

CLIMATE IMPACTS: SALMON

Overview:

In this lesson, students read two essays and complete reading comprehension worksheets to review basic salmon ecology and begin to investigate potential impacts of climate change on salmon populations. Students document and share the views and experiences of community members about salmon and climate change.

Objectives:

The student will:

- review the life cycle of salmon;
- describe salmon's connection to other parts of Alaska ecosystems;
- explore the potential impacts of climate change on salmon and their habitats; and
- interview community members about the importance of salmon in their lives and the changes they have observed in salmon populations over time.

Targeted Alaska Grade Level Expectations:

Science

- [11] SA1.1 The student develops an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, analyzing data, developing models, inferring, and communicating.
- [11] SA3.1 The student demonstrates an understanding that interactions with the environment provide an opportunity for understanding scientific concepts by conducting research and communicating results to solve a problem (e.g., fish and game management, building permits, mineral rights, land use policies)
- [11] SC3.2 The student demonstrates an understanding that all organisms are linked to each other and their physical environments through the transfer and transformation of matter and energy by analyzing the potential impacts of changes (e.g., climate change, habitat loss/gain, cataclysms, human activities) within an ecosystem.

Alaska High School Graduation Qualifying Exam Performance Standards Addressed:

- R4.1 Apply knowledge of syntax, roots, and word origins, and use context clues and reference materials, to determine the meaning of new words and to comprehend text.
- R4.2 Summarize information or ideas from a text and make connections between summarized information or sets of ideas and related topics or information.
- R4.4 Read and follow multi-step directions to complete complex tasks.

Vocabulary:

alevin – the first stage of the lifecycle of a salmonid after emerging from the egg; the yolk sac is still attached to the young fish's abdomen

anadromous – a term describing fish that migrate to fresh water from the ocean to breed

escapement – the portion of a salmon run that is not harvested and survives to spawn sustainable harvest

fry – the stage of a salmon's lifecycle after it leaves the gravel nest and the yolk sac has been absorbed

keystone species – a species on which others in an ecosystem largely depend; if it were removed the ecosystem would change drastically

redd – gravel nest dug by a female salmon

riparian – relating to the land along a river or stream

smolt – the stage of a salmon's lifecycle when it loses its vertical markings and becomes silver; this is when its body adjusts to salt water and it migrates to the ocean

spawn – to lay eggs

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Whole Picture:

Salmon are essential to Alaska's ecosystems and cultures. One study conducted by the Washington Department of Fish and Wildlife indicated that more than 137 species of wildlife rely upon salmon for nutrients at some stage of the salmon life cycle. Many animals prey directly upon salmon as eggs, alevin, fry, smolt and adults. However, plants, animals, microorganisms and fungus all benefit from the ocean-derived nutrients that an adult salmon returns to the stream ecosystem. Just think of all the salmon carcasses that are scavenged by insects and birds, decomposed by fungus and bacteria, and then absorbed by the roots of plants and trees! Research has traced isotopes of two important nutrients (nitrogen and carbon) from dead salmon and found them throughout ecosystems along rivers and streams. It is estimated that salmon may provide 18% of the nitrogen in streamside trees, 25-30% of the nitrogen and carbon in insects, and 25-40% of the nitrogen and carbon in young salmon. Without salmon, Alaska ecosystems would be much less productive and diverse. Salmon can be considered a keystone species for many riparian ecosystems in Alaska.

Salmon are the basis of a subsistence diet and a key part of the culture and identity of many Alaska Native people. In many regions, commercial salmon fishing is also a mainstay of the economy. Scientists don't fully understand how climate change will impact Alaska's salmon populations and the communities that depend upon them. As climate warms thawing permafrost causes the land above it to collapse, washing silt, gravel and mud into rivers and streams. This can cloud and slow the water in rivers where salmon spawn, bury eggs and decrease dissolved oxygen. Thawing permafrost can also drain lakes and disrupt salmon migration routes. Milder temperatures can allow new species of plants, wildlife and pathogens to survive in Alaska waters. These new species could be detrimental to salmon survival.

