Unit Two
Fish Species

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Objectives:

To help students:

- Identify the five species of salmon based on their observable characteristics (Activity 1).
- Compare the five species of salmon in the saltwater and freshwater phases of their life cycles (Activity 1).
- Read about salmon and their life cycle (Activity 2).
- Identify the sequence of salmon life cycle stages as egg, alevin, fry, smolt, and adult (Activity 2).
- Make a mural of local salmon habitat and hazards (Activity 3).
- Calculate salmon survival potential (Activity 4).
- Diagram the role of herring in the ocean's food web (Activity 5).
- Taste herring (Activity 5).
- Camouflage a halibut in a watercolor painting (Activity 6).
- Observe a blackfish's ability to survive low oxygen conditions (Activity 7).
- Become familiar with Alaska's freshwater fish species by making and playing a freshwater fish card game (Activity 8).
- Design and make a tissue paper fish adapted for a particular habitat (Activity 9).
silver, red, pink, chum, king, spawning salmon circled.
Right panel: salmon at sea (on map clockwise from bottom:
pike, lake trout, rainbow trout, cutthroat, bull trout,
mountain whitefish, lake whitefish, lake charr,
rainbow smelt, coho, sockeye, chum, pink, chum, king,
longnose sucker, stickleback, brook, brown, brook, chub.
Left panel: trout, salmon, coho, salmon, rainbow, cutthroat.
Activity 1
Name that Salmon

Background:
Salmon are the most important Alaskan fish for commercial, subsistence, and sport fishing. Alaska produces 85 to 95 percent of the entire U.S. salmon harvest and almost half of the world's catch.

All five species of Alaskan salmon are anadromous (pronounced a-nah-dra-mous), meaning that they hatch from eggs in fresh water, travel to salt water to grow and mature, and then return to fresh water to deposit their eggs. Ocean salmon are bright silver. As salmon travel up freshwater streams to spawn, their color turns from silver to shades of copper, brown, red, or green. The upper jaw of the male becomes hooked downward, and the shape of his body may also change.

(This activity was contributed by Laurie Dumdie, Science Resource Teacher, Anchorage School District.)

Vocabulary:
- chinook
- sockeye
- humpback
- coho
- chum
- spawning
- anadromous
- protective coloration

Materials:
- scissors
- color pencils or small felt-tip markers
- ocean salmon cards (one per student)
- salmon identification chart (one per student)
- master card for each species of salmon
- worksheets:
  - ...Ocean Salmon Cards (2A)
  - ...Spawning Salmon Cards (2B)
  - ...Ocean Salmon Identification Chart (2C)
  - ...Spawning Salmon (2D)
  - ...Ocean and Spawning Salmon (2E)

Procedure:
1. Each student will need a salmon picture card (ocean phase) for this activity. First make a master set for yourself by duplicating the ocean and spawning salmon card worksheets accompanying this unit. Laminate the ocean and spawning phases back-to-back for handier identification. For student cards, block out the identifying names before copying.

2. Ask students to guess how many different kinds of salmon are in Alaska (five). Can they name some of the species? Record these names on the board. Tell students that each species has at least two names. Add any they omitted: king or chinook; coho or silver; pink or humpy
(humpback); sockeye or red; dog or chum.

3. Shuffle the ocean salmon picture cards and pass them out one per student. Ask students to find others with salmon cards exactly like their own. When several students have identified their salmon as the same, they should cluster as a group. There should be five groups.

4. Within each group, have students guess their species of salmon. Then give each group copies of the worksheet Ocean Salmon Identification Chart with which to compare their guesses. As each group is ready, ask them to tell you the name of their salmon. Compare their answer with your master set. If the answer is correct, give the group the master card to hold. Continue this procedure until all groups have the correct master card.

5. As a class, discuss the differences between the fish and the distinguishing physical characteristics of each species. Talk about how the coloration of ocean fish gives them protective coloring. The fish are darker above so that predators such as eagles, gulls, and people have trouble seeing them; and lighter underneath so predators from below can't readily pick them out. Ask students if salmon always look like the fish you have been discussing. Have each group turn over the master card and compare the spawning appearance of the species with its saltwater appearance. Salmon change rapidly during their spawning migrations.

6. Distribute the worksheet Spawning Salmon. Allow time for students to draw and color the different species. Check the bibliography for several sources of salmon species color charts.

7. Use the worksheet Ocean and Spawning Salmon to compare and review salmon changes.

Additional Activities:

1. Science: Make flashcards or a card game with picture sets of the ocean and spawning salmon. A card game suggestion: Students try for four of a kind by asking other students and drawing from the main deck.

2. Home Economics, Art: Make stuffed-animal salmon out of cloth, filling them with old hose, rice, or beans. Color them with permanent felt-tip markers to look like specific salmon species.
Activity 2
The Salmon Life Cycle

Background:
The stages of a salmon life cycle are summarized in the following paragraphs:

Egg
This is the first stage of the life cycle, in which a female salmon deposits as many as 10,000 eggs in the gravel of a stream. The bright pink eggs, about one-fourth inch in diameter, are covered to help protect them from predators and direct sunlight. After about a month, become visible within the eggs. It is essential to the eggs' survival during this time that water flow and temperature are suitable. Salmonids are coldwater fish and normally cannot tolerate temperatures above 68°F. The greatest mortality in the salmon life cycle is the egg-to-fry stage.

Alevin
In late winter and spring, salmon eggs hatch and become quarter-inch alevins (pronounced ay-luh-vins) which grow slowly under the gravel for three to four months. The alevin is a fragile creature with huge eyes and a large yolk sac protruding from its belly. The orange yolk sac contains a balanced diet of protein, carbohydrates, vitamins, and minerals. The vitelline vein, running through the center of the sac, extracts oxygen from the water. The fish at this stage remains under gravel, protected from predators and other hazards. A good flow of pure water is critical to alevin survival.

Fry
Alevins absorb their yolk sacs and emerge from the gravel as fry in late spring and summer. About an inch long, they are easy prey for larger fish. Sockeye, chinook and
coho spend at least one year in streams or lakes, unlike the pink and chum which usually head directly to sea. Fry feed on plankton and small insects. At this stage, important survival requirements include good streamside cover and an ample food supply.

Smolt (or fingerlings)

Young salmon remain in fresh water for varying periods: chinook spend one year, coho one to four years, sockeye one or two years, and pinks and chum about six months. At the smolte stage, they head downstream. Four to six inches long, they swim seaward in late May during the spring freshet, and enter salt water where they grow to adulthood.

Spawnng Adults

Usually in the early summer of their maturing year, salmon begin to head back to their home streams, navigating at least partially by their sense of smell. They stop feeding as they enter fresh water, living on stored body fats. They struggle sometimes for weeks against falls and obstructions to reach the same spawning beds in which they themselves were hatched. During the trip upstream, many are killed by natural predators or man. When a pair of salmon reaches its spawning ground, the female digs a nest, or redd, up to 16 inches deep in the gravel. When the nest is ready, which may be weeks after the pair reaches the gravel beds, the female lays her eggs. The male fertilizes them by covering them with a milky substance known as milt, which contains the sperm. The female then covers the eggs with gravel to complete the spawning process. The salmon’s life is finished and within a short time it dies and the body drifts downstream, providing nutrients to the stream system as it decays.

Vocabulary:

- redd
Materials:
- paper
- glue
- scissors
- worksheets:
  - Salmon Life Cycle Stages
  - A Salmon's Life Cycle
  - Salmon Match Game
  - Salmon Word Search

Procedure:

1. Ask students to tell you what is meant by a "life cycle." Discuss the idea that it is the chain of life from birth to death to birth again. Distribute the worksheet Salmon Life Cycle Stages. Have students cut out the pictures depicting the stages. Challenge students to place the pictures in their proper order. Suggest they look for the clues in the pictures, and not rely on the labels for each of the stages. Remind them that it's a life cycle, so the pictures should be placed in a circle. Have students leave these cards on their desk in their predicted order for later reference.

2. Distribute copies of the worksheet A Salmon's Life Cycle. Call attention to the questions at the beginning of the worksheet which are designed to guide student reading. Notice that there is a space for predicted answers to complete beforehand and then the actual answers which they can complete as they read. (Answers: 1: six; 2: five; 3: born in fresh water, enter salt water, returns to fresh water; 4: in stream; 5: pea-sized; 6: alevin; 7: fry; 8: smolts or fingerlings; 9: silvery; 10: nose or sense of smell; 11: redd; 12: die; 13: by providing food for animals (including people), nutrients to streams, beauty, recreation.)

3. Have students re-examine the life cycle pictures on their desks and make any changes inspired by their reading. Then have them glue the pictures on another piece of paper and place arrows between them depicting the correct order. They might add where each stage occurs. For example, the egg stage occurs in fresh water in a gravel bed.


Additional Activities:

1. Science: Play "only your nose knows for sure" to illustrate how salmon find their stream by smell. Place several different powerful odors (vanilla, garlic, onion, basil, spruce needles, orange
peel, molasses, tea, coffee) in little jars or cans. Be sure all the containers are the same size and with lids, if possible, to concentrate the smells. Give one container to each group of students. Tell them to close their eyes and sniff, but do not discuss what they smell. Then place all the containers, which represent the smells of the different streams, at the front of the classroom. Tell the students that salmon can find their way back by smell. Let's see if the students can. Blindfold and lead them up by groups to see if they can find their "stream"! (Suggested by Hill Hastie, Oregon.)

2. Science, Art and Language Arts: Construct a timeline for your area showing when salmon return to local streams. Students may need to question local biologists, fishermen, long-time residents.

3. Art: Make salmon egg paintings. Mix paint by blending fresh or frozen salmon eggs with a little water and crushed charcoal to color the paint. Red ochre also works well to color the paint. Paint designs on paper, rock, or driftwood pieces. (Suggested by Laurie Dumdie, Science Resource Teacher, Anchorage School District.)

4. Math, Science: Have students make bar graphs of local salmon seasons and runs.

Activity 3
Salmon Habitat

Background:

At each stage in their life cycles, salmon have different habitat needs and face different hazards. Habitat is a place that provides the basic needs of an animal or plant. It's an animal or plant's "home."

Wetlands with their accompanying streams, ponds, lakes, and rivers are important to the early and final stages of a salmon life cycle. In the period between the first and last stages, salmon need salt water and the abundance of smaller food fish found in Alaska's coastal waters. Quality water and habitat is critical to salmon survival.

Vocabulary:

- cover
- wetland
- water quality
- stream bed
- flow
- temperature
- volume
- velocity
- habitat (review)
- plankton (review)
Materials:

- large piece of butcher paper or newsprint
- felt-tip markers or tempera paint and brushes
- paper
- pencils
- map of Alaska
- Salmon Habitat Map
- worksheet

...Pink Salmon Game (2J)

Procedure:

1. Divide students into small groups. Have them brainstorm and write down the habitat needs and hazards a salmon faces throughout its life. Have them look at a map of Alaska and sketch a map of the journey their local salmon travel. Students may want to question local residents or biologists to check their predictions of salmon routes.

2. As a class, draw a mural with markers or paints of one of your local salmon streams on a large piece of butcher paper or newsprint. Discuss each habitat need or hazard as it's brought up by your students or you. Mention some of the future hazards salmon in your area may face, as well as hazards and habitat losses in other places. Use the following map and notes to guide your discussion.

SALMON HABITAT NEEDS

- Stream: Eggs, alevin, fry, smolt, and spawning salmon need cool, high quality water with lots of oxygen, and adequate water flow. Bushes and trees along the stream help keep the water cool by shading the stream and providing places to hide (cover) for fry, smolt, and spawning salmon. The bushes and trees also provide places for insects to live. Some of these fall in the water for fry and smolt to eat. However, most insects the salmon eat are aquatic insects that live in the stream itself. Gravel on the stream bottom provides a place for spawning salmon to lay their eggs. Different types of salmon like different sizes and types of gravel.

- Lake: Red salmon like to spawn in lakes. And the young of several salmon species often feed in shallow lakeshore waters.

- Rivers: Salmon require high quality water to survive. Often, Alaska's rivers are so sily that salmon wait to spawn until they reach the clearwater streams or lakes.

- Marsh and Tundra Wetlands: The soggy spongy grounds surrounding streams, lakes, and rivers help assure that there is enough water for salmon in the waterways because they soak up rain water and release it slowly. In this way, wetlands also help prevent floods, as they have the capability of soaking up water during storms. Wetlands also produce nutrients which they add to the waterways. The nutrients mean that there will be better plankton, plant, and in turn animal growth (like salmon) in the system.

- Estuary: Among wetlands, estuaries are the most pro-
ductive and richest! An estuary is created where a river meets the sea. There, the mixing of the fresh and salt water produces tremendous quantities of nutrients and food for young growing salmon, as well as for other plants and animals. Estuaries probably are our best food producers, yielding even more than the commercial agriculture. And they don't take any human effort, just habitat protection.

Ocean: The main habitat requirement of ocean salmon is cool, high quality water with adequate oxygen and abundant food.

HABITAT HAZARDS

- Predators: Commercial fishermen, subsistence fishermen, and sport fishermen all try to catch salmon. Ducks, seabirds, other fish, gulls and eagles eat some of the smolts. Sharks and toothed whales eat some adult salmon. And gulls and eagles eat the spawners. Gulls also eat salmon eggs. Foxes and bears eat spawning salmon.

- Towns with their houses, airstrips and factories produce sewage and other pollution that reduce the amount of healthy wetland habitat that normally would contribute to stream flow. Oil and chemicals from garbage, trash and industrial dumps seep into the water. Roads can be especially hard on salmon because roadbanks often erode, sending silt into rivers and streams, covering salmon eggs, and reducing water quality. Also, oil and gaso-line can wash from the road into the stream.

- Ocean pollution can affect salmon by poisoning smaller fish that the salmon eat. Also, scientists are concerned that even a tiny amount of oil in the water might impede a salmon's sense of smell, preventing it from finding its home stream.

- Dams block salmon migration routes. They also change the water quality by raising its temperature (Sun rays heat the greater surface area of the lake impounded by the dam.), and reducing water flow and velocity.

- Logging, especially if improperly done, can contribute to salmon losses by causing stream erosion. Skidding operations (bulldozers) and logging roads construction can add silt to the stream.

- Culverts are difficult for salmon to negotiate because of the velocity of culvert water. Also, some culverts are placed too high for salmon to reach without repeated jumping attempts.

- Float planes and boats with motors can add oil, gasoline, and noise pollution to lakes, rivers, and the sea.

3. Remind students that human communities require some development. However, most of that development—houses, stores, factories, airstrips, logging operations—can be located where they will least damage salmon habitat. Usually it's not one particular development that ruins a
salmon run, but the cumulative effect of many developments.

Ask students:

- How can we help local salmon runs? (By taking no more salmon than we need; by not disturbing salmon in their spawning grounds; by taking care that our motorboat engine is running efficiently so that less oil and gasoline gets into the water; by stepping very carefully when we cross streams.)

- What developments now underway in our area will affect salmon? (Discuss their positive and negative effects.)

- Is there any way these effects can be reduced?

- Is there any way our class can help?

Additional Activities:

1. Science, Language Arts: Have students play the Pink Salmon Game (Worksheet 2J). Students may want to color the game and cover it with clear contact paper, or laminate it. Explain to students that sac fry is another name for alevin and that fingerlings are the same as smolts.

2. Language Arts: Write a story from the viewpoint of a salmon about its journey down or upstream and the dangers it faces in its daily life.

3. Social Studies, Math: Make an overhead transparency of the Ocean Migration of Alaskan Salmon maps included with this activity. Imagine where your local salmon are going. Discuss the idea that salmon are an international fish. Talk about the number of different nationalities that eat salmon, and some of the ways the United States has been trying to protect Alaskan Fisheries. (See Unit 7, Activity 3 for a description of the 200 mile limit and the Law of the Sea.)

4. Physical Education, Science: Make a salmon journey game in your gym or other large open area. Design a variety of hazards for an obstacle course:

- Erosion: Small piles of dirt or torn brown crepe paper plus four large jars filled one-fourth full with dirt and three-fourths full with water that students can shake and see how cloudy water can become with erosion and how long it takes to filter down.

- Humans obstacles: Fish net, fishing poles, model boats.


- Garbage and toxic wastes: Old tires, bottles, containers, plumbing fixtures, pictures of car batteries, gas, oil, antifreeze, pesticides.

- Culverts: Chairs with blankets over them or cardboard boxes to crawl through.

- Good salmon habitat: Overhanging boughs, logs to hide behind, good stream water with lots of oxygen and flow made out of blue construction
paper, nearby wetlands made out of sponges, insects, good spawning gravel, pools in which to rest.

- Predators: Students dressed as bears, gulls, eagles.

Swimming is a good activity to include as part of the game. Older students might want to develop the obstacle course for younger students. (The idea for this game comes from the ORCA Curriculum Activity Guide, Life Cycle of the Salmon.)
Activity 4
Salmon Survival

Background:

Biologists use mathematics to predict fish runs and to plan for a "sustained yield" of fish for future generations.

Materials:

- worksheet:
  ...Only the Strong Survive
  (2K)

Procedure:

1. Discuss how biologists plan for the future so there will always be fish to catch and eat. The worksheet Only the Strong Survive illustrates what happens in just one redd. (Answers: 1=5000; 2=4,500; 3=4,440; 4=3,440; 5=3,140; 6=2,640; 7=2,599; 8=2,339; 9=839; 10=744; 11=188; 12=8; 13=5; 14=5; 15=5.)

2. After your students complete the worksheet, have them figure the number of salmon redds for a whole stream, using a local stream as an example.

3. Discuss various other calamities that might occur in the stream, such as running a bulldozer through the stream right after the salmon spawn; an earthquake; or silt covering the eggs from mining, logging or road construction for a new subdivision. Ask students to list ways they can help care for salmon in nearby streams. By not disturbing salmon in their spawning grounds; by not taking more salmon than needed; by cleaning and taking care of fish right away so they don't spoil; by not wasting salmon served with meals; by not spilling oil or gas into the water; by walking carefully when crossing salmon streams.)
Activity 5
Herring and the Food Web

Background:

Every living organism must have food to survive. Large fish feed on smaller fish that feed on smaller fish that feed on smaller fish, and the smallest fish feed on plankton (tiny plants and animals). When animals eat more than one type of food, the food "chain" expands into a food "web."

Nutrients present in sea water are derived from decaying sea plants and animals, and from materials carried to the sea by rivers. The nutrients in the sea become food for seaweeds and for the one-celled, microscopic plants called phytoplankton. Phytoplankton, which often drift abundantly in ocean waters, are food for the microscopic animals called zooplankton, which include the larval forms of many sea animals. Seaweeds, at the same time, serve as food for grazing animals. Each feeding animal is in turn food for another animal. Any animal or plant that is not eaten directly, dies, decays, and becomes food for scavengers or is changed by microorganisms into the nutrients that will feed succeeding generations of life in the sea.

Herring, one of Alaska's important commercial and food fishes, plays an important role in the ocean's food web. In Alaska, hundreds of millions of herring spawn from mid-March to early July. They spawn in early spring in southeast and in June and July in Bristol Bay and Norton Sound. They may spawn as late as August in the Kotzebue area. Females lay from 10,000 to 60,000 eggs per year depending on their size and age. Unlike salmon, herring females spawn year after year and the older females produce more eggs. But 50 to 99 percent of the eggs may be lost because of wave action, exposure at high tide, and predation. Eggs are laid on seaweed, brush, pilings, or rocks in shallow water. The males fertilize them by releasing milt into the water. The eggs hatch after about 10 days into tiny yolk-sac larvae. About two weeks later, the young herring have absorbed their yolk sacs and begin feeding on plankton. At this stage, herring are eaten by jellyfish, amphipods, young salmon, and other small fish. Herring continue their growth in shallow bays and estuaries and by the end of the summer are five inches long. As the fish grow, they eat larger food items. Adults eat crustaceans and a wide variety of small fishes. Adult herring are preyed upon by virtually every animal large enough to eat them: dogfish and other
sharks, salmon, cod, mackerel, squid, seals, sea lions, birds, baleen whales, and man.

Many commercial fisheries have developed around herring. Herring are caught whole for bait, food, or eggs. Their eggs also are harvested after the fish deposit them on seaweed. Herring eggs (roe) in various forms are considered delicacies in Japan. Because herring spawn only over a period of one to two weeks, the harvest can be hectic. Herring are shipped whole to Japan, or the roe is harvested and sent while the carcass is processed into fish meal.

Alaska's Native peoples have harvested and eaten the Pacific herring for perhaps thousands of years.

Southeast Natives still eat herring roe; and villages in western Alaska on the Yukon-Kuskokwim Delta depend heavily on herring as a major subsistence food. About 200,000 pounds are harvested there annually. In northern Europe, the Atlantic herring has served as a basic food fish for people for centuries. In several ancient languages including Norse and Old English, the word "herring" meant "army." In Old English it referred particularly to hordes of Anglo-Saxon invaders. It might be interesting to point out the old definition to students and ask them to compare how vast schools of herring are like an army.

Vocabulary:
- food chain
- food web
- predator
- prey
- phytoplankton
- zooplankton
- herring
- roe
- fish meal

Materials:
- herring to taste
- worksheet:
  ...What's For Dinner (21.)

Procedure:

1. Introduce the terms "predator" (one who eats other animals) and "prey" (the one eaten). Give an example of a local food chain. Start with something students had for lunch, such as a fish sandwich.

   Now have students make that into a food web.

2. Distribute the worksheet What's For Dinner? and have students try to figure out who's eating who. The sun is the powerhouse that runs the whole system.

3. Discuss the role of herring in commercial fisheries and in the food web.

Copy the following diagram on the blackboard:

```
1 adult fin whale eats:
3,000 herring/day

each herring eats:
700 copepods/day

each copepod eats:
130,000 phytoplankter/day
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Discuss the diagram. If students are unfamiliar with copepods, explain that they are tiny crustaceans (animals with jointed appendages and external skeletons like crabs' or shrimps').

Ask a student to consult an encyclopedia or science book for a description of copepods. Phytoplankton, too, can be the subject of student research. Take time to calculate the following:

How many copepods would it take to feed the herring that a fin whale eats in one day? (2,100,000)

How many phytoplankters per day would be needed to feed those copepods? (273,000,000,000)

How many herring would be needed to feed 2 fin whales for a week? (42,000)

Ask the students:

- What would happen if herring were overharvested? (Other animals such as whales would be short on food.)

- What would happen if herring were underharvested? (Other animals would have a lot to eat and their populations would increase.)

- Why do we have to be especially careful with overharvesting herring? (Because we're taking eggs which are the future fish.)

- Why might it be hard to know just the right amount of herring to harvest? (No one knows exactly how many herring are in the ocean. Biologists have to estimate. Also, there are so many people fishing for herring in such a short period, that just one extra hour of fishing might result in too many herring being caught. In some small bays in Alaska the season has been closed after only five minutes of frantic fishing! See Tidelines, Volume III, Number 7, "The Herring Bonanza."

4. Bring smoked, kippered, pickled, dried, fresh or frozen herring for students to cook and taste. Look for herring as cans of kippered herring, or in a variety of styles in the oriental section, or pickled in little jars in the refrigerated meat and fish department. Parents or fishermen might be sources of fresh, smoked, dried, or frozen herring. Japanese restaurants usually will have a variety of herring roe dishes.

Additional Activities:

1. Science, Social Studies: Invite someone involved in the herring fishery to show your class some of his or her gear and talk about what happens in the harvesting process. Native elders might be able to tell the class about herring legends or history and subsistence harvest methods.

2. Art, Science: Make a mobile showing the herring's role in the food chain.
Activity 6
Hide a Halibut

Background:
Students in coastal communities from Ketchikan to St. Lawrence Island may be familiar with halibut, the largest flatfish in the world and one of the best food fishes. The halibut also is a good example of camouflage or protective coloration. Many bottom-dwelling fish, including halibut, can change color patterns on their skins to match those of their surroundings. They also can flick their bodies to toss silt from the ocean floor over their backs to hide. Then they remain motionless, or "freeze," which is an important camouflage ploy. The halibut also has a dark, mottled upper surface to blend into the bottom of the ocean. Its undersurface is white, so that if it is swimming higher in the water column its light-colored belly will be difficult to see against the ocean's surface. A very young halibut is nearly transparent so that its surroundings show through and make it difficult to see.

Vocabulary:
- camouflage
- protective coloration

Materials:
- paper
- watercolors and brushes
- worksheet:
  ...Halibut, Halibut (2M)

Procedure:
1. Introduce "camouflage," a term meaning "whiff of smoke" and introduced in World War II to describe the technique of making soldiers, tanks, and all kinds of fighting equipment seem to disappear through the use of colors and patterns. Of course, animals have been using these techniques of protective coloration for millions of years!

Ask the students:
- What examples of camouflage can you think of? (Snowshoe hares and ptarmigan change to white in the winter to match the snow; sea anemones look like flowers until their tentacles close around a nearby fish to paralyze it; female ducks are the same color as the marsh grasses; octopus release clouds of ink."
- Have you ever seen an animal "freeze" to blend with its background?
- Why would an animal want to be a master of camouflage? (To hide from predators or to attract prey.)

2. Pass out the worksheet Halibut, Halibut. Explain that we will be studying a fish that is a master of camouflage. Have students
read and answer the questions. (1: It moves over to the right side; 2: In the ocean waters; 3: Shrimp, young crabs, and other bottom-dwelling animals; 4: false; 5a: almost 9 feet; 5b: 500 lbs; 6: 7-12 years old; 7: 50-100 fathoms; 8: Because many other animals eat them; 9: Other animals have trouble seeing them to eat; 10: Dark above and white below, change colors, motionless, hide in sand on ocean floor, transparent young; 11: $89.25)

3. Have the students make watercolor paintings of halibut to illustrate some of their camouflage properties.

Display your paintings and invite younger students to see if they can "find the halibut!"

Activity 7
The Amazing Alaska Blackfish

Background:

The Alaska blackfish is a small mud minnow that grows to eight inches. It is a rather sluggish, bottom-dwelling fish, which in winter tends to live in deeper portions of lakes where the oxygen is more abundant. In summer, it moves to heavily vegetated tundra, ponds, streams, rivers and lake edges. The blackfish uses its large pectoral fins to paddle slowly about the vegetation in search of aquatic insects and other small invertebrates. Once it spots something to eat, it captures it with a quick dart, much like the lightning dash of a northern pike.

The blackfish is a Native food in western Alaska. In the early spring, people set traps for these creatures in freshwater ponds, lakes, and sloughs.

The blackfish also is prized as a dog food with a high oil content. Many a musher has poured a gunny sack full of frozen blackfish into a dog pot only to be amazed as the creatures thaw and begin swimming. Children all over western Alaska take them out of
frozen gunny sacks and put them into a glass of water indoors to watch them "come alive." However, experiments have shown that even partial freezing of Alaska blackfish results in eventual death. Frozen tissue means dead tissue.

Alaska blackfish are unique because they have a modified esophagus capable of gas absorption. This means they can exist off atmospheric oxygen! Alaska blackfish thus can live in small stagnant tundra pools that are almost devoid of oxygen and they can survive in moist tundra mosses during extended dry periods while waiting for rain to fill the pools again.

Because of the blackfish's air breathing capabilities, handling and care of them in the classroom is relatively easy. But be sure you get a permit to hold blackfish, or any other native fish, from the Alaska Department of Fish and Game. (The idea for this activity came from Mark Pope, Ambler. Technical information was supplied by Bob Armstrong, associate professor of fisheries, University of Alaska, Fairbanks.)

Vocabulary:

- adaptation

Materials:

- thermometer
- 2 large jars (peanut butter)
- 2 or more live blackfish
- damp moss
- large deep container (dish pan)
- live bugs
- chunks of meat, fish, bread, etc.

Procedure:

1. Obtain at least two blackfish. A funnel-shaped trap can be made from strips of tamarack, spruce or small mesh galvanized hardware cloth. Local residents may be glad to give you a couple blackfish or show you how to make a trap. In early spring, the trap can be placed around holes in lake ice where blackfish come up to breath because oxygen often becomes depleted there in late winter. Blackfish can also be easily caught in spring and fall as they migrate to and from their summer habitats, by placing the traps in narrow sloughs or stream channels.

2. Place each blackfish in a wide-mouthed jar of cold water. Then prepare a tundra model by placing at least four inches of moist moss in a deep container such as a dish pan. Tell the students that the moss and the jars of water represent tundra habitat. Ask the students how they think blackfish have adapted to life on the tundra. Explain that blackfish can breathe atmospheric oxygen because they have a modified esophagus that can absorb oxygen! The blackfish's airbreathing ability can be demonstrated by taking the fish out of the water and placing it in the moist moss for an hour. Both the moss and the water in the jars should be kept cool, and approximately the same temperature. Cold water holds more oxygen and cool temperatures slow down respiration. Blackfish are air breathers.
but there are limits to everything! (Be sure students wet their hands before touching the blackfish so they do not disturb its protective layer of mucus. Explain the importance of being quiet and making slow movements when working with animals so that they are not stressed unnecessarily. Since this is a scientific experiment, students should handle the fish in the jar (the control) an equal amount of time. Then leave both fish to rest quietly.)

3. At the end of the hour, put the fish on the moss back in the water. What differences do the students notice between the two fish? What survival advantages do the blackfish have because of this adaptation?

4. Later, after the excitement subsides, have students try feeding the blackfish with crumbs, bits of meat or any other food that doesn't squirm. The fish probably won't sample it.

5. Now have students offer the blackfish small live insects. If the fish are hungry, they'll eat; if they don't, try again later. When they eat the insects, ask students why they ate the live food instead of the "dead" food. (You may want to try feeding the "dead" food again at that point.)

6. Discuss the basic requirements of blackfish. Like any animal, they need food, water and cover. Keep daily records of blackfish observations by your students.

Change the water and feed them once a day. Drop ice chunks into the water to keep it cool, especially if your classroom temperature is in the 70-80° range. Cold water holds more oxygen. Alternatively, set up an aquarium and aerator. Release the blackfish when your observations are completed. Students may be interested in being able to tell males from females. Mature males can be distinguished from females by a reddish fringe along the dorsal, caudal, and anal fins. Also, in mature males, the tips of the pelvic fins extend well beyond the front of the anal fin, whereas in females, they do not.

---

**Blackfish Experiment**

**Object:**
To verify an investigation described by Belle Mitchell of the Alaska Sea Grant College Program, wherein a blackfish is kept in a damp moss environment instead of water.

**Hypothesis:**
A blackfish should be capable of surviving a damp moss environment without water by virtue of its gills, being able to absorb atmospheric oxygen rather than being solely dependent upon its gills.

**Method:**
Moss was soaked in water and shaken dry and placed in coffee cans or 500-ml. beakers. A live healthy blackfish was removed from water at room temperature (68-70 degrees F) and placed in the moss. A thermometer was inserted through a loose fitting cover and the arrangement was left in a quiet place for one hour. Afterwards, the entire contents of the container were dumped into an aquarium and the condition of the blackfish was observed.

**Conclusion:**
The information is largely subjective as only temperature measurements were taken.

In six specific trials all blackfish survived regardless of temperature and no difference in the trials could be discerned in temperatures ranging from 40F to 50F.

It appears the behavior of the blackfish may be as significant as the physiology. In all cases the Blackfish thrashed about periodically in convulsive type of activity until they reached the lowest layers of the moss, and in most cases worked their way completely below the moss to rest at the bottom of the container. After one hour all fish remained still with the mouth closed.

Recovery in some cases was very slow. A fish would remain motionless for some time were returned to the aquarium and not was for several hours afterward. All fish were stable and did not belly-up.

Mike Stichwick

Here's the blackfish experiment as
actually conducted by Bethel-Kilbuck science teacher Mike Stichick. You might want to use it as a model and have your own class record its observations and write a similar "scientific report" of the experiment.

Additional Activities:

1. History: Have a village elder show your class how to make a wooden blackfish trap. Then try making your own.

2. Language Arts, Home Economics: Collect and try some blackfish recipes.

3. Science: Weigh a dead blackfish, then cut it into pieces and boil them in water. Wait 10 minutes, then ask students what they see floating on top of the water (oil). Skim off the oil and weigh it. What percentage of the blackfish is oil? Might this be a key to their success in the cold?

4. Science: Conduct yarn tagging experiments with the assistance of the Alaska Department of Fish and Game. Insert different colored yarn in the dorsal fin, depending on which local body of water the blackfish were captured. Then release them in the same water and see if they are recaptured in any other places. Note time, date, size, place and when captured. (Activity suggested by Mike Stichick, Bethel-Kilbuck Elementary.)
Activity 8
Freshwater Fish Card Game

Background:

Alaska's uncounted lakes and ponds and thousands of miles of rivers and streams are home to incredible numbers of fish. Salmon are perhaps the most famous, but those species are covered in other activities in this unit. For this activity, we'll concentrate on the many other freshwater and estuarine varieties. A good reference for this activity is James Morrow's *The Freshwater Fishes of Alaska*.

Vocabulary:

- circumpolar
- lamprey
- sheefish
- inconnu
- cisco
- dolly varden
- grayling
- eulachon
- hooligan
- sucker
- pike
- burbot
- tomcod
- stickleback
- sculpin
- flounder
- sturgeon

Materials:

- copies of freshwater fish cards (4 per each group of 4-6 students)
- scissors
- glue
- contact paper or laminator
- person knowledgeable about local freshwater fish

Procedure:

1. Make up sets of freshwater fish cards before class time or have students help put them together. Copy four sets for each group of four to six students. Pick two of the species to color red. Each of those cards will be worth extra points. Cut and fold the cards so the fish appears on one side, its description on the other. Laminate or glue.

2. Shuffle the cards and you're ready to play the freshwater fish card game. Explain to students that this is a game to test their observational powers and memories, as well as a chance to learn about freshwater fish. Lay the deck fish-side up. Before the game starts, have individual students decide at which level they want to play the game.

   Beginning fishermen can simply pick up the card, read aloud its name and one "fish fact," and keep the card.

   Intermediate fishermen get to keep the card only if they can tell the name of the fish. If they miss, that card goes to the bottom of the deck. If they're right, they read aloud
one "fish fact" before the next player takes a turn.

Super fishermen get to keep the card only if they can name the fish plus tell three interesting facts about the fish. If they miss, that card goes to the bottom of the deck.

Students can advance to higher levels as they become more proficient. After all the cards are picked up, have each student count his number of cards. Beginning fishers get one point per card; intermediate fishers get two points per card; and super fishers get three points per card. Add two points for each red fish. Have students total their points to determine the winner, and try the game again.

3. Invite a person knowledgeable about local freshwater fish to come to your class and tell you more about the fish in your area. Check with village elders, the bilingual staff, biologists, local fishermen. Amaze them with what you know and ask any questions you've been saving.

Additional Activities:

1. Science, Language Arts: Have students research and report on local freshwater fish. These are the names, species and ranges of those found on the cards.

- Arctic Lamprey, Lampetra japonica: Kenai Peninsula north along the western coast and all along the northern coast and up to Yukon River into Canada.

- Sheefish, Inconnu, Stenodus leucichthys: Kuskokwim, Yukon, Selawik, Kobuk, and lower reaches of the Koyukuk and Tanana Rivers.

- Least Cisco, Coregonus sardinella: Streams and lakes north of the Alaska Range, and from Bristol Bay to the Arctic coast. Also in the Kuskokwim and Yukon drainages.

- Round Whitefish, Prosopium cylindraceum: Throughout mainland Alaska from the Taku River, near Juneau, to the arctic coast.

- Humpback Whitefish, Coregonus clupeaformis: Northern and western coastal Alaska and Yukon River drainages.

- Cutthroat Trout, Salmo clarki: From the northern parts of Prince William Sound down through Southeast Alaska.

- Rainbow Trout, Salmo gairdneri: Throughout Southeast Alaska north to the Kuskokwim River and West to Port Moeller on the Alaska Peninsula.

- Lake Char, Salvelinus namaycush: From the Alaska Peninsula north and east into Canada and down to northern Southeast Alaska.

- Arctic Grayling, Thymallus arcticus: Throughout Alaska except the Aleutians and southeast islands.

- Dolly Varden, Salvelinus malma: Throughout Alaska.
- Eulachon, Thaleichthys pacificus: From the Southeast coast north to Bristol Bay and west to the Pribilof Islands.

- Alaska Blackfish, Dallia pectoralis: From the Colville River Delta on the arctic coast west and south to the central Alaska Peninsula near Chignik. In the Yukon-Tanana drainage to around Fairbanks and on Nunivak and St. Lawrence Islands.

- Northern Pike, Esox lucius: Northern, western and interior Alaska.

- Longnose Sucker, Catostomus catostomus: Throughout Alaska except southeast Alaska islands, Aleutian Islands, and islands in the Bering Sea.

- Burbot, Lota lota: Throughout Alaska except southeast, Aleutians and Bering Sea Islands.

- Saffron Cod, Eleogobius gracilis: North Pacific Ocean and Bering and Chukchi Seas, plus along coast down to Sitka and north to Kotzebue plus sometimes enters rivers.

- Ninespine Stickleback, Pangioptus pungitius: Northern and western coastal Alaska (the three spine stickleback is found in southern and southeastern coastal Alaska, plus some western areas, and both types are found on St. Lawrence Island).

- Slimy Sculpin, Cottus cognatus: Throughout Alaska except for the Aleutians and southern Southeast Alaska.

- Starry Flounder, Platichthys stellatus: Throughout coastal Alaska except for the Aleutians.

- White Sturgeon, Acipenser transmontanus: In rivers, estuaries, and the sea in Southeast Alaska north along the Gulf of Alaska.

2. Language Arts, Science: Encourage students to make up their own freshwater fish game, everything from tag, relays, and quizzes to board games.
Freshwater Fish Cards

CISCO
- are good eating.
- spawn at night in the fall.
- stream-dwelling populations migrate upstream to spawn.
- lake-dwelling populations don't migrate.
- eat plankton and plants.
- are eaten by eagles, hawks, kingfishers, pike, sheefish, lake trout, burbot and man.

LAMPREY
- have no jaws.
- have seven round holes for gill openings.
- have cartilage skeleton.
- include anadromous and freshwater species.
- are parasites of salmon and trout.
- young are eaten by pike, trout, and salmon.
- are eaten as a delicacy by Europeans.

SHEEFISH OR INCONNU
- are excellent sport and subsistence fish.
- are very tasty.
- support a commercial fishery in Kotzebue.
- young eat plankton and insect larvae.
- adults eat other fish.
- usually winter in lower rivers and estuaries.
- slowly move upstream to clear waters beginning in the spring.
- spawn in the fall.
LAKE CHAR

- are good, but eating easily affected by pollution such as DDT.
- eat plankton, insects, clams, snails, fish, mice, and algae.
- spawn and live in lakes.
- can grow as big as 100 pounds!

RAINBOW TROUT

- have a reddish band along each side.
- are called steelhead if they migrate to sea.
- are very important sport fish.
- like cold water.
- include stream-dwellers that do not migrate to sea.
- include lake-dwellers that migrate to streams to spawn.
- migrate at night.

CUTTHROAT TROUT

- usually have red or orange mark on underside of each jaw (sea-run cutthroats often lack this mark).
- are famous sport fish.
- can easily be overfished.
- usually spawn in small, gravel-bottomed streams.
- include anadromous populations along the coast.
- eat insects, young fish and eggs.
ALASKA BLACKFISH

- have rounded tails.
- live in small muddy ponds and quiet streams with lots of vegetation.
- are subsistence food for both people and dogs.
- can live off atmospheric oxygen.
- as adults eat insects, small fishes and invertebrates.

NORTHERN PIKE

- have sharp teeth and long, flat snout (nose).
- are delicious eating.
- have a circumpolar range.
- winter in deep water of lakes and rivers.
- spawn in marsh areas in the spring.
- as adults eat mostly fish, but also ducklings, frogs, mice, insects.

LONG NOSE SUCKERS

- feed by sucking up insect larvae and other invertebrates on stream or lake bottoms.
- are important as dog food in some areas.
- supposedly eat many eggs of other fish but damage is probably greatly exaggerated.
- most commonly eat whitefish eggs which are spread over the bottom (Whitefish do not build reds.).
ARCTIC GRAYLING

- have huge dorsal fins.
- have small mouths.
- are famous sport fish.
- are subsistence fish in some areas.
- spawn in spring after breakup.
- eat insects.
- establish territories for feeding (biggest and strongest fish take the best feeding spots).

DOLLY VARDEN

- have light pink spots on a dark background.
- are a type of char (not trout) and are very similar to the arctic char found in northern and southwest Alaska.
- include some anadromous populations.
- are important sport fish.
- used to have a reputation for being serious predators on salmon eggs and young salmon. Now biologists are finding that's not so.

HUMPBACK WHITEFISH

- are important subsistence fish.
- usually are anadromous.
- move upstream to spawn.
- young eat plankton.
- adults eat clams, crabs, shrimp, and midge larvae.
BURBOT
• also are called lush or fresh-water cod.
• are excellent food fish.
• liver is prized in Europe.
• liver contains lots of vitamins A and D.
• often are caught by ice fishing in the winter.
• range is circumpolar.
• have a large head.
• young eat mostly insect larvae.
• adults eat mostly fish.
• spawn in the winter at night under the ice.

SAFFRON COD
• also are called tomcod.
• are mainly saltwater fish, but ranges upstream in coastal rivers.
• have large head, barbel hanging from chin.
• are important subsistence food fish for animals in arctic seas, as well as people.
• liver are very high in vitamins A and D.
• are caught commercially in Siberia.

STARRY FLOUNDER
• are bottom-dwellers.
• have both eyes on same side of their heads.
• fins have dark and light bars.
• live in salt water as well as brackish water and may head upriver into fresh water.
• are excellent eating.
• may have color and eyes on either right or left side.
• can change color to match the ocean or river bottom.
WHITE STURGEON

- bodies have five rows of large bony plates.
- are anadromous.
- begin upstream spawning migrations in the spring.
- favorite foods are eulachon and lamprey.
- flesh is delicious fresh or smoked.
- eggs make excellent caviar.
- size includes one that weighed more than 1,300 pounds when caught.
- could be the Lake Iliamna monster.

ROUND WHITEFISH

- are important subsistence fish.
- are very good smoked.
- are found throughout mainland Alaska and from Juneau north to the arctic coast.
- spawn in the fall, after migrating upstream or inshore in lakes.
- eat various insects and in some places, lake trout eggs.

EULACHON

- also are called hooligan, ooligan, or candlefish.
- have a very high fat content, so that when dried they can be burned directly or with the addition of a wick.
- are very tasty.
- are anadromous.
- migrate into freshwater streams in the spring to spawn.
- sometimes migrate in such large numbers that they can be scooped out of rivers with hand nets. Gulls and eagles enjoy the feast too and congregate in great numbers to eat hooligan.
STICKLEBACK
- also are called needlefish or pinfish.
- include two species in Alaska: one species has three spines; the other has nine spines.
- are an important food of larger fishes and birds.
- sometimes compete with young salmon for food.
- can lock spines upright to prevent predators from swallowing them.
- males' breasts turn bright red orange when spawning.
- males build a nest, attract a female, and raise the young by themselves!

SLIMY SCULPIN
- are bottom-dwelling fish.
- have large head.
- have many spines.
- are mostly marine, but this is a freshwater species.
- include at least one sculpin species has a natural antifreeze in its blood to help survive life in cold waters.
- eat mainly insects.
- sometimes eat or compete with salmon fry.
- males "bark" at each other by rapidly opening and closing their mouths.
- males often fight to the finish in defense of their territories.
- males guard eggs and "fan" them with their large pectoral fins.
**Activity 9**
Design a Fish

**Vocabulary:**
- adaptation (review)

**Materials:**
- paper
- pencil
- colored tissue paper
- old newspaper or scrap paper for stuffing
- glue
- scissors
- felt-tip markers
- yarn or string

**Procedure:**

1. Have students create their own fish, adapted to a real or imaginary habitat. Have them first sketch their fish on paper and tell:
   - how it gets its food
   - what it eats
   - what eats it
   - where it lives
   - how it gets oxygen
   - how it moves in the water
   - where it hides
   - what its purpose is in life

   Encourage everyone to use imagination.

2. Have students make a tissue paper model of their fish by cutting the paper to the right size, then gluing three of the sides. After it dries, stuff the model with paper. Glue the last edge. Use felt-tip pens to add eyes and designs. Then tie yarn or string through the dorsal fins (or the tops of the fish) and hang them from the ceiling for a real fantasy fish world!

3. Have each student show his creation to the rest of the class, and tell about its wonderful adaptations.
Ocean Salmon Cards
Spawning Salmon Cards
Ocean Salmon Identification Charts
from ALASKA Tidelines

Black gums
King or Chinook

Tiny scales
Silver or Coho
Spots may not be clear

Pink or Humpback

Fine black speckling
Chum or Dog

Red or Sockeye
Very narrow
Dark fin edges
# Spawning Salmon

As salmon move into freshwater and start their journey upstream to the place where they will spawn, they stop feeding. They begin to "grow old." If their journey is a long one, the changes happen more slowly than they do if the journey is short. But by the time any Pacific salmon is ready to spawn, the silver of its ocean coat is gone. The fish may begin to look tattered and torn. Its body has changed both in shape and color.

Below is a chart that will help you tell one kind of spawning salmon from another. Draw and color a picture of each type of salmon in its spawning colors in the blank spaces below.

<table>
<thead>
<tr>
<th>KING</th>
<th>COHO</th>
<th>SOCKEYE</th>
<th>CHUM</th>
<th>PINK</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COLOR</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dull red to copper or black</td>
<td><em>Female - dark red, often with yellow green blotches</em>&lt;br&gt;Male - bright red back&lt;br&gt;darker red sides&lt;br&gt;Head of both sexes - olive green&lt;br&gt;Lower jaw - white</td>
<td><em>Male - up &amp; down bars of green &amp; purple on sides</em>&lt;br&gt;<em>Female - a dark band along each side</em></td>
<td><em>Male - brown to black white underside.</em>&lt;br&gt;<em>Female - Olive-green with tan bars of patches. white underside</em></td>
<td></td>
</tr>
<tr>
<td>Males - darker than females</td>
<td>Maroon-red sides</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>JAW</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male - Hooked upper jaw</td>
<td>Male - teeth large&lt;br&gt;Male - upper jaw jaw very hooked&lt;br&gt;Lower jaw - slightly hooked</td>
<td><em>Male - Hooked upper jaw</em></td>
<td><em>Male - Hooked upper jaw, very large teeth</em></td>
<td>Male - hooked</td>
</tr>
<tr>
<td><strong>BACK</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male - Somewhat ridged instead of rounded</td>
<td>Little change</td>
<td>Male - Large hump</td>
<td>Little change</td>
<td>Male - Very large hump</td>
</tr>
</tbody>
</table>
Ocean and Spawning Salmon

Using your ocean salmon identification chart and your Spawning Salmon worksheet, answer the following questions about the five species of salmon found in Alaskan waters.

1. Which ocean salmon can be identified by large black spots on the dorsal and caudal fins?

2. Which ocean salmon has black spots ONLY on the upper half of the caudal fin?

3. Which ocean salmon has black gums?

4. Which spawning male salmon turns bright red?

5. In which two salmon does the spawning male salmon develop a humped back?

6. Which spawning male salmon develops very large teeth?
Salmon Life Cycle Stages

Directions: Cut apart and place in the proper order.

- Spawning salmon
- Ocean salmon
- Eggs
- Alevins
- Fry
- Smolt
**A Salmon's Life Cycle**

Predict the answers to these questions before you read the following paragraphs. Then put down the correct answer as you read. How well did you predict? (super, great, O.K., or better next time!)

<table>
<thead>
<tr>
<th>My Prediction</th>
<th>Correct Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. How many kinds, or species, of Pacific salmon are there?</td>
</tr>
<tr>
<td></td>
<td>2. How many kinds of Pacific salmon are found in Alaskan waters?</td>
</tr>
<tr>
<td></td>
<td>3. What does <strong>anadromous</strong> mean?</td>
</tr>
<tr>
<td></td>
<td>4. Where do salmon lay their eggs?</td>
</tr>
<tr>
<td></td>
<td>5. How big are salmon eggs?</td>
</tr>
<tr>
<td></td>
<td>6. What are salmon called when they have a yolk sac?</td>
</tr>
<tr>
<td></td>
<td>7. Salmon an inch long are called _________.</td>
</tr>
<tr>
<td></td>
<td>8. Salmon 3-4 inches long are called _________.</td>
</tr>
<tr>
<td></td>
<td>9. What color are ocean salmon?</td>
</tr>
<tr>
<td></td>
<td>10. What helps a salmon return to the stream where it was hatched?</td>
</tr>
</tbody>
</table>
11. What is a salmon "nest" called?

12. What happens to Pacific salmon after they have spawned and covered their eggs?

13. How do salmon help our world?

Pacific salmon are found along the North American coast from California to Alaska and in Asia from Japan to the Soviet Union. In Alaska, we have five of the six species of Pacific salmon. The Japanese cherry salmon is found only around the Japanese Islands and the nearby Asian mainland. The one species of Atlantic salmon lives in the waters of New England, Canada's eastern provinces, and across the Atlantic Ocean in Iceland, the British Isles, Norway and as far south as Spain.

Pacific salmon are all anadromous. That means they hatch from eggs in fresh water, travel to salt water to grow and mature, and then return to fresh water to deposit their own eggs, or spawn in gravel. The eggs are bright pink, about the size of a pea. In late fall or winter, the eggs hatch and become alevins (pronounced alˈ-luhn-vins). These little baby salmon, or larvae, have huge yolk sacs attached to their bodies. The yolk sac provides all the food each fish needs. By late spring or summer, these alevins have consumed their yolk sac and are ready to emerge from the gravel as fry. By this time, the baby salmon are an inch long. They eat small insects and plankton (tiny floating plants and animals). After one or more winters in lakes or streams, the salmon are 3-4 inches long and are called smolts or fingerlings. They are ready to begin their journey downstream to the ocean. When they reach the ocean, salmon begin to eat greedily. They grow rapidly. They are bright and silvery. After 1 to 5 years in the ocean, they travel up freshwater streams to reach their spawning place. The salmon stop feeding and their bodies change rapidly. Their color turns from silver to shades of copper, brown, red or green. The upper jaw of the male becomes hooked downward, and the shape of his body may change as well.

Salmon almost always spawn in the same stream in which they were hatched. Biologists think a salmon's sense of smell is important in helping it return home. When the salmon reach
their spawning spot, the female digs a nest, or redd, with her tail. As she deposits eggs in the redd, they are fertilized by a male of the same species. Using her tail, the female salmon then covers her eggs with material from the stream bed. Soon after they have spawned, the salmon die. Their bodies become food for bears, birds and other animals of the stream and bays into which the water flows. And the nutrients from their bodies help make these waters more productive. Thus, the adult salmon help to insure that there will be food for their young.
# Salmon Match Game

**Directions:** Write the word from the column on the left in front of the correct meaning.

<table>
<thead>
<tr>
<th>Word</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humpy</td>
<td>1. A young salmon ready to go to sea.</td>
</tr>
<tr>
<td>Chum</td>
<td>2. A round hole in a gravel bed where salmon eggs are laid.</td>
</tr>
<tr>
<td>Fry</td>
<td>3. To lay and fertilize eggs.</td>
</tr>
<tr>
<td>Alevin</td>
<td>4. Any fish that is hatched in fresh water but lives most of its life in salt water.</td>
</tr>
<tr>
<td>Spawn</td>
<td>5. Very tiny plants and animals that live in the sea.</td>
</tr>
<tr>
<td>Chinook</td>
<td>6. Salmon young that have used up their yolk sac.</td>
</tr>
<tr>
<td>Redd</td>
<td>7. Newly hatched salmon with its yolk sac still attached to its body.</td>
</tr>
<tr>
<td>Sockeye</td>
<td>8. A kind of circle of life. The chain of life from birth to death, to birth again.</td>
</tr>
<tr>
<td>Life cycle</td>
<td>9. The symbol of male animals.</td>
</tr>
<tr>
<td>?</td>
<td>10. The symbol for female animals.</td>
</tr>
<tr>
<td>Plankton</td>
<td>11. Another name for a smolt.</td>
</tr>
<tr>
<td>Fingerling</td>
<td>12. Red salmon.</td>
</tr>
<tr>
<td>Smolt</td>
<td>15. Silver salmon.</td>
</tr>
<tr>
<td>♂</td>
<td>16. Pink salmon.</td>
</tr>
</tbody>
</table>

**How well did you do?**

- 16 right - Biologist
- 13-15 right - Better luck next time
- 10-12 right - Just getting started
- Under 10 right - Well, I like to eat fish!
Salmon Word Search

Can you find the 13 "salmon words" in the square below? Some words may be diagonal or even backwards!

R E U S A M O N P V I Q U Y
M O Z R M N U Y L B D D E R
X N C G A P A K S O C I M F
S O C K E Y E D S P A U N T
L M A I R O D N R N A S B C
N L R O T I G N Y O V V S T
T A H B S P A W N M M I G K
V S I C L D E M E U N O T S
E G H S C T A R S H O N U T
L N S T A P E N U C T P A S
A I G R N O B B L E O P S I
Q K G U N S V E S T E H R D
S I E S P I N K S A L M O N
M S U H C N Y H R O C N O Y

1. ALEVIN
2. ANADROMOUS
3. CHUM
4. COHO
5. EGGS
6. FRY
7. KING SALMON
8. MIGRATE
9. PINK SALMON
10. REDD
11. SOCKEYE
12. SPAWN
13. STREAM
The Pink Salmon Game

Even though the Pink salmon is the smallest of all the Pacific species, it is a favorite with the beginning recreational salmon fisher. It has the shortest life cycle of any species; the salmon can be caught again within just six weeks after its first effort.

Each species has its own special pattern of living which affects its growth and its ability to return. The pink salmon spend time in the sea and then travel 2,400 miles up the Fraser River. Pink and silver salmon may spend two or three years in the sea and more before returning to spawn. But all that important living involved is just a part of the story and will be told as you play the game.

1. Roll the die to move ahead, and follow the instructions on the space on which you land. If you don't have a die, roll a coin three times and count spaces. Each space is one year.


For instructions on the spaces, please see the accompanying book. "The Salmon's Life Cycle" by J. L. and G. L. EP.

Instructions on playing the game are on the back of this sheet.
Only the Strong Survive
(Adapted from the Alaska State Museum's Salmon Kit)

Use the numbers below to find out how many salmon are left.
Use this page for your work.

1. A salmon deposited 5,000 eggs in a redd.

2. Five hundred (500) eggs were not fertilized.

3. Sixty (60) were washed out of the gravel when a 3-wheeler crossed the stream.

4. Mud from building a new subdivision eroded into the stream and suffocated one thousand (1,000).

5. Three hundred (300) alevins died because they were very weak.

6. After the alevins developed into fry, five hundred (500) were eaten by other fish in the stream.

7. Forty-one (41) were eaten by birds.

8. As they neared the ocean, 260 salmon were caught in a pool where they got too hot because of thermal pollution from a coal-fired power plant.

9. In the ocean, 1,500 were eaten by bigger fish.

10. Seals ate 95.

11. Fisherman caught 556.

12. As the salmon returned to their spawning stream, bears ate 180 of them.

13. Three (3) were dashed against the rocks trying to jump a waterfall.

14. The rest of the salmon spawned.

15. **HOW MANY SALMON WERE LEFT TO SPAWN?**
What's for Dinner?

All animals and plants must have food to survive. Our coastal waters are particularly rich in food resources. See if you can figure out who eats who in this picture. Draw arrows from the predators to the prey. What runs this whole system?
Halibut, Halibut

After hatching from the pelagic larval stage the larvae are

plankton for 4 to 6 months, feeding on small plankton and eventually developing to the post-larval stage.

During the free-swimming pelagic post-larval stage the larvae pass through several developmental stages. In this period the larvae are near the ocean's surface and are carried by current changes in oceanic waters. As these changes create a change in form occurs: metamorphosis, the larvae are gradually transformed into the adult stage.

Note: All detailed sketches within are drawn to scale shown below.

0 5 10 15

Adult halibut attain commercial size between 30 to 275 pounds in depth. Females mature at 12 years of age on average while males mature after 7 to 9 years. Both have lower fecundity than many and may spawn up to 10 years, while males grow to 25 years of age. Halibut are the largest of all flatfish, and have been known to weigh nearly 200 pounds. Adult feed on a variety of fish and some crustaceans.
Halibut are the biggest flatfish in the world. The largest one caught in Alaska weighed about 500 pounds and came from near Petersburg. Females grow faster than males and get bigger. One record-sized female was 8 feet, 9 inches long. Females live longer, too. The oldest recorded female was 42 years old, but the oldest recorded male was only 27 years old.

Halibut, and about 20 other species of fish found in Alaska's waters, are called flatfish. They are flat and built to spend much of their lives lying quietly on the ocean floor, motionless, but alert for any smaller fish that might make a good meal.

Halibut spawn in the winter in deep ocean waters. Each spawning female may produce as many as 3 million eggs. Instead of depositing her eggs on the ocean floor, she releases them into the ocean. The eggs are just heavy enough to stay adrift about 300 to 600 feet below the surface. The young fish that develop from the eggs are transparent except for their eyes, and like salmon, they have a large yolk sac for food. Until they are about one-half inch long, halibut look like normal, upright fish. But then, the eye on the left side of the head starts to move around to the right. By the time the fish is a little over an inch long, the left eye has stopped moving and the young fish looks like its parents. Now it is a fish that can lie on its side on the ocean bottom and still be able to see with two eyes because both are on the top side of its head. Underneath, the halibut is white to match the ocean's surface, while its top side is dark and mottled to match the ocean bottom. It can even change colors to match the different colored ocean floor.

Now flat, the young fish rise and are carried toward shore by ocean currents. By the time they are 6 or 7 months old, halibut settle to the bottom of the sea where they feed on shrimp, young crabs, and other bottom-dwelling animals. When the fish are older, they move farther from shore. When they are 7 to 12 years old, they begin to spawn once a year. Soon, they are big enough to be caught by fishermen and women, like you and me!

Now answer these questions:

1. What is curious about the left eye of the halibut?

2. Where do female halibut leave their eggs when they spawn?
3. When young halibut settle to the ocean floor, what do they eat?

4. Male halibut grow faster and live longer than female halibut. (True or false?)

5. a. How long might a very large halibut be? 
   b. How much might a very large halibut weigh?

6. How old are halibut before they begin to reproduce?

7. Halibut eggs drift 300 to 600 feet below the ocean surface. There are 6 feet in a fathom. How many fathoms below the surface are the eggs?

8. If each mature female halibut releases as many as 3 million eggs a year, why isn't the ocean clogged with halibut?

9. Halibut eggs are transparent. How is that important to their survival?

10. List four different ways that halibut camouflage themselves.
   a. 
   b. 
   c. 
   d. 

11. If you caught a 105 pound halibut and decided to sell it to the cannery at $5.00 per pound, how much would your fish be worth?