Catch Me If You Can

Adapted from *Fishing for The Future* in *Curriculum Guide 2002*. Retrieved from www.facingthefuture.org

Subject

Natural resource management dynamics/ climate change/sustainability

Objectives

The students will:

- Use a model to explore how fishing effects ocean populations
- Describe local events that can positively or negatively affect the salmon population
- Construct explanations and design solutions for impacts of fisheries on healthy oceans

Materials

You will need a large outdoor space

- 200 Poker Chips / similar material
- Timer
- Graphing paper / writing utensils for fishing log (5 or 6 clipboards recommended)
- Start line (rope, reflective tape, or small cones)

Size/Setting/Duration

Entire class working in small groups (example: 26 students, 1 group of 2 (orcas), 5 groups of 4-5 (fleets)) /outside/~60 minutes

Background

Consider showing one or more of the following videos.

- "Skagit River has lost half of important salmon habitat that Southern Resident orcas depend on," on KING5, from 0:00 to 3:16. https://www.youtube.com/watch?v=Xv9qcEYAXlM
  This short video explains that salmon are the main food source for the Southern Resident Orcas and that both orcas and salmon are endangered species. It shows local researchers studying fish quantity on the Skagit River and emphasizes the importance of habitat restoration.
- "Not Enough Salmon for Endangered Orcas," on News 1130, full video. https://www.youtube.com/watch?v=WVPVf4BMrxY
  This video highlights the importance of salmon in the food industry, and offers ideas for the future.

- "Saving the Orcas: Solving the Salmon Problem," on KING5, from 0:00 to 2:37. https://www.youtube.com/watch?v=N1qLakclrR0
  This video shows the importance of hatcheries, providing salmon for orcas and fisheries, identifying that hatcheries are a supplement and not the solution.

The following information is for teachers to review to get more familiar with fish quantity. Additionally, these points can be reiterated to students after the videos.

Fish quantity is important to the Pacific Northwest, and our communities value a healthy salmon population for a variety of reasons.

1. Culture – Salmon play an important role in Coast Salish culture, literature, artwork, and spirituality. The fish is considered the symbol of lifeblood.
2. Economy/Jobs – Fishing in a big economic driver in the Pacific Northwest. Commercial and recreational fisheries supported 16,374 jobs in 2006. The decline has resulted in the loss of millions of dollars.
3. Environment – Over 137 species benefit from and utilize the ocean-origin nutrients that salmon deliver. As a keystone species, salmon also act as a barometer for the Northwest ecosystem. Their abundance describes the health of rivers and forests in which they flourish, and their decline points to the challenges we continue to face as this decline points towards a crisis. For example, resident orcas eat only salmon, primarily Chinook salmon. Orca populations are decreasing as the salmon population decreases and they lose their main food source.

For a longer overview on salmon and the significant role they play on the economy, native culture, and the environment read *Why Protect Salmon* by the Wild Salmon Center. https://www.wildsalmoncenter.org/why-protect-salmon/

Puget Sound's salmon population is declining, three species in the salmonid family that reside in Puget Sound are federally listed as threatened under the Endangered Species Act. For further explanation, see *Salmonids* from Sound Institute, University of Washington. https://www.eopugetsound.org/terms/363

Chinook Salmon	Threatened
Chum Salmon	
Sockeye Salmon	
Pink Salmon	
Coho Salmon	
Steelhead	Threatened
Cutthroat trout	
Bull Trout	Threatened

We can help increase salmon populations.

Things that increase fish quantity:

- Regulations – Limit when, where, and how many fish one can legally catch, this keeps the population large enough to replenish itself. A local example is limitations on harvesting wild Chinook salmon.
- Hatcheries – A hatchery provides a controlled environment to hatch eggs and keep young salmon alive until they are released into a waterway. More eggs grow to adults in a hatchery than in the wild. Hatcheries can provide more quantity, but not quality of fish. Hatchery fish are easier prey and do not reproduce in the wild very often/successfully.
- Restoration practices – Practice of renewing and restoring degraded, damaged, or destroyed ecosystems and habitats in the environment by active human intervention and action (i.e. planting trees, removing invasive species, removing fish passage barriers (such as dams that don't have fish ladders and culverts)).
- Sustainable choices – Individual choices can be significant when added up. Conserving water, reducing energy, recycling waste, etc. Choosing to support more responsible fishing practices and purchasing options can promote a healthier fishing system.

We can also add to the problem.

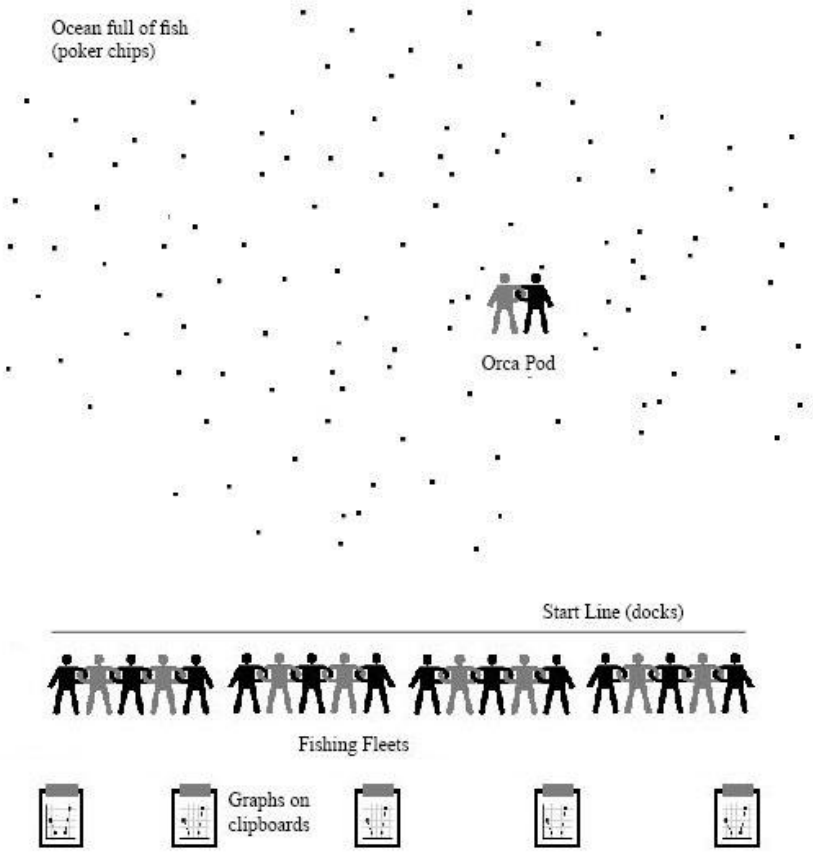
Things that decrease fish quantity:

- Overfishing – The removal of a fish species from a body of water at a rate that the species cannot replenish in time, resulting in depletion or significant reductions in population in that given area.
- Climate Change – The climate is changing faster than fish can adapt. Climate change affects salmon through natural disasters (such as Nooksack River flooding), ocean acidification (more carbon dioxide in the atmosphere and ocean breaks down shells of pteropods – a type of zooplankton and vital part of the marine salmon food chain), warming waters (holds less oxygen and leads to exhaustion sooner), and unpredictable water availability in streams throughout the year. This affects both their physiology (such as ability to detect predators), and their ability to successfully reproduce and survive to spawn.
- Pollution/Disease – Pollution from agricultural runoff, factories, stormwater pollution, etc., have negative impacts on the health of salmon which leads to increased risk of disease. More examples include oil spills, plastic pollution, increased fecal coliform from agriculture or domesticated animals, and wastewater dumping.

To learn more about how we impact the population follow this link to read *Environmental Impact of Salmon Decline: This Isn't Just About Fish* from the Seattle Times at https://www.seattletimes.com/sponsored/environmental-impact-of-salmon-decline-this-isnt-just-about-fish/

Set up

1. Spread 50 poker chips per group across the field. Try not to create clusters. Each poker chip represents a fish. (5 groups = 250 chips)
2. Set a start line a good distance away from the poker chips.
3. Split students into small groups of 4 or 5 each and give each group a blank fishing log. Each group will represent a fishing fleet whose livelihood depends on catching salmon. Have students name their fleet and record both fleet name and student names on their fishing log. Designate two additional students to be the orca pod and give them a blank fishing log. These orca pods will be competing with the fishing fleets for the fish and will begin each round in the ocean. Fleets will begin each round at the start line or "dock".



4. Explain the activity to your class.
    a. Example: Today we are going to represent multiple fishing fleets, similar to the commercial fishing industry in the Salish Sea. Your job is to catch enough salmon to make money. The more fish you catch, the more money you make. Each fleet needs to catch at least 20 salmon per round to reach this goal.
    b. But here's the tricky part, as a fleet you must stay together at all times. To guarantee this, you must hold hands or link arms into a line.
    c. When I say "Go!" you'll have one minute to grab as many salmon (poker chips) as you can and return to dock when the timer runs out. Students with one hand (or arm) free are able to catch salmon and hold onto your "catch," not the students in the middle.

d. Orcas -your job is to eat enough salmon to survive. You two will also link yourselves together and try to catch 30 fish. When the timer runs out we all return to the starting line and count our catch to record in our fishing logs. Any questions?

Procedure

1. A fishing season is 30 seconds long. When the season begins, each group (fleets and orcas) will hold hands or interlink arms. They will run across the field collecting as many poker chips as possible before time runs out. Begin by saying Go, or other "magic word."
    a. The fleets will be at a disadvantage because 4 or 5 students are attached, meaning they only have two open hands free on either end to collect chips. The orca pod will have much more maneuverability, along with starting in the ocean.
    b. Each fleet must catch at least 20 fish per season to survive. The orca pod must catch at least 30 fish per season.

2. When the season is over, the students must cross the start line to "return to dock". Have them add up their catch and record results in their fishing log. Each fleet and orca pod should have its own graph. After each round, if possible, graph all of the student data on one "master graph." This can be done on a whiteboard or a larger sheet of paper, so students can grasp the population changes as a whole through each consecutive season.

3. Bring the students together in a big circle (or line up at the start line). Announce that every year, different events have an impact on salmon, and can increase or decrease the salmon population. Reinforce the local impact of some of these events, and how they are sometimes on a larger scale. For example, farmers' crops in Washington's booming fruit industry are affected by pests, weather and varying amounts of precipitation. These events (which are out of their control) change the total yield of their crops, and largely impact their business. The fishing economy is similar in that it suffers from similar random and unpredictable events that affect the total amount of fish harvested.
   For this game, a single event will occur between each season and the event order will be as follows (positive-negative-negative-positive). That way the game will start and end on a positive note while still encompassing the negative possibilities. Recite each event below, and ask students to identify if this would negatively or positively affect salmon populations (and why), before starting another season (or round). Do not tell the students how many chips you're placing in the field. The event should guide their decision making, not knowledge of exact numbers available.
    a. **For the first event**: The Nooksack Salmon Enhancement Association finished restoring Squalicum Creek with local families and community members. This has improved ten miles of riparian habitat.

i. Positive - Place 100 fish in the ocean (50 designate reproduction and 50 represent additional due to positive event).

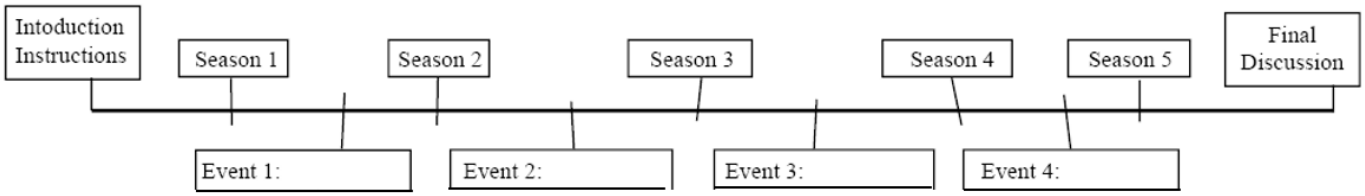
b. **For the second event**: The changing climate has impacted our local weather. Warmer temperatures are accelerating snow and glacial melt up on Mt. Baker, resulting in less water flow into creeks and the Nooksack River. These smaller creeks tend to dry up in the warm summer months and result in small salmon fry trapped in pools with reduced oxygen levels and increased vulnerability to prey. Additionally, dry creeks do not support adult salmon moving upstream to lay their eggs.
   i. Negative - Place 50 fish in the ocean (designating reproduction).

c. **For the third event**: An oil spill by one of the large tankers in the Rosario Strait has effected large numbers of marine life, reducing food sources for adult salmon. Additionally, the oil has spread impacting salmon eggs in nearby creeks.
   i. Negative - Place 50 fish in the ocean (designating reproduction).

d. **For the fourth event**: This year, the Nooksack River Middle Fork Dam was removed thanks to many collaborative partners, including the City of Bellingham. This opened up 16 miles of healthy habitat.
   i. Positive - Place 100 fish in the ocean (50 designate reproduction and 50 represent additional due to positive event.

4. After announcing each event, ask the students the following questions to get them brainstorming:
   - What impact will this have on the salmon population? Do you think it will decrease the population or increase it?
   - Do you have any fishing strategies for this season?
   - Are you going to change your strategy in any way compared to last fishing season?
     a. The students will begin to see the connection the events have between salmon populations and catch quantity, and will need to change their fishing strategies and work together to keep the ocean full of fish. It is likely that one season, the students will overfish the salmon to extinction or not meet their minimum catch limits. If this occurs, rewind time and let them try the round again. Encourage them to work together and implement new fishing strategies.
     b. Possible strategies include: evenly distributing the catch amongst all fleets, setting catch limits (20 max), designating areas of the field as marine reserves (more successful reproduction), making stricter rules/regulations, shortening a fishing season to 15 seconds, , abstain from fishing for a season (rely on the excess from the previous round), etc..

5. After discussing the brainstorming, begin the next fishing season. For the remaining seasons follow this timeline:



6. By the end of season five, bring all the students together. Ask the students the following questions to wrap up:
    - Ask the fleets and the orcas to show their graphs to the class and explain why they look the way they do.
    - Did all of the fleets and orcas find enough salmon to survive every time?
    - What strategies worked well?
    - What should we have done differently?
    - What events increased or decreased the populations?
    - Is fish quantity important in the Salish Sea? Why?

Conclusion

By the end of this activity, your students will have a better idea of what impacts fish populations both positively and negatively. It's important to let them know that everyday choices such as recycling, conserving water, reducing electricity, preventing litter, buying local, following fishing rules, and buying sustainably sourced salmon can have a positive impact on salmon, and therefore the environment. This links back nicely to the "Not Enough Salmon for Endangered Orcas" video where local restaurants and food prep companies are removing Chinook salmon from their menus. This can pose a question you can facilitate with your students – when conserving a species, such as the Chinook salmon (or as a result of conserving Orcas), "is it best to designate it off limits?"

Consider passing out the *Monterey Bay Aquariums Seafood WATCH Consumer Guide*. This program has science-based recommendations on seafood consumption and is an example of making sustainable choices in purchasing. The recommendations are broken into categories – "Best Choice" (green), "Good Alternative" (yellow) and "Avoid" (red). Included in Washington's guide on the "Avoid" list is Chinook salmon. The Seafood WATCH guide can be found here: https://www.seafoodwatch.org/seafood-recommendations/consumer-guides.

Extensions

Ideas for modifying the lesson.

Alternative events:

Positives, increasing the population: Add 100 fish to the field, 50 designate reproduction and 50 represent additional due to positive event.

- Local students worked together to clean up trash along creeks throughout Whatcom county. This has increased marine health by reducing the amount of debris before it travels into Bellingham Bay. Marine life often digests small plastics, and/or entanglement results in marine species (including salmon) unable to survive.
- Bellingham Technical College's (BTC) hatchery in Maritime Heritage Park in downtown Bellingham artificially raised chum salmon eggs. Students at BTC just released this stock into Whatcom Creek.

Negatives, decreasing the population: add 50 fish to the field, 50 designate reproduction.

- A net pen (aquaculture method for farming fish) collapsed and invasive fish have infiltrated the Salish Sea. They're competing with our salmon for food sources, and aren't being eaten by orcas.
- Several poachers were caught after taking a large number of salmon illegally from Bellingham Bay.
- Stormwater runoff from roads has brought unwanted chemicals into the Salish Sea affecting salmon and other marine life.
- Climate change is affecting the chemistry of the water, making it harder for salmon to be able to detect predators.

For a younger audience consider simplifying:

a. The graphing component should be modified depending on the age.
   i. We suggest working through the graph together aloud on a large white board or piece of construction paper. Try using a single graph for the whole activity instead of one per fleet. Help the students add up the catch from everyone.
   ii. An alternative to the graph can be done by showing volume. Try filling clear containers with the poker chips collected and positioning them side by side. This will show the contrast between seasons.

   iii. Instead of holding hands or linking arms, consider using a rope that all students hold onto while they run around (take in account potential for multiple ropes being entangled)
   iv. Connect the idea of "saving animals" like salmon or orcas into the explanation of the game, rather than the more complex topics of population dynamics and shared resources.
   v. Rephrasing the game as a story.

For an older audience consider additional challenges:

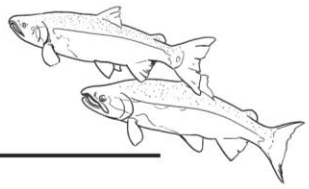
b. In the real world, fishing vessels must keep their distance from orca pods. Inform your students they must stay at least 5 feet away from the pods at all times. If they get too close, they have to drop half of their catch. Consider including a referee.
c. Have 1 fleet be a tribal fleet. This tribal fleet serves with the state of Washington as co-managers of salmon. Additionally, the Boldt decision of 1974 stated that native tribes have "sharing equally the opportunity to take fish," so the native fleet gets to harvest up to 50% of the harvestable number of fish. To incorporate this, consider allotting the tribal fleet a certain number of fish (higher than 20) that they are allowed to harvest each round. More information on the Boldt decision can be found here: https://www.justice.gov/enrd/us-v-washington
d. Consider making every event random by pulling the events from a hat/container or making a spinner with the event on it.
e. Open up a conversation on hatchery vs wild fish by providing two different color poker chips.
    i. Restock the ocean based on wild fish reproduction. You can do this while the students are graphing or have an additional adult re stock the ocean. We have provided a template table in the appendix to help you get started.
        1. The wild fish remaining in the ocean represent the reproductive population, and thus one black chip will be added for every black chip currently in the ocean. Hatchery fish do not reproduce as successfully in the wild.
f. Instead of using the pre-written final positive impact, incorporate youth voice by letting students decide their own positive impact that they can make to positively affect salmon populations. This student-driven positive impact can then be incorporated instead of (or in addition to, if time permits) the last positive impact designated above.
g. Take a deeper dive into the conclusion when bringing up the idea of conserving a species and if designating that species as off limits is the best way to manage the situation. Ask the students what the difference is between conservation and preservation, which goes back to the Theodore Roosevelt Administration in the early 1900s and involved Gifford Pinchot (conservation) and John Muir (preservation), resulting in the National Forest Service and National Park Service. For a quick history outlining these viewpoints, and the resulting lands that were protected, refer to this article: https://www.usda.gov/media/blog/2016/03/22/conservation-versus-preservation.

Next Generation Science Standards

Performance Expectation
3-LS4-3: Construct an argument that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. **3-LS4-4:** Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change. **5-ESS3-1**: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

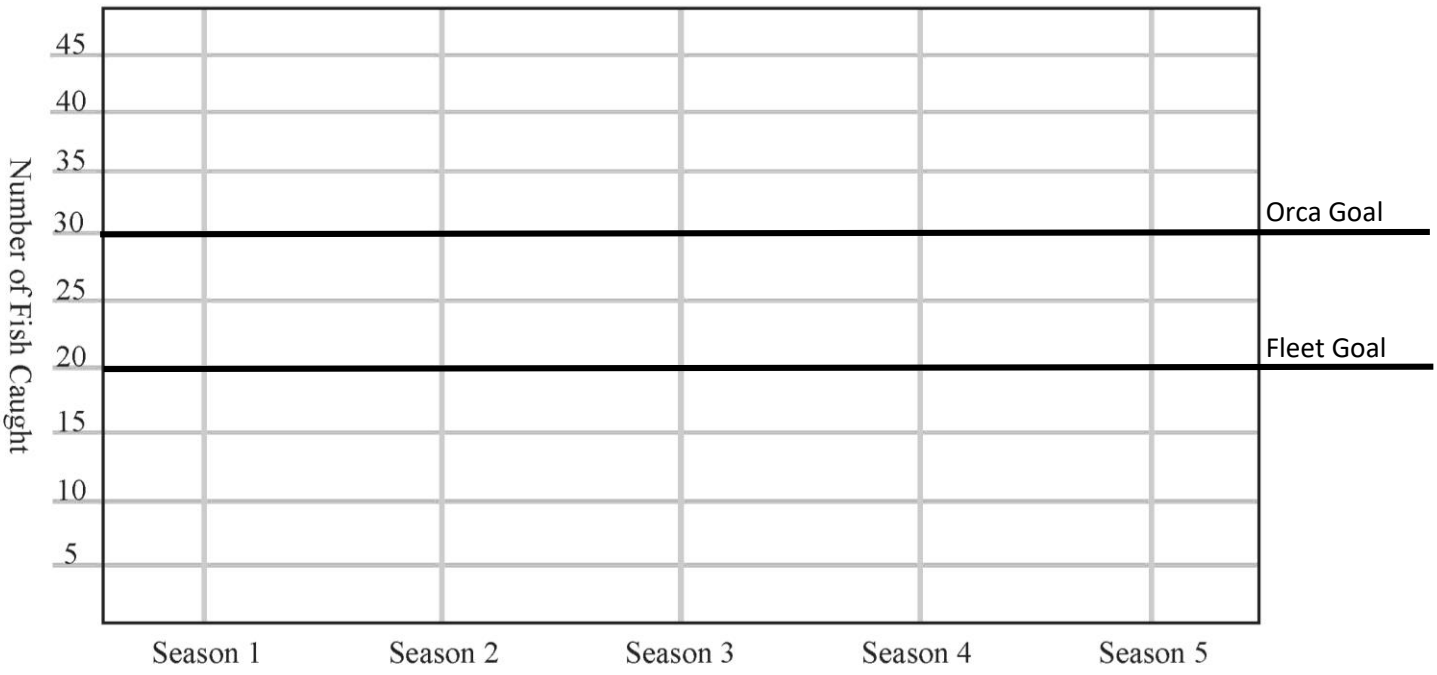
Scientific and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
▪ Developing and Using Models ▪ Constucting Explanations and Designing Solutions ▪ Engaging in Argument from Evidence ▪ Analyzing and Interpreting Data	▪ LS2.C: Ecosystem Dynamics, Functioning, and Resilience ▪ ESS3.C: Human Impacts on Earth Systems	▪ Patterns ▪ Systems and System Models ▪ Cause and Effect: Mechanism and Explanation

FISHING DATA LOG



Fishing Fleet Name: _____

Student Names: _____



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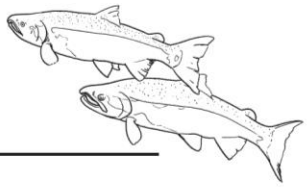

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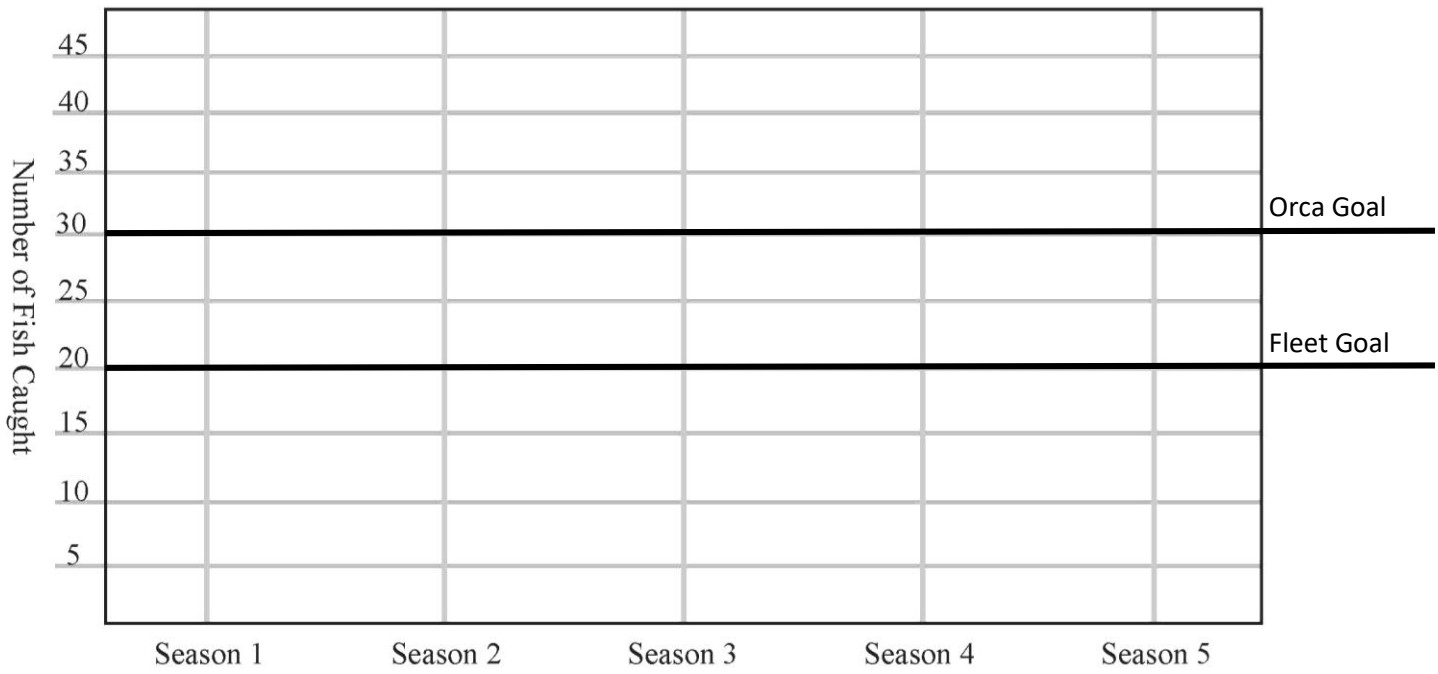

	# Reproduced	# Event	Starting # (Surviving + Reproduced + Event)	Student Fleet Catch							Total # caught	Total Surviving reproductive population (Starting - Caught)	
				group 1	group 2	group 3	group 4	group 5	group 6	group 7			
Season 1													Activate Event 1
Season 2													Activate Event 2
Season 3													Activate Event 3
Season 4													Activate Event 4
Season 5													

How to repopulate the ocean:

Take the total number surviving fish and add that number to the field. This will always double the amount in the ocean.
The surviving population are the only fish who can reproduce. Add one fish for every fish remaining in the ocean.

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