Tale of a Scale

Grade Level
4-12

Subject Areas
Language Arts, Science

Time
45 minutes

Vocabulary
anadromous, circuli, cycloid scale, migration, otoliths, scale, smolt, smoltification, spawn

Summary

Students "read" a steelhead's life history by examining a scientifically accurate drawing of a steelhead scale.

Objectives

Students will...

- identify the stages in a steelhead's life cycle
- correlate different seasons with a steelhead's growth
- discover the effect life cycle events have on fish's health
- propose ways people can help steelhead and salmon

Materials

- copies of enlarged fish scale for each student
- transparency of scale to lead class in labeling
- markers, colored pencils, or crayons in the following shades: red, pink, light green, dark green and blue

Background

In this activity, we will examine a steelhead trout's scale. Although steelhead trout are the same species as rainbow trout, they have a different life cycle. Steelhead are anadromous, like salmon, meaning they hatch in freshwater streams, travel to live in the ocean for a few years, then return to freshwater to spawn (reproduce). Ocean-going forms of the trout can convert back to resident forms during droughts or when a dam blocks access to the ocean. Unlike salmon, steelhead do not always die after spawning and may live to spawn multiple times.

As we will learn, a trout's life history can be read in its scale. Steelhead and rainbow trout have very similar scales. However, because the steelhead is anadromous, its scales will "read" a little differently and show more life events than a rainbow trout.

There are four types of fish scales - placoid, cycloid, ctenoid (pronounced 'ten-oid'), and ganoid. Trout, salmon, and most bony fish have cycloid scales. Fish with cycloid scales have the same number of scales their entire lives - the scales enlarge to accommodate growth. This results in a pattern of concentric growth rings on the scale, which look similar to the growth rings in the trunk of a tree. The growth rings on a scale are known by scientists as circuli (singular circulus).

Just like counting the rings of a tree, biologists can determine a great deal of information about a steelhead by reading its scales with a microscope. The age of the fish, time spent at sea and the number of times it has spawned can all be determined.

So, how do biologists do this? Actually, aging fish is fairly easy. The development of circuli is similar to that of tree rings. During periods of rapid growth, the rings are widely spaced and when growth slows, the rings are more tightly spaced. Rings are formed on a cycloid scale every few months, so biologists can read into seasons, rather than just years with trees. Steelhead grow rapidly in the summer months when water temperatures and food availability are highest; they experience slower growth during the colder winter months. Therefore, steelhead scales typically exhibit alternating bands of widely spaced (summer) and narrowly spaced (winter) growth rings.

Two specific life events can also be seen in a steelhead's scale - smolting and spawning. As a young steelhead prepares for life in saltwater, its body undergoes tremendous change. A silvery sheen replaces the parr marks, and they undergo a complex internal transformation to survive in saltwater. This process of adapting and migrating to saltwater is called smoltification. The steelhead's scale shows a smolt mark - a bold band separating circuli formed previously in freshwater from those formed in saltwater.

The other life event impacting steelhead is spawning. While a steelhead migrates and fights its way back upstream to its place of birth, it is beaten up by the current, is hurdled over rocks and falls, and is weakened by bacteria and fungus. In addition, steelhead do not eat while spawning and rely solely on energy reserves built up in the ocean. Spawning steelhead decrease in size as they use up their energy reserves to fight the current. It is believed that the scales soon become too big for a shrinking steelhead, and the scales' edges become worn and eroded, forming spawning scars.

In addition to viewing a trout's scales to age a fish, biologists can also collect and examine otoliths. The otolith (which literally translates to "ear stone") is a small bone that floats in a fluid-filled capsule located near the base of a fish's skull. They help a fish balance and maintain equilibrium. Otoliths also show growth rings so may be used to age fish. They are generally considered more accurate than scales (particularly for older specimens). However, the fish must be dead before an otolith is removed. Therefore, scale reading is less invasive.

Procedure

1. Discuss the life cycle of a steelhead. Explain that steelhead are the same species as rainbow trout, with one important difference - steelhead are anadromous. This background will allow students to hypothesize and interpret the meaning of the scale's markings.

2. Begin by asking the class if the small fry in their aquarium will grow more scales as they get bigger. Will they have all the scales right now that they will have for the rest of their lives?

   - Explain how steelhead (just like trout) have the same scales throughout their lives and that the scales grow with the fish.

3. Pass out copies of the scale drawing and coloring utensils. Have students observe the scale. Does this remind them of anything else found in nature?

   - A tree's rings. If you have a picture or tree cookie, compare it to the drawing of the scale.

4. Discuss tree rings and how they are formed. Each tree ring is a layer of wood cells produced in one year. Does a tree grow the same amount every year? Are the rings all the same size? Why not?

   - Each year brings different weather and a different growing season. A drought one year won't allow the tree to grow much while a wet and warm year will promote tremendous growth.

5. We can see the same is true with steelhead. The rings are not all the same size. Trout, however, grow rings every few months (not every year). Knowing what we do about trees, what do you think causes changes in the growth rate of a steelhead?

   - Summer brings warm weather and lots of food for growth. The opposite occurs in the winter.

6. Point out and label the core of the scale and explain that the first growth rings, or circuli, are formed from this point. The first circuli form when the fish is in its early stages. We see that the first rings are widely spaced apart, so what season do you think the steelhead emerged from its egg?

   - The fry emerged sometime in the late spring/early summer - depending on weather, water temperatures, etc.
   - Label these first, widely-spaced circuli as 'summer in freshwater' and color red.

7. The next set of circuli was formed closely together. What does this tell us about the fish's growth and the time of year?

   - The steelhead's growth slows. These rings were formed in the fall and winter.
   - Label this section 'winter in freshwater' and color pink.
   - There may be discrepancy over when summer growth ends and winter begins. Just estimate since we are only labeling with two seasons.

8. The fish then spends another year in freshwater. Find the summer and winter growth rings for the second year. Label the 'second summer in freshwater' and color red. Label 'second winter in freshwater' and color pink.

9. Next there is a bold, dark circulus. What happens in a steelhead's life after about two years in freshwater? What does the process entail?

   - At this point, the steelhead prepares for its migration to the sea. The steelhead is called a smolt at this stage. Its body goes through some major changes and the scales show a dark band.
   - Label this 'smolt mark or scar'.

10. The next few circuli are spaced far apart. Label these rings 'first summer at sea' and color light green.

11. This is followed by a winter at sea. Label these rings 'first winter at sea' and color dark green.

12. Next you will see a scar, or blank spot, on the scale that stands out from the rest of the growth rings. What might a steelhead do as an adult, after a year at sea? What could cause a strain on the fish, leaving a scar on the scale?

   - The steelhead returns to freshwater to spawn. During this time it doesn't feed and the scales develop special marks or scars.
   - Label this mark 'spawning scar' and color blue.
   - Rings around the scar may be eroded so the spring/summer spent in freshwater spawning is not easily distinguished.

13. The steelhead spends the winter in freshwater and then returns to the ocean the next spring.

   - Label this 'winter in freshwater' and color pink.

14. After another summer and winter at sea, it travels back to freshwater to spawn again.

- Label the 'second summer at sea' and color light green. Label 'second winter at sea' and color dark green. Label 'second spawning scar' and color blue.

15. Ask the students how the scales of the trout they are raising would compare to the scale of this wild steelhead. Do you think hatchery trout or steelhead would show the same markings on their scales as wild fish?
    - No, hatchery fish are fed the same amount every day, so their growth rings are perfectly even. Wild fish will almost never have perfect growth, so if you see a scale with evenly spaced rings at the center, it was probably stocked by a hatchery.
16. Compare the growth at sea with the growth in freshwater. Does the growth seem to increase when at sea? Why?
    - The steelhead is older and bigger with more choices of prey.
    - The ocean provides more food than freshwater. This is why the fish will make that dangerous journey.
17. Review the life cycle of the steelhead. Discuss dangers the steelhead faces at each stage of the life cycle – including predators in freshwater and the ocean, commercial harvesting, travel through dams, and habitat degradation.
18. Encourage the students to think of things we can do to help keep steelhead and salmon populations healthy.

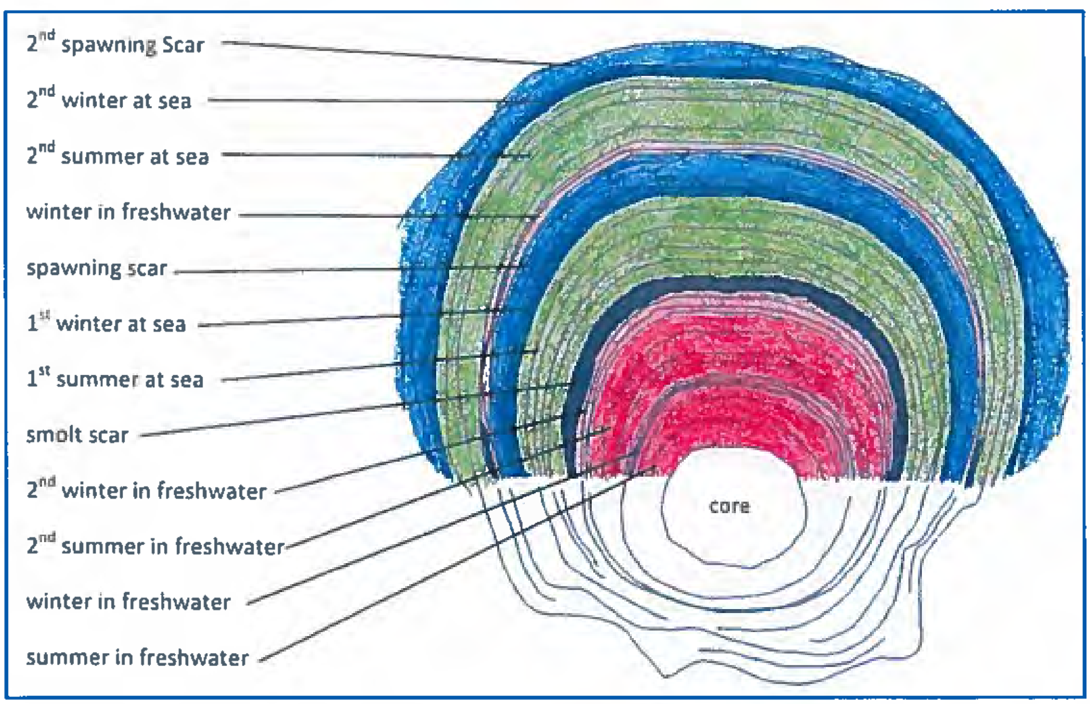
Evaluation

Write a first-person narrative as a steelhead trout that hatches in an Idaho creek, describing life at each stage of its life cycle. Conclude the story by suggesting ways we can lessen our impact on steelhead and salmon in Idaho.

Extension

View real fish scales under a microscope. You may make your own slide or order one from a science teaching supply source. If you plan to conduct a fish dissection, you can easily use a scale from the rainbow trout you dissect. Remove scales by rubbing a finger nail up a small section of the trout – from tail toward head. Place the scale and a drop of water on a slide. Cover the scale with a slip cover to observe under a microscope.

Fish Scale Answer Key



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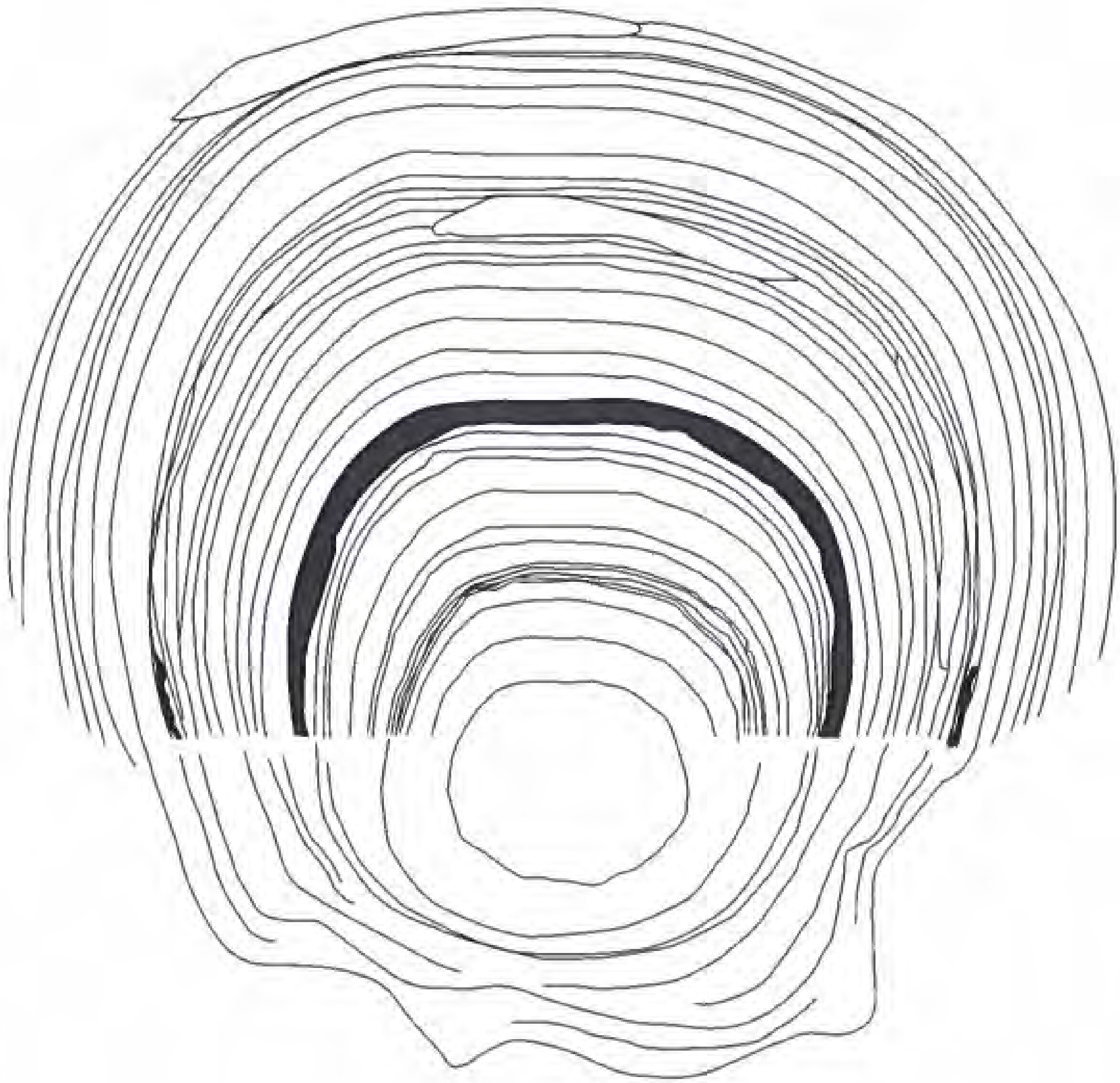
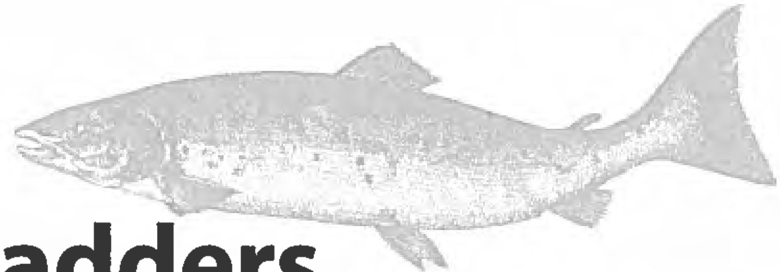
FISH SCALE





Hooks and Ladders

Objectives

Students will: 1) describe how some fish migrate as part of their life cycles; 2) identify the stages of the life cycle of one kind of fish; 3) describe limiting factors affecting Pacific salmon as they complete their life cycles; and 4) generalize that limiting factors affect all populations of animals.

Method

Students simulate the Pacific salmon and the hazards faced by salmon in an activity portraying the life cycle of these aquatic creatures.

Materials

Large playing area (100 feet x 50 feet); about 500 feet of rope, string or six traffic cones for marking boundaries (masking tape may be used if area is indoors); two cardboard boxes, 100 tokens (3" x 5" cards, poker chips, macaroni, etc.); jump rope

Grade Level: 5-8

Subject Areas: Social Studies, Science, Environmental Education, Expressive Arts

Duration: one 30- to 60-minute session

Group Size: 20 to 30 students or more

Setting: outdoors or large indoor area

Conceptual Framework Topic Reference: IDIIB

Key Terms: life cycle, limiting factors, population, migration

Appendices: Simulations, Ecosystems

Background

Many fish migrate from one habitat to another during their lives. Both the Atlantic and Pacific salmon are examples of fish that endure a spectacular migration.

The life cycle for Pacific salmon begins when the female deposits 1,000 to 5,000 eggs in her freshwater spawn. The eggs are deposited in a shallow gravel depression that she digs by flapping her tail from side to side. Once deposited, the male fertilizes the eggs and then both fish nudge the gravel back over the eggs to offer as much protection as possible. The eggs are susceptible to such factors as predation or oxygen deprivation. Within a few days both the male and female salmon have completed their reproduction cycle and soon die.

Newly hatched salmon, called "alevins," live in the gravel and survive by absorbing proteins from their yolk sacs. After a few weeks the yolk sacs are gone and the small fish, known as "fry," move into deeper water to find food on their own. Salmon remain in freshwater streams feeding and growing for many months or even years before migrating downstream to the ocean. These small ocean-bound salmon are now called "smolts." These salmon will feed in estuaries where fresh and saltwater mix. After a few weeks of adjusting to the brackish water the young salmon swim into the ocean.

In the ocean the salmon grow rapidly by feeding on a rich food supply that includes other fish, shrimp and crustaceans. Young salmon may encounter many limiting factors, including sharks, killer whales and other marine mammals, along with humans who are fishing for salmon for commercial and personal uses.

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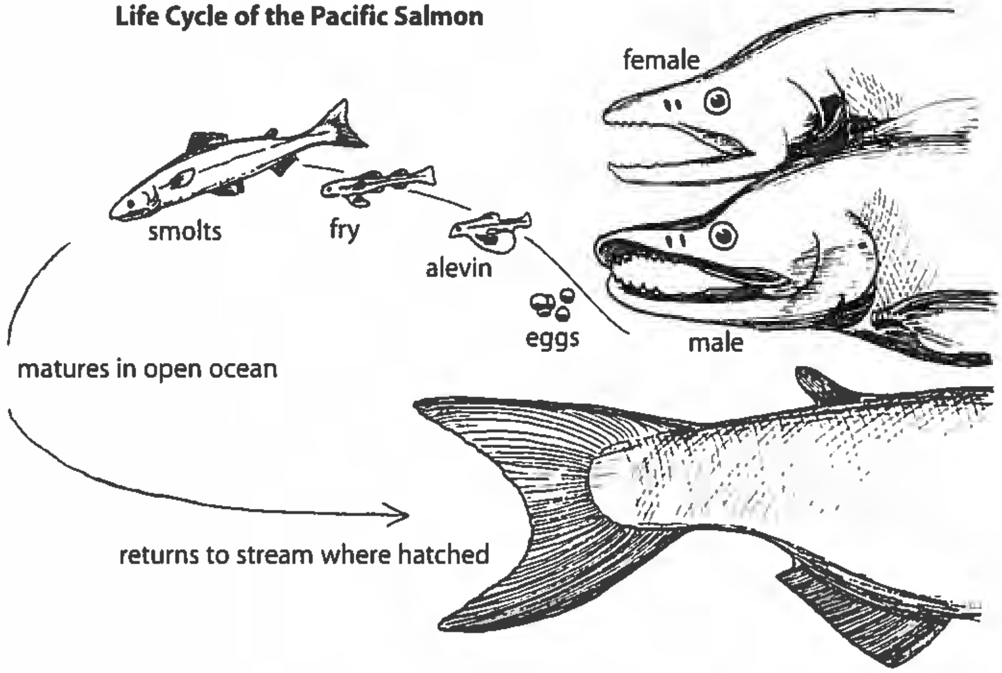
Life Cycle of the Pacific Salmon



After two to five years in the ocean the Pacific salmon begin the journey that guides them to their own hatching sites. Pacific salmon spawn only once in their lives. Salmon have an inherent ability to return to their original streams. Juvenile salmon imprint or memorize the unique odors of their home streams. As returning adults they use their senses of smell to detect these odors and guide them upstream to where they were hatched. Once there, the salmon spawn and then die.

Salmon face a variety of limiting factors in the completion of their life cycle. A limiting factor is a reason or cause that reduces the population of an organism. Some limiting factors are natural, and some result from human intervention with natural systems.

Natural limiting factors include drought, floods, predators and inadequate food supply. Throughout their lives salmon depend on a habitat that provides plants to shade streams and deep pools of water for spawning and resting. Incorrect logging practices, grazing, mining, road building and development often destroy streamside vegetation, erode land and fill streams with silt that covers gravel beds.

Dams are another limiting factor that block or slow migration to and from the ocean. Salmon become disoriented by the reservoirs formed by the dams and become exposed to unhealthy conditions like high water temperatures and predators. Fish ladders can be installed to help salmon through the dams. Fish ladders can be water-filled staircases that allow migrating fish to swim around the dam.

Another threat to salmon is over-fishing. Over-fishing, combined with habitat destruction, is viewed by biologists as a cause for the decline of salmon populations.

NOTE: All possible conditions are not covered by the design of this activity. However, the activity does serve to illustrate three important concepts—life cycle, migration and limiting factors.

Procedure

1. Ask the students what they know about the life cycles of fish that live in their area. Do any local fish migrate to spawn? If yes, which ones? (Mullet, shad, lake trout, striped bass, suckers, carp and salmon are examples of fish that migrate to spawn.)
2. Set up a playing field as shown in Diagram A on this page, including spawning grounds, reservoir, downstream, upstream and ocean. The area must be at least 100 feet by 50 feet. Assign roles to each of the students. Some will be salmon, others will be potential limiting factors to the salmon. Assign the students roles as follows:
   - Choose two students to be the turbine team. They will operate the jump rope, which represents the turbines in hydroelectric dams. Later in the simulation, when all the salmon have passed the turbine going downstream, these students move to the upstream side to become the waterfall-broad jump monitors. (See diagram.)
   - Choose two students to be predatory wildlife. At the start of the simulation the predators will be stationed in the reservoir above the turbines to catch the salmon fry as they try to find their way out of the reservoir and move downstream. Then they will move to below the turbines where they catch salmon headed downstream. Later in the activity, when all the salmon are in the sea, these same two predators will patrol the area above the "broad jump" waterfalls. There they will feed on salmon just before they enter the spawning ground. (See diagram.)
   - Choose two students to be humans in fishing boats catching salmon in the open ocean. These students in the fishing boats must keep one foot in a cardboard box to reduce their speed and maneuverability.
   - All remaining students are salmon.

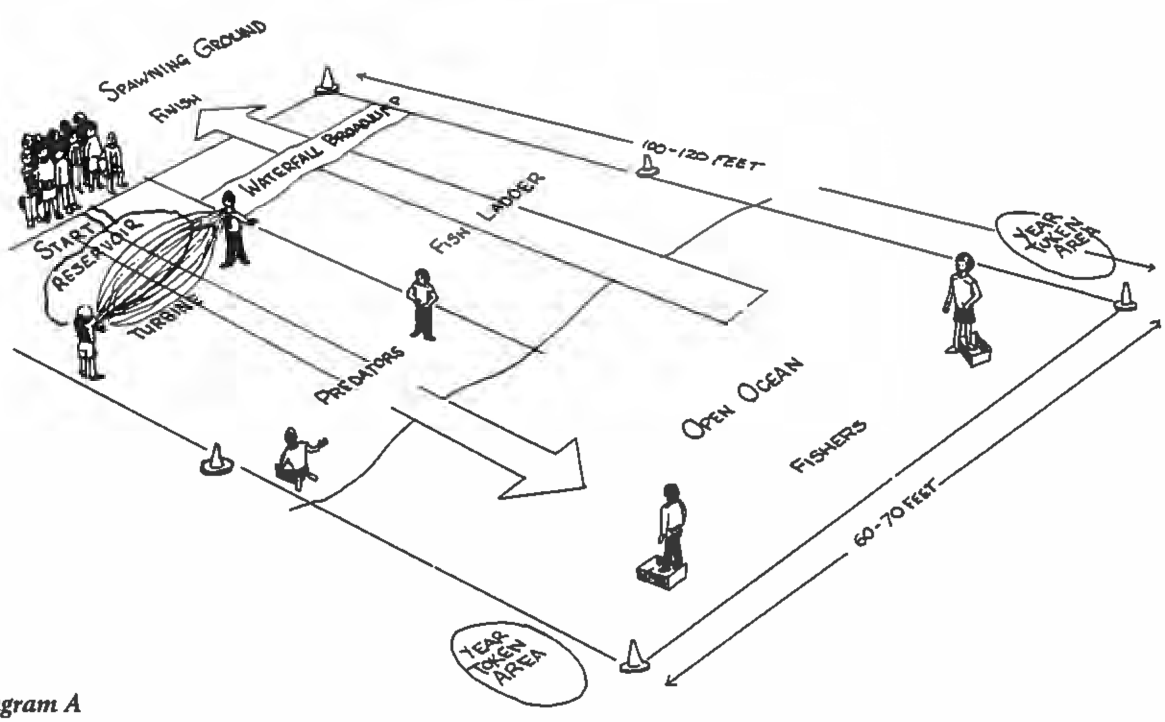


Diagram A

continued

NOTE: These figures are based on a class size of 25 to 30. If the group is larger or smaller, adjust the number of people who are fishing and predatory wildlife accordingly.

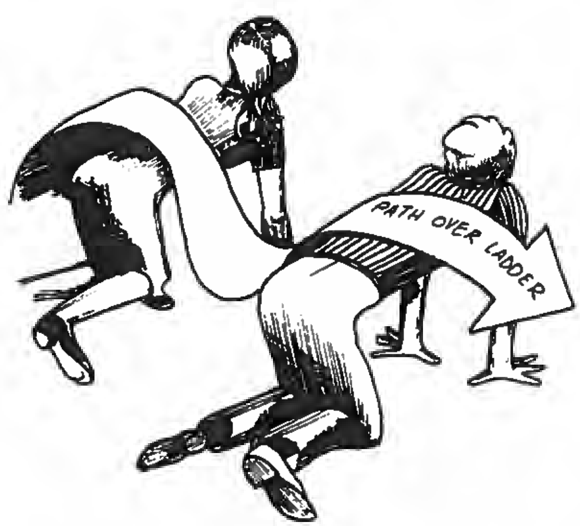
3. Begin the activity with all the salmon in the spawning ground. The salmon first move into the reservoir above the dam. They must stay in the reservoir while they count to 30. This simulates the disorientation that salmon face due to a lack of current in the lake to direct them on their journey. During this time the predators may catch the salmon and escort them one at a time to become part of the fish ladder. The salmon then start their journey downstream. The first major limiting factor the salmon encounter is the turbines at the dam. At most dams, escape weirs guide migrating salmon past the turbines. The student salmon cannot go around the jump-rope swingers, but they can slip under the swingers' arms if they do not get touched while doing so. A salmon dies if the turbine (jump rope) hits it. The turbine operators may change the speed at which they swing the jump rope. Any salmon that "dies" at any time in this activity must immediately become part of the fish ladder. The student is no longer a fish, but becomes part of the physical structure of the human-made fish ladders now used by migrating salmon to get past barriers such as dams. The students who are the fish ladder kneel on the ground as shown on page 47, with one body space between them.
4. Once past the turbines the salmon must pass some predatory wildlife. The predators, who have moved from the reservoir area to the area below the turbine, must catch the salmon with both hands—tagging isn't enough. Dead salmon are escorted by the predator to become part of the fish ladder. Later, the salmon that survive life in the open ocean will pass through the fish ladder to return to the spawning ground. NOTE: Both the predatory wildlife in the downstream area and the people fishing in the open ocean must take dead salmon to the fish ladder site. This moves the predators and fishing boats off the field regularly, helping to provide a more realistic survival ratio.
5. Once in the open ocean the salmon can be caught by fishing boats. The salmon must move back and forth across the ocean area in order to gather four tokens. Each token represents one year of growth. Once each fish has four tokens (four years' growth), that fish can begin migration upstream. The year tokens can only be picked up one at a time on each crossing. Remember, the salmon must cross the entire open ocean area to get a token. The "four years" these trips take make the salmon more vulnerable and thus they are more readily caught by the fishing boats. For purposes of this simulation, the impact of this limiting factor creates a more realistic survival ratio on the popula tion before the salmon begin the return migration upstream.
6. When four of the year tokens are gathered the salmon can start upstream. The salmon must walk through the entire pattern of the fish ladder. This enforced trip through the fish ladder gives the students a hint of how restricting and tedious the upstream journey can be In the fish ladder, predators may not harm the salmon.
7. Once through the ladder the salmon face the broad-jump waterfall. The waterfall represents one of the natural barriers the salmon must face going upstream. Be sure the jumping distance is challenging but realistic. The two former turbine students will monitor the jump. The salmon must jump the entire breadth of the waterfall to be able to continue If the salmon fails to make the jump, then it must return to the bottom of the fish ladder and come through again.

NOTE: When playing indoors, the broad-jump waterfall may be changed into a stepping-stone jump defined by masking tape squares on hard floors.

8. Above the falls, the two predators who started the simulation as the predators below the turbines are now the last set of limiting factors faced by the salmon. They represent bears—one example of predatory wildlife. Again, remember that the predators must catch the salmon with both hands. If they catch a salmon they must then take the student they caught to become part of the structure of the fish ladder.

9. The activity ends when all the salmon are gone before the spawning ground is reached—or when all surviving salmon reach the spawning ground.

10. Next engage the students in a discussion. Explore topics such as:
    - the apparent survival-mortality ratio of salmon;
    - the role of the barriers;
    - the role of the predatory wildlife and the people fishing;
    - where the losses were greatest;
    - where the losses were least,
    - what the consequences would be if all the eggs deposited made the journey successfully; and
    - what seemed realistic about this simulation and what did not.



11. Ask the students to summarize what they have learned about the life cycle of salmon, the salmon's migration and limiting factors that affect salmon. Make sure the students have a clear working definition of limiting factors. Encourage the students to make the generalization that all animals—not just the Pacific salmon—are affected by limiting factors. Ask the students to give examples of limiting factors. They might mention the availability of suitable food, water, shelter and space; disease; weather, predation; and changes in land use and other human activities.

Variation: Atlantic Salmon

This activity can easily be adapted to feature Atlantic salmon. The most significant difference between Pacific and Atlantic salmon is that the Atlantic salmon can spawn more than once. Many Atlantic salmon make their complete migratory journey and spawn two or more times. All Pacific salmon die after spawning only once. To adapt this activity for Atlantic salmon, students are to make as many complete migratory trips as possible. After the activity is finished, ask students to report how many times they successfully completed the migratory cycle. Graph the data. Have the students explain how age influences mortality rates and susceptibility to limiting factors.

Variation: Striped Bass

This activity can also be adapted to feature striped bass rather than salmon. The striped bass is more widely distributed along the United States' coastlines than either the Atlantic or Pacific salmon. Like the salmon, striped bass reproduce in freshwater and migrate to and mature in saltwater. They also must face the same limiting factors described in this activity.

continued

Extensions

1. Write a report on the life history of one of the species of salmon (e.g., chinook or king, chum or dog, pink or humpback, coho or silver, sockeye or red, Atlantic). Create a mural showing the life cycle of this salmon.
2. Research and illustrate the life cycle of any local fish. If possible, look for one that migrates.
3. Compare how the life cycle of a Pacific salmon is similar to and different from the life cycle of one or more local fish.
4. Investigate similarities and differences in the migration and life cycles of an Atlantic and a Pacific salmon. Investigate the life cycle of salmon in the Great Lakes region of the United States.
5. Visit fish hatcheries that work with migratory species and investigate how they function.
6. Explore ways that dams can be modified to let fish safely pass downstream and upstream. Design the "perfect" fish ladder.
7. Investigate and discuss commercial fishing for salmon. Investigate and discuss personal, including recreational, fishing for salmon.
8. Find out about laws protecting migratory species, including fish.
9. Consider this and try the activity again:

In the last 100 years salmon have experienced many new, human-caused limiting factors. Dams, commercial fishing, timber harvest and road construction have had tremendous impact on salmon populations. In 1991 the Snake River sockeye salmon was placed on the federal endangered species list. In the past, tens of thousands of sockeyes would make the 900-mile return trip from the sea to Idaho's mountain streams and lakes. There they spawned and died. Their offspring hatched and began their early development in freshwater. The actual migration to the Pacific Ocean could be completed in as few as nine days. Today that trip takes more than 60 days. In 1991 only four Snake River sockeye salmon returned to their spawning grounds.

To simulate these increases in salmon limiting factors, play several rounds of "Hooks and Ladders." Allow each round to represent the passage of 25 years. Start in 1850. In that year do not include dams or commercial fishing operations in the scenario. As time passes, add the human commercial fishing operations. Build dams (jump ropes) as the scenario progresses into the 21st century.

Describe some of the possible effects on salmon from increased limiting factors as a result of human activities and interventions. Discuss possible positive and negative effects on both people and salmon from these increases in limiting factors affecting salmon. When the activity reaches "the present" predict what might happen to salmon in the future. Approaching this as a complex dilemma, discuss possible actions, if any, that might be taken to benefit both people and salmon.

10. Find out if salmon exist in your state. If so, are they native or were they introduced?

Evaluation

1. List, describe and illustrate the major stages in a Pacific salmon's life cycle
2. Identify and describe some of the limiting factors that affect salmon as they complete their life cycles.
3. Identify and describe some limiting factors that might affect other animal populations

Fashion a Fish

Grade Level
3-12

Subject Areas
Science, Visual Arts

Time
30-45 minutes

Vocabulary
adapt, adaptation, behavioral adaptation, camouflage, characteristic, coloration, habitat, species, structural adaptation

Summary

Students design fish with unique forms, shapes and behaviors to discover the benefits of these adaptations.

Objectives

Students will...

- describe adaptations fish have to their environments
- describe how adaptations can help fish survive in their habitats
- interpret the importance of adaptations in animals

Materials

- one copy of adaptation cards (additional copies with a class of more than 30); cut and separate the cards into groups of four cards each: one coloration, one mouth type, one body shape, and one reproduction in each group
- paper or poster board
- markers, colored pencils or paint

Background

All animals are the product of countless adaptations that occurred over time. Adaptations are features that increase the animals' likelihood of surviving in their habitat. When a habitat changes, either slowly or catastrophically, animals must adapt to those habitat changes to survive. As those adaptations become part of the fish's design, the fish becomes better suited to the habitat in which it lives. Because of the variety of conditions within each habitat, many different fish can live together and flourish. Some species have adapted to such a narrow range of habitat conditions that they are extremely vulnerable to change. These species are usually more susceptible than other animals to death or extinction. In this activity, students design a fish based upon certain adaptations.

Procedure

1. Begin a discussion by asking the class to define what the word adaptation means. An adaptation is a special feature of an organism that increases its chance of survival in its habitat. How do species adapt? Those individuals that are best equipped for life in a specific habitat are more likely to survive to the age where they can reproduce. Therefore, their genes and characteristics are more likely to be carried on to the next generation.
2. Assign students to find a picture or make a drawing of a species of animal that has a special adaptation. For example: a picture of a giraffe with a long neck for reaching vegetation in tall trees, or an owl with large eyes that gather light to aid with night vision.
3. Conduct a class discussion on the value of different kinds of animal adaptations. As part of the discussion, ask the students to identify different kinds of adaptations in humans.
4. Collect the students' pictures or drawings of adaptations. Categorize them into the following groups:
   - protective coloration and camouflage
   - body shape or form
   - mouth type or feeding behavior
   - reproduction or behavior
   - other (one or more categories the students establish, in addition to the four above that will be needed for the rest of the activity)
5. Break up the classroom into five groups. Pass one complete set of cards to each group of students. There might be five groups with four to six students in each group.
6. Review the adaptations by asking each group what they think the advantages are to the adaptations they were given. Record a list of the advantages to each adaptation on the board.
7. Ask the students to "fashion a fish" from the characteristics on the cards they received. The fish will be fictitious and may not look like a "real" fish. Each group should:
   - create an art form that represents their fish
   - name the fish
   - describe and draw the habitat for their fish
8. Ask each group to report on the attributes of the fish they have designed, including identifying and describing its adaptations. Ask the students to describe how this kind of fish is adapted for survival.
9. Ask the students to make inferences about the importance of adaptations in fish and other animals.

Evaluation

1. Grade the students on their presentations of their drawings to the class and their explanations of the adaptions they incorporated. Is the habitat they drew their fish in realistic for the adaptations they were asked to incorporate in the fish?

2. Have the students invent an animal that would be adapted to live in their community or a different and exotic habitat of their choice. Consider mouth, shape, coloration, reproduction, food, shelter, and other characteristics. Draw and describe the animal. Older grades may write a natural history of the animal – also describing social interactions, life cycle, and general life style.

Extension

1. Take an adaptation card from any category and find a real fish with that adaptation.

2. Look at examples of actual fish. Describe the fish and speculate on its habitat by examining its coloration, body shape and mouth.

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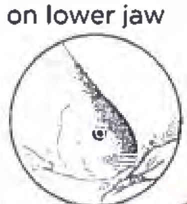
Adaptation	Advantage	Examples
Mouth		
Sucker-shaped mouth	Helps to feed on very small plants and animals on bottom	Sturgeon, sucker, carp
Elongated upper jaw	Helps to feed on prey it looks down on	Channel catfish
Hard plate on lower jaw	Helps to scrape algae off of rocks and the bottom	Chiselmouth
Duckbill jaws	Helps to firmly grasp prey	Northern pike, muskellunge
Extremely large jaws	Helps to completely surround prey	Largemouth bass, grouper
Body Shape		
Torpedo shaped	Increases the speed of the fish	Muskellunge, trout, salmon, tuna
Flat bellied	Allows fish to lay on bottom	Sculpin, catfish, sucker
Snake-like	Streamlines the fish for long distances	Pacific lamprey
Vertical disk	Allows the fish to move easily between vertical plants and feed above or below	Pumpkinseed, crappie, bluegill
Large, spiny dorsal fin	Makes fish look larger, prevents predator attack from behind	Yellow perch
Coloration		
Light-colored belly	Camouflages so that predators have difficulty seeing it from below	Sockeye salmon, perch, stugeon
Dark upper side	Camouflages so that predators have difficulty seeing it from above	Bluegill, crappie, flounder
Vertical stripes	Allows the fish to hide in vegetation	Tiger muskellunge, pickerel, bluegill
Spotted	Helps the fish hide in rocks and on the bottom	Rainbow trout, cutthroat trout
Mottled coloration	Helps the fish hide in rocks and on the bottom	Black crappie, sculpin, burbot
Reproduction		
Eggs deposited in nest on bottom	Hides eggs from predators, keeps them oxygenated	Bull trout, salmon, most minnows
Defends spawning territory	Eggs are protected by adults	Longnose dace, bass
Cavity spawners	Eggs are hidden from predators	Bullhead catfish
Eggs attached to vegetation	Eggs remain stable until hatching	Carp, perch, northern pike
Migrate to spawn in groups	Helps mix genes to maintain diversity in population	Burbot, grouper

Fish Adaptation Cards

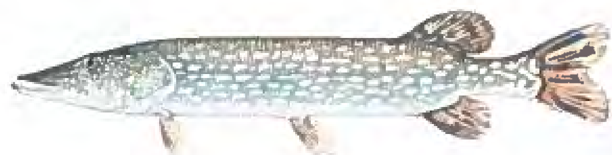
Mouth/Feeding:
sucker shaped mouth
Sturgeon

Mouth/Feeding:
elongated upper jaw
Channel catfish

Mouth/Feeding: hard plate on lower jaw
Chiselmouth



Mouth/Feeding:
duck-billed jaws
Northern pike

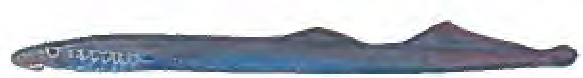


Mouth/Feeding:
extremely large
Largemouth bass

Body shape:
torpedo shaped
Rainbow trout

Body shape:
flat bellied
Sculpin

Body shape:
snake-like
Pacific Lamprey



Fish Adaptation Cards

Body shape:
vertical disk
Bluegill

Body shape:
spiny dorsal fin
Yellow perch

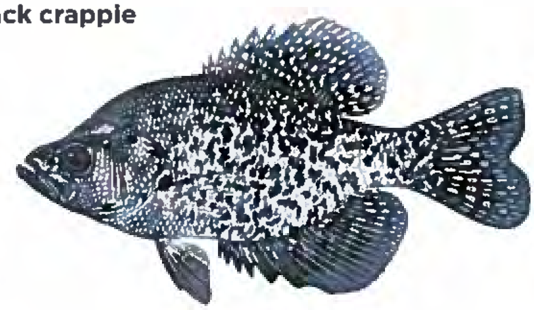
Coloration:
light-colored belly
Salmon

Coloration:
Darker on top
Bluegill

Coloration:
vertical stripes
Tiger muskellunge

Reproduction: eggs deposited in bottom nests
Bull trout

Coloration:
mottled
Black crappie



Coloration:
spotted
Rainbow trout

Fish Adaptation Cards

Reproduction:
defends spawning territory
Longnose dace

Reproduction:
cavity spawner
Bullhead catfish

Reproduction:
eggs deposited on vegetation
Northern pike

Reproduction:
migrates to spawn in groups
Burbot