Orca Jenga: Food Web Game

Modified from the “Whale Jenga Food Web Game” from the Cabrillo Marine Aquarium, found online at:
http://www.cisanctuary.org/ocean-acidification/PDFs-WorkshopPage/Hands_on_acivities/Whale_Jenga/Whale_Jenga_web.pdf

Introduction:

How can orcas--which weigh between 8,000 and 16,000 pounds--be affected by things as small as microscopic phytoplankton? Or as unassuming as suburban dog waste? Or as distant as agricultural fertilizer? Everything is connected. What we do in our watersheds--no matter how far from the ocean--can impact the health of orcas, Puget Sound, and the rest of the world.

Southern Resident Killer Whales feed almost entirely on Chinook salmon! That means that we need healthy salmon populations in order to have healthy orca populations. The Southern Resident Killer Whales are listed as endangered under the U.S. Endangered Species Act. Chinook salmon are also listed as threatened in the Puget Sound area. What will happen if salmon populations continue to decrease?

This game is meant to demonstrate the connectivity of our ecosystems, and that our actions across the watershed can affect these creatures living in Puget Sound. Observe what happens to the blocks higher up as those lower on the web are disturbed. If the balance of the food web is disturbed too much by climate change or other human actions, the other levels will be affected and the food web could collapse.

Game Contents:

25 green blocks (phytoplankton)
13 blue blocks (zooplankton)
9 pink blocks (small fish)
6 silver blocks (salmon)
1 black block (orca)
Set of Orca Jenga playing cards
Informational whale cards
Puget Sound food web diagram

Directions:

Prepare the Game:

1. Color or paint Jenga blocks as described above.
2. Print instructions, playing cards, informational whale cards, and Puget Sound food web diagram.
3. Cut playing cards into card shapes, following lines on page.

Game Set-Up:

*The blocks are stacked the same as in regular Jenga, but following the food web levels.

1. Place three green blocks side by side
2. Place three more green blocks side by side, perpendicular to first layer.
3. Continue to stack the rest of the green blocks in this way.
4. Stack blue, pink, silver, and black blocks in this way.
5. Shuffle playing cards and place upside down.

Focus Questions:

If the ocean is so large, why do small changes make a difference?
How are actions connected from terrestrial systems to the ocean?
How does this game relate to other projects you have done (water quality testing, tree planting, salmon tossing, etc.)?
How do human actions impact other species?

Learning Procedure:

Explain to students that this game is a representation of how changes can impact the stability of a whole system. Prior to the game, introduce vocabulary to ensure understanding of terminology used on the playing cards.

Instructions for Play:

Suggested group size is 4 students

1. First player draws a card from the stack, reads it aloud, and follows the instructions. Only touch the block specified, and only use one hand! No holding the rest of the tower in place.
2. Put the used card in a discard pile.
3. Place removed blocks in a discard pile. You will need to use some discarded blocks for certain playing cards.
4. Continue to take turns drawing cards until the tower falls and the food web collapses, or all the playing cards are used. If you do not have the right number of blocks in the tower or discard pile to follow the card's instructions, place the card on the bottom of the stack, and draw a new card. Encourage students to discuss what happened to their food web, and what the tower collapsing means.
5. Reset to play again following Game Set-Up instructions.

Review Questions:
Have students read, analyze, and discuss whale information pages and Puget Sound food web diagram.
What questions or ideas from this game would you like to investigate further?
What actions could you take to help orcas?
What did you find interesting or surprising about this game?
How does the Jenga game demonstrate what happens in the natural world?

Extension:
Create additional playing cards, or modify to make a more localized game for your watershed or your students' activities. Add an additional rule for game play: after so many silver (salmon) blocks are removed, the orca immediately dies. Tie this into classroom discussion of the importance of a stable and secure food source for orcas, and, more broadly, for any predator in an ecosystem.

In this game, we are focusing on Southern Resident Killer Whales, which are a specific kind, or "ecotype," of orca. Other orca ecotypes include Transient Killer Whales, which feed on seals and other marine mammals, and Offshore Killer Whales, which feed on fish and squid. All three kinds of orca whale ecotypes pass through the Pacific Ocean off the coast of Washington. For higher level students, you can add a trophic level to include a differentiation between resident orca whales, which eat almost entirely salmon, and transient orcas, which eat pinnipeds (seals, sea lions, etc.). How would this change the game?

The Orca Jenga game is meant to demonstrate trophic levels and how they interact in Puget Sound. You will notice there are the most phytoplankton blocks, which are the base of this food web. The numbers of blocks are representational, and do not directly reflect ratios of species between trophic levels. In a real-life food web, the ratios between each trophic level would be much more extreme, as only 10% of energy moves up the food web. By biomass, this means that there are **10,000 pounds** of phytoplankton for every **one pound** of orca!

Orca Jenga Vocabulary:

Algal bloom: rapid increase of algae population in a water body. Can lead to reduced oxygen levels as it decomposes.

Climate change: Climate is the usual pattern for a specific area. Climate change is a global shift in what the climate typically is. This happens by natural phenomena such as the Earth's orbit around the sun, but is now predominantly caused by human activity such as the burning of fossil fuels. Remember, climate is different than weather: it takes hundreds of years to change the climate, but the weather can change multiple times in a day.

Endangered species: an animal or plant at risk of becoming extinct as result of overharvesting, habitat destruction, or other causes.

Engineered log jam: structure made from logs installed in streams and rivers to mimic natural log jams. Log jams create valuable freshwater habitat for salmon.

Estuary: where a river meets the sea. Important habitat for juvenile salmon migrating to the ocean, called smolts.

Food web: all the interactions of predator and prey, along with the flow of nutrients into and out of the ecosystem; how energy is converted and passed from one ecosystem to another.

Hypoxia: condition in which water has low levels of oxygen, and cannot support life. This can happen naturally, or more often, as a result of nutrient pollution from human activities, and is becoming more common due to climate change.

Invasive species: introduced organisms that are not native to an area, are able to out-compete for resources, and can cause ecological harm.

Microplastic: small (5mm or less long) plastic pieces that can be harmful to aquatic life. Plastic is the most common type of marine garbage.

Nonpoint source pollution: Pollution that comes from many small sources. Rain and storm water move pollutants through the watershed and down storm drains. Includes fertilizers, oil, dog waste, other urban runoff.

Ocean acidification: reduction in the pH of ocean water (making it more acidic), caused by the increase of carbon dioxide in the atmosphere from the burning of fossil fuels.

Phytoplankton: plankton that photosynthesizes; microscopic, free-floating aquatic plants.

Plankton: floating or weakly swimming organisms that move with the currents in water; can be photosynthetic like plants (phytoplankton) or animal (zooplankton).

Urban runoff/ stormwater: water containing non-point source pollutants (oil, soaps, pesticides, fertilizers, animal waste, litter, etc.) which washes into storm drains and rivers, and eventually gets into the ocean.

Watershed: the land area that drains into a common body of water.

Zooplankton: tiny aquatic animals.

Additional Resources:

- NOAA Killer Whale Information:

https://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/killer_whale/

- NOAA Killer Whale Activities:

https://www.westcoast.fisheries.noaa.gov/education/killer_whale.html

- Killer Whale Tales, Orca Facts:

http://killerwhaletales.org/students/orca-facts/

- Washington Department of Fish and Wildlife, Orca Conservation and Management:

https://wdfw.wa.gov/conservation/orca/

- Seattle Aquarium, Orca Fact Sheet:

https://www.seattleaquarium.org/sites/default/files/files/Orca%20curriculum_07-2016-2.pdf

- Alternate version of Whale Jenga:

http://www.cisanctuary.org/ocean-acidification/PDFs-WorkshopPage/Whale%20Jenga%20A%20Food%20Web%20Game_October_2015.pdf

Orca Jenga Playing Cards:

Explosion in population of invasive filter feeding invertebrates consume too much zooplankton. Remove **1 blue block**	Increasing ocean acidification causes mortality in zooplankton population, and reduces food for small fish. Remove **1 pink block**
Changes in ocean currents disperses phytoplankton. Remove **2 green blocks**	Bacteria decomposing algae following an algal bloom take oxygen from the water, and negatively impact small fish. Remove **1 pink block**
Increases in atmospheric carbon dioxide lead to increased ocean acidification. Organisms that build shells are especially vulnerable. Remove **2 blue blocks**	Ocean temperatures rise, and create unsuitable habitat for various species. Remove **1 green block** and **1 blue block**
Oil spill in local marina! These contaminants harm phytoplankton health. Remove **2 green blocks**	Someone didn't inspect their boat for invasives! Introduction of invasive zooplankton reduces the number of phytoplankton. Remove **1 green block**
Local park installs dog waste bag station, and reduces some of the nonpoint source pollution that comes from this waste. Habitat improves for zooplankton. Put back **1 blue block**	Rain gardens are installed in the upper watershed to filter out nonpoint source pollution! Habitat is improved for phytoplankton Put back **1 green block**

Orca Jenga Playing Cards:

