Everblue Education

From Oceans to Rivers

In this lesson, students will learn about the importance of salmon and other fishes that migrate between the ocean and rivers, as well as human impacts. This lesson is based on a paper that explored the effects of damming rivers in the northeastern United States.

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Research Paper:
Damming, lost connectivity, and the historical role of anadromous fish in freshwater ecosystem dynamics. *Steven Mattocks, Carolyn J. Hall, and Adrian Jordaan. 2017.*

Grade Level:	Timing:
Elementary School, Grades 1-5	1 hour

Materials:
Chalk *or* painter's tape; printer and scissors *or* blank sheets of paper and writing utensils; string/dry spaghetti/toothpicks/*something* to visualize connections

Next Generation Science Standards

Science & Engineering Practices:	Crosscutting Concepts:	Disciplinary Core Ideas:
Using Models	Energy & Matter Stability & Change	Ecosystems: Interactions, Energy, & Dynamics Earth & Human Activity

Activity Overview

Title of Activity	Learning Cycle Stage	Time
River Travelers	Invitation, Exploration	10 minutes
Food Webs	Exploration, Concept Invention	15 minutes
Chutes and Fish Ladders	Application	30 minutes
Reflection	Reflection	5 minutes

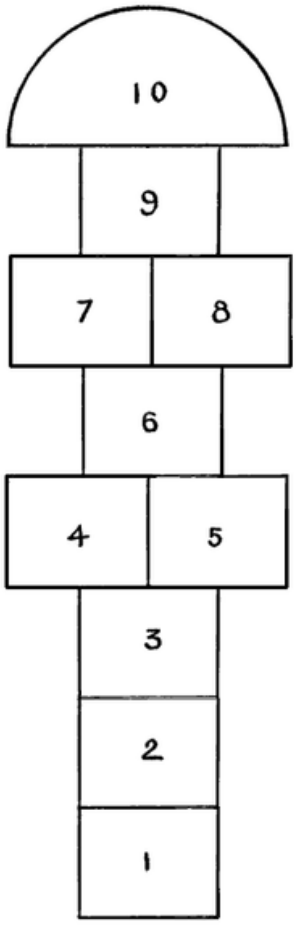
Appendix Contents

Appendix I Instructor Support	Appendix II Attached Lesson Materials
Ocean Vocabulary Common Questions	Critter Cards for Food Webs Activity Game Board for *Spillways and Fish Ladders* Playing Pieces for *Spillways and Fish Ladders* Playing Cards for *Spillways and Fish Ladders*

Activity

River Travelers

Follow the rules below to play a fun and fishy game of river hopscotch! For this activity, you will need chalk (if playing outdoors) or painter's tape (if playing indoors) to draw the hopscotch game. Let's call it our "river." You will also need two objects such as small pillows to use as river obstacles.



1. Set up the game by copying the hopscotch playing field to the left of these instructions. If you're playing outside, use chalk to draw it. If you're playing inside, use painter's tape to mark it on the floor.
2. Have the students one at a time hop down the hopscotch field, hopping with one foot on numbers 1, 2, 3, 6, and 9, and two feet on numbers 4 & 5, 7 & 8, and 10. Once the students reach 10, have them turn around and hop all the way backwards.
3. Place one of the small objects on square 3. This will be our first obstacle! Have the students hop down the hopscotch field again, with the same rules for footing, but this time, they have to hop *over* square 3 with the pillow.
4. Place the second small object on square 9. Have the students hop down the hopscotch field, this time hopping over squares 3 and 9.

Ask your students which hopscotch game was easiest to play: no objects in the path, one object in the path, or two objects in the path? Why?

Fishy Food Webs in Raging Rivers

In this activity, students will be exploring how salmon are tied to lots of other organisms in their river ecosystems through **food webs**. For this activity, you will need to print the Critter Cards included in Appendix II. You'll also need something your students can use to connect the Critter Cards together into a food web, such as string, dry spaghetti, or toothpicks.

Start by asking your students about the energy flows in their own lives. For example, grass turns energy from the sun into the energy it needs to grow, a cow eats the grass and gets that energy, then we eat the cow as a hamburger and get energy from that.Where do they get their energy from? What kinds of things do they eat? How do the things that they eat get their energy (i.e. what is eaten by the plants and animals that we humans eat).Use their answers to these questions to construct a simple **food chain** that they are a part of. All energy comes from the sun and is passed up the food chain. We need plants to convert solar energy into other forms of energy. There is a blank food chain included in Appendix II that you and your students can fill in together!

Now that they understand the basics of food chains, it's time to explore deeper. Every living thing on earth is part of a food chain! That includes salmon. Use the Critter Cards to help your students construct a food chain involving salmon. Their food chain starts with phytoplankton. Phytoplankton are tiny plants in oceans and rivers, so they are the ones converting the sun's energy into food for themselves and other animals. This makes them **primary producers**. These tiny plants will be eaten by **zooplankton**, which are tiny animals. Baby salmon can then eat the zooplankton. Young salmon make great food for birds like kingfishers. If the salmon survive and grow long enough, they can become food for many other animals, like black bears, river otters, humans, and even trees! Yes, trees; when the salmon die, their bodies decompose in the river and on its banks. This provides extra nutrients to the trees which grow along the river.

Once your students have made a salmon food chain, have them work to expand it out to a food web. What other interactions are there between these animals? For example, juvenile salmon are eaten by pikeminnow, could any other animals eat juvenile salmon? See how many connections you can make!

This should make it clear that salmon are important to the health of the whole river ecosystem. Now let's think about what would happen if salmon were removed from a river because a dam was built at the mouth, making it impossible for salmon to migrate up river from the ocean. What in our food web would change? What would stay the same? Is it possible to have a healthy ecosystem without salmon? Try manipulating the food web you've built to illustrate what the ecosystem would look like without salmon. It should become evident that many animals would be missing a major source of food without salmon around.

Spillways and Fish Ladders

Have you ever wondered what it would be like to be a salmon traveling upstream? In this game, you'll get to do exactly that! This game is called *Spillways and Fish Ladders,* and you'll get to travel as a river herring from the salty ocean water up the river to lay your eggs in the fresh water. River herring are **anadromous** fish, which means they spend their lives in the ocean and then travel up the river to **reproduce**. In the past, when rivers ran free, anadromous fishes like river herring, salmon, and steelhead could swim up the river without any barriers except for the natural ones in the river like the water current and rocks. In fact, some fishes like salmon can make huge jumps to get up steep areas in the river! But when people started putting **dams** in the rivers to try and control where the water would go, it made it really difficult for the fishes to make it up the river.

Dams have technology called **spillways** that make it easy for water to get through the dams, but after a while, people started wondering if we needed technology built into or near the dams that would allow fish to get *up!* This idea turned into **fish ladders**, which give the fishes places where they can jump up water "ladders" to make it past the dams and up the river to **spawn**, or lay their eggs.

In this game, each of you will be a river herring trying to make your way up a river that has both dams (which make it harder to get up the river) and fish ladders (which make it easier to get up the river)!

Print and cut out the game board, playing cards, and fish pieces in Appendix II of this lesson and follow the game rules below. Alternatively, if you do not have access to a printer, you can draw a game board with 25 squares (5x5) on a sheet of blank white paper and use small tokens as your playing pieces. A dice can also be used in lieu of the playing cards, as long as you make sure to read the playing cards with important fishy information out loud to your students!

GAME RULES

1. Have each player write their name on the back of their fishy playing piece to remember whose is whose.
2. Shuffle the playing cards and place them face down next to the game board.
3. Have every student place their fish on top of the river herring fish on space 1 on the game board.

4. Have students take turns in order from youngest to oldest. When it is a player's turn, they will pick the first playing card off the top of the deck, read it out loud, and move the amount of spaces forwards or backwards that the card specifies. *Note: there is one card that neither has the player move forwards or backwards - when this card is chosen, skip that player's turn for the round and have them pick another card as normal on their next turn.*
5. If a student lands on a space at the bottom of a fish ladder (spaces 3, 12, and 19,) they automatically get to hop their fish up the ladder to the space that the fish ladder connects with! (Space 3 moves forward to 7, space 12 moves forward to 20, and space 19 moves forward to 23.) Remember, fish ladders only go up the river, so if you land at the top of a fish ladder (spaces 7, 20, and 23,) nothing happens.
6. If a student lands on a space at the top of a dam (spaces 9, 16, 18, and 24,) they automatically have to slide their fish down the spillway to the space that the dam connects with. (Space 9 moves backward to 2, space 16 moves backward to 15, space 18 moves backward to 8, and space 24 moves backward to 17.) Remember, dams and spillways only go down the river, so if you land at the bottom of a dam (spaces 2, 15, 8, and 17,) nothing happens.
7. Keep picking cards until one student makes it all the way to space 25, past the dams and the fish ladders, and gets to lay their eggs! If you run out of cards, simply re-shuffle them and place them face down next to the game board.
8. When the game is done, have the students carefully put the pieces aside to play another time and move on to the discussion.

GAME DISCUSSION

After playing the game, have a discussion! What was a success or frustration you had while playing? Did hitting fish ladders and dams make it harder or easier to get to your destination? How do you think dams and fish ladders in rivers affect how fish can get upstream to lay their eggs? Do dams and fish ladders make rivers more or less connected to the ocean?

Reflection

As you and your student are cleaning up, talk to your student about what you just did together. Here are some guiding questions to help shape your conversation.

- ➢ What was your favorite part of our activity today?
- ➢ Did you notice any patterns during our activity today?
- ➢ What is something you wonder about anadromous fish?
- ➢ What surprised you the most during our activity today?

Appendix I - Instructor Support

Ocean Vocabulary

- Anadromous - fish that are anadromous spend parts of their life cycle in both oceanic and freshwater environments
- Dam - a barrier constructed in a waterway to control the flow of water
- Fish ladder - a structure that allows fish to swim over a dam which would otherwise block their migration upstream
- Food chain - organisms in an ecosystem that are linked together by consumption. Energy flows from primary producers to primary, secondary, and tertiary consumers.
- Food web - multiple overlapping food chains that represent the complexity of energy transfer within an ecosystem
- Primary producer - organisms that can capture energy from their environment to make and store organic compounds. For example, plants are primary producers that use the sun's energy to grow via photosynthesis, and they are the foundation of many food chains.
- Reproduction - the way that organisms create offspring by sexual or asexual means
- Spawn - the process that fish use to reproduce by laying eggs
- Spillway - channels that are built into the structure of a dam to control water flow
- Zooplankton - from the prefix *zoo*, meaning "animal" and *plankton*, meaning "drifter," zooplankton are animals (usually fairly small) that live in open water and are moved by currents.

Common Questions

What's the difference between fish and fishes?

Just like with deer referring to both individuals and groups of animals, fish is the plural of fish! However, fishes is also a commonly used term when referring to a group of fish that contains multiple species. So if you're talking about a group of salmon, you would say "fish," but if you're talking about a group of salmon and river herring, you would say "fishes."

Why do salmon migrate hundreds of miles upriver to reproduce?

When it is time to reproduce, salmon will swim from the ocean back to the exact same river or stream where they were born. The adults can remember the specific scent of their natal river (meaning the river where they were born) and can trace that scent from the mouth of the river. But why go to all the effort of traveling so far? By laying their eggs in rivers, salmon parents provide their young with a better chance of survival. Rivers are a safer habitat with fewer predators and more places to hide than the open ocean, so the fry (baby salmon) are more likely to live long enough to reproduce themselves.

Why do we dam waterways?

Dams are primarily used to generate electricity (hydropower) and to store water by creating reservoirs behind the dam.

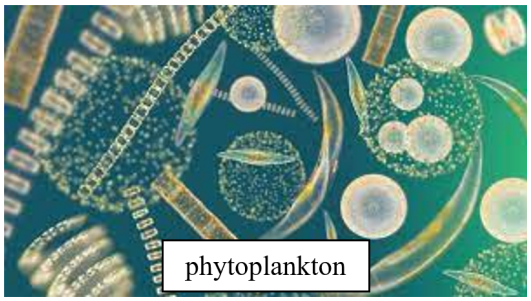
How do salmon reproduce?

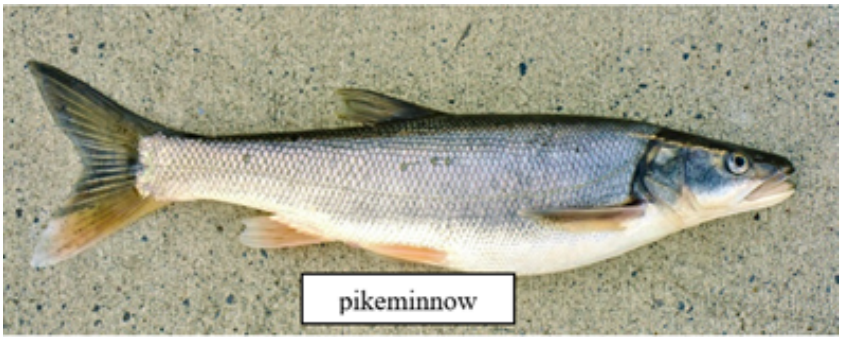
Salmon are external spawners, meaning that rather than the female carrying her babies inside her like us mammals do, eggs are fertilized outside the body. When adult salmon reach their natal streams, the females will find a nice patch of clean gravel and begin to dig a hole, called a redd, using her powerful tail. When the redd is ready, a male swims alongside her and they will both release their gametes (eggs and sperm) into the redd, so that the eggs can be fertilized. The female then carefully buries the fertilized eggs in gravel so that they are protected. Larval fish will grow inside the eggs and when they hatch, they are small enough to escape the redd by swimming out through gaps in the gravel.

Appendix II - Attached Lesson Materials

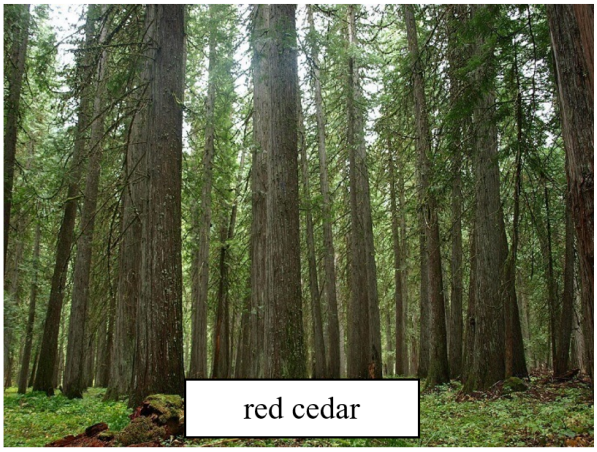
Critter Cards for Food Webs activity

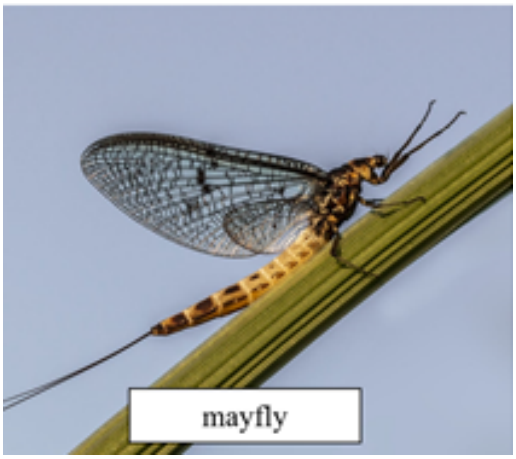
Primary producer (plants) | 1st consumer (herbivore) | 2nd consumer (carnivore)




pikeminnow


river otter

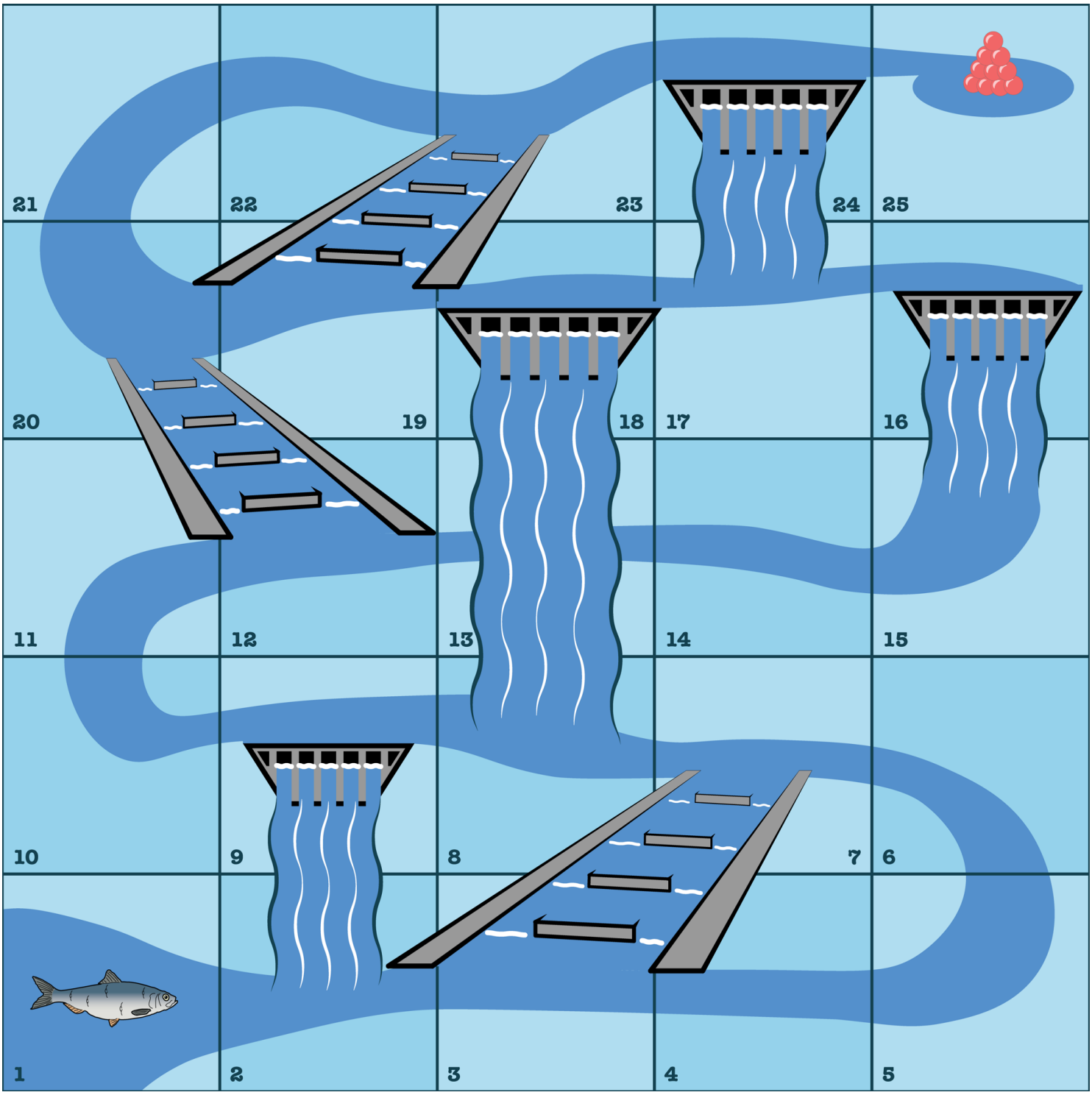

red cedar


mayfly

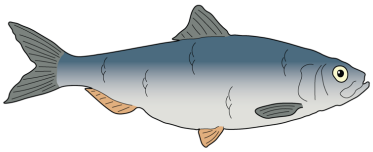
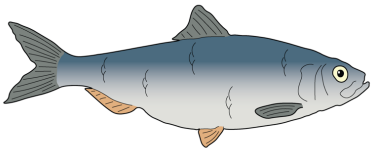
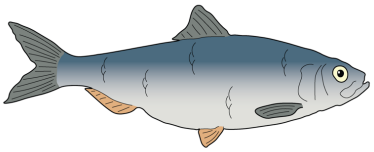
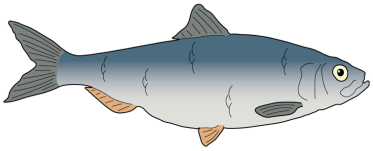
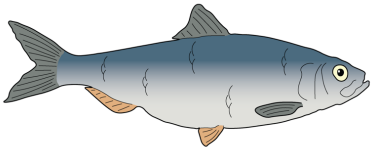
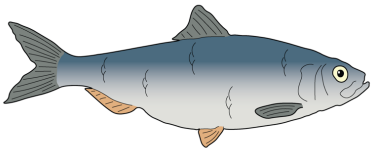

kingfisher


humans

Game Board for *Spillways and Fish Ladders*



Playing Pieces for *Spillways and Fish Ladders*

Playing Cards for *Spillways and Fish Ladders*

Just keep swimming! Move forward two spaces.	Just keep swimming! Move forward two spaces.	Just keep swimming! Move forward two spaces.	Just keep swimming! Move forward two spaces.	Just keep swimming! Move forward two spaces.
Just keep swimming! Move forward two spaces.	You come to a section of the river with no dams for miles. Hooray! You can swim without barriers! Move forward four spaces.	You come to a section of the river with no dams for miles. Hooray! You can swim without barriers! Move forward four spaces.	You come to a section of the river with no dams for miles. Hooray! You can swim without barriers! Move forward four spaces.	You come to a thin section of the river with reduced habitat from historic use of dams. You can't swim as fast in this area, so you can only move forward one space.
You come to a thin section of the river with reduced habitat from historic use of dams. You can't swim as fast in this area, so you can only move forward one space.	You come to a section of the river that used to have a reduced habitat, but it has since been restored through dam removal! You have more space in the river to swim, so you can move forward three spaces!	You come to a section of the river that used to have a reduced habitat, but it has since been restored through dam removal! You have more space in the river to swim, so you can move forward three spaces!	You hit a dam that is closed for this part of the season and doesn't have a fish ladder. Move backwards one space.	You hit a dam that is closed for this part of the season and doesn't have a fish ladder. Move backwards one space.
You come to a dam in the river that is currently closed, but will be open soon for spawning season. Because of this, you can't move forward - stay where you are until your next turn.	You come to a dam in the river that is currently closed, but will be open soon for spawning season. Because of this, you can't move forward - stay where you are until your next turn.	You come to a stream that has slower flows than normal because of a drought. Move forward one space.	You come to a stream that has slower flows than normal because of a drought. Move forward one space.	You come to a stream that has slower flows than normal because of a drought. Move forward one space.