



Changing Climate, Changing Habitats, and Salmon

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Introduction:

Across the globe, cold water dependent fisheries are being impacted by climate change, and salmon are no exception. In the Pacific Northwest, the populations of many salmon species are already in significant decline and many are protected under the Endangered Species Act. The effects of climate change include altering the timing and magnitude of stream flows, increasing ocean and stream temperatures, raising the sea level, and changing shorelines and ocean current patterns; all of which make recovery even more challenging. Thus, to conserve Pacific salmon, impacts from climate change must be taken into account, from the “snowcaps to white caps,” from the river to the ocean, to provide scientific support for mitigating and adapting to climate change. With the decrease in salmon populations, Native cultures who have depended on salmon for thousands of years (“since time immemorial”) are at risk of losing their lifeways, culture and traditions. Additionally, the critical local economies connected to the fishing and seafood industry also face a grim future.

General

- **Salmon Populations Are at Risk:** There are five species of Pacific salmon on the west coast of the United States: Chinook, coho, sockeye, pink, and chum. The populations of all of these species are already in significant decline and many are designated for protection under the Endangered Species Act.
 - NOAA, *Pacific Salmon and Steelhead*: <https://www.fisheries.noaa.gov/species/pacific-salmon-and-steelhead>
- **Salmon Are a Keystone Species:** Salmon are an essential food source for many species, including humans. The nutrients from the carcasses of spawned out adults also plays an important role in keeping streams, rivers, and forests healthy. This makes them a keystone species because their presence (or lack thereof) impacts the health of the entire ecosystem.
 - CBS, *Nature Up Close: Salmon, a Keystone Species in the Pacific Northwest*: <https://www.cbsnews.com/news/nature-up-close-salmon-a-keystone-species-in-the-pacific-northwest-judy-lehmborg/>
- **Salmon are an Indicator Species:** The health of salmon tells us a lot about the overall health of the ecosystems in which they live. As soon as things get out of balance, their populations let us know there is something wrong in the ecosystem; and is an indicator that other species are likely struggling as well.
 - Encyclopedia of Puget Sound, *Indicator Species*: <https://www.eopugetsound.org/articles/indicator-species>

Salmon Are Essential to Pacific Northwest Cultures and Economies:

Pacific Northwest Tribes and Salmon People

Many Native American Nations of the Pacific Northwest define themselves as “Salmon People” because salmon are intrinsically linked to their culture. These sacred fish have been shaping tribal diet, cultures, societies and religions since “time immemorial.”

The salmon was put here by the creator for our use as part of the cycle of life. It gave to us, and we, in turn, gave back to it through our ceremonies... Their returning meant our continuance was assured because the salmon gave up their lives for us. In turn, when we die and go back to the earth, we are providing that nourishment back to the soil, back to the riverbeds, and back into that cycle of life.

~ Carla HiaghEagle, Nez Perce

Learn more:

- Columbia River Inter-Tribal Fish Commission, *We Are Salmon People*: <https://www.critfc.org/salmon-culture/we-are-all-salmon-people/>
- Native Knowledge 360°, *Why is Salmon Important to Native People and Nations of the Pacific Northwest*: <https://americanindian.si.edu/nk360/pnw-history-culture/index.cshtml#sq1>

Fisheries Industry and Local Economies

Salmon fisheries are critical to local coastal economies. In 2017, Salmon fisheries earned \$688 million, the highest value of all commercial species. As the impacts of climate change continue to take hold, the fishing and seafood industry also face a grim future – by the end of the century, catches in fisheries are expected to decline by 21-24%.

Salmon Have Specific Needs:

➤ *In the Rivers Salmon Need Cold, Clean, Connected Water:*

- **Cold Water:** Water temperature is one of the greatest threats to salmon survival. At the beginning and end of their life (spawning and rearing) salmon live in freshwater, all of which is done in the stream where they were born. During these stages of their lifecycle, they need cold water for spawning and early life rearing. The optimal temperature for salmon spawning is 50 °F, but can range from 33-68 °F. Stressful conditions for adult salmon begin as temperatures increase to greater than 60 °F, and lethal effects occur at temperatures greater than 69 °F. Increased stress from rising water temperature increases salmon’s susceptibility to disease, which then significantly decreases their survival rate.
- **Oxygen to Breathe:** Salmon don’t breathe oxygen from the air. Their gills filter out oxygen in the water which is called dissolved oxygen. Water with plenty of oxygen is necessary for the survival of developing embryos and baby salmon. Cold water holds more dissolved oxygen; warm water has less. So, the warmer it gets, the harder it is for them to breathe.
- **Clean Water:** Clean water includes water that does not have a lot of suspended sediment which can bury and suffocate salmon redds (a.k.a., salmon nests). The ecosystem of plants and trees that grow along the stream is called the riparian zone, and those plants and leafy trees create shade that keeps the water cold. Sediment is caused from soil erosion, which occurs when roots systems aren’t available to hold the soil in place; therefore, a healthy riparian zone

is needed to both keep the water cold as well as to prevent sediment from entering the stream. But upland forest environments also play an important role in stabilizing the soil and preventing mud and dirt from ending up in streams and rivers when it rains.