Engineered log jam in the upper watershed helps support juvenile salmon by providing more habitat diversity. Add **1 silver block**	Help your family member fix an oil leak in your vehicle, and reduce nonpoint source pollution. Add **1 green block**
Bring your own reusable bag to the grocery store, and help reduce plastic pollution to protect marine wildlife. Add **1 blue block**	Skip the plastic straw at a restaurant, and help reduce plastic pollution and protect marine wildlife. Add **1 pink block**
Dispose of household hazardous waste by taking to a recycling facility. Help reduce nonpoint source pollution and improve marine habitat. Add **1 blue block**	You motivate your family to use organic compost on your garden instead of a chemical-based fertilizer. Your choice helps reduce nonpoint source pollution! Add **1 green block**
Layer of smog reduces sunlight reaching the ocean, and reduces phytoplankton. Remove **1 green blocks**	High pollution causes hypoxic conditions, and reduces available dissolved oxygen. Remove **1 blue block** and **1 pink block**
Big rain event sends polluted stormwater down the drain. Remove **1 green block**	Low salmon run this year. Remove **1 silver block**

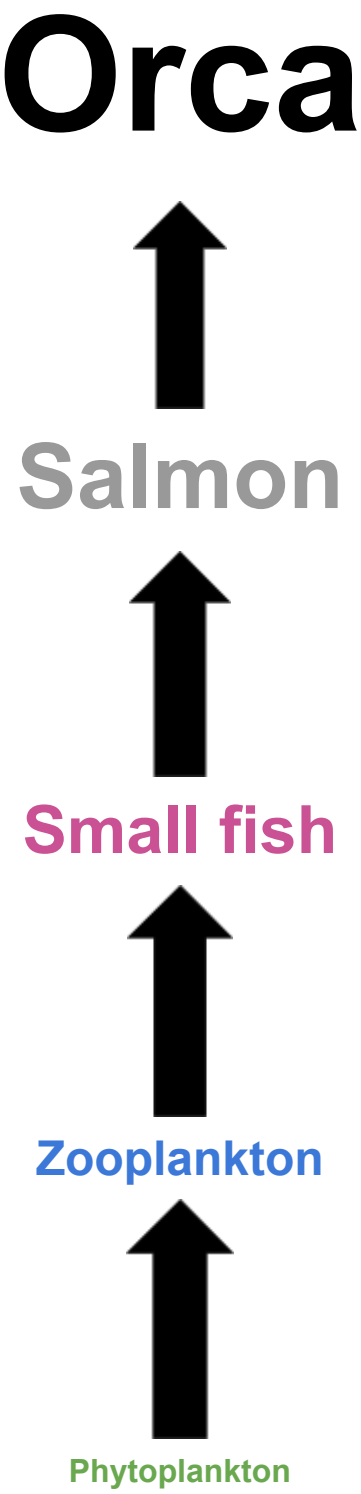
Orca Jenga Playing Cards:

Leaky car in the neighborhood sends oil down the storm drain. These toxins harm zooplankton. Remove **1 blue block**	Your neighbor washed their car in the paved driveway, and the soap washed down the storm drain. The soap is harmful for phytoplankton Remove **1 green block**
A farmer over-fertilizes her crops right before a big rainstorm. The excess nutrients create unhealthy conditions for zooplankton. Remove **2 blue blocks**	Too many microplastics in the bay! This pollution harms small fish species. Remove **1 pink block**
A recreational boat in the bay has an oil leak. These toxins harm phytoplankton growth. Remove **1 green block**	Big event on the waterfront! Crews do not clean up properly, and lots of trash gets into the bay. Remove **1 pink block**
A major logging operation begins in the upper watershed, and lots of sediment enters the stream. This creates unhealthy habitat for juvenile salmon. Remove **1 silver block**	Heavy rains wash away lots of excess dirt from an improperly managed construction site, and creates unfavorable water conditions. Remove **1 pink block**
Too many pesticides are applied to a suburban neighborhood to keep spiders out of homes, and some end up in the water. Remove **1 green block**	A tailings pond from a heavy metal mine fails, releasing tons of toxic waste! Remove **2 green blocks**, **1 blue blocks**, **1 pink block**, and **1 silver block**

Orca Jenga Playing Cards:

Runoff from a bridge with heavy traffic use is full of metal particles which contaminate the water. Remove **1 green block** and **1 pink block**	Your neighbors forget to pick up dog waste from their yard before a big rainstorm, and it ends up going down the storm drain. Remove **1 blue block**
A big company buys a large portion of the estuary, and begins developing it as vacation homes. Remove **1 silver block**	Heavy logging in the upper watershed reduces healthy salmon spawning and rearing habitat. Remove **1 silver block**
Low flows in the river over the summer cause juvenile salmon mortality. Remove **1 silver block**	A septic tank in the neighborhood fails, and adds excess nutrients and various toxins to the watershed. Remove **1 green block** and **1 blue block**

Simple Puget Sound Food Web:



Complex Puget Sound Food Web: