SALMON BIOLOGY STATION

Overview

A salmonid is a type of fish that belongs to the family Salmonidae, which includes salmon, trout, char, and whitefish. Some salmonids are known for their anadromous life cycle, meaning they are born in freshwater, migrate to the ocean to grow, and then return to freshwater to spawn. In this lesson students will observe migrating salmon in the river to gather information on why the salmon exhibit the behavior. They will deepen their understanding of the salmon life cycle and life stages. Finally, the lesson will discuss the impact of invasive species, including New Zealand MudSnails and Northern Pike on salmon throughout their lifecycle. For the educator teaching this lesson, use the background information prior to the lesson plan to supplement your understanding and knowledge. Definitions for italicized words can be found in the appendix.

Time: 30 Minutes

Learning Goals: By the end of this station, students will be able to:

- Identify the basic life cycle of salmon from egg to adult, including the life stage of the salmon that they see in the river today.
- Explain the behavior of the salmon they see in the river as it relates to the life cycle of salmon.
- Describe how invasive species such as the New Zealand Mudsnails and Northern Pike impact the salmon life cycle.

Materials: The salmon biology Station Kit should include:

- Salmon Life Stage Specimens
- Salmon carcass (when available)
- Invasive species specimens
- Polarized Glasses
- White Board
- WSC Invasive Mudsnails
- NOAA Salmon Life Cycle Sheet
- Additional Resources: The file folder contains additional resources and facts on salmon to aid in your teaching. You have the option to use these when it makes sense.

Teaching Tips

Get students focused with brief introductions and allow them to make general observations about the salmon in the river. Ask students to describe, observe, and look closely at the species they find. When students share, encourage them to use the phrases:
" I notice…" " I wonder…" "It reminds me of…"

If there are no salmon in the river today please use the salmon carcass lesson plan in the folder

Background Information

Salmon Culture of the Pacific Northwest Tribes

Salmon have long been a symbol and lifeblood of the people who call the Pacific Northwest home. The Columbia River Inter-Tribal Fish Commission shares that the tribal cultures of the Columbia River Basin could be called "Wy-kan-ush" or "Salmon People" with their deep present and ancestral relationship to salmon. Salmon typically spend their early life stages in freshwater, much of their adult life in the ocean, and then return to freshwater to spawn and die. This unique *anadromous* life cycle connects them to many species from the ocean to the rivers providing nutrients to these different ecosystems. Salmon have continued to be an integral part of tribal religion, culture, and subsistence through time immemorial (Columbia River Intertribal Fish Commission). The Sandy River, Eagle Creek, Salmon River, and the other tributaries to the Willamette and Columbia flow through the ancestral homelands of many Indigenous nations including the Multnomah, Clackamas, and Chinook Peoples. We owe thanks and gratitude to the presently recognized nations and would also like to honor the many groups of Indigenous peoples whose nationhoods are not currently recognized at this time but whose history, presence, and ways of life continue to shape salmon populations and ecosystems.

Western Science Perspectives

Salmon is a colloquial term that includes species that migrate and some that do not. The genus for salmonids is Oncorhynchus, and it contains about a dozen species native to the Western United States and Northern Pacific Ocean. Seven of these species, including trout and salmon, live in the Pacific Northwest. Trout is a colloquial term for salmonids that are *iteroparous* or may reproduce many times in their lives. Depending on specific conditions, they typically remain in freshwater for their whole lives or may spend some time in the ocean. In the Pacific Northwest, we have Cutthroat Trout (O. clarkii) and Rainbow Trout/Steelhead (O. mykiss). Salmon is a colloquial term for salmonids that are semelparous or reproduce once before dying. Five such fish are native to the Pacific Northwest: Chinook, Coho, sockeye, chum, and pink. In this lesson, we focus on Chinook, Coho, and sockeye, as they are most frequently seen at our field trip sites.

CHINOOK SALMON

CHINOOK SALMON NAMES:

The Chinuk Wawa term t'sə́m-sámən means "marked fish" in the lower Columbia River-area dialect. The scientific name for Chinook salmon is *Oncorhvnchus tshawvtscha*, ("on-ko-rink-us tau-wee-cha"). This is from the Greek word onkos (hook), rynchos (nose) and tshawytscha (the common name for the species in Siberia and Alaska. Sometimes known as "King" salmon because they are the largest species of Pacific salmon.

DESCRIPTION: Robust, round body. Color is generally darker on the dorsal side than the belly in freshwater; with large, blotchy black spots on the upper half of its body with gray/black mouth coloration along the gums. Large black spots along the entire caudal fin. Up to 58 inches in length and weigh up to 129 pounds; although Chinook salmon average up to 36 inches in length and weigh up to 30 pounds.

LIFE CYCLE: Spawning in larger and deeper streams than other salmon utilize, Chinook salmon spawn from late summer to late fall, depending on the run. Fry and smolts usually stay in freshwater from 1 to 18 months before traveling downstream to estuaries, where they remain up to 6 months. Chinook salmon may spend 1 to 8 years in the ocean before returning to their natal streams to spawn; though the average is 3 to 4 years.

RANGE: Chinook range from Kotzebue Sound, Alaska, to Santa Barbara, California. Spawning and *rearing* Chinook are found in most of the rivers in this region, with significant runs in the Columbia River, Rogue River, and Puget Sound.

HABITAT AND ECOLOGY: Freshwater streams and estuaries provide critical habitat for Chinook salmon. Juvenile Chinook feed on *terrestrial* and aquatic insects and small crustaceans, while older salmon primarily feed on other fish and squid when they reach the ocean. Eggs are laid in deeper water with larger gravel and need cool water and good water flow (to supply oxygen) to survive. Mortality of Chinook salmon in the early life stages is usually high due to natural predation and human-induced changes in habitat, such as siltation, high water, temperatures, low oxygen conditions, loss of stream cover, and reductions in river flow. These impacts result from poor agricultural and forestry practices, dams, and water diversions. Some causes of adult mortality are harvest, predators, poor ocean conditions, and changes in hydrology.

Estuaries and their associated wetlands provide vital nursery areas for the Chinook before their departure to the open ocean. Wetlands help buffer the estuary from sediments and pollutants and provide important feeding and hiding areas. The draining and filling of wetlands and the pollution of the estuary from industrial discharges and run-off negatively impact Chinook salmon. Pools are essential for fish, providing a calmer and slow-moving place for fish to rest and abundant plant matter resources for hiding.

ECONOMIC VALUE: Chinook salmon are highly valued by commercial fishermen. They are also a vital subsistence fish and a valuable recreational resource.

Prepared by the Pacific States Marine Fisheries Commission, F.I.S.H. Habitat Education Program

COHO SALMON (Silver salmon)

COHO SALMON NAMES:
"Coho" comes from a word In the Halkomelem dialect of the Salish peoples. The scientific name for Coho is *Oncorhynchus kisutch* ("on-ko-rink-us ki-sooch"). This comes from the Greek word onko (hook), rynchos (nose) and kisutch, the common name for the cner-ioq in Siberia and Alaska.

DESCRIPTION: Black spots on the back and upper lobe of the caudal fin. Smaller and slimmer than the Chinook salmon, the inside of the mouth is gray or black with white gums. Coho salmon reach up to 38.5 inches in length and weigh up to 31 pounds, although they usually weigh between 6 and 12 pounds.

LIFE CYCLE: Spawning occurs from September to January, with the eggs hatching the following spring. Coho fry remain in streams for one to two years. Moving seaward the following spring, most Cohos return to spawn when they are three years old.

HABITAT AND ECOLOGY: Coho salmon utilize freshwater, near-shore, and offshore environments during its life cycle. Coho salmon have similar spawning habitat requirements as Chinook. However, Coho prefer slower-moving streams, shallower water, and smaller gravel. Most Coho fry stay in the stream for over a year, feeding on aquatic insects, zooplankton, and small fish. Mortality is especially high during freshwater life stages, often a result of poor forest and agricultural management practices that lead to siltation, which may ruin spawning beds or smother the eggs. Migrating Coho salmon also face physical obstacles and high-water temperatures resulting from dams, inadequate water flows due to diversions for irrigation, and impoundment of water for power generation. Harvest, competition with hatchery fish, and poor ocean conditions may also contribute to mortality. Once reaching the estuaries, Coho salmon fall prey to several other species and may be impacted by human changes, such as shoreline development, residential drainage and the filling of marine wetlands. The time spent in this habitat is critical to the development of the species and their ability to survive in the offshore environment.

RANGE: Coho salmon spawn in coastal streams from Northern Japan to the Anadyr River in Siberia and from Monterey Bay in California to Point Hope in Alaska. This species can also be found in the ocean from Baja, California, to the Bering Sea in Alaska. Major U.S. spawning grounds are in Alaska, Washington, and Oregon.

ECONOMIC VALUE: The fourth most abundant salmon species, Coho salmon, are a culturally and economically important resource and an important subsistence fish.
Prepared by the Pacific States Marine Fisheries Commission, F.I.S.H. Habitat Education Program

SOCKEYE SALMON

SOCKEYE SALMON NAMES:

The name "sockeye" is believed to be derived from a word in the Halkomelem language of the indigenous peoples in the Pacific Northwest, which was likely "suk-kegh," meaning "red fish." The scientific name for sockeye salmon is Oncorhynchus nerka ("on-ko-rink-us ner-ka"). This name is derived from the Greek word onkos (hook), rynchos (nose), and nerka, which is the Russian common name for this species in Siberia.

DESCRIPTION: Sockeye salmon are medium-sized compared to other Pacific salmon species. They typically have a streamlined body and are more slender than Chinook or Coho salmon. In freshwater, adults have a striking appearance with a bright red body and greenish head, especially during the spawning season. They can reach up to 33 inches in length and weight between 4 to 15 pounds, although some can grow larger. Unlike other salmon species, sockeye lack prominent spots on their back or tail fins.

LIFECYCLE: Sockeye salmon have a unique life cycle compared to other Pacific salmon. They spawn in lakes or in streams connected to lakes. Spawning typically occurs from August to November. After hatching, the fry usually spend one to three years in the lake environment, feeding on zooplankton and small aquatic insects. Once they mature into smolts, they migrate to the ocean, where they spend one to four years before returning to their natal streams to spawn. The majority of sockeye salmon return to spawn ataround 5 years old.

HABITAT AND ECOLOGY: Sockeye salmon have complex habitat requirements due to their dependency on lake environments during their juvenile stage. Freshwater lakes are essential for rearing fry, and these habitats must have adequate food resources, cool temperatures, and good water quality. During their ocean phase, sockeye primarily feed on plankton, small crustaceans, and fish. Like other salmon, they require cool, oxygen-rich water for successful spawning. Habitat degradation, such as the warming of lakes, reduced water flows, and barriers to migration, pose significant challenges to sockeye populations. In the ocean, they face threats from overfishing, climate change, and competition with hatchery-raised salmon.

RANGE: Sockeye salmon have a broad range that extends from the northern Pacific Ocean to inland freshwater lakes. They are found along the coastlines of the Pacific Ocean, from northern Japan and the Anadyr River in Siberia to the Columbia River in the United States and as far south as Northern California. Major spawning grounds are located in Alaska, British Columbia, and Washington. Some of the most significant sockeye salmon runs occur in the Fraser River in British Columbia and the Bristol Bay region in Alaska.

ECONOMIC VALUE: Sockeye salmon are highly prized for their firm, red flesh, which is considered a delicacy. They are one of the most commercially valuable salmon species and support large fishing industries, especially in Alaska and British Columbia. In addition to their commercial importance, sockeye salmon are also culturally significant to Indigenous peoples in the Pacific Northwest and Alaska, who rely on them for subsistence and cultural practices. Sockeye salmon are also popular among recreational anglers, particularly in areas where their runs are abundant.

STEELHEAD (COASTAL RAINBOW TROUT)

SCIENTIFIC NAME: Oncorhynchus mykiss, ("on-ko-rink-us my-kiss")

DESCRIPTION: In the sea, bluish from above and silvery from below tend to be greener in freshwater. There are small black spots on the back and most fins. It is up to 45 inches in length and 40 pounds in weight, although it usually weighs less than 10 pounds.

LIFECYCLE: Spawning in streams and rivers, steelhead rear in freshwater for 1 to 4 years before migrating downstream through estuaries to the open ocean. Steelhead spend 1 to 5 years at sea before returning to the stream or river they were born in. At least two categories of steelhead have developed: those that enter freshwater during fall, winter, and early spring -- the winter run -- and those that enter in spring, summer, and early fall - the summer run. Steelhead do not always die after spawning; some will migrate through estuaries to the ocean again. Steelhead may spawn several times, unlike most salmon, which die after spawning.

HABITAT AND ECOLOGY: Steelhead rely on streams, rivers, estuaries, and marine habitats during their lifecycle. In freshwater and estuarine habitats, steelhead feed on small crustaceans, insects, and small fishes. Eggs are laid in small and medium gravel and need good water flow (to supply oxygen) to survive. After emerging from the redd (nest), they remain in streams and rivers for 1 to 4 years before migrating through the estuaries to the ocean. Because young steelhead spend a significant portion of their lives in rivers and streams, they are particularly susceptible to human-induced changes to water quality and habitat threats. Poor land-use practices in urban and rural areas can lead to siltation in streams, which may ruin spawning beds or smother the eggs. Additionally, in the Columbia River, migrating steelhead face physical obstacles and high water temperatures resulting from dams, inadequate water flows in rivers and streams due to water diversions for irrigation, and water impoundment for power generation.

RANGE: Steelhead were originally found from northwestern Mexico to the Kuskokwim River in Alaska; however, it is now unusual to find steelhead south of the Ventura River, California. Some of the significant steelhead rivers in Oregon include the Rogue, Umpqua, and Clackamas Rivers.

ECONOMIC VALUE: Steelhead are one of North America's top five sport fish, caught primarily in streams and rivers. At present, only Native Americans are allowed to fish for steelhead commercially in Washington or Oregon.

Prepared by the Pacific States Marine Fisheries Commission, F.I.S.H. Habitat Education Program.

Invasive Species

Invasive species can modify the environment. This sometimes comes at the detriment of wild salmon. Invasive species can damage spawning habitat, make waterways unnavigable, or act as novel predators. These effects can be either direct or indirect. Here are a few examples:

- New Zealand Mudsnails: These invasive snails consume algae and other primary producers at the base of the food web, competing directly with native invertebrates that are important food sources for juvenile salmon. Salmonids, including juvenile salmon, may inadvertently consume New Zealand Mud Snails. However, these snails provide little nutritional value due to their hard shell and low caloric content. If salmonids consume these snails in significant quantities, it could lead to poor growth and condition, making them less fit for survival and migration.

- Northern Pike: Currently occurs in the northern reaches of the Columbia River in north eastern Washington and a lake in the San Juan Island in western Washington. Northern pike are voracious predators. They are known to eat astonishing numbers of juvenile salmon and grow to an impressive size.

- Quagga Mussels/Zebra Mussels: These are highly prolific and known to clog waterways and thickly colonize over most substrates and surfaces. They can filter tremendous amounts of water, removing nutrients and particles needed for macroinvertebrates and young fish to survive. Furthermore, these mussels are very sharp and can cover stream beds, sometimes affecting available spawning habitat.

- Milfoils: This noxious weed has the potential to block fish passage in waterways and choke out native plants as it develops thick mats. Overcrowding from Milfoil has also been known to result in large amounts of dead plant material, which consumes oxygen during decomposition, lowering water oxygen levels.

Cumulative Impacts:

Many invasive species pose individual, direct threats to salmon populations and their habitats. However, the combined effects of multiple invasive species can lead to more significant, indirect impacts, often altering various aspects of the ecosystem. For example, when quagga and zebra mussels colonize an aquatic environment, they increase water clarity by filtering out suspended particles like algae and organic matter. This disrupts the base of the food chain, directly impacting salmon by reducing the algae that supports other aquatic organisms. Additionally, the increased sunlight penetration due to clearer water can promote the growth of invasive aquatic plants, such as milfoils, which further degrades salmon habitats.

Frequently Asked Questions:

What kind of Salmon are these?

Most Salmon Watch field trips will be observing fall Chinook salmon, while some sites will include Coho salmon.

What are “Jack” salmon?

Jack is a name given to any male salmon that returns to freshwater after a minimal time at sea. They are smaller than males that spend more time in the ocean. They are also called “precocious” males. They participate in spawning the same and any other adult with the exception that groups of jacks will sometimes trick larger males in order to spawn with females. Jacks will also sometimes pretend to be female to trick other salmon.

What are they doing when they return?

They are returning to the river where they were born in order to build redds, spawn, reproduce and die. After generations of natural selection salmon become adapted to conditions in a specific section of the river. Through this process, separate and identifiable "stocks" develop.

What are redds?

Redds are fish nests, depressions dug in the river gravel 6 to 18+ inches deep made by the female salmon in which to lay her eggs. The water near the redds must be the proper depth and velocity, have plenty of oxygen to percolate around the eggs, and have the right sized gravel without silt.

The average redd is built in water that is from 9 inches to 3 feet deep.

How do salmon spawn and how long does it take?

The female turns on her side facing upstream and digs a redd by thrashing up and down with her body and tail, alternately digging and settling back into the redd to release the eggs. A male moves in next to the female and releases sperm at the same time. Due to the shape of the redd, the oscillating water mixes the sperm with the eggs and fertilization occurs. Each egg pocket in the redd is covered by gravel as the female digs the next redd upstream. The redd increases in size upstream as the spawning is completed reaching a size of 25 to 60 square feet. Spawning may take 3 to 7 days.

Do all adult salmon return to the stream of their “birth”?

All salmonids have a complicated array of senses that help them navigate across long distances. This includes not only a strong sense of smell, but also the ability to sense geomagnetic fields across the world that help them imprint on their home stream and return after long migrations. That said, not all salmon return to their home streams and professionals call these “strays.” These strays might wind up in a nearby tributary, or even whole other river systems. It is a rare, but consistent phenomenon.

How many eggs does each fish lay?

The number of eggs laid averages about 5,000, depending upon the size of the female. Eggs incubate in the gravel and hatch the following spring. The newly hatched eggs called "alevins" remain in the gravel for 3-7 weeks. After emerging, the "fry" spend 3 months in freshwater and grows to about 4 inches long before migrating in schools to the sea. During this time, they slowly undergo many physiological changes, called "smolting," enabling them to adapt to the saltwater conditions in the ocean. Estuaries, where fresh and saltwater mix, are important for this transition.

How many fish survive?

Only 2% to 8% of all the eggs survive to become smolts. Predation by other fish, birds and unfavorable river conditions including high water temperatures, high winter flows that wash the eggs out of the gravels, or too much silt deposited in the redds that may suffocate the eggs may hinder the survival of the fish.

How many fish return to the River?

On the average only 0.5% to 3% of all the smolts that migrate to the ocean will survive to return and spawn. Natural predation, food supply and fishermen affect ocean survival. For fall Chinook in the Sandy River Watershed, 5% return as jacks (early maturing males) after one year at sea, 36% return after two years, 51% return after three years, and 8% return after four years.

What is the white stuff on the fish skin?

As the fish become weaker during spawning, a white fungus invades their skin and they begin to quickly deteriorate. The decaying carcasses release nitrates and phosphates into the water, providing the basis for more life.

Are fish carcasses important?

Yes, biologists have determined that carcasses play and important role in stream ecosystems. Carcasses provide food for aquatic invertebrates, juvenile fish and wildlife as well as nutrients for riparian trees.

What do salmon eat?

Juvenile salmon feed on macroinvertebrates as they are developing in their freshwater habitat. Macroinvertebrates are a rich source of protein, fats and nutrients that are important for developing salmon. Once salmon leave for the ocean they may feed on a variety of other animals such as other fish, squid, eels, shrimp, etc. Spawning adults generally don't feed but have been found to occasionally consume the eggs of other salmon.

How can the wild populations be maintained?

The importance of maintaining high-quality habitat to ensure the existence of wild fish populations cannot be over-emphasized. Silt-free pools and riffles and cool water temperatures must be maintained. Healthy riparian vegetation must be present on the streambanks to stabilize them and prevent erosion. Healthy streambanks also store and slowly release water during critical low flows, provide thermal cover, and are a source of important woody debris and nutrients. In addition, the fisheries must be regulated to allow enough spawners to reach spawning areas, and hatcheries must be operated to minimize genetic changes in hatchery fish that may spawn with wild salmon.

Advanced Questions:

1. **Why don't salmon just live in either the river or the ocean?** The clear, nutrient-poor Cascade streams provide much less food for the organisms living in them than in other parts of the world. Because of this, there are fewer predators. By overwhelming the river with thousands of offspring all at once, salmon ensure that every predator can eat its fill and still leave the vast majority their eggs and fry safe. The Pacific Ocean is rich in nutrients and life. By moving to the ocean as somewhat larger smolts, salmon enter at the middle of the ocean food chain rather than at the bottom. This allows them to take advantage of the abundant food supply as ocean predators. Salmon must change their entire metabolism to transition between fresh and salt water.
2. **Steelhead fish are able to return to the ocean after spawning yet Chinook, Coho and other salmon species are essentially programmed to die**. Biologists have determined that this programmed death evolved more recently as a special adaptation. Why? By depositing their nutrients in the clear Cascade waters, salmon provide food (mostly indirectly) for their young. The carcasses feed aquatic invertebrates, thereby increasing their populations and feeding the fry that will hatch in the spring. The nutrients (most importantly Nitrogen and Phosphorus) lead to more bacteria, fungi and algae in the stream which also provides food for aquatic macroinvertebrates. It's also important to remember that salmon evolved around the time of the Ice Ages. As glaciers melted away salmon were among the first fish to explore the rivers these glaciers left behind. Dying in mass to deposit nutrients helped the barren landscape develop rich forests.
3. **How might a healthy forest's riparian zone benefit salmon?** Salmon need cold, clear water, food, resting places and protection from predators. A healthy forest has trees with roots that prevent soil from eroding into the water and burying redds in silt . The nurse logs and duff on the forest floor act as a sponge, preventing flash floods from destroying the redds and gradually releasing cool water to the stream during the warm, dry months. The shade from riparian trees helps keep the water cool. Leaves from alder and other riparian trees feed many macroinvertebrates. Trees that fall in the river slow the current and add structure, providing places for salmon fry to rest, safe from many predators.
4. **How do returning salmon benefit the forest?** See the answer to question 10, above. Kids will be able to name some animals that might eat salmon carcasses. The feces from those animals fertilize the forest, often far from the river. Decomposition by weathering and bacteria further releases nutrients from carcasses into a usable form for trees. As much as 70% of nitrogen in the riparian zone has been traced back to decomposition of carcasses. By studying isotopes of nitrogen, biologists have determined that more than 20% of the nitrogen in the tissues of riparian trees and shrubs originated in the Pacific Ocean. Isotopes are when the same element has a different atomic weight due to additional protons. The proportion of different isotopes varies on location (i.e. the ocean tends to have heavier protons).
5. **Research in Yellowstone Park shows that the reintroduction of wolves has benefited fish. How might that have happened?** This question is about trophic cascades. Trophic cascades are when changes in one part of the food change have a large impact on other parts of the food chain. Wolves essentially make deer and elk nervous, preventing them from feeding too long in one patch of the riparian zone. Areas that were once sparse now support rich riparian forests.

6. **You can find marine nutrients inside trees in land-locked Idaho. Do you know why?** While in the ocean, salmon feed on smaller fish and invertebrates. Animals in marine environments contain nutrients that are chemically distinct from those in freshwater. As salmon eat more and more food from the ocean, they also become filled with marine nutrients. After a returning adult salmon dies, the body decays, or is scattered by predators. The chemically distinct marine nutrients that the salmon acquired from living in the ocean are recycled into the surrounding forests despite being land-locked! Scientists are able to test the soil and plants in a given area to see how far these marine nutrients are distributed.
7. **How are salmon able to live in both fresh and saltwater environments?** Salmon use a physiological process called osmoregulation, which allows them to maintain the right balance of salt and water in their bodies. When salmon are in freshwater, they need to prevent their bodies from absorbing too much water and losing too much salt. To do this, their kidneys produce large amounts of dilute urine to expel excess water, and their gills actively take in salts from the surrounding water. As salmon transition to saltwater, their bodies undergo significant changes to adapt to the saltier environment. Their gills start to excrete excess salt, and their kidneys produce more concentrated urine to conserve water. This process, known as smoltification, occurs as young salmon (smolts) prepare to migrate from freshwater rivers to the ocean.
8. **What are 0 day salmon eggs "green eggs"** "green eggs" are eggs that have not yet been fertilized by milt.
9. **How long do different salmon species spend in the river and estuary before moving to the ocean?**

Salmonid	Time in Estuary	Time in Freshwater
Coho	Weeks - months	1 to 2 years (usually 1 year)
Chum	Days - weeks	Usually 2-4 months
Chinook	1-3 months	0-1 yr
Pink	Days-weeks	> 1 yr
Sockeye	1-2 months	1 to 3 years (usually 1-2 years)
Steelhead	Days-weeks	1-4 yrs

Lesson Plan - Salmon Biology

Objective: Students will understand basic salmon biology, including the impact that salmon have on freshwater and ocean ecosystems, the salmon lifecycle, and the impacts of invasive species on various stages of the salmon life cycle.

Introduction (3 Mins)

1. Introduce yourself to the group and ask students to share their names and introduce themselves.
2. Ask the group what they already know about salmon.
    a. *What do we already know about salmon?*
    b. *Where do they live? How are they connected to other living creatures and plants?*
3. Describe to the learners what they will be doing today:
    a. We will observe salmon in the river and describe their behavior.
    b. Observe salmon specimens throughout the early stages of the salmon life cycle.
    c. Gather information about how an invasive snail impacts salmon.
4. Have students generate ideas about how we can gather more information about salmon today.
    a. Students may share that they can make observations, record what they see, and ask questions.

Salmon Observations (7 Minutes)

1. Using the observation methods they just generated, students will have 3 minutes to observe the river and gather as much information as they can about the salmon. It may be helpful to tell students to record their observations in their nature journals.
    a. Encourage students to make thoughtful observations and remind them that our goal for this station is to gather more information about salmon through our curiosity and observation of them.
    b. If salmon are not presently spawning in the river, please use a salmon carcass for this section.

2. After 3 minutes of individual observation, bring the group together to share what they noticed and recorded.
    a. Write the phrases on the white board and encourage students to use them as they share.
    "I notice.." "I wonder…" "it reminds me of…"
    If someone shares a fact or statement that is not an observation or personal connection, remind them that our goal is to share what we observe.
    b. Use some of the following categories and questions to help guide group discussion.
        i. What do the salmon look like? (size, similarities/differences to other salmon or fish in the river today? Damaged or hurt?)
        ii. What behaviors did people notice? (swimming, speed, direction, interactions with other fish/salmon?)
        iii. What can we notice about the health of some of the salmon? (Are some dead/damaged? Are some not moving?)

c. If you are using a carcass, ask students what they notice about the salmon
    i. Describe the body of the salmon.
    ii. Describe the unique characteristics they see.
    iii. What direction would this salmon be swimming in the river?
3. Ask students to discuss with their partner how old they think the salmon in the river today are?
    a. Are these young baby salmon? Teenage juvenile salmon? Young adult salmon? Or adult salmon?

Salmon Life Cycle Stages (7 Minutes)

1. Pass out the Salmon Life Cycle sheets to pairs of students and hold up the Salmon Life Cycle Specimens for everyone to see.
2. *Do the salmon that we see in the river today match any of these life stages? What other information can you gather to support the live stage that you choose?*
    a. The salmon we see are spawning adults.
    b. Ask someone to read the blurb about spawning adults on the life cycle page.
    c. **Tell students that the salmon in the river today are making their way back from the ocean in order to mate and reproduce**.
3. Connect back to student ideas on the reason for the dead and damaged salmon in the river today.
    a. **Share:** Salmon die once they have reproduced and their carcass brings an abundance of marine /ocean nutrients to the ecosystem.
    b. **Ask students:** If these salmon will die, what will happen in the river over the next few months?
        i. The salmon eggs will hatch.
    c. **Ask students:** How many eggs do you think one salmon will lay? (Don't give them the right answer but you can write it down if you want)
4. **Ask students** what will happen next? The eggs they lay will spawn into Alvin!
    a. You can go through the different stages with the group by having students read the stages outloud and looking at the wooden specimens.
        i. **Ask students** to share what salmon are doing in the fry stage?
            - They will begin to eat macroinvertebrates!
        ii. **Ask students** to share what salmon are doing when they reach the smolt stage.
            - They will begin their journey to the estuaries. This is where you can bring up that salmon are Anadromous fish. Anadromous fish spend part of their lives in freshwater, such as rivers, and part of their lives in the ocean's saltwater.
        iii. **Ask students** to share what happens after the smolt stage.
            - After spending anywhere from a few weeks up to a year in the estuary they are ready to leave the river and live their life in the ocean!
        iv. **Ask students** to guess how long they think salmon live in the ocean.
            - Different species of salmon spend different amounts of time in the river and ocean. Some live in the ocean for only a year before they begin their migration, some salmon like chinook spend up to 7 years in the ocean before migrating back to spawn!

5. Return back to the students' guesses about how many eggs were laid.
    a. We guessed that one salmon could lay ____. **On average a single female salmon will lay 5,000 eggs!** Wild Coho salmon lay 2,500 - 3,000 eggs
    b. Use the wooden specimen guide, start at the egg stage and move through towards the mid fry sac (90 days)
    c. Of **5,000 eggs only 750** will survive to become a **fully developed alevin 15%** (late sac fry)
    d. Use the wooden specimen guide to go from late sac fry to smolt.
    e. Of the **750 alevins** (late sac fry) **only 75** survive to the **smolt stage! 10%**
    f. **Share:** Once the 75 smolts are ready to enter the ocean they spend on average 3-4 years in the ocean but some species like Chinook can spend up to 7 years! Only 5-6 of the 75 ocean adults will survive being in the ocean.
    g. **Share:** Of the **5-6** that start their migration back up the stream only **1-2** will make it back to spawn!
6. **Stop and have students watch the salmon again:** Each salmon you see is one of 2,000-5,000 that survived this amazing journey from the river to the oceans and back.
7. **Ask students** to share with one another, what could be contributing to the loss of salmon over each of their life stages?
    a. Salmon die from different things at each stage including: habitat destruction, predators, pollution, delays in downstream migration from dams, they are also impacted by invasive species.

Invasive Species Discussion (5 Minutes)

1. Using the **Invasive Mudsnail Sheet** have students generate ideas about the impacts that invasive mudsnails can have on the salmonids that eat them.
2. Look figure 1 and compare the invasive mudsnail to the three other native snail species.
    a. **Ask students:** What do you notice about the invasive mud snails compared to the native pond, pebble, and rock snails?
3. **Share with students** that New Zealand Mud Snails Have a valve called an operculum that allows them to close off their shell. This allows them to survive being eaten.
4. **Describe the figure 2 graph to students:** This graph shows the impact that consuming invasive mudsnails have on trout (a similar anadromous salmonid).
    a. Research on trout that have ingested New Zealand Mud Snails indicates that a diet consisting predominantly of these snails can significantly negatively affect their health. Researchers assessed the trout's "Body Condition" by measuring their body weight and length. The body condition factor is an indicator of the fish's overall "plumpness" or "fattiness." Fish with a body condition factor closer to 1 are within a healthy weight range for their length, while those with a condition factor below 1 have lower body weights than expected for their length.
5. **Ask Students**: What is happening to the salmonids that are eating the invasive mudsnails?
    - **Tell students**: Salmon are unable to get nutrients from these snails because they pass through their digestive system

6. Look at the map of Oregon.
    a. **Ask students:** Where are the mudsnails located?
    b. **Ask students:** What stage of the lifecycle are salmon when they are living with populations of invasive mudsnails.
7. **Tell students:** Salmon in the fry and smolt stage eat macroinvertebrates. Scientists have seen that in the Columbia River Estuary, salmon smolts are eating New Zealand Mudsnails.
    a. **Ask:** What impact might that have if the snail population grows larger?
    Tell Students: They might not survive the juveniles stage because they would not be getting enough nutrients from the food they are eating to develop and grow into smolts and then onto ocean adults!
8. **Optional:** Show Students the Wanted Northern Pike Invasive sheet.
    a. Invasive Northern Pike also harm juvenile salmon populations.
    b. Northern Pike are aggressive, ambush predators that feed on a variety of fish, including juvenile salmon. They have a large appetite and can significantly reduce salmon populations by preying on young fish, especially in shallow waters where juvenile salmon typically reside.

Wrap Up (1 Minute)

1. **Wrap Up:** In a whole group have students pass all the sheets back for you to put away into the kit. Remind students the one of the best ways that we can take care of what we love is to learn and share our knowledge. Our goal of being here today on the Salmon Watch program is to learn about salmon and the important role they play in the rivers here.

Appendix: Definitions

Anadromous - Is a word for fish that is born in freshwater, migrates to the ocean to grow and mature, and then returns to freshwater to spawn. This life cycle is typical of species like salmon, which hatch in rivers or lakes, spend the majority of their adult lives in the ocean, and then migrate back to their freshwater birthplace to reproduce.
Iteroparous - Iteroparous refers to organisms that are capable of reproducing multiple times throughout their lives. Unlike semelparous organisms, which reproduce only once before dying (such as Pacific salmon), iteroparous species can go through several reproductive cycles over the course of their lifetime

Kokanee - salmon populations landlocked due to geological forces, will not return to the ocean, these are called.

Natal - Anything related to birth or the place where an organism was born. In biology and ecology, "natal" is often used to describe the original location or environment where an animal or plant originates. For example, in the context of salmon, "natal stream" refers to the specific stream or river where the salmon were born and to which they return to spawn.

Rearing - The process of raising and caring for young organisms until they reach a certain stage of development. In the context of fish, particularly salmon, rearing involves the period during which the juvenile fish (fry or smolts) grow and develop in a specific habitat, such as freshwater streams, lakes, or hatcheries, before they are ready to migrate or transition to a new life stage.

Siltation- The process by which fine soil particles, such as silt, are transported by water and accumulate in a body of water, like a river, lake, or estuary. This buildup of silt can lead to the clogging of waterways, reduced water depth, and the smothering of aquatic habitats, including fish spawning beds. Siltation often results from soil erosion caused by activities like deforestation, agriculture, construction, and poor land management practices.

Terrestrial - Refers to anything related to or occurring on land, as opposed to in water or air. In ecology, terrestrial typically describes organisms, habitats, or ecosystems that are land-based, such as forests, grasslands, or deserts. Terrestrial animals, for example, are those that live primarily on land, like mammals, birds, insects, and reptiles.

NOAA FISHERIES

Salmon Life Cycle

1. EGGS

Under the gravel, thousands of eggs develop in nests called redds

2. ALEVIN

Alevin hatch and remain under the gravel for protection against predators until their yolk sac is fully absorbed.

3. FRY

Once alevin have absorbed their yolk, they become fry. They head for protected spots like under logs and behind boulders. They dart out to catch tiny insects, like aquatic macroinvertebretes, that come their way.

4. SMOLTS

When they feel the urge, young salmon begin migrating toward estuaries where they begin adapting to saltwater in a process called smoltification.

5. OCEAN ADULTS

Salmon enter the ocean as juveniles and leave as mature adults. In the ocean, salmon travel thousands of miles and feed on other fish, squid, eels, and shrimp.

6. MIGRATING ADULTS

When adults are ready to spawn, they are guided home by the smells of their home stream. Once they reach freshwater, they stop eating and lose their silver color. On their way home, they must battle rapids, waterfalls, dams, and predators. Males develop hooked jaws and sharp canine teeth; some species develop humped backs.

7. SPAWNING ADULTS

When they reach the spawning grounds, they find a mate. Females dig nests in the gravel and lay thousands of eggs that are fertilized by milt. Most salmon die after spawning and their bodies provide food for other wildlife including bald eagles, bears, minks, river otters, and invertebrates.

At every life stage, salmon need abundant cold, clean water.

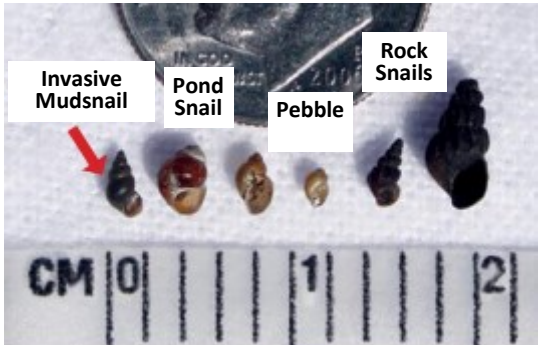
Invasive Mudsnails

Invasive Macroinvertebrates

D.L Gustafson

Figure 1:

Comparison of Invasive Mudsnail to native snails

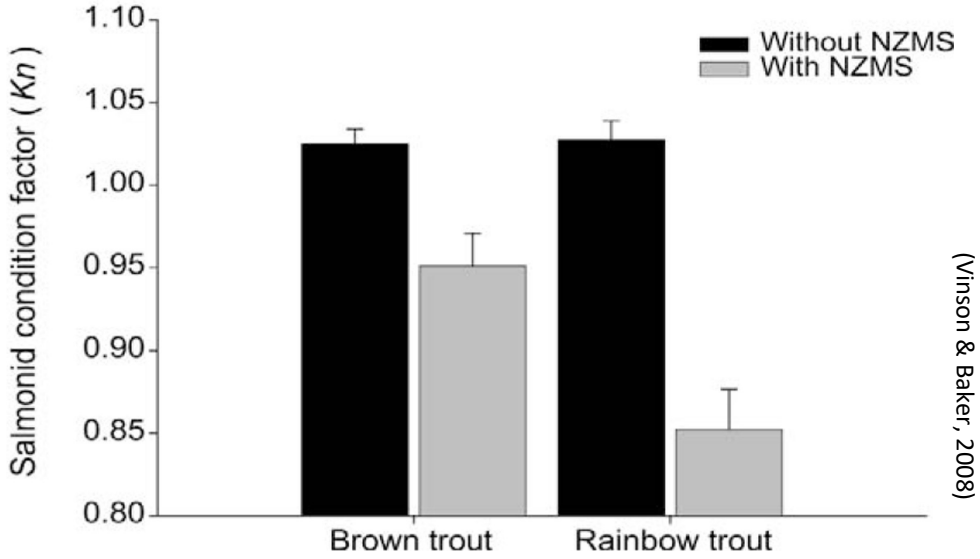


(L. Limongan)

Note: Pond Snails, Pebblesnail and Rock Snails are native to the Pacific Northwest.

Figure 2:

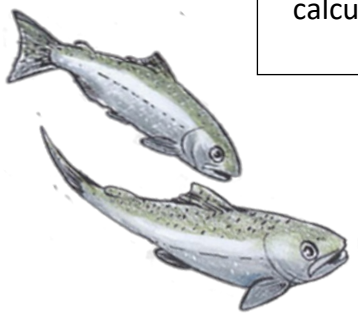
Impact of Snails on Fish Health



(Vinson & Baker, 2008)

Note: Comparison of Salmonid condition factor between brown trout and rainbow trout with and without Mudsnails. Trout collected from the Green River in Utah. The Salmonid Condition factor (Kn) is a measure of fish health and wellbeing that was calculated using the fishes weight and the length of its body.

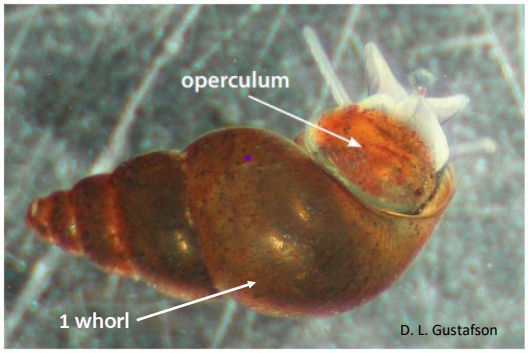
Salmon Fry



Salmon Smolts

Salmon fry and smolts need to eat lots of freshwater macroinvertebrates so they can develop into ocean juveniles.

Invasive Mudsnails Facts & Distribution



Facts:

- Only 4 –6 mm long
- Reproduce asexually by cloning themselves.
- Have a valve called an operculum that can be used to seal the mouth of the shell. This allows the mudsnails to survive out of water for several days and survive being eaten.
- Can pass through a fish alive after being eaten.

How to identify:

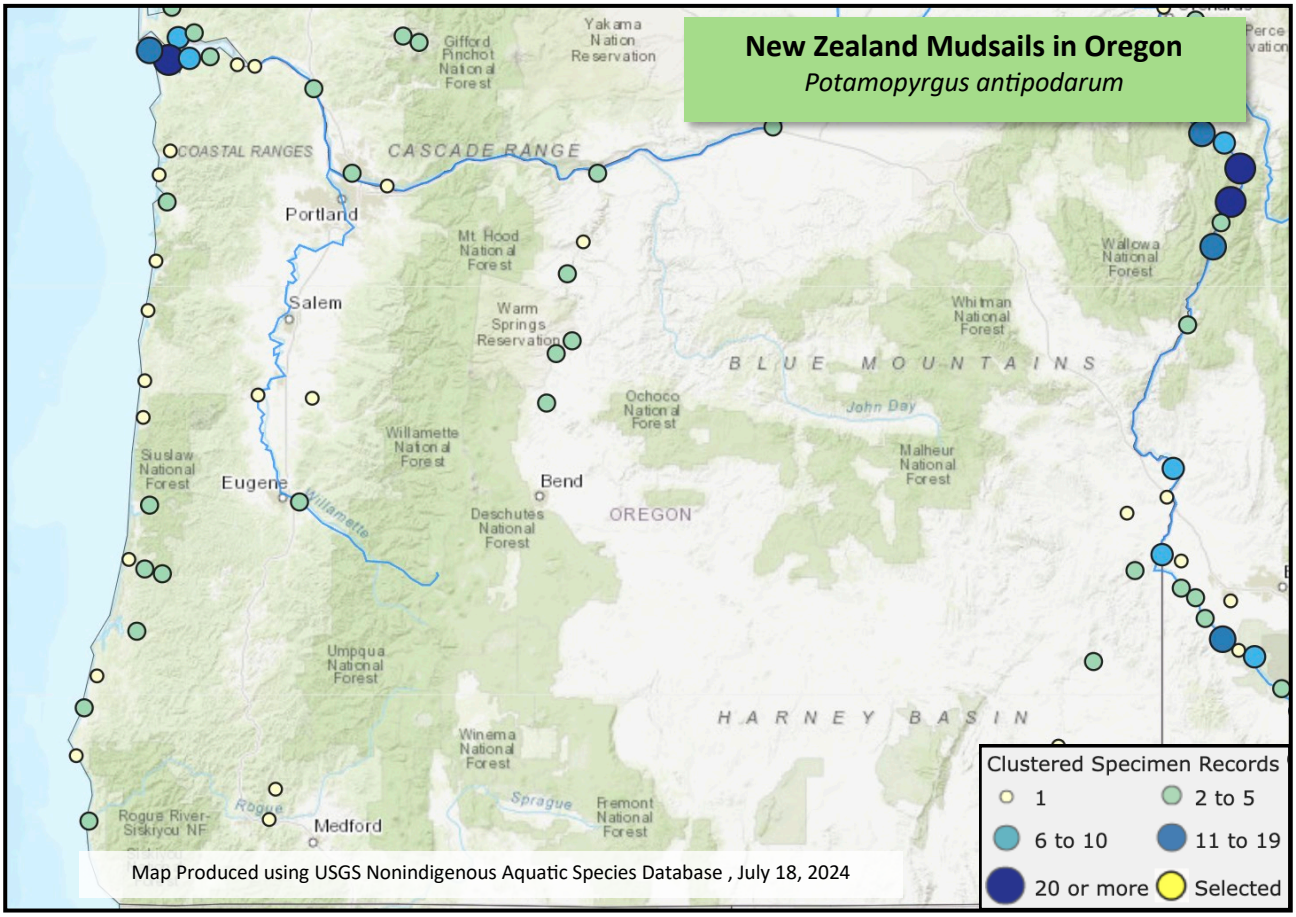
Size: A mature snail is typically less than 5 mm (.2 in) long

Shape:

- Shell is elongated
- Has whorls or spirals and a right-side opening
- Shells usually have 5 to 6 whorls

Color: Most snails have a light to dark-brown shell that can appear black

P. Skawinski, 2013



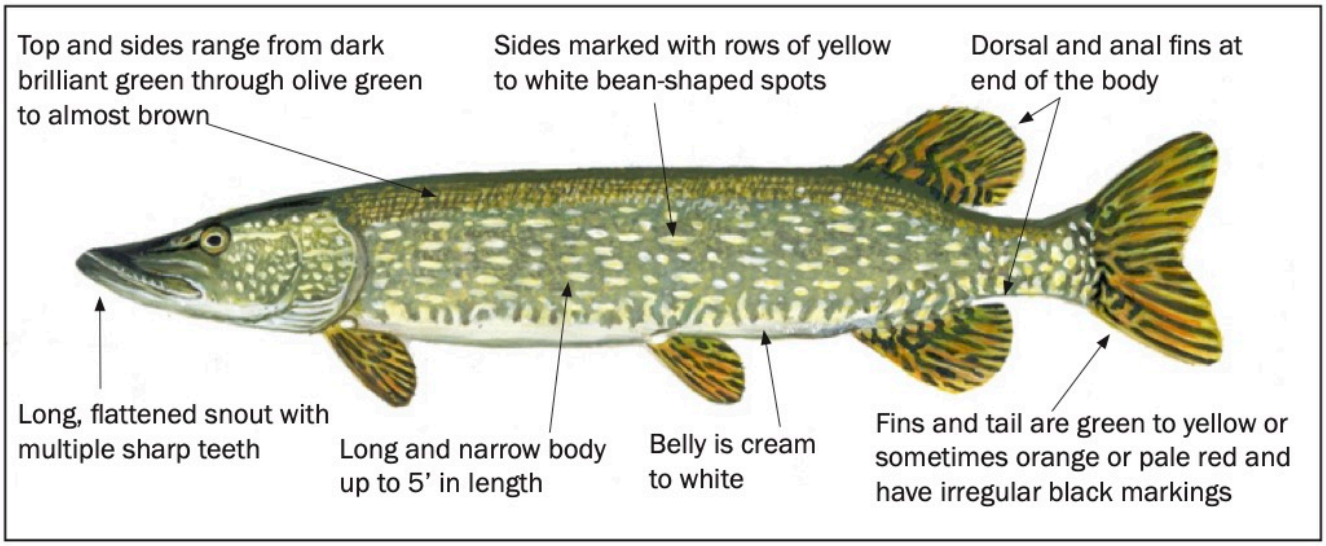
(E. Jones, 2024)

WANTED

DEAD OR ~~ALIVE~~

NORTHERN PIKE

Northern pike (*Esox lucius*) is a non-native, invasive species that threatens salmon and other native Columbia River basin fish. If caught, **DO NOT RELEASE!** Keep it for positive identification and contact Blaine Parker, CRITFC Invasive Species Lead, at **(503) 731-1268.**



Juvenile pike have yellow stripes along a green body

Native **three-spine sticklebacks** can look like very small northern pike. Look for the three distinctive spiny fins on their back.

Even though they have "pike" in their name, the native **northern pikeminnow** are not related to northern pike (and look nothing like them, either)

Columbia River Inter-Tribal Fish Commission, 2023

Table 9.2 - Generalized life history patterns of salmon, steelhead, and trout in the Pacific Northwest

Species	Adult Weight (lbs)	Egg Incubation Time	Emergence Time	Time in Freshwater	Time in Estuary	Time in Ocean	Ocean Distribution	Timing of Adult Upstream Migration	Spawning
COHO	6-12 lbs	6-7 months	Mar-Apr	1-2 yrs	0-3 mo	18 mo	Coastal	Sep-Feb	Oct-Mar
CHUM	7-18 lbs	4-5 months	Feb-Apr	None	Days-weeks	2-5 yrs	Coastal	Sep-Jan	Nov-Feb
CHINOOK	15-30 lbs (40 lbs)	3-5 months	Jan-May	0-1 yr	1-3 mo	2-4 yrs	Coastal & Offshore	Apr-Oct (fall) May-Jul (spring)	Sep-Dec (fall) Apr-Jun (spring)
PINK	3-5 lbs	4-5 months	Feb-Mar	None	Days-weeks	18 mo	Coastal & Offshore	Jul-Sep	Aug-Oct
SOCKEYE	5-7 lbs	3-4 months	Mar-Apr	1-2 yrs	1-2 mo	2-3 yrs	Offshore	Jul-Oct	Sep-Jan
STEELHEAD	8-11 lbs (20 lbs)	1-4 months	Feb-May	1-4 yrs	Days-weeks	1-4 yrs	Coastal & Offshore	Feb-Apr (winter) May-Jun (summer)	Mar-Jun (winter) Jan-Apr (summer)

Table 2: Spawning and Migration Habitat Requirements for Salmonids in Northern Coastal Streams

Species	Migration Timing	Spawning Time	Location	Maximum Substrate Size	Water Velocity	Water Depth	Spawning Water Temperature	Dissolved Oxygen	Percent Fines Tolerable	Notes
Chinook - Fall	Sep-Dec	Oct-Dec	Main stem, estuary	Pebble to cobble (13-25.6 cm)	0.1-1.6 m/s; 2-24 hrs	0.18-0.61 m	5.6-13.9°C	>5 mg/l	First 1-4 m from surface of substrate	May spawn more than once
Chinook - Spring	Mar-Jun	Sep-Dec	Main stem, upper mainstem	Pebble to cobble (13-25.6 cm)	0.1-1.6 m/s; 2-24 hrs	0.18-0.61 m	5.6-13.9°C	>5 mg/l	First 1-4 m from surface of substrate	May spawn more than once
Coho	Sep-Jan	Sep-Jun	Small rivers, upper mainstem	Small gravel (5-10 cm)	0.03-0.91 m/s; 2-8 hrs	0.18-0.61 m	4.4-11°C	>5 mg/l	First 1-4 m from surface of substrate	May spawn more than once
Chum	Oct-Dec	Oct-Dec	Small rivers, estuary	Small gravel (5-10 cm)	0.03-0.91 m/s; 2-8 hrs	0.18-0.61 m	4.4-11°C	>5 mg/l	First 1-4 m from surface of substrate	May spawn more than once
Steelhead - Winter	Nov-Apr	Dec-Apr	Small rivers, lower mainstem	Medium gravel (13-25.6 cm)	0.21-1.27 m/s; 2-24 hrs	0.18-0.61 m	3.9-8.9°C	>8 mg/l	First 1-4 m from surface of substrate	May spawn more than once
Steelhead - Summer	May-Jul	Jan-Jun	Small rivers, upper mainstem	Medium gravel (13-25.6 cm)	0.21-1.27 m/s; 2-24 hrs	0.18-0.61 m	3.9-8.9°C	>8 mg/l	First 1-4 m from surface of substrate	May spawn more than once
Sea-Run Cutthroat Trout	Jul-Oct	Dec-Feb	Small rivers, estuary	Small gravel (5-10 cm)	0.03-0.91 m/s; 2-8 hrs	0.18-0.61 m	3.9-9.4°C	>5 mg/l	First 1-4 m from surface of substrate	May spawn more than once

Table 3: Habitat Requirements for Salmonids in Northern Coastal Streams

Species	Incubation Period	Preferred Temperature for Incubation	Fry Emergence	Fry Habitat	Freshwater Rearing Period	Preferred Temperature for Rearing	Estuary Rearing	Notes
Chinook - Fall	Oct-Dec	5.6-13°C	Mar-May	Stream edges	1 year	7.1-14.5°C	Minimal	Hatchery and naturally spawning; some remain in estuary 1+ year, spring smolt
Chinook - Spring	Feb-Mar	5.6-13°C	Mar-May	Stream edges	1 year	7.1-14.5°C	Minimal	Large body size required for adult ocean survival, some remain in estuary 1+ year
Coho	Sep-Mar	4.4-11°C	Feb-Jun	Stream channel, some edges	1 year	4.4-11°C	Essential, fry 2-5 days	Essential; large body size increases ocean survival; wood and cobble habitat important
Chum	Nov-Dec	4.4-11°C	Mar-Jun	Stream channel, some edges	Less than 1 year	4.4-11°C	Essential, fry 2-5 days	Uses both high and low velocity, essential for fry; adults die in fresh water after spawning
Steelhead - Winter	Dec-Apr	3.9-8.9°C	Apr-May	Stream channel, some edges	2-3 years	7.2-13.3°C	Essential for fry and adults	Essential, wood is primary structure; large body size increases ocean survival
Steelhead - Summer	May-Jul	6.1-17.8°C	Mar-Jul	Stream channel, some edges	2-4 years	7.2-13.3°C	Essential for fry and adults	Essential, wood is primary structure; large body size increases ocean survival
Sea-Run Cutthroat Trout	Dec-Mar	4.4-11°C	Mar-Jun	Stream channel, some edges	2-4 years	4.4-11°C	Fry remain up to 5 years	Essential, some remain in estuary 1+ year; small body size reduces ocean survival