- **Safe Passage and Connected Water:** Dams can change temperature regimes and delay migratory timing, in the best of cases. In the worst case, dams without fish passage prevent adults from accessing their historic spawning grounds.
 - NOAA Pacific Salmon Lifecycle Poster: <https://www.unh.edu/unhtoday/2018/10/winter-ticks-kill-70-percent-moose-calves-research-shows>
 - USFWS Pacific Salmon and Steelhead Coloring Book: <https://www.fws.gov/arcata/kidsCorner/salmonColoringBk.pdf>

➤ ***In the Ocean Salmon Need:***

- **Cold Water:** Salmon live in the cold water of the North Pacific. Once they enter the ocean they can swim up to a thousand miles to reach their feeding ground.
- **Plenty of Food at the Right Time:** Salmon can get quite large. The largest Chinook salmon ever recorded, was 126 pounds! In order to get large they must migrate to the ocean where there is more food. Once they enter the ocean, if there is plenty of food and the timing is right they grow quickly and can add on a pound each month.
- **Avoid Predators:** Out at sea they also have many predators that they have to evade with their fast swimming skills. Salmon are built for speed and can swim as fast as 24.5 miles per hour, and 36 feet per second.

Impacts of Climate Change on Salmon:

➤ ***In the River:***

- **Increased Water Temperature:** As our climate continues to warm, stream temperatures are continuing to increase.
- **Less Snowpack, Less Streamflow during the Late Summer:** Snowpack is expected to decrease in the future, affecting the amount of flow and stream temperatures. This is particularly harmful to salmon populations during the late summer when historically the snowpack in the mountains provides the cushion needed during the waning summer months. Limited water resources in the future will also impact all sorts of species, including humans.
- **Poor Water Quality:** Climate change creates extreme weather events like flooding, drought and unprecedented heat waves. As a result, we are witnessing more frequent winter flood events, as well as droughts and uncharacteristic wildfires. In combination, less trees and vegetation available to hold the soil in place results in increased erosion and poor water quality. The loss of vegetation also creates less shade, which results in increased water temperature.

➤ ***In the Ocean:***

- **Coastal Upwelling, Timing and Availability of Food:** In the ocean, climate affects the key process of coastal upwelling, a process that brings deep, nutrient-rich, cold waters to the surface and fuels the growth of phytoplankton, which forms the base of the marine food web. Changes in this upwelling can circulate throughout the food web to such species as salmon by affecting the survival of juvenile fish when they swim from their birth stream into the ocean. The timing and location of sufficient food resources is essential to salmon survival, and

unprecedented changes in coastal upwelling caused by climate change are throwing the entire food web off.

- NOAA, Ocean Upwelling Defined: <https://oceanservice.noaa.gov/facts/upwelling.html>
- Climate Change and the Coastal Upwelling: <https://climatecirculator.org.wordpress.com/2016/01/19/climate-change-and-coastal-upwelling/>
- **Warmer Water, Less Oxygen, and More Predators:** Changes in marine water temperature also affect salmon survival by influencing the distribution, abundance and timing of predators that eat salmon. It also impacts the amount of oxygen in the water, just as in the river, salmon need enough oxygen to breathe. Warmer water holds less oxygen.
- **Ocean Acidification:** Oceans absorb carbon from the atmosphere, which makes the water more acidic. This process is called ocean acidification. As the water becomes more acidic, it breaks down calcium and erodes the shells of many species, including a number of species salmon eat like pteropods. Shrimp, one of salmon's favorite foods, are also being negatively impacted by ocean acidification.
 - Shrimp and Ocean Acidification: <https://scripps.ucsd.edu/news/study-reveals-ocean-acidifications-effects-shrimp-biology>

We Can Help Salmon!

- We all must work to protect the remaining habitat that supports salmon spawning and rearing.
 - Volunteer to restore a stream!
- We all must ensure salmon have unimpeded migratory corridors to healthy habitat.
 - Decrease the need for dams by using solar or wind energy.
- We all must do everything we can to decrease the harmful impacts of climate change.
 - Drive less: take public transit, ride your bike or walk.
 - Use less electricity: turn your lights off, choose green sources of energy, decrease heat and AC use.
 - Waste Less: re-purpose, reduce, reuse, recycle, and avoid food waste.
- Teach others what you've learned!

Learn more:

- USFWS Endangered Species Bulletin, Salmon Research and Climate Change: <https://www.fws.gov/endangered/news/bulletin-summer2009/salmon-research-and-climate-change.html>
- USFWS Pacific Salmon and Steelhead Coloring Book: <https://www.fws.gov/arcata/kidsCorner/salmonColoringBk.pdf>
- NOAA Impacts of Climate Change on Salmon of the Pacific Northwest pdf: https://www.webapps.nwfsc.noaa.gov/assets/4/9042_02102017_105951_Crozier.2016-BIOP-Lit-Rev-Salmon-Climate-Effects-2015.pdf
- USFWS Brook Trout and Climate Change: <https://www.fws.gov/news/blog/index.cfm/2011/6/1/Tennessee-Joint-Venture-Strives-to-Determine-the-Effects-of-Climate-Change-on-Brook-Trout#more>
- USDA Climate Change Resