## UNIT 6B. SALMON FISHERIES SIMULATION

| LEVEL | TIME (min.) |
| ---: | :---: |
| Advanced | 60 |


| BENCHMARKS |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- |
| Next Generation Science Standards | MS-LS2-1 | HS-LS2-7 | HS-ESS3-3 | MS-LS2.C |
|  | MS-ESS3.C | HS-LS2.C | HS-LS4.D | HS-ESS3.A |
|  | HS-ESS3.C |  |  |  |
| NGSS Science \& Engineering Practices | 2. Developing and using models.  <br>  4. Analyzing and interpreting data. |  |  |  |
| OR Social Sciences Academic Content HS.61 HS.63  <br> Standards    |  |  |  |  |

## INTRODUCTION

Historical and archaeological evidence indicates that native Columbia River salmon populations were large in the past, just as the bison herds were once plentiful on the Great Plains. However, within the past two human generations, salmon have declined to possible extinction; a decline which mirrors that of the bison. Human population pressure directly and indirectly caused the decline of the bison. Are there any indications that the same might be true of the salmon? How does this compare with what we have learned about our community's attitudes about salmon?

In this section, we explore the effects of human populations on a salmon fishery. The core curriculum opens with an activity in which students simulate a large ocean fishery, and explore the effects of fishing fleet owners' decisions on the salmon population. In the supplementary curriculum, students graph and interpret human population, geographical areas, and salmon populations. The extension provides an opportunity to compare the relative changes in population in five salmonid species.

## OBJECTIVES:

- Students will explore and discuss the effects of human populations on a commercial salmon fishery.


## MATERIALS:

$>$ Large area: 30 meters on a side, such as gym, mowed lawn, parking lot
> 600 paper clips
> play money
$>$ poster board/black board to record data
> large area
> STUDENT HANDOUT 6B-1: Salmon Fisheries Group Worksheet
> STUDENT HANDOUT 6B-2: Salmon Fisheries Simulation Directions \& Questions
> STUDENT HANDOUT 6B-3: Pacific Fisheries Status Report
> STUDENT HANDOUT 6B-4: Salmon Fisheries Graph

## KEY QUESTIONS:

How do we know salmon populations are declining?
What are some factors which contribute to such a decline? How do they contribute to the decline? What are possible solutions to increase salmon populations?

VOCABULARY (Brief definitions of vocabulary terms are found in the Glossary.) fishery fleet population
simulation carrying capacity

## PROCEDURE:

Background: The simulation, Salmon Fisheries, was developed in 1994 by Eric Baack. In the game, student groups act as fishing fleets, capturing as many salmon as possible each season. At the end of each season, they can choose to keep their earnings, or use them to purchase more fishing boats.

1. The simulation requires a large surface area, about 30 meters on a side, to be used as the fishery. A large square is marked out, and four student groups, each acting as a fishery, situate themselves on its corners. Each group will represent a different fishery. For example, they might be the Alaskan fishing, deep Pacific gillnet, Canadian fishing, and Oregon coastal fleets. Up to 600 paper clips are scattered randomly throughout the square fishing area. Each group starts with one "boat" and $\$ 100$. To play each game year, the "boats" will have one minute to pick up as many paper clips as they can. Each paper clip represents a ton of salmon. For every ton of salmon (paper clip) collected, the group will earn $\$ 10$.
2. One student is designated as Timer. When the Timer calls "start," each "boat" (one student per boat) enters the "fishery" and collects as many paper clips as possible in one minute. (Each group fields one boat in the first round.) At the end of the minute, the boat returns, and the group totals its catch (paper clips), calculates profits, decides whether to purchase new boats, and turns in an accounting sheet (STUDENT HANDOUT 6B-1: Salmon Fisheries Group Worksheet) to a student acting as Banker, who posts a Pacific Fisheries Status Report (STUDENT HANDOUT 6B-3). See the Pacific Fisheries Status Report for an example of how this report is filled out for one season. (You might copy this worksheet on to $11 \times 17$ paper to make it easier for the class to see.)
3. Then, salmon "reproduce," one paper clip being added to the fishery for each paper clip remaining in the fishing area, up to a total of 600 paper clips. (Each paper clip represents one ton of salmon, so one paper clip reproducing another is not the same as one salmon reproducing another salmon. The carrying capacity is arbitrarily set at 600 paper clips, so there can never be more than 600 tons of salmon (paper clips). Have students randomly spread these new salmon out in the ocean.
4. The Timer then calls out another 1 minute fishing season. This procedure continues until either all of the paper clips are gone, or there is no change in the number of paper clips caught by each fleet. Groups may "buy" additional boats for $\$ 100$ each. Then, instead of one person "catching salmon", two people may. The only limit to the number of boats is the number of people in the group and their profits. If a group cannot catch enough salmon to pay for the operation of their boats, they either sell excess boats or are eliminated from the game. Continue to play the game until there are no more salmon, or there are no changes in the number of salmon being caught by each fleet.
5. Students keep tables of data, then graph their results and respond to questions about the process and its results. Time permitting, students should complete the Extension offering, Where Have All the Salmon Gone? This activity explores the actual changes in the number of salmon in the Columbia River salmon fishery from 1870 to 1989.

