Modelling the impact of fish harvesting on pink salmon

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Acknowledgements

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Activity summary

This is a free resource for teachers and students, and is part of the Callysto project, a federally-funded initiative to bring data science skills into Grade 5-12 classrooms in Canada.

In this activity, students will use an online Callysto notebook to learn:

- The concept of a life cycle;
- The life cycle of pink salmon;
- How you can use mathematics to understand pink salmon populations.

This activity can be done with students in person, or, online.

Grade level

Grades 9 - 12.

Learning outcomes

- Indigenous knowledge and perspectives.
- Environmental impact of overharvesting fish.
- Mathematical thinking in relation to First Nations Peoples traditions.
- Engage in problem-solving experiences connected to a place, story, cultural practices and perspectives relevant to the Tla'amin Nation.

Before you start

1. This lesson plan allows you to use Callysto notebooks, mathematical modeling, and coding to understand the impact of fish harvesting on pink salmon. You can choose to let students work through the notebook with you. Or, you could introduce this topic separately and use the notebook for the interactive activities.
2. Students should know how to log in to the Callysto Hub as well as run a notebook prior to interacting with it. Teachers, to get started with Callysto notebooks and running material on the Callysto Hub, see our Starter Kit.
3. This lesson plan may be used in conjunction with the Modelling Coast Salish Fish Traps lesson plan, where students explore different kinds of traps used by Northern Coast Salish peoples to harvest fish.

   Suggested complementary reading: Indian Fishing: Early Methods on the Northwest Coast by Hillary Stewart.

Required materials

1. A charged computer.
2. Access to the internet.
3. An installed internet browser, preferably Google Chrome, Safari or Firefox.
4. A Google or an Outlook email account.

In class activities

1. **Introduce the concept of a life cycle**

   A life cycle describes the stages in which an organism moves from birth to adulthood, and ends at the stage in which the organism reproduces. See here.

2. **Share with the student this video on tišosəm - Tla'amin Community**

   https://youtu.be/X6aNgeD4Idc

   This video was produced by the Tla'amin Nation, a First Nations self-governing nation whose traditional territories reside on the upper Sunshine Coast in British Columbia. In this video,

Tla'amin Nation elders are interviewed on the impact of Herring when overharvesting took place within the Nation.

3. **Talk with the students about different kinds of fish and sea creatures harvested by the Tla'amin Nation.**

   These include: salmon and herring. The five species of Pacific salmon found in waters of British Columbia are Sockeye, Pink, Chum, Coho, and Chinook.

   For thousands of years, the Coast Salish Peoples have depended on salmon as a staple source of food. Additionally, it has served as a source of wealth and it is a key component in Coast Salish Peoples trading, identity and existence. See here for more information. Tla'amin Nation Peoples would crush barnacles when the tide came, as it helped attract all kinds of sea creatures.

   Use this to facilitate a discussion on what students think happens to salmon or herring populations that were typically harvested using Coast Salish traditional fishing practices when industrial harvesting was put into place.

4. **Ask the student to learn about life cycle of salmon**

   Ask the students to watch this video on the life cycle of salmon.
   https://www.youtube.com/watch?v=nkXthUsnRz4

   Ask the students to identify stages in the life cycle of salmon (Reference: National Park Service):

   1. Salmon eggs.

   2. Eggs hatch and alevins emerge.

   3. Alevins consume yolk sack, swim upwards and develop into fry.

   4. Fry migrates to the sea, turning into a smolt. Smolt needs to feed heavily and grows to adapt to conditions in the ocean. Turning into salmon at the end of this stage.

   5. Some salmon remain in coastal water, while others migrate northward to feedings grounds. Salmon may spend one to seven years in the ocean. Pink salmon, for example, spend 18 months at sea.

