

The Salmon's Journey up the Clackamas River Basin

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| Theme | Salmon overview | Portland salmon history | Clack River Salmon | Salmon Body transformation | How do salmon navigate home? | What makes good salmon habitat? | Spawning |
| Scene | Mouth of Columbia R. | Columbia Willamette | Willamette Clackamas | Clackamas Mainstem | Clackamas Eagle Ck. | Eagle Ck. | N. Fork Eagle Ck. |
| Location | Astoria | Sauvie Island | Clackamette Park | Underwater ? | Bonnie Lure | Clackamette Park | ?? |
| | | | | | | HS-LS2-7 | |

2.1 Columbia Salmon

<https://clackamas360.glitch.me/1ColumbiaSalmon.html>

ColumbiaMouth

1) Learning Objective: HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

- a) How have our abundant salmon influenced our region?
 - i) The Pacific Northwest is home to the most productive ecosystems on Earth. The world's largest trees grow here, forming Earth's most carbon-dense forests, protecting watersheds all the way down to the ocean, at estuaries teeming with life.
 - ii) The moist, temperate climate supports stable growing seasons. Our trees store water in their massive trunks, expanding across the radiant summers. The Cascades capture the ocean's generously wet winds.
 - iii) Yet if water is life, Salmon is the life force.
 - iv) Here, at the Mouth of the Columbia River, our richest resource enters our region's bloodstream. Connected to capillary streams deep into the Canadian Rockies and throughout the western United States, salmon bring the ocean's Nitrogen up into the mountains. Nitrogen is the key ingredient for chlorophyll, the plant kingdom's magic alchemy that turns sunlight and water into energy. Salmon-delivered marine-derived Nitrogen nourishes up to a quarter of some trees' growth. Salmon deliver Nitrogen to bears, insects, Eagles and even sustain juvenile salmon.
- b) Salmon as keystone species
 - i) Salmon (*Oncorhynchus* spp.) are **keystone species** in a vast network of food webs. They are so productive and vastly distributed that they are vital for many marine and terrestrial ecosystems to thrive. They are food for orca, seals, bears, wolves, Eagles, Ravens, Herons, Kingfishers, amphibians, and other fish. In fact, over 40 vertebrate species directly

benefit from salmon. They are also top predators in many stream, river, lake and ocean food chains. Their prodigious success as hunters, spawners, and survivalists makes them key providers for the entire temperate latitudes of Ring of Fire coastline.

- c) Human relationships to salmon in settling the region
 - i) Many of the native people of the Pacific Northwest call themselves Salmon People. Salmon influence their culture, spiritual beliefs and sense of place. The abundance of salmon helped make these peoples healthy and powerful and they sustained vast trade networks to share food, technologies, stories and language. Today many Salmon People still make their living by fishing in their traditional ways. They fight for their rights to fish and they stand up to protect salmon and water.
- d) Introduce the Challenges salmon face
 - i) We must acknowledge that centuries of colonialism brought destruction to the salmon, these forests, and to the Salmon Peoples.
 - ii) Colonizers fought native peoples to claim lands for the United States. In efforts to assimilate native peoples into American society, colonizers forbade them from speaking their languages and took children away from their families to control their educations.
 - iii) Colonizers have killed too many salmon, too, starving these vast ecosystems of the world's largest trees. Industrial pollution poisons the watersheds. Fertilizers, pesticides, metals, and chemicals sicken salmon and other plants and animals. Dams further cut off the flow of salmon life-blood from nourishing the forests throughout the region. Anthropogenic (human-caused) greenhouse gasses heat up the globe, causing global climate change and powerful chain reactions that affect precipitation patterns, nutrient cycles, and the very rhythms of nature.
 - iv) We must understand all of these causes of destruction in order to stop them. If we don't, we will continue to be complicit in the ecological and cultural genocides of both salmon species and Salmon People.
 - v) In this tour, we will examine these challenges that salmon species face. We will meet people who work to address these damages to help salmon recover, and we will learn actions we can take ourselves to support salmon.
- e) Go Beyond:
 - i) Often, when we think about colonization, we might picture pilgrims and explorers from hundreds of years ago, and we tend to disassociate ourselves from destructive actions that we now recognize as wrong. But the truth is, many of the processes of colonization are at work today, and we may be unknowingly supporting them. For instance, damming Celilo Falls with The Dalles Dam in 1957 was one of the most consequential actions in the United States government's efforts to develop the West. At Celilo Falls, native peoples from throughout the region gathered for

thousands of years to catch salmon, trade, and celebrate. The dam flooded the falls and some of the villages, destroying one of the Pacific Northwest's oldest gathering places.

- ii) Watch the short film "Echo of Falling Water: The Inundation of Celilo Falls" to learn more: <https://www.youtube.com/watch?v=gBj70AjWDDg>
 - (1) What do you think about the decision to dam Celilo Falls?
 - (2) What should governments consider when making decisions that benefit one group of people but harm another?
 - (3) How do you feel about Celilo Village Chief Tommy Kuni Thompson (Wyam) saying: "There goes my life. My people will never be the same," the day Celilo Falls was flooded?
 - (4) What do you think will happen to the dam in the future?

f) [Echo of Falling Water: The Inundation of Celilo Falls](#)

g) Assets:

- i) Cape Disappointment State Park
- ii) Ruby Island
- iii) Pacific Ocean
- iv) Sand Island
- v) Astoria
- vi) Baker Bay
- vii) Chinook River
- viii) Port of Ilwaco
- ix) Saddle Mountain
- x) Mouth of the Columbia River

2.2 Salmon Physiology, Life History and an Upstream Battle

<https://clackamas360.glitch.me/2SalmonLife.html>

Eagle Creek Salmon Habitat

2) Learning Objective:

- a) **HS.16. Analyze the interconnectedness of physical and human regional systems and their interconnectedness to global communities. Investigate and compare the variation of biodiversity around Earth. EL Strand 2.**
- b) **Research particular places on Earth, or particular species, that demonstrate either protection or loss of biodiversity. Show the causes and effects of these changes from a human perspective. EL Strand 3**
- c) **Learning Objective: Investigate and compare the variation of biodiversity around Earth. EL Strand 2.**
- d) Pacific Northwest Salmon
 - i) Salmon are **anadromous** - they spend their lives in both freshwater and the ocean. They hatch from **eggs** high up mountain streams as **alevins**. They grow, becoming a **fry**, then head towards estuaries as **smolts**. Their

bodies undergo special physiological changes to be able to transition from freshwater to saltwater, called **smoltification**.

- e) Salmon Life Stages
 - i) The Pacific Northwest is home to 5 species of anadromous salmon - they spend their lives in both freshwater and the ocean. They hatch from eggs high up mountain streams as alevins. They grow to become fry, then head downstream towards estuaries as smolts. Their bodies undergo special physiological changes to be able to transition from freshwater to saltwater, called smoltification.
 - ii) Salmon depend on diverse habitats and are vulnerable to changes in each. Climate change affects salmon at every life stage. Salmon must navigate rising water temperatures and unpredictable water availability, and they must adapt to a changing phenology - the timing of natural events.
- f) Clackamas Populations
 - i) While salmon populations across the Pacific have declined drastically since the arrival of European settlers, the Clackamas River remains a bright spot, supporting some of the healthiest salmon and steelhead populations in the region. The Clackamas Populations include fall chinook, spring chinook, chum, winter steelhead, and the last wild late-winter coho salmon population in the Columbia Basin.
 - ii) The Clackamas Partnership is an collection of organizations working to address the main challenges - or "Limiting Factors - that harm the Clackamas Populations of salmon, including restoring habitat, removing unnatural barriers and shielding against future effects of climate change.
- g) Eagle Creek
 - i) Eagle Creek is the largest tributary of the Lower Clackamas, and has one of the healthiest salmon runs in all of Oregon. Eagle Creek starts up in the old-growth forests of the Salmon-Huckleberry Wilderness and supports coho, spring and fall chinook and steelhead. The creek's healthy riparian buffer protects the waters from overheating in the summertime, and its natural features provide great habitat for spawning and for juvenile fish.
- h) Go Beyond:

2.3 Salmon & Climate

<https://clackamas360.glitch.me/3ClimateChange.html>

Mt. Adams

- 3) A Changing Landscape
 - a) When we think about climate change, we often picture a calving glacier dropping into the ocean. We do have glaciers in the Pacific Northwest - just look at the top of Mt. Adams. But climate change in our region will be a slow, imperceptible process. The forests on Mt. Adams should be covered in snow throughout the Spring, but our winters are bringing less snow. We will have warmer, drier

summers with greater risk for wildfires. Our signature PNW rains will be less predictable, sometimes causing torrential flooding, sometimes long droughts.

- b) For salmon, these many changes compound their challenges.
- 4) Salmon & Climate
 - a) Salmon depend on diverse habitats and are vulnerable to changes in each. Climate change affects salmon at every life stage. Salmon must navigate rising water temperatures and unpredictable water availability, and they must adapt to a changing phenology - the timing of natural events.
 - 5) Phenology
 - a) Phenology is the study of the seasonal and cyclical timing of natural events. Salmon rely on seasonal changes in water temperature as signals telling them it's time to migrate to sea or to spawn. The timing of spawning correlates to a specific overlap in conditions for adults and eggs and is the most important indicator of climate change. Spawning dates for Columbia River chinook shifted one week from 1950-2010 as water temperatures rose 2oC. Smolt migration is happening 2.5 days earlier per decade as the environment warms.
 - 6) Temperature
 - a) The temperature of their water is the most influential factor to determine salmon behavior. Temperature even controls some bodily functions and physiological development, so salmon really need water temperatures to be within certain ranges to grow and reproduce properly. Salmon avoid waters altogether when the temperature is above a certain threshold - entire tributaries could become inhospitable to our native trout and salmonids as the Clackamas watershed continues to warm.
 - 7) Ocean acidification
 - a) The ocean has increased its acidity by approximately 30% since it began absorbing the anthropogenic carbon of the industrial revolution. In some places, the changing pH is beginning to dissolve shell-forming species like juvenile oysters. These effects will continue to ripple up the food chain, reducing the ocean's productivity and making it harder for salmon to find enough food to survive at sea.
 - 8) Drought
 - a) The PNW's wet climate is influenced by the moisture-laden tradewinds of the El Niño Southern Oscillation (ENSO), a weather phenomenon that happens once each 20 years. Based on climate models, NOAA scientists predict ENSO events will be more intense and happen more frequently. In warm (El Niño) cycles, the PNW is more likely to have warmer winters. That means reduced mountain snowpacks will melt earlier in the Spring, potentially causing summer droughts that expose salmon to higher water temperatures. Low water levels can also cut off salmon from reaching their spawning streams, impair water quality, reduce oxygen levels in the water, and benefits invasive predators from warmer climates.
 - 9) Floods
 - a) Projected changes in annual precipitation, averaged over all models, are small (+1 to +2%), but some models project wetter autumns and winters and drier

summers. Increases in extreme high precipitation (falling as rain) in the western Cascades and reductions in snowpack are key projections from high-resolution regional climate models. (Littell et-al., 2009) In September, NOAA's Climate Prediction Center announced that a La Niña had developed in the Pacific and was likely to last through the Northern Hemisphere winter.

10) Habitat Degradation

- a) Together, all of these climate change effects combine to degrade salmon habitat across the species' ranges. Floods increase sedimentation, reducing habitat suitability. Droughts that cut-off streams fragment habitat. Acidic oceans eliminate hunting waters. Altered phenologies may prevent salmon from migrating to coincide with prey species or ocean currents. Warm waters make habitats uninhabitable. Everywhere they turn, salmon face greater challenges - and they are running out of places to go.

2.4 Wildfires

<https://clackamas360.glitch.me/4Wildfires.html>

Faraday Fire

1. Wildfire effect on salmon
 - a. Oregon will not escape wildfires. Our future holds drier, warmer summers, reduced snowpacks, and an increasing frequency of droughts. Fire-prone, weed-like invasive species are replacing our native, fire-resistant forests. Beetle infestations destroy acres of trees, leaving dead, dry timber ready to ignite. Our history of fire suppression leaves us with crowded forests, a century of undergrowth for fire to climb. We've checkered our Cascades and Coast Ranges with clear-cuts. We've strung power lines throughout the mountains, pumping voltage through the canopy across rough terrain. Thousands of people pitch tents everywhere, enjoying the night sky next to thousands of campfires.
 - b. We must learn how to live with wildfire, prevent wildfire, manage wildfire.
2. Recap of the Riverside Fire
 - a. Acreage
 - b. Effects
 - c. Damages
 - d. Direct effects upon salmon
3. Wildfire Ecology
4. Winners/Losers
 - i. Winners: Salmon?
 - ii. Winners: Woodpeckers
 - iii. Winners: Deer and Elk
 - iv. Winners: Insects
 - v. Losers: Spotted Owl
5. Nutrient Cycling
6. Forest Management
 - a. Soil BAER
 - b. Landslides

- c. Hazard Trees
 - d. Fire prevention
 - e. Burn patterns
7. Post-fire succession
- a. Eagle Creek Fire

2.5 Pollution

<https://clackamas360.glitch.me/5Pollution.html>

Carli Creek

1. Clackamas Partnership
 - a. A coalition of multiple organizations, including watershed councils, government agencies, public utilities, local companies, and land managers are working together to reduce the impact of climate change, pollution, and habitat loss on our Clackamas Populations of salmon, trout, and Pacific lamprey.
2. Impervious surfaces
 - a. The watershed used to be all nature. Each raindrop would likely be absorbed into the soil where it landed. Now, expansive areas of concrete, asphalt, and buildings don't absorb precipitation, diverting water directly to our waterways. Impervious surfaces that funnel water collected across large areas can cause flooding and introduce pollutants like chemicals, metals, garbage, and fertilizers into the water.
3. Rain Gardens
 - a. Rain Gardens prevent runoff from impervious surfaces from reaching the waterways. Rain Gardens are composed of native plants that love water. The wetland soils absorb rainwater and stormwater runoff, storing pollutants and filtering the water. The Carli Creek Project is designed by Clackamas Water Environment Services to be a giant Rain Garden to store, treat, and evaporate water coming from the Clackamas industrial area.
4. Stormwater Management
 - a. A vast network of pipes and weirs collects water from across 400 acres of the industrial area and diverts it to the Carli Creek Project site for treatment.

2.6 Habitat Loss

Eagle Creek Project

Habitat Restoration

Humans have destroyed habitat for millions of species by altering the environment. For salmon and other freshwater fish species, our dams have changed the natural flow of rivers. These unhealthy rivers heat up behind dams, are deprived of silt and gravels, and no longer flood as frequently or as powerfully, meaning the river systems are static instead of dynamic.

Dynamic Rivers

Dynamic rivers change course. They take over forests and pull trees into their flow. Rivers flood and leave behind ponds and moist habitat all along their reaches. They create sandbars and

bring in obstacles that create riffles that oxygenate the water. These dynamic flows strengthen riparian habitats - the forests and shrubs that specialize in living alongside rivers and streams.

Riparian Habitat

Riparian habitat connect rivers to the land and sky. The trees and shrubs draw water from the streams and grow as great habitat for bugs, birds, frogs, and mammals. When the trees - or bugs - fall into the water, the fish benefit with in-stream habitat structures to hide among - and food to eat. Wood in streams is important for young salmon for many reasons.

Large Woody Debris

Large Woody Debris provides juvenile salmon structures to hide among. Young fish hide from predators like birds with wood above them, and can hide among branches and roots from other fish. The wood can create pools where young fish rest. Wood also stirs up the water, which oxygenates it, giving developing eggs the oxygen they need to grow.

In-Stream Restoration

Not only have we restricted river floods and have cut down riparian forests, but our fisheries managers also removed wood from river systems, thinking erroneously that wood obstructed salmon in their journey upstream. Now, we are putting wood back into river systems to provide instream habitat all throughout the Pacific Northwest, like here at Eagle Creek.

Eagle Creek Video

2.7 Spawning: Life and Death

Eagle Creek Fish Hatchery

Spawning

Salmon return to their home stream to lay their eggs. It's a one-way, heroic journey. They stop eating and are singularly driven to swim upstream, return home, and procreate. Shortly after mating and laying their eggs, these fish will die. Their sacrifice is encoded into their DNA. For millions of years, salmon have returned home, giving their life force to their future generations and to our forests.

The End

Just like the salmon, you too have finished your journey on the Clackamas360 Virtual Watershed Tour. Thank you! Now go get out there...

11) "Finding Home"

12) "Salmon Ecosystems"

- a) Learning Objective: HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

13) "Spawn"