## Simplified Student Rules

1. Each group starts with one boat.
2. Any fleet may call a Pacific Fisheries Conference to discuss fishing.
3. Each boat gets to fish for one minute. This equals one year in the game.
4. To fish, a person (the boat) goes and picks up paper clips (the salmon).
5. Each paper clip caught represents one ton of salmon, and is worth $\$ 10$. Take them to the banker to cash them in.
6. It costs $\$ 100$ to operate each boat each year. Pay this to the Banker.
7. You may buy a new boat for $\$ 100$. Pay the cost to the Banker.
8. You cannot have more boats than members in your group.
9. If you ever don't have the money to pay for the operation of your boats, you can sell excess boats for \$50 each.
10. If you either have no boats, or cannot pay the $\$ 100$ operating fee, then you are bankrupt and out of the game.

## EVALUATION

Have the students consider the following questions
a. How well did you maintain the salmon resource? Is this resource renewable or non-renewable? How do you know?
b. Did any fishery change its strategy about the salmon resource during the game? Why?
c. Were you able to conserve the salmon resource by the end of the game? Why or why not?
d. Did anyone win? What does this mean?
e. Describe other human impacts, which might affect the number of salmon in the fishery.
f. How is this model similar to fishing in the Pacific Northwest? How is it different? The rest of the world? (You might direct discussion towards issues of knowledge of populations, patterns of reproduction, etc.) (You may wish to play the game a second time after announcing the explicit goal of maintaining fish populations while allowing the fishermen a reasonable profit. Will the class be able to agree on a strategy? You might also wish to expand the game to include Native American and sport fisheries.)

## STUDENT HANDOUT 6B-1 <br> Salmon Fisheries Group Worksheet

Names:
Fleet:


| YEAR | $\begin{aligned} & \hline \$ \$ \text { AT } \\ & \text { START } \end{aligned}$ | \# OF BOATS | FISH CAUGHT | $\begin{gathered} \hline \$ \$ \$ \\ \text { EARNED } \end{gathered}$ | $\begin{gathered} \hline \text { SUBTRACT } \\ \text { COSTS } \end{gathered}$ | NEW BOAT COST | BALANCE |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 |  |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |  |
| 4 |  |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |  |
| 6 |  |  |  |  |  |  |  |
| 7 |  |  |  |  |  |  |  |
| 8 |  |  |  |  |  |  |  |
| 9 |  |  |  |  |  |  |  |
| 10 |  |  |  |  |  |  |  |
| 11 |  |  |  |  |  |  |  |
| 12 |  |  |  |  |  |  |  |

## STUDENT HANDOUT 6B-2

## Salmon Fisheries Simulation Directions and Questions

## Directions

1. Each group starts with one boat.
2. Any fleet may call a Pacific Fisheries Conference to discuss fishing.
3. Each boat gets to fish for one minute. This equals one year in the game.
4. To fish, a person (the boat) goes and picks up paper clips (the salmon).
5. Each paper clip represents one ton of salmon, and is worth $\$ 10$. Take them to the Banker to cash them in.
6. It costs $\$ 100$ to operate each boat each year. You pay this cost to the Banker.
7. You may buy a new boat for $\$ 100$. You pay this to the Banker.
8. You cannot have more boats than members in your group.
9. If you ever don't have the money to pay for the operation of your boats, you can sell excess boats for $\$ 50$ each.
10. If you either have no boats, or cannot pay the $\$ 100$ operating fee, then you are bankrupt and out of the game.

Graph the data on numbers of salmon and fishing boats on the sheet provided. Use it, the Salmon Fisheries Group Worksheet, and the Pacific Fisheries Status Report to help answer the following questions.

## Questions

1. List at least three factors that affected the salmon resource in your fishery. Describe their effects.
A.
B.
C.
2. How well did you maintain the salmon resource? Is this resource renewable or non- renewable? How do you know?

## STUDENT HANDOUT 6B-2

3. Did any fishery change its strategy about the salmon resource during the game? Why?
4. Were you able to conserve the salmon resource by the end of the game? Why or why not?
5. Did anyone win the game? What does this mean?
6. Name and describe one other factor that might affect the number of salmon in the fishery.
7. How is this model similar to fishing in the Pacific Northwest? How is it different? The rest of the world? Do your best thinking and writing here.

## STUDENT HANDOUT 6B-3

Fisheries Status Report


## STUDENT HANDOUT 6B-4

## Salmon Fisheries Graph