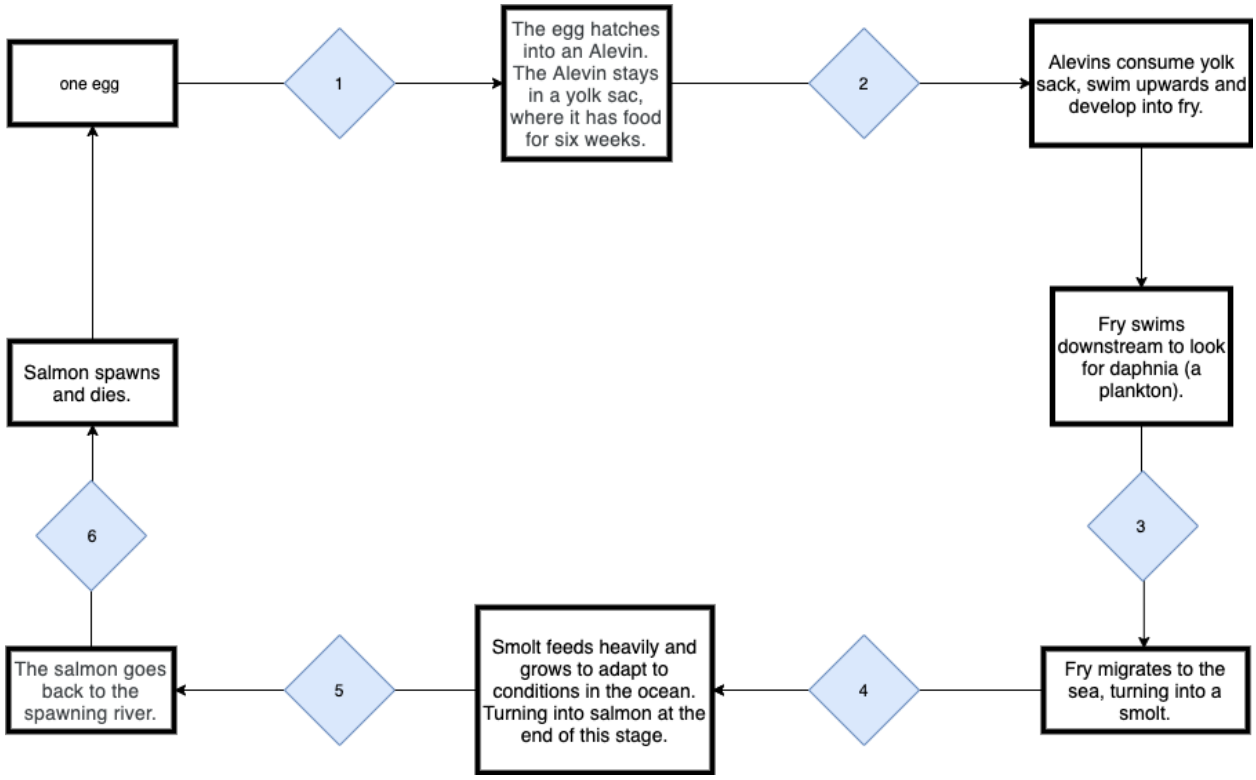
   6. Salmon migrate back to the spawning river to begin reproduction.

   7. Salmon spawn.

   8. Salmon die after spawning.

5. **Work with the students to create a flow diagram of the life cycle of salmon. You can use the diagram below to help you.**

   In the diagram below, **rectangles** symbolize a stage in the life cycle of salmon, and **diamonds** represent a potential death (due predators, natural causes, fishing, etc). A copy of an empty diagram is provided at the end of this document.



6. **Student activity. Ask the students to research and write a report about one particular salmon species: pink salmon.**

   Background:

   - Pink salmon is a species of salmon found in North America. It has the shortest life span of all Pacific salmon found in this region.
   - This species completes their life cycle in two years. This two-year cycle has created two genetically distinct populations: an odd-year population, and an even-year population. These populations do not interbreed, i.e. fish pink salmon from odd years cannot mate with pink salmon from even years.

Example of a resource students can use: https://www.adfg.alaska.gov/index.cfm?adfg=pinksalmon.main#:~:text=Pink%20salmon%20have%20the%20shortest,year%20populations%20of%20pink%20salmon

7. Introduce the concept of mathematical modeling

A mathematical model is a description of a system using mathematical concepts and mathematical language. You can think of a math model as a tool to help us describe what we believe about the workings of phenomena in the world. We use the language of mathematics to express our beliefs. We use mathematics (theoretical and numerical analysis) to evaluate the model, and get insights about the original phenomenon. You can use the table below to help with outlining steps followed in mathematical modelling.

Step	Description
1	**Choose what phenomenon you want to model**
2	**What assumptions are you making about the phenomenon**
3	**Use a flow diagram to help you determine the structure of your model**
4	**Choose equations**
5	**Implement equations using Python**
6	**Solve equations**
7	**Study the behaviour of the model**

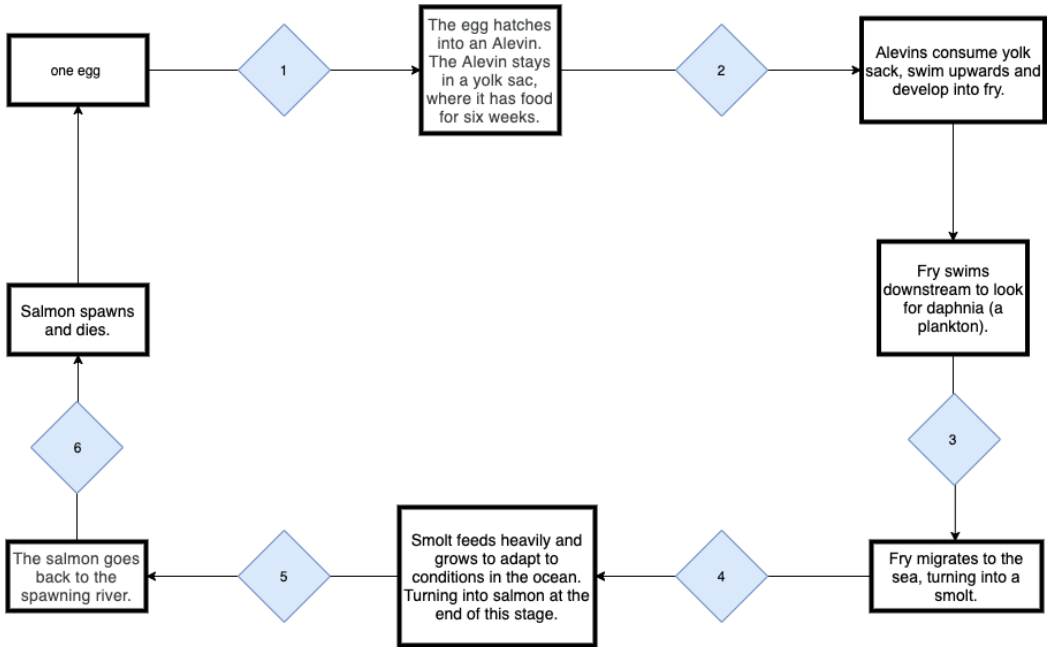
8. Ask the students to open this Callysto notebook link https://tinyurl.com/y6cdcw2n

Review the section on "**Model Assumptions**". This notebook contains a mathematical model that explores the impact of harvesting on pink salmon over the course of 10 years. This notebook outlines the following assumptions:

a. Model assumes we are working with pink salmon, i.e. two year cycle with two populations: odd year population and even year population.

b. Model assumes pink salmon are harvested at the adult stage, on their way back to the spawning stream. This means fish that are harvested could not reproduce.

9. **In the Callysto notebook, ask the students to identify where in the life cycle salmon harvesting is happening according to the model. Make sure the students have already completed the Salmon Life Cycle activity (step 5) before they attempt this.**

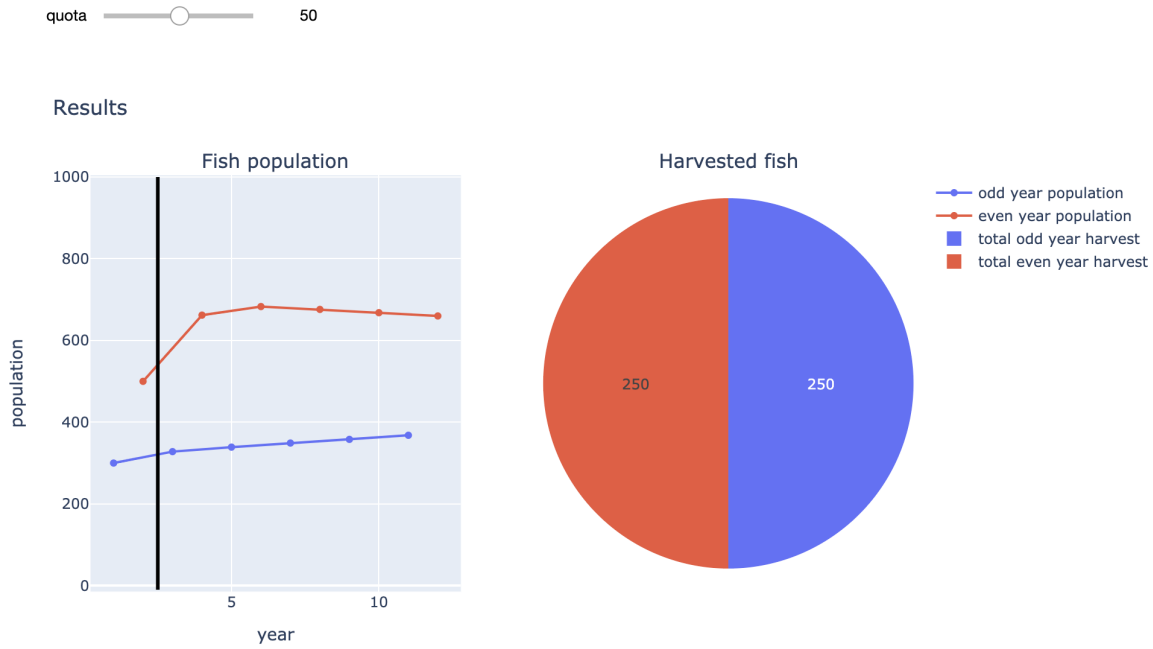


Use the salmon life cycle diagram you worked on previously to identify the correct diamond. (Hint: it is diamond number 5). Students can enter their answers in the notebook by double clicking the cell.

Your answer here ✏️

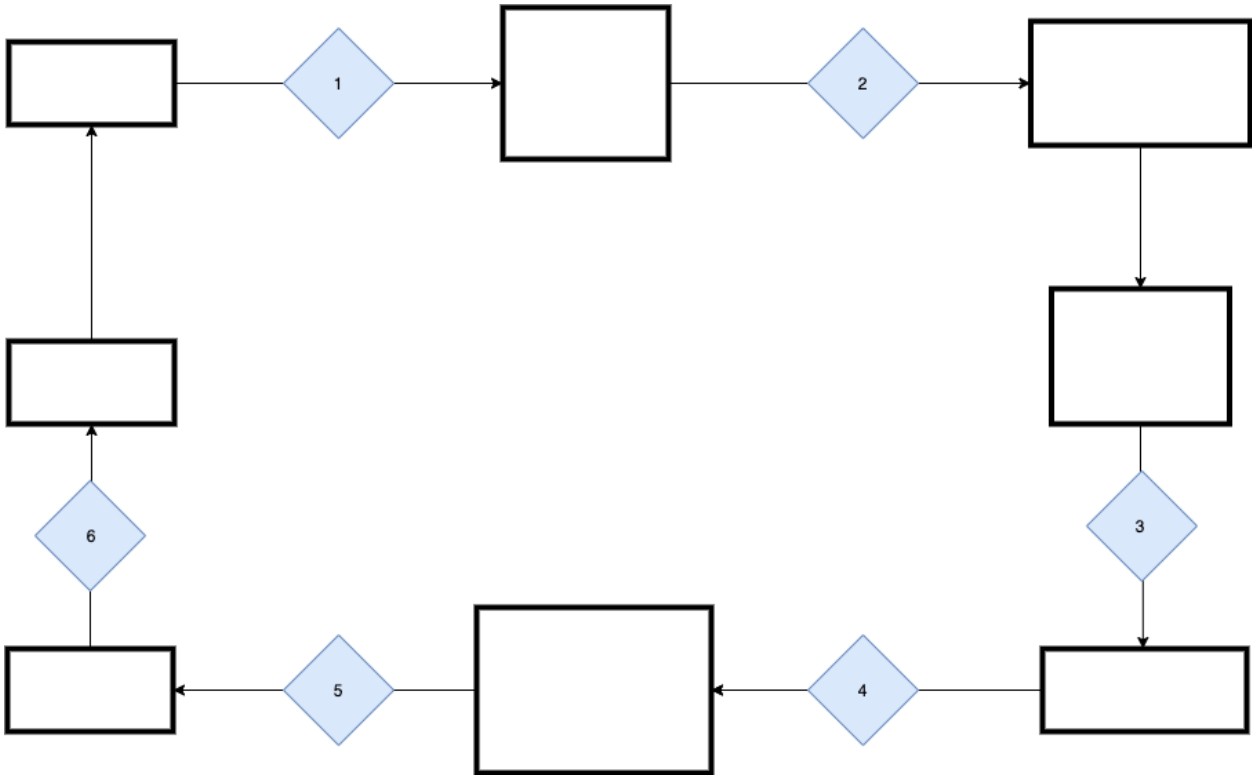
Double click this cell to identify when harvesting takes place in our model. Use the numbers in the diamons to identify when you think the salmon died due harvesting in our model.

10. **In the Callysto notebook, ask the students to "run" the code cells and mathematical model. They can do this by selecting "Cell" -> "Run All" from the menu.**
11. **Ask the students to interact with the application and answer the questions:**



a. Why does harvesting affect the even-year and odd-year populations differently?
b. What quota (how much salmon you harvest per year) kills one of the two populations in less than ten years?
c. What happens to the population that survives shortly after the other population dies?
d. What quota (how much salmon you harvest per year) kills the two populations in less than ten years?
e. Students can write a report where they include their answers to the questions above and also add a short reflection on the different methods for salmon harvesting used in a given region in Canada. Here are two sources for British Columbia.

    i. First Nations and Coast Salish Peoples **https://indigenousfoundations.arts.ubc.ca/aboriginal_fisheries_in_british_columbia/**
    ii. Fisheries and aquaculture **https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/fisheries-and-aquaculture**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