Science Unit: *The Journey of the Pacific Salmon*
Lesson 5: *Salmon and Non-Native Species*

School year:	2008/2009
Developed for:	Grenfell Elementary School, Vancouver School District
Developed by:	Jean Marcus (scientist), Jane Hughes and Gary Loong (teachers)
Grade level:	Presented to grade 3; appropriate for grades 2 – 5 with age appropriate modifications.
Duration of lesson:	1 hour and 30 minutes

Objectives

1. Review spawners, the Pacific Salmon life cycle stage that returns from the open ocean to natal streams to reproduce.
2. Introduce non-native species, also known as exotic, alien or introduced species.
3. Discover the consequences of interactions such as competition between non-native species (e.g. Atlantic salmon) and native species (e.g. Pacific Salmon).

Background Information

Salmon at any stage of the lifecycle can interact with non-native species. Non-native species are introduced organisms (animals and plants) that are not indigenous to a given location. Species that live outside of their natural range are also called aliens or exotics, and are currently one of the major threats to biodiversity. People are responsible for introducing these organisms, either by accident or more commonly with intention. In Canada, alien species are still being imported intentionally from various places around the world for use in many areas, from agriculture and horticulture to the pet trade to medical and scientific research. A famous introduction is the zebra mussel, native to the Caspian Sea area of Asia, which was brought to North America in ship's ballast water in the late 1980s. The zebra mussel has subsequently wreaked havoc on the Great Lakes ecosystem.

This lesson will focus on two non-native species which can negatively impact Pacific salmon: Atlantic salmon and the water lily. Salmon farms on the BC coast mostly cultivate Atlantic salmon because they grow and survive better under farming conditions than Pacific salmon. However, problems arise when nets break and farmed Atlantic salmon escape into BC waters. These non-native salmon may compete with wild Pacific salmon for food and habitat. Atlantic salmon may also predate on the juvenile stages of Pacific salmon and they can carry diseases and parasites (e.g. sea lice) that are detrimental to native salmon. Another invasive species that can indirectly harm Pacific salmon is the fresh water plant, the water lily. Once established in small lakes and ponds this species proliferates quickly and accelerates the process of the small bodies of water turning into bogs and eventually forest floor. The water lily can thus reduce Pacific salmon spawning habitat. This is thought to have happened at Beaver Lake in Stanley Park, BC. This lesson explores the possible impacts of introduced Atlantic salmon and invasive water lilies on Pacific salmon survival and habitat.

Vocabulary

Word:	Brief definition.
Non-native	An introduced species (also known as an alien or exotic species) is an organism that

species	is not indigenous to a given location.
Atlantic salmon	A species of fish in the family Salmonidae (*Salmo salar*) with a natural range in the northern Atlantic Ocean.
Water lily	Tuberous plants, rooted in soil with leaves and flowers floating on the water surface. Typically belong to the Family Nymphaeaceae.
Ecological Competition	The interaction of two (or more) organisms (or species) such that, for each, the birth or growth rate is depressed and the death rate increased by the presence of the other organisms (or species).

Materials

Competition Game

- Scissors
- Worksheet 1: page 1 = game board with Pacific salmon, page 2 = water lily playing pieces, page 3 = Atlantic salmon playing pieces, page 4 = species key, page 5 = game rules, page 6 = game instructions
- Worksheet 2

In the Classroom

Introductory Discussion

1. Review the spawner stage of the salmon life cycle.
    - Who are spawners? How are they different from adult salmon?
    - Review the entire life cycle as today we are "closing the loop" (started with eggs, ending with spawners laying eggs).
2. Explain that salmon returning to the stream may encounter non-native species.
    - What is a non-native species? Give alternate names and examples.
    - Do you remember the salmon farms (Lesson 3)? Explain that most salmon farmed in BC are actually Atlantic salmon, not Pacific Salmon.
    - What will happen if Atlantic salmon escape from the farm nets? Review the many possible ways escapes may negatively impact native Pacific salmon.
    - What are water lilies? Explain they are an invasive species that can decrease available spawning habitat.
3. Brief description of the activities:
    - Activity 1: Competition game.

Science Activity

Activity #1: Competition game.

Purpose of Activity: Students integrate their learning about non-native species and their impact on Pacific salmon via competition and habitat loss.

Methods and Instructions:

Set-up prior to activity:

Assemble all materials (see Competition game materials above). Need to print out enough copies so each group of 5 students has a complete set (board game, playing pieces, species key and instructions).

In class activity, divide students into groups of 5:

1. Read the rules and instructions with the class before you start the game. See Worksheet 1 (pages 5 and 6).
2. Emphasize that each species (Pacific salmon, Atlantic salmon and water lily) requires 1 space to live.
3. The 5 instructions must be followed in order. Each student in the group takes a turn reading and following an instruction of the game. After each instruction has been followed, students answer the related question on Worksheet 2. For example, after instruction #1 is complete (Worksheet 1) students answer question 1 (Worksheet 2), after instruction #2 is complete (Worksheet 1), students answer question 2 (Worksheet 2) etc.
4. End with a discussion of the game's result. Results will differ slightly from group to group, but in general many Pacific salmon were lost due to competition with introduced Atlantic salmon and loss of habitat due to invasive water lilies.

Closure Discussion

This week the students do not end with the board game (game will be finished next week). After the lesson, ask each team one question that relates to today's work and if answered correctly the team moves to the end of the Estuary In section. Explain briefly the intent of next week's lesson: to review the entire life cycle, explore stream microhabitats, and discuss the relationship between people (recreational fishers) and salmon.

References

1. Government of Canada. Invasive species in Canada. http://www.invasivespecies.gc.ca

2. http://www.invasivespecies.gc.ca/English/view.asp?x=1Sanderson, B.L., Barnas,K.A., and Wargo Rub, M. 2009. Nonindigenous species of the Pacific Northwest: An overlooked risk to endangered salmon? *BioScience* 59: 245-256.

3. Volpe, J. P. et al. 2000. Evidence of natural reproduction of aquaculture escaped Atlantic salmon (Salmo salar) in a coastal British Columbia river. *Conservation Biology* 14(3): 899-903.

4. Volpe, J.P. 2001. Super Un-Natural. Atlantic salmon in BC waters. David Suzuki Foundation.

5. David Suzuki Foundation. Escaping Farmed Salmon Pose Risks. http://www.davidsuzuki.org/Oceans/Aquaculture/Salmon/Escapes.asp

6. Living Oceans Society. Escaped Atlantic Salmon. http://livingoceans.org/programs/fishfarms/environment/escaped_salmon.aspx

7. Department of Ecology, State of Washington, Non-native invasive fresh water plants (water lily). http://www.ecy.wa.gov/programs/wq/plants/weeds/aqua005.html

Name: _____

"Alien Species Game"

At the start of the game there are 10 open habitat spaces and 10 Pacific salmon occupying 10 habitat spaces.

Answer question #1 after you complete instruction #1, answer question #2 after you complete instruction #2, and so on.

1. Are any habitat spaces still open on the game board? _____
   If yes, how many? _____

2. Are any habitat spaces still open on the game board? _____
   If yes, how many? _____

3. Are any habitat spaces still open on the game board? _____
   If yes, how many? _____

4. Are any habitat spaces still open on the game board? _____

   How many Pacific salmon lost their habitat space to non-native Atlantic salmon? _____

5. How much of the Pacific salmon habitat was lost to the non-native water lilies? _____
   (hint: count all the spaces without water lilies)

Which salmon species was most abundant at the end of the game? Why?

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