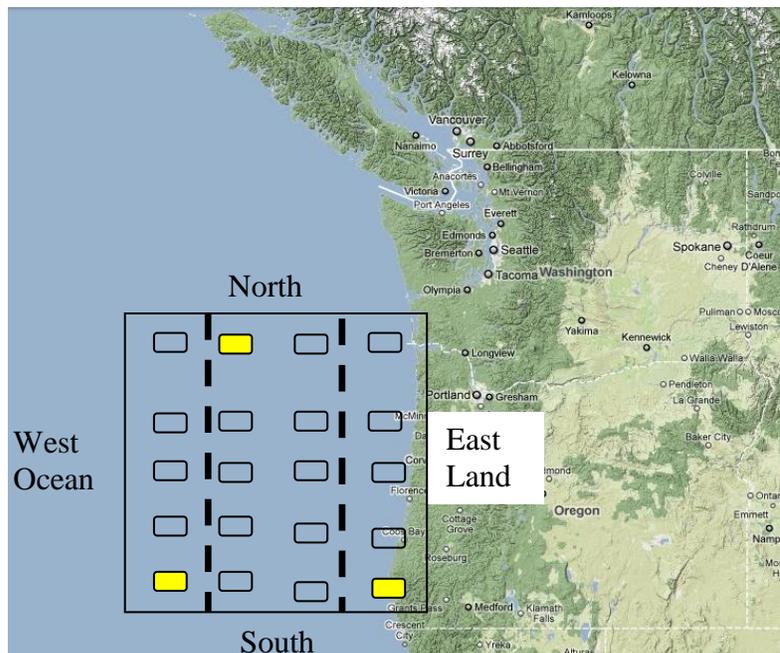
PROCEDURE

Game prep before students arrive:

1. Activity is run inside a classroom or similar space. Don’t worry about moving desks/tables out of the way – it will help slow the students down.
2. Lay two lengths of masking tape down to divide the classroom into 3 roughly equal-sized sections (see diagram below – place masking tape on dotted lines).
3. Designate one desk in each section to be a buoy (yellow desks in diagram).
4. Cut the “wall card” in half, tape the Land sign on the “East” side of the room, and the Ocean sign on the “West” side of the room. *East and West directions are only for playing the game, don’t have to be placed on the actual East or West facing walls.
5. When appropriate, either before students arrive or after students arrive, scatter beads on floor (you may want to do this after they arrive so that they don’t step on them and fall).
6. If helpful, you can share the classroom over the map (see below) to show the general relationship between the classroom set-up and the coastal ocean.

Classroom set-up diagram:





Game prep with students:

1. Divide the class into trophic groups by handing out one animal card, corresponding yarn color, and food bag to each student. The yarn ends should be tied together and worn by each student as a necklace to that it is easy to distinguish which student is which animal.
 - a. For 20 students:
 - i. 1 sea lion (red)
 - ii. 2 salmon (yellow)
 - iii. 6 herring (green)
 - iv. 11 copepods (blue)
2. Explain to students that there has been an algal bloom in the area. The organisms that are able to eat the algae are the copepods. Remind the students of the food web involving algae, copepods, herring, salmon, and sea lions.
3. The animal cards have two sides: Action and Fact Cards. The Action Card tells the student how they should act when they enter the feeding area, and the Fact Card tells them their water habitat, or the range of environmental conditions, that they can survive in.
4. Show students where the buoy desks are located. Explain that these “buoys” are monitoring the water conditions in each section and that they will have to check the buoy during each round to make sure that their animal would survive in that section.
5. There will be four rounds of play, so students can switch roles between rounds.
6. Rules of play:
 - a. Copepods eat algae by collecting beads; herring eat copepods, salmon eat herring, and the sea lion eats salmon by tagging the prey’s elbow.

- b. Once eaten, prey give their food bag to the predator and the prey sits down.
 - c. Once the predator is done with their task, stand in place and raise your hand so that the teacher knows you are done. When the next predator enters, you may move around the room again.
7. General safety rule (optional): No running. Walking feet.

General Game Play:

1. *Copepods enter feeding area:* Give the copepods 30-45 seconds to move around the feeding area and graze on the algae without any predators. At the end of the timed period, the herring will enter. Copepods continue to feed throughout the game until they get eaten (tagged).
2. *Herring enter the feeding area:* Herring enter the feeding area and follow instructions on their Action Card. When all the herring are raising their hands, allow the salmon to enter.
3. *Salmon enter the feeding area:* Salmon enter the feeding area and follow the instructions on their Action Card. When all the salmon are raising their hands, allow the sea lion to enter.
4. *Sea lion enters the feeding area:* Sea lion enters the feeding area and follows the instructions on his/her Action Card. When the sea lion has completed his/her task, the game ends.
5. Once the sea lion has eaten, review what occurred by having the students share what was written on their “Action Card” starting with the copepods and ending with the sea lion.

PLAY THE GAME!

Round 1: Harmful Algal Bloom

*This will be a review of the activity Alicia introduced in the August workshop

6. Once the game has been played, inform the students that some of the algae that they ate were toxic! If the copepod consumed red or orange beads, they consumed toxic algae!
7. Have the students go through their food bags and sort their food. Have them count the total number of M&M's they collected and the number of red and orange beads they collected. Have them calculate the amount of toxic algae they consumed as a percent of their total consumption. $100 \times [\# \text{ red} + \# \text{ orange}] / [\text{total } \#]$
8. If there are any copepods still alive that “ate” ANY red or orange beads/algae, they ate toxic algae! Luckily for copepods, the toxins produced by the algae do not affect them.
9. If there are any herring still alive that “consumed” 20% or more red and orange beads/algae, they are now dead.
10. If there are any salmon still alive that “consumed” between 20%- 30% red and orange beads/algae, they are now sick. If there are any seals still alive that “ate” over 30% red and orange beads/algae, they are now dead.
11. If the sea lion “ate” between 20%-30% red and orange beads/algae, it is now sick. If the sea lion “ate” over 30% red and orange beads/algae, it is now dead.

Round 2: Downwelling

Pre-game instructions:

- Don't add any beads collected by the students back into the feeding area.

- Place the Downwelling conditions on the buoy desks in each section.
- Copepods have to play with one hand behind their backs to simulate that there is less food available. Picking up food and holding the food bag is to be done with one hand only.
- Remind students to stay within their condition ranges

Condition	Ocean section	Middle section	Land section
Temperature	High	Mid	Mid
Salinity	Mid	Mid	Mid
Oxygen	High	High	High
Chlorophyll (food)	Low	Low	Low

Post-game debrief:

- What happened?
- Did conditions change behavior? Was anyone limited by habitat?
- How many beads did the sea lion end up with? Is that more or less than the previous rounds? Why?

Round 3: Upwelling

Pre-game instructions:

- Add half of the beads collected back into the feeding area in the LAND section only.
- Place the Upwelling conditions on the buoy desks in each section.
- Copepods can use both hands, and increase the amount of time copepods have to eat by 15 seconds to simulate the greater amount of food.
- Remind students to stay within their condition ranges

Condition	Ocean section	Middle section	Land section
Temperature	High	Mid	Low
Salinity	Mid	Mid	High
Oxygen	High	Mid	Mid
Chlorophyll (food)	Low	Low	Mid

Post-game debrief:

- What happened?
- Did conditions change behavior? Was anyone limited by habitat?
- How many beads did the sea lion end up with? Is that more or less than the previous rounds? Why?

Round 4: Sustained Upwelling

Pre-game instructions:

- Add all of the beads collected back into the feeding area in the LAND section only.
- Place the Sustained Upwelling conditions on the buoy desks in each section.

- Copepods can use both hands, and increase the amount of time copepods have to eat by 30 seconds to simulate the greater amount of food.
- Remind students to stay within their condition ranges

Condition	Ocean section	Middle section	Land section
Temperature	Mid	Mid	Low
Salinity	Mid	Mid	High
Oxygen	High	Mid	Low
Chlorophyll (food)	Low	Low	High

Post-game debrief:

- What happened?
- Did conditions change behavior? Was anyone limited by habitat?
- How many beads did the sea lion end up with? Is that more or less than the previous rounds? Why?

Post activity group discussion:

- Which round was the best for the animals? Which round was the worst?
- Was it easy to stay within the ocean conditions on the card?
- Think about copepods for a moment: they are plankton and drift with the ocean current. How is this different than the game? How do you think this type of life impacts how copepods feed?

CREDITS:

Modified from “You Are What You Eat” designed by Bigelow Lab (http://www.bigelow.org/edhab/tracing_toxins.html)

RESOURCES:

Ocean Observing, NANOOS: www.nanoos.org

Ocean conditions and salmon: <https://www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/db-coastal-upwelling-index.cfm>

Sea Lion

Action Card



You come across a group of salmon feasting on a school of herring. You are successful at catching one of the salmon for your afternoon meal.

Take the food bag of the salmon that you caught.

Salmon

Action Card



You come across a school of herring feasting on copepods. You are very stealthy in your hunt, and as a result you are successful at catching 4 herring for your afternoon meal.

Take the food bags of the herring that you caught.

Salmon

Action Card



You come across a school of herring feasting on copepods. You are a bit late in joining the hunt, and as a result you catch 2 herring – not bad for a snack.

Take the food bags of the herring that you caught.

Salmon

Action Card



You come across a school of herring feasting on copepods. You are too busy investigating a new cavern you found, so you are only able to catch 1 herring – you are probably going to be hungry again soon!

Take the food bag of the herring that you caught.

Herring

Action Card



You come across a swarm of copepods feeding on an algal bloom. While you are trying to feed on the copepods, the algae irritated your gills.

You have died and are washed ashore.

Herring

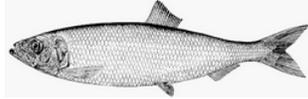
Action Card



You come across a swarm of copepods feeding on an algal bloom. You feast on the copepod, eating 4 in one dive through the swarm.

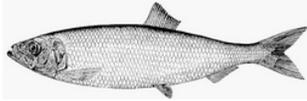
Take the food bags of the copepod that you caught.

<p>Sea Lion <i>Fact Card</i></p>  <p>Animal length: 10 feet Temperature range: 3-15°C (37-59°F) (Low-Mid) Salinity range: 0-35 parts per thousand (ppt) (Low-High) Dissolved Oxygen range: 0-10 milligrams oxygen/Liter of water (mg/L) (Low-High)</p>	<p>Salmon <i>Fact Card</i></p>  <p>Animal length: 3 feet Temperature range: 5-15°C (41-59°F) (Low-Mid) Salinity range: 31-34 parts per thousand (ppt) (High) Dissolved Oxygen range: 6-10 milligrams of oxygen/Liter of water (mg/L) (High)</p>
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<p>Herring <i>Action Card</i></p>  <p>You come across a swarm of copepods feeding on an algal bloom. You are able to catch a couple (2) of copepods.</p> <p>Take the food bags of the copepods that you caught.</p>	<p>Herring <i>Action Card</i></p>  <p>You come across a swarm of copepods feeding on an algal bloom. You are able to catch a couple (2) of copepods.</p> <p>Take the food bags of the copepods that you caught.</p>
<p>Herring <i>Action Card</i></p>  <p>You come across a swarm of copepods feeding on an algal bloom. You just finished eating a bunch of copepods along the coast, so you aren't very hungry. You eat only 1 copepod.</p> <p>Take the food bag of the copepod that you caught.</p>	<p>Herring <i>Action Card</i></p>  <p>You come across a swarm of copepods feeding on an algal bloom. You just finished eating a bunch of copepods along the coast, so you aren't very hungry. You eat only 1 copepod.</p> <p>Take the food bag of the copepod that you caught.</p>
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Herring
Action Card



You come across a swarm of copepods feeding on an algal bloom. Your hunt is successful and you are able to catch 3 copepods.

Take the food bags of the copepods that you caught.

Copepod
Action Card



You come across an algal bloom and it's a feeding frenzy! You only have limited time to graze before the current causes the bloom to dissipate. Grab everything that you can to get those needed nutrients!

Place the algae that you find in your food bag.

Copepod
Action Card



You come across an algal bloom and it's a feeding frenzy! You only have limited time to graze before the current causes the bloom to dissipate. Grab everything that you can to get those needed nutrients!

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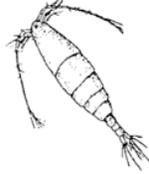
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Action Card



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Place the algae that you find in your food bag.

Copepod

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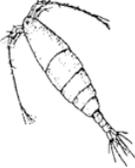
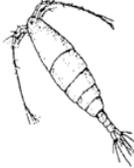
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Copepod

Action Card



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Place the algae that you find in your food bag.

Copepod

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Copepod

Fact Card



Animal length: 0.1 inch

Temperature range: 3-15°C (37-59°F) (Low-Mid)

Salinity range: 15-35 parts per thousand (ppt) (Mid-High)

Dissolved Oxygen range: 0.2-10 milligrams oxygen/Liter of water (mg/L) (Low-High)

Copepod

Fact Card



Animal length: 0.1 inch

Temperature range: 3-15°C (37-59°F) (Low-Mid)

Salinity range: 15-35 parts per thousand (ppt) (Mid-High)

Dissolved Oxygen range: 0.2-10 milligrams oxygen/Liter of water (mg/L) (Low-High)

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Copepod

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Salinity range: 15-35 parts per thousand (ppt) (Mid-High)

Dissolved Oxygen range: 0.2-10 milligrams oxygen/Liter of water (mg/L) (Low-High)

Dissolved Oxygen: High

Salinity: Mid

Temperature: Mid

Land Section buoy – Downwelling

Land Section buoy – Upwelling

Temperature: Low

Salinity: High

Dissolved Oxygen: Mid

Land Section buoy – Sustained Upwelling

Temperature: Low

Salinity: High

Dissolved Oxygen: Low

Land Section buoy – Make up your own!

Temperature:

Salinity:

Dissolved Oxygen:

Dissolved Oxygen: High

Salinity: Mid

Temperature: Mid

Middle Section buoy – Downwelling

Middle Section buoy – Upwelling

Temperature: Mid

Salinity: Mid

Dissolved Oxygen: Mid

Dissolved Oxygen: Mid

Salinity: Mid

Temperature: Mid

Middle Section buoy – Sustained Upwelling

Middle Section buoy – Make up your own!

Temperature:

Salinity:

Dissolved Oxygen:

Ocean Section buoy – Downwelling

Temperature: High

Salinity: Mid

Dissolved Oxygen: High

Ocean Section buoy – Upwelling

Temperature: High

Salinity: Mid

Dissolved Oxygen: High

Ocean Section buoy – Sustained Upwelling

Temperature: Mid

Salinity: Mid

Dissolved Oxygen: High

Ocean Section buoy – Make up your own!

Temperature:

Salinity:

Dissolved Oxygen: