Designing Fish-Friendly Culverts (and bridges)

OVERVIEW:

Students will demonstrate how a poorly designed culvert impacts fish and the environment, and design a fish-friendly culvert (or bridge).

OBJECTIVES:

- Demonstrate a basic understanding of why fish migrate.
- Identify potential barriers to fish migration.
- Identify potential biological and environmental problems associated with culverts that are not fish-friendly.

TIME REQUIRED: 1- 2 hours

KEY ISSUES/CONCEPTS:

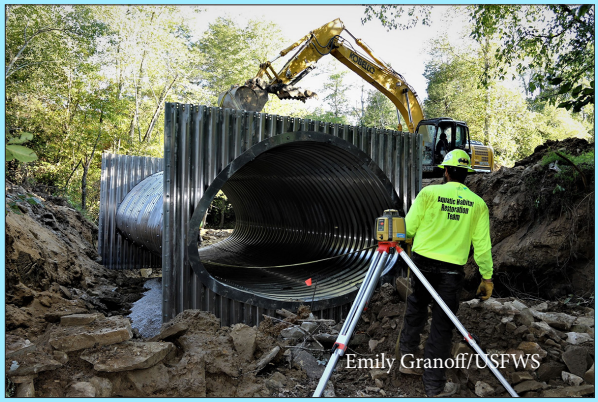
- Fish migration
- Fish passage
- Habitat fragmentation
- Aquatic connectivity
- Environmental sustainability

SUBJECT AREAS:

- Social Studies/History
- Science
- Math
- Engineering
- Art
- Language Arts

CORRELATIONS TO:

- NGSS:
  - Disciplinary Core Idea, ETS1.A, Defining and Delimiting Engineering Problems
  - Disciplinary Core Idea, ESS3.C, Human Impacts on Earth Systems
  - Disciplinary Core Idea, LS2.A, Interdependent Relations in Ecosystems
- STEM or STEAM



GRADE LEVEL: 5 - 8

VOCABULARY:

- **Aquatic connectivity:** Lakes, rivers, wetlands and oceans have connections between and within each other that allow fish to move from place to place.
- **Culvert:** A structure designed to allow streams and rivers to flow under a road, railroad or trail, from one side to the other side.
- **Diadromous:** Two-way migration which generally refers to fish that spend part of their life in saltwater and part in freshwater. Some diadromous fish, however, spend their entire life in freshwater.
  - **Anadromous:** A fish that is born in freshwater, then migrates to the ocean (saltwater) to grow into adulthood before migrating back into freshwater to spawn. Examples: American shad, Atlantic sturgeon, Atlantic and Pacific salmon, and Pacific sea lamprey.
  - **Catadromous:** A fish born in the ocean that returns to freshwater as a juvenile before migrating back to the ocean to spawn. Example: American eel.
  - **Amphidromous:** A fish that migrates from fresh to saltwater or from salt to freshwater at some stage of the life cycle other than the breeding period. Example: Hawaiian goby.

VOCABULARY: (cont'd)

- **Potamodromous:** A fish that lives in freshwater but migrates between spawning and feeding grounds - usually between a river and a lake, but sometimes they migrate within a river system. Example: lake sturgeon, Colorado pikeminnow, American paddlefish.
- **Fish passage:** Places where fish can move between oceans, rivers and lakes, including upstream and downstream within a river. Sometimes, structures are removed or built to allow fish passage around barriers to their migration.
- **Habitat fragmentation:** Habitat within and between water bodies that is fragmented, or not connected, making it challenging for fish to reach spawning and feeding grounds.
- **Migration:** The movement from one place to another, and in many cases, back again.
- **Road-stream crossings:** A bridge, culvert or other structure constructed to allow a road (or railway) to cross a stream.
- **Spawn:** The process of fish reproduction, fish deposit eggs or release sperm to fertilize eggs.
- **Spawning grounds:** A place where fish lay their eggs for fertilization.

MATERIALS/PREPARATION:

- Miscellaneous art supplies
- Note paper
- Heavy cardstock or construction paper
- Various cardboard tubes
- Rulers
- Tape and/or glue
- Popsicle sticks and pipe cleaners
- Clay

BACKGROUND:

Lesson Introduction Video: Did you know? Fish migrate too! https://youtu.be/KzlBtMFc43s

You and I need transportation connections like roads and sidewalks to help us get from place to place in our daily lives, whether we are returning home from school or going to visit friends and family that live far away. For fish, waterways are their highways and how they get from place to place. They need connections between and within these waterways to reach unique places (or habitats) where they can spawn, feed, find shelter, and escape extreme temperatures or high and low water flows.

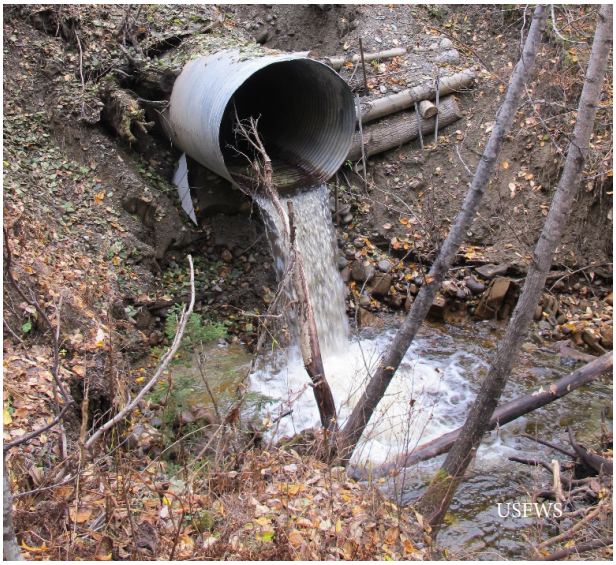
Most of us are familiar with the seasonal migrations of birds, we see and hear them every spring and fall. But did you know that underneath the surface of our waters, swimming up and down our rivers are millions of diadromous fish migrating every year from the oceans to the rivers, and then back to the ocean again to complete their life cycle. There also are millions of fish that spend their entire life in freshwater, and they too are migrating thousands of miles up and down big rivers like the Mississippi, the Missouri, the Connecticut, and Colorado … just to reach their special spawning grounds. And then there are some fish that stay closer to home in their freshwater environments, but still move to find places to feed, spawn and places for young fish to grow. No matter whether they are long-distance travelers or home-bodies, large or small, all fish need connected aquatic habitats.

Millions of road–stream crossings and dams, irrigation ditches and other man-made structures have changed the flow of water, reducing aquatic connectivity between rivers, wetlands and oceans. These structures cause the habitat to become fragmented, and often prevent fish from reaching those places where they reproduce, grow, and survive. Culverts are frequently installed where roads cross rivers or streams, they are less expensive and easier to install than a bridge, but they can also cause habitat fragmentation. Some culverts, may not be large enough to accommodate the size of the river or seasonal water flows, which impacts the ability of fish to swim through the culvert. Culverts not designed with fish in mind not only prevent fish from moving up and downstream, they can cause erosion and flooding upstream of the culvert.

All across the United States, there are federal and state biologists, natural resource managers, local citizens, engineers and city planners working together to restore our rivers, lakes, wetlands and coastal areas for fish and people.

How many culverts do you cross on your route to school or to the store or to a friend's house? Think about how frustrating it would be if you could not get to where you wanted to go, much less where you needed to be in order to find food or a place to rest.

before



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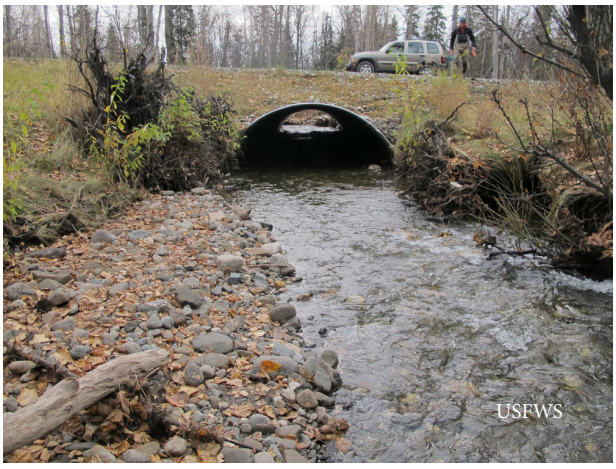

PROBLEM: [Note: See The Problem with Blue Brook]

PROCEDURE:

1. Optional: show students examples of before and after construction of fish-friendly culverts, or let students design first prior to showing examples.
2. Provide art supplies to students.
3. Divide students into small groups and determine who will be the activity note-taker.
4. Provide students with lesson Background about fish migration.
5. Generate an initial discussion with students on barriers that might affect fish passage. What are some man-made barriers affecting fish passage?
6. Have students generate a list of man-made barriers. Ask the groups to share their lists. [Note: The Problem presented is on culverts, if culvert is not included in student lists, introduce before continuing lesson.]
7. Present the lesson Problem, The Problem with Blue Brook. [Note: You can show examples of culverts, or let students design first.]
8. Provide students with the culvert handout: Structure Shapes.
9. Students work together in their groups and review the lesson problem; they brainstorm attributes of a fish-friendly culvert, and ways to design a culvert that improves fish passage. [Note: See Things to Think About as You Design Your Culvert.]
10. Students will design and build a fish-friendly culvert as a solution to the lesson problem.
11. Groups will display their designs and explain how they came to their conclusions.
12. After student designs are presented, share After Photo of the installed culvert design implemented by biologists. [Note: See lesson photos.]

ASSESSMENTS

Pre-Activity Assessment: Briefly evaluate student's knowledge of fish migration and barriers to migration. Ask students to provide examples of what might be a barrier to fish movement. Encourage all responses, write examples on whiteboard or flip chart. After a few minutes, review the list, if culvert is included, explain that it

is a type of barrier and the focus of the lesson. If culvert is not listed, include as another example. [Note: Procedure 5 and 6 can serve as a pre-activity assessment.

Post-Activity Assessment: Student groups illustrate, design and construct a fish-friendly culvert, each group presents their culvert design and explains why it would resolve the problem presented.
Discussion questions:

- What problems are created by a culvert that is too small in relation to the width of the stream?
- If the bottom of the culvert outlet is above the stream (this is called perched), what problems can this create in the stream and for fish?
- What are some possible environmental impacts from culverts?
- What happens to fish populations over time if fish can't reach their spawning grounds?
- What impacts might habitat fragmentation in rivers have on fish in the oceans?
- How can fish-friendly culverts help sustain fish populations worldwide?
- Why might people want more fish-friendly culverts?

ACTIVITY EXTENSIONS:

- What Makes Migration Tough Matching Game
  - In-class activity - Observe What Makes Migration Tough poster, and discuss obstacles to fish migration. Handout copies of the poster (legend covered) and student worksheet. Students match numbered obstacles with descriptions on their worksheet. Answers are provided on educator copy; students can self-check to original poster with legend.
- Introduce students to the concept of fish migration, aquatic connectivity and barriers to fish movement. Provide a list of barriers from the poster, What Makes Migration Tough. Have students research various barriers to fish migration and then discuss in class.
- Students research fish barrier problems and prepare a plan or design to solve the problem.
- Conduct a case study of a local fish passage issue and analyze how fish passage was resolved.
  - What criteria were considered in making the decision to install a fish passage structure? Is it working? What problems do the students see with the design? And would they recommend a different or better solution?
- Design a monitoring program to evaluate fish passage effectiveness at a culvert, or at a dam.
  - Describe the monitoring concept, develop a list of materials and describe methods to be used. Determine how data from the monitoring plan will be collected. Discuss how the monitoring results can be used to help resource managers.
- Investigate and write a report on the social, environmental and economic impacts of barriers to fish passage. Think about impacts to fish populations over time, impacts to the fishing industry, and impacts to the quality of the river habitat and to private property along the river.

RESOURCES:

National Fish Passage Program, http://bit.ly/2reAr1O

Fish and Aquatic Conservation, Migratory Fish Handouts, http://bit.ly/2rgHtmP

Project Wild, Aquatic, http://www.projectwild.org/aquatic/

Project Wet, http://www.projectwet.org/

U.S. Forest Service Stream Simulation Design, http://bit.ly/2xtQE8j

North Atlantic Aquatic Connectivity Collaboration, https://streamcontinuity.org/

Flood Effects on Road-Stream Crossing Infrastructure: Economic and Ecological Benefits of Stream Simulation Designs, http://bit.ly/2ffG8us

The Importance of Healthy Floodplains to Pacific Salmon and Steelhead, http://bit.ly/2xumulb

VIDEOS:

A River Flows Free in New Haven, CT, http://bit.ly/2xuQjCg

Fish passage problems and solutions, K. Liebich, https://vimeo.com/185348321

Did You Know? Fish Migrate Too!, http://bit.ly/2oilHw5

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