Materials:

- Flip cameras
- VIDEO FILE: "Yukon River"
- STUDENT INFORMATION SHEET: "The Life and Times of Fred the Red Salmon"
- STUDENT INFORMATION SHEET: "Salmon nose deep into Alaska ecosystems"
- STUDENT WORKSHEET: "The Life and Times of Fred the Red Salmon"
- STUDENT WORKSHEET: "Salmon nose deep into Alaska ecosystems"
- STUDENT WORKSHEET: "Yukon River"
- STUDENT WORKSHEET: "Salmon Jukebox"

Activity Preparation:

1. Decide if STUDENT WORKSHEET: "The Life and Times of Fred the Red Salmon" will be used as homework.
2. Consider how/where you will conduct interviews for STUDENT WORKSHEET: Salmon Jukebox. Decide if students should work individually or in small groups. Think about who you would like students to interview. Possibilities include other students and teachers, family members, community members, Elders, or even each other. Decide how, where and when interviews will take place. Students may conduct interviews on their own (in the evening or on weekends) or invite community members to your classroom to conduct interviews during school hours. Think about what will work best for your class and community. Decide if interviews will be recorded in written form, or in both written and digital form (with Flip camera).
3. Consider how you want students to share their interview experiences. Possibilities include a short class presentation, a short essay and/or watching clips from the interviews (if they were recorded).

Activity Procedure:

1. As a class or in small groups, ask students to brainstorm all of the ways they encounter salmon in their everyday lives. Keep a list of these on a white board. What do salmon add to their lives? Stress salmon are an important element in many parts of Alaskan life including our economy, natural resource management,

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- and the diet of people in cities and villages. Ask students to think about how this might be different for people in other places (urban/rural, different regions of Alaska, different states, different countries).
2. Read STUDENT INFORMATION SHEET “The Life and Times of Fred the Red Salmon” and complete STUDENT WORKSHEET: “The Life and Times of Fred the Red Salmon” individually or together as a class, whatever works best for your class. If it was already assigned as homework, review the answers together.
 3. Read STUDENT INFORMATION SHEET: “Salmon nose deep into Alaska ecosystems” and complete STUDENT WORKSHEET: “Salmon nose deep into Alaska ecosystems” individually or together as a class.
 4. Pass out STUDENT WORKSHEET: “Yukon River.” Allow time for students to view VIDEO FILE: “Yukon River” (running time: 5 minutes 48 seconds) and answer the reflection questions.
 5. Instruct students how to conduct interviews (individually or in groups, during school or after school, how to choose interviewee, etc.) and how to complete STUDENT WORKSHEET: “Salmon Jukebox.”
 6. Instruct students on how and when they will share their interview experiences.

Extension Ideas:

1. Encourage students to create a piece of art or an essay that exemplifies their personal and/or cultural relationship with salmon and how this may be changing.
2. Discuss or assign a writing assignment exploring the different voices involved in salmon management in your community. These may include: subsistence users, commercial fishermen, tribes, government agencies, businesses (such as guides) and non-governmental organizations.
3. Research and discuss the history of commercial salmon fishing in Alaska.
4. See the *Alaska Wild Salmon Teachers Guide* produced by the Alaska Department of Fish & Game for more ideas.

Answers to STUDENT WORKSHEET: The Life and Times of Fred the Red Salmon

Reading Comprehension

1. **Alevin** is the name for the first stage of the lifecycle of a salmon after emerging from the egg when the yolk sac is still attached.
Fry is the name for the stage of a salmon’s lifecycle after it leaves the gravel and the yolk sac has been absorbed. It still lives in fresh water and feeds on plankton.
Smolt is the name of the stage of a salmon’s lifecycle when it loses its vertical markings, becomes silver, its body adjusts to salt water and it migrates to the ocean.
Thrive means to prosper or flourish.
Brackish is a word used to describe a mixture of salt and fresh water (as in estuaries).
Spawning grounds are the streams where salmon reproduce.
2. Fred lives in the following habitats throughout his lifetime: the gravel bed of a stream, a lake, large rivers, the ocean (or gulf) and a river delta (or estuary). Students may answer with the specific names of these locations provided in the story.

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Thinking Deeper

Answers to these questions will vary slightly but should reflect the main ideas below.

3. Salmon require clear gravel beds to spawn. Silt and mud can bury gravel beds, suffocate eggs and kill the insects that young salmon eat.
4. Draining lakes results in a loss of habitat (especially for fry). Disappearing lakes may also stop salmon from being able to migrate back to their home stream to spawn.
5. Invasive fish compete with salmon for food and spawning grounds and can spread disease. Many other invasive species may prey upon salmon. Invasive plants can change the characteristics of a stream by growing along the bottom and covering up the gravel, trapping sediment, etc.

Answers to STUDENT WORKSHEET: Salmon nose deep into Alaska ecosystems

1. Answers will vary, but should at least touch on the idea that a keystone species is a species on which others in an ecosystem largely depend. If removed, the ecosystem would change drastically. Animals, plants, bacteria, and fungus depend upon salmon. Animals eat salmon at all stages of their lives. Algae and bacteria feed on decomposing carcasses of salmon and insects lay their eggs in them. "Salmon tea" (composed of nutrients from carcasses) provides nutrients for plants.
2. Answers will vary. Students may discuss implications for the food supply of humans and other animals; income to support the livelihoods of families and community services; loss of culture and traditions.
3. Answers will vary but should include the idea that salmon bring nutrients from the ocean to inland Alaska. These nutrients are used by all parts of the food web (plants, mammals, birds, bacteria, insects, etc.)

Answers to STUDENT WORKSHEET: Yukon River

1. Answers will vary.
2. 5th
3. Reverend Helen Peters says that when the cotton starts flowing in the springtime, King Salmon is coming.
4. Jake Duncan is trying to learn when the Chinook salmon outmigrate (head towards the ocean), when they are moving and how many fish are produced by each fish that gets to spawn in the river.
5. Answers will vary.
6. Corrine Marion Sheldon talks about being a part of fisheries management by working with managers to shut down the fishery for their harvest at least two days/week. She says it is important to cooperate with management to sustain the food harvest for generations to come.
7. Answers will vary.

Answers to STUDENT WORKSHEET: Salmon Jukebox

1. Answers will vary.

The Life and Times of Fred the Red Salmon

Alaska Science Forum article # 1656, by Ned Rozell, July 24, 2003

Scooped by dipnetters from Kenai to Chitina, red salmon possibly occupy more freezer space in Alaska than any other fish. For the fisherman who ponders the life of this excellent source of protein, here's the story of a red named Fred, based on information from the Alaska Department of Fish and Game and other sources:

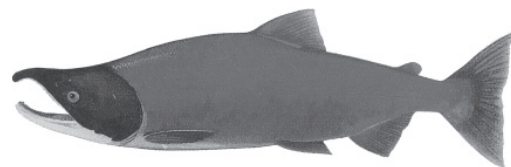
Fred begins life as one of thousands of eggs resting in the gravel bed of a stream that flows into Paxson Lake. As early as February, Fred hatches into an alevin; alevins are about one-inch long and carry a yolk sac, a leftover pack of nutrients from the egg. Being a tiny, tasty guy sought after by other fish and birds, Fred stays tucked in the gravel during his alevin stage.

In a few months, Fred has absorbed all the nutrients from his yolk sac and he emerges as a fry, growing to a few inches long and developing dark bars along his sides. As a fry, he migrates downstream into Paxson Lake, where he feeds on plankton near the surface. He spends the first year of his life in Paxson Lake.

When the ice breaks up on Paxson Lake in his second spring, Fred feels a mysterious pull toward the ocean and leaves Paxson Lake via the exit ramp of the Gulkana River. He is now a one-quarter ounce smolt, a salmon bound for salt water. After a few days of slicing downstream, Fred enters the Copper River, which drains the glaciers of the Wrangell Mountains. While zipping downstream through the Copper, Fred's gills and kidneys undergo subtle changes as he adapts for life in salt water.

Fin-to-gill with hundreds of other red salmon, Fred reaches the Copper River delta in early summer. Fred's world turns from cloudy to clear as he reaches the deep, cold water of the Gulf of Alaska.

His organs adapted to salt water, Fred thrives in the gulf, one of the richest feeding grounds on Earth. He eats crustaceans, small fish, and the occasional squid. He may wander 500 miles out to sea and migrate most of the length of the Aleutian Chain. He sometimes dives to depths greater than 250 feet to feed, but normally stays within 45 feet of the surface.



*A male red salmon, also known as a sockeye.
Illustration by U.S. Fish & Wildlife Service.*

The ocean version of Fred is metallic greenish-blue on top with silver sidewalls and a white belly. His flesh is brilliant orange. In just two months of ocean life, Fred is sexually mature, but he remains in the ocean with millions of other red salmon. His relatives to the west, in Bristol Bay, make up the largest red salmon fishery in the world. He and his cohorts in North America range from the Canadian arctic to the Klamath River in California.

After three years in the ocean, Fred has grown to the length of a man's arm and bulked up to seven pounds. Now in his fifth year of life, Fred noses his way back to the Copper River delta. As he passes through brackish water into the fresh water of the Copper River, he stops eating. Fred is now a fish on a mission, guided back to the vicinity of Paxson Lake by chemical markers in the water, Earth's magnetic field, or perhaps a combination of the two.

Swimming upstream in the Copper River, Fred avoids dipnets held in eddies by fishermen and the fishwheels upstream. He is digesting himself, fueled by the oils and proteins of his own flesh, skeletal structures, and his scales. As he nears Paxson Lake, his body turns a vivid red, his head green, his back develops a hump and his jaws curve into a snarl.

Near where he first wriggled from an egg sac, after clicking off 3,500 miles on his lifetime odometer, Fred sidles up next to a female that is dropping eggs. As the eggs fall to the gravel, he covers them with a stream of milt.

One week later, Fred dies as a five-year old, but he has beaten the odds: Fred is one of only two of the 3,800 eggs his mother dropped that has returned to the spawning grounds.

NAME: _____

THE LIFE AND TIMES OF FRED THE RED SALMON**Reading Comprehension**

Use the STUDENT INFORMATION SHEET: The Life and Times of Fred the Red Salmon to answer the following questions in complete sentences.

1. Use context clues to determine the meaning of the following words:

alevin _____

fry _____

smolt _____

thrive _____

brackish _____

spawning grounds _____

2. Based on Fred's story, list five habitats that sockeye salmon use during their lifetime.

Thinking Deeper

Scientists don't fully understand how climate change will impact Alaska's salmon populations. Based on Fred's story, explain how you think each of the following climate-related habitat changes may impact salmon populations.

3. Thawing permafrost can cause the land above it to collapse, washing silt, gravel and mud into rivers and streams. This can cloud the water and make it run more slowly.

4. Thawing permafrost can allow lakes to drain.

5. Milder temperatures can allow new species of plants, fish and other wildlife to survive in Alaska.

Salmon nose deep into Alaska ecosystems

Alaska Science Forum article # 1721, by Ned Rozell, October 21, 2004

During a good year in Bristol Bay, a surge of more than 100 million pounds of sockeye salmon fights its

way upstream, spawns, and dies. In Bristol Bay and elsewhere in Alaska, this incredible pulse of salmon carcasses enriches streams and rivers and makes young salmon hardier.

That's the finding of scientists who study Alaska streams and rivers that are teeming with salmon. Aquatic ecologist Mark Wipfli of the University of Alaska Fairbanks' Institute of Arctic Biology is one of those scientists who pull on rubber boots to find the ways that salmon enhance the waters of their birth and the surrounding forests.



A bear ate the brain of this male pink salmon that it pulled from a stream in southeast Alaska. Scientists have found that salmon carcasses have a big influence on Alaska streams and the forests surrounding them.

The process starts with the return of millions of salmon to Alaska rivers and streams. Nosing their way upstream, salmon are a swimming package of protein, fats, and nutrients like nitrogen and phosphorus. Bears are among the first to intercept them, carrying salmon away from the water and sometimes eating only part of the fish, like the brains of male salmon and the eggs of the females. Once munched by a bear, a carcass on land is fair game for flies and other insects, which lay eggs that soon grow into larvae. Heavy rains can wash larvae back into streams, where young salmon and other fish snap them up. Carcasses on land also provide food for other animals and fertilize streamside plants as they decompose.

Salmon that escape bears and other hazards go on to lay eggs—rich in protein, fat and nutrients—that are perhaps the best food in any stream. After salmon die and begin to disintegrate, algae and bacteria take up salmon nutrients, and aquatic insects in turn eat the thriving algae and bacteria. Aquatic insects also feed on specks of decaying salmon, and fish and birds reap the benefits of more insects. Nitrogen and phosphorus from the “salmon tea” that rivers become can penetrate the soil up to 70 meters (about 210 feet) from a stream, and scientists have found traces of ocean-derived nitrogen in shrubs and trees more than 500 meters (1,500 feet) from southeast Alaska streams.

“These salmon literally bring back tons of fertilizer to these systems,” Wipfli said.

Curious about how salmon carcasses help young salmon, Wipfli and his colleagues set up “artificial streams” in southeast Alaska by diverting small portions of existing streams through manmade channels in the forest. The scientists enhanced the water of each artificial stream with different doses of salmon carcass to see how juvenile coho salmon responded. Young salmon exposed to two, three, or four carcasses per square meter of stream bottom grew larger than salmon in habitats without carcasses.

Juvenile fish exposed to salmon were higher in omega-3 fatty acids than fish in water without carcasses and had much higher levels of lipids, fats that serve as energy reserves during lean times. Wipfli and his colleagues have also compared natural streams with and without salmon, and have found salmon streams to be a better place for developing young fish and other animals.

“We’re learning now that salmon are not only making food webs more productive, but are improving the health of fish and other creatures that live there,” Wipfli said.

The lack of returning salmon in the Columbia and other Lower 48 rivers that had good populations before the advent of dams might be a reason restoration of salmon has not worked there, Wipfli said. The effect of millions of bodies fighting gravity and returning nutrients upstream is so profound that land and fisheries managers might need to pay more attention to the interconnectedness of different species than they have in the past. Wipfli and other Alaska scientists believe what’s good for the salmon is good for the flying squirrel, black-tailed deer, Sitka spruce, and arctic tern.

“A lot of different parts of the ecosystem either directly or indirectly rely on salmon,” Wipfli said.

NAME: _____

SALMON NOSE DEEP INTO ALASKA ECOSYSTEMS

Time to Think

1. A keystone is the central stone in an arch that holds the whole structure together. Scientists describe salmon as a **keystone species** in many Alaska ecosystems. Using examples from the Alaska Science Forum article #1721, write a definition for keystone species and explain how salmon are a keystone species in Alaska.

2. Think about a world without salmon. What would your community be like? Describe the impact on humans.

3. Describe the impact on other plants and animals if there were no salmon.

NAME: _____
YUKON RIVER

Directions: Watch the video "Yukon River." Answer the following questions.

1. What is your Native language word for salmon? _____
2. The Yukon River empties the _____ largest drainage in North America into the Bering Sea and has some of the longest salmon migrations in the world.
3. What is one sign that king salmon are coming according to Reverend Helen Peters from Tanana, Alaska?

4. What is Jake Duncan trying to learn by studying juvenile (young) salmon in the Yukon River?

5. Corrine Marion Sheldon from Executive Council of the Teslin Tlingit First Nation (in Canada) says, "We're part of the land and part of the water. Tlingit People, as stewards of the land, it is our responsibility to sustain that food harvest." What does it mean to be a "steward of the land"?

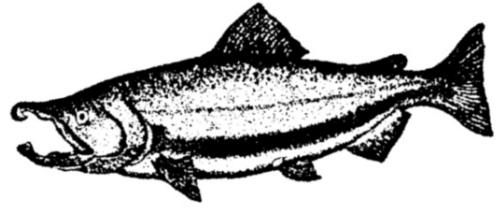
6. According to Corrine Marion Sheldon, how do the Tlingit people help manage the fish populations in their communities? Why does she say it is important to be a part of managing fish populations?

7. Can you think of a way people in your community are a part of managing fish populations?

NAME: _____

SALMON JUKEBOX

Directions: Choose a person to interview based on the guidelines provided by your teacher. If you will be recording the interview, practice using the camera. Remember to listen carefully. Do more listening than talking and take notes.



Interviewee: _____

Location: _____

Date: _____

Questions:

1. What is the first word you think of when I say, "salmon"? _____

2. What are some ways that salmon are important in your life? _____

3. Have you noticed any changes in the salmon in this area during your lifetime? Please tell me about them.

4. Can you imagine life in our community without salmon? What or who do you think would be affected most?

