STREAM TO SEA ACTIVITY High School

British Columbia Species: Native, Introduced or Invasive?

Prescribed Learning Outcomes met and Curriculum Organizers

It is expected that students will:

Science 10

Explain the various ways in which natural populations are altered or kept in equilibrium.

Biology 11

Describe the process of evolution.

Analyze the functional inter- relationships of organisms within an ecosystem.

Overview of Activity:

The goal of this activity is to have students consider the importance of biodiversity. University of British Columbia professor characterizes biodiversity as the "necessary, precondition for the long-term maintenance of the biological resources upon which humans depend". Students do this by becoming acquainted with the concepts of native, introduced and invasive and then playing a game of tag that shows how one of four known pairs of stickleback species pairs in B.C. went extinct.

Estimated Time: Step 1 is homework and Steps 2-4 can be completed in 2 hours. Step 5 the test will take about 30 minutes.

Season: anytime

Natural area required: playing field in good weather

Overview of Materials:

Backgrounder and Student Homework Worksheet

Suggested Assessment Activities: test and homework

Recommended Additional Resources:

Stickleback Pairs Species at Risk Brochure (6 pages)

http://www.env.gov.bc.ca/wld/list.htm

Native Species, Nature's Choice – Inquiry-base Lesson Plans on introduced species in Canada (24 pages)

www.wildeducation.org/programs/nww2003/nww2003booklet_e.pdf

Battle with the Alien Space Invaders – on-line game

www.wildeducation.org/maze_invasives/battle_mazecc.htm

Support may be available

Contact your local Stream to Sea Education Coordinator or community Advisor at www.streamtosea.ca

Step 1 – Student Homework

Give students one week to complete the homework worksheet. This can be an assessment. They are finding and documenting one example of each of the following:

Native Species

Native species are established within an ecosystem, having evolved there over thousands of years. (from p. 4, Introduced Species, Global Environmental Change Series)

Introduced Species

Introduced species have been brought to an ecosystem, intentionally or otherwise, through human activity. (from p. 4, Introduced Species, Global Environmental Change Series)

Invasive Species

Invasive species is capable of propagating itself and by doing so disrupting native ecological processes thus causing environmental and economic harm. (Adapted from Exotic Invasive Species: The Guests that Won't Go Home in Green Teacher, Summer 2006)

INTERESTING FACT: Researchers at Cornell University estimate that approximately 42 percent of the species designated as threatened or endangered in the U.S. are at risk primarily because of introduced species. (p.7 Green Teacher, Summer 2006)

Discovering whether a species is actually invasive (causing economic or environmental harm) will likely be the most difficult part of this homework assignment. Have the students use the Canadian Wildlife Federation web-site. The CWF hosts the Invasive Species in Canada database on their web-site. You can search there for invasive species.

Step 2 – Classroom Discussion

If possible invite a specialist from your area. The Ministry of Forests may have weed specialist, the Ministry of Environment an Invasive Species Coordinator or a local group (environmental, agricultural) may have a willing speaker.

Have some of the students present their examples and discuss them with the speaker.

Introduce the Backgrounder on stickleback pairs in BC to the class. Break the students into three groups. If you have time download a more complete version from http://www.env.gov.bc.ca/wld/list.htm and provide one copy to each group. Assign one of the following topics to each group and ask them to prepare a short presentation;

1. Habits Of Stickleback Pairs
2. Process Of Evolution in Stickleback
3. Threats And Why Should We Care?

Step 3 – Game

Take the students to a gymnasium or a playing field. Have them mark off a large round open space which represents Hadley Lake, B.C. Select two students to be an invasive species – catfish. Tape a sign on their front and back. They hold hands. Explain the species is going to reproduce and spread, eating native species like stickleback and their food. All of the other students are stickleback. The catfish pair run around tagging stickleback. Every time the catfish pair line tags a stickleback, the stickleback must join hands with the person who tagged it. The symbolism here is that the stickleback died and is now part of the catfish. When the line reaches ten in length it splits into two groups of five that can pursue the remaining stickleback. The thrilling climax occurs when there is only one stickleback left to put up a heroic last-ditch effort on behalf of health and biodiversity. Make a big deal of the last stickleback. This game simulates the situation at Hadley Lake situation where the stickleback are made extinct. You can recognize the last stickleback with a prize.

You should play the game at least three times and document how quickly the stickleback become extinct. Stop the game at 30 seconds, 1 minute and so on so a count be made as in the chart below.

THE INVASION OF THE CATFISH INTO HADLEY LAKE, B.C.

TIME	#Catfish	#Stickleback

Step 4: - Debrief

Have the students talk about how quickly stickleback went extinct both in the game and in relative time (probably decades as opposed to evolutionary time of millions of years for change).

Once the concept of extinction has sunk in have the students consider how they would use education and communication to change peoples' behaviours. Have them pretend that they are the leader of the Texada Stickleback Group Association – a real group by the way. They have about $5,000 funding from the Habitat Stewardship Conservation Program – a real funder. Have them consider:

- What behaviours they need to change
- Who they need to reach
- Why that group is not changing
- How they would reach that group

Step 5: - Test

Students can take the test provided. You may want them to complete the test in groups that each include at least one representative from each presentation group above, i.e. mix the original 3 groups created for presentations.

The Case of Stickleback Pairs in B.C.

BACKGROUNDER

The stickleback is abundant in coastal waters throughout the northern hemisphere, and has fascinated scientists since it was first formally described by Linnaeus in 1758. Researchers have used the stickleback as a model organism for studying many topics including: mate choice and courtship; learning and cognition; evolution and speciation and, more recently, environmental monitoring, genetics and gene mapping. "These fish have been compared to the Galapagos Finches of Darwinian fame"![1]

The Habits of Sticklebacks

One unique aspect of sticklebacks is that in several ecosystems they are a pair of species. There is a benthic (bottom-feeding) species and a limnetic (open-water feeding) species. The benthic species forage along the bottoms of the shallow margins of the lake foraging for relatively large prey such as snails, clams and dragonfly nymphs. The benthic species eat similar food types throughout their life, shifting to larger prey as they themselves get bigger. The limnetic species feeds on tiny plankton at the lake edge among the reeds and submerged plants when it is young. Here the young stickleback can hide from predators such as cutthroat trout. As individuals get older the limnetic species hunts in large schools in the open waters of lakes. There they feed on water fleas and other tiny animals. Since they have different diets in the same lake, and feed in different places, the two species of stickleback do not compete with one another.

Process of Evolution

Stickleback species pairs are among the youngest species on earth.[2] In the life sciences, species are said to 'evolve' when there is a change in the traits of living organisms over generations. Stickleback pairs evolved at the end of the last glaciation – 13,000 years ago which is relatively quick since species usually takes millions of years to evolve. As the glaciers receded some of the young sticklebacks stayed in lakes and streams surviving without a migration to the sea. These would later be known as the benthic species. When shifting sea levels restored access to the sea a second population 'invaded', probably the limnetic species. The benthic population did not see these 'new' sticklebacks as potential mates and two distinct species may have evolved. In British Columbian the life histories of at least four pairs of sticklebacks have been described. There are species pairs living in Enos Lake, Paxton Lake and lakes connected by Vanada Creek [Priest, Balkwill, Emily lakes]. The Hadley Lake species are extinct.

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[1] From Royal British Columbia Museum web-site on Nov. 9, 2006

[2] Brochure published by the Habitat Conservation Trust Fund , February, 1999. http://wlapwww.gov.bc.ca/wld/documents/stickleback.pdf

Two Ways Stickleback Populations Have Been Altered
Catfish, an invasive species, caused the extinction of stickleback species in Hadley Lake, BC. Species pairs in other lakes are also threatened by invasive species such as pumpkinseed fish, sunfish and brown bullheads. Crayfish are a threat in Enos Lake. The second threat is land development causing effects like soil erosion. The species pairs have been responding to the increased turbidity in the lakes in which they live by hybridizing thus reducing two populations to one. One hypothesis is that turbidity may make it impossible for females to differentiate the males of each species and thus interbreeding occurs. Another hypothesis is that since crayfish in Enos Lake have eaten all the vegetation, the two species were forced to breed in the same microhabitats (benthics species normally nest under vegetation) increasing hybridization.

Ethical, Responsible and Cooperative Behaviour
University of British Columbia professor Paul M. Wood argues that current legislation in Canada is unlikely to conserve unique and rare species like stickleback pairs.

"On a case by case basis, the perceived value of individual species can seldom compete with the value of the development projects that annihilate them. Increment by increment, development continues to win and species lose." (Lovejoy in Wood in Perspective, p 6)

Scientists seem to agree that nothing less than a change in paradigms is required. We have to begin seeing humans as part of an intricate and diverse web rather than as resource developers in an endlessly providing world. Humans must value an economy that depends on a healthy environment not one that proceeds independently from it.

" Biodiversity is valuable precisely because it is a necessary, precondition for the long-term maintenance of the biological resources upon which humans depend. It should be given priority and not traded-off against resource values, as if they were on the same logical plane." (Wood in Perspectives, p. 6)

Marveling at the evolution of stickleback pairs, loving the bright red throats and blue eyes of mating males and being fascinated by their feeding behaviours are ways in which we can come to appreciate another creature in the diverse ecosystems in which we live. When these attitudes of wonder spread, humans may conserve species and ultimately their own health.

HOMEWORK DESCRIPTION
Who's Who in your Neighbourhood

One of the first thing you might be asked when you're getting to know someone is "Where are you from?". But have you ever thought about where the plants and animals in your neighbourhood come from? You may be surprised to find that they're not all from North America originally.

Do some research on birds, plants, insects and animals you commonly see until you have found one native, one introduced and one invasive species.

Native Species

Native species are established within an ecosystem, having evolved there over thousands of years. (from p. 4, Introduced Species, Global Environmental Change Series)

Introduced Species

Introduced species have been brought to an ecosystem, intentionally or otherwise, through human activity. (from p. 4, Introduced Species, Global Environmental Change Series)

Invasive Species

Invasive species is capable of propagating itself and by doing so disrupting native ecological processes thus causing environmental and economic harm. (Adapted from Exotic Invasive Species: The Guests that Won't Go Home in Green Teacher, Summer 2006)

Use identification guides and the Internet to help you determine the name of the species and whether it is native or introduced. The Canadian Wildlife Federation hosts the Invasive Species in Canada database on their web-site. This web-site will help you find out whether an introduced species is invasive.
HINT: invasive means causing environmental and economic harm

Fill out the attached sheet and bring it to school as well as any documentation you have of the native, introduced and invasive species, e.g. illustration, rubbing, photograph.

Who's Who in your Neighbourhood – Homework

STUDENT NAME: _____

DATE: _____

Native	Introduced	Invasive
EXAMPLE: **Bald Eagle** Haliaestus leucocephalus Indigenous to N. America	**EXAMPLE:** **Japanese Maple** Acer palmatum Originally from China, Korea and Japan	**EXAMPLE:** **Purple Loosestrife** Lythrum salicaria Introduced from Europe in the 1800s as seed contained in soil used as ship's ballast.

NOTE: Attach your documentation for each species to this page.

Student Test-Questions

1. **Describe the difference between native and introduced?**

2. **When does an introduced species become invasive?**

3. **Are catfish an introduced or invasive species? Why?**

4. **What does it mean to evolve?**

5. **How did stickleback living in the ocean evolve into two different species living in lakes?**

6. **What makes two species a pair?**

7. **Describe at least one food and one habitat requirements for each of the benthic and limnetic stickleback.**

8. **Describe the two main threats to stickleback pairs in British Columbia.**

9. **How can diversity in living things help humans?**

Student Test

10. **Describe the difference between native and introduced?**
    Native species are established within an eco-system, having evolved there over thousands of years. Introduced species have been brought to an ecosystem, intentionally or otherwise, through human activity. Most introductions have happened during the last century.

11. **When does an introduced species become invasive?**
    When it disrupts native ecological processes thus causing environ-mental and economic harm.

12. **Are catfish an introduced or invasive species? Why?**
    Catfish are invasive because they are impacting the lives of stickleback by eating them and their food.

13. **What does it mean to evolve?**
    Species are said to 'evolve' when there is a change in the traits of living organisms over generations.

14. **How did stickleback living in the ocean evolve into two different species living in lakes?**
    Glacial melt brought the first introduction of stickleback to lakes where they probably stayed as a benthic species (feeding near the bottom of the lake). In the next glacial melt stickleback that invaded lakes and stayed were probably the limnetic (feeding in the open water) species.

15. **What makes two species a pair?**
    We call two species a pair when they live in the same lake. All the stickleback populations are descended from the same marine ancestor, but the limnetic and benthic of a pair are not each other's closest living relative.

16. **Describe at least one food and one habitat requirements for each of the benthic and limnetic stickleback.**
    Benthic food: snails, clams and dragonfly nymphs
    Benthic habitat: bottom of shallow margins of lakes
    Limnetic food: microscopic animals and water fleas
    Limnetic habitat: open water areas of the lake

17. **Describe the two main threats to stickleback pairs in British Columbia.**
    The two main threats for stickleback pairs in British Columbia are invasive species and habitat alteration that leads to erosion**.**

18. How can diversity in living things help humans?

Some scientists believe that life on earth is like an intricate web, part of the environment and species are like the strands of the web. When we impact either we weaken the web. This reduces the ability of the web to support what remains, including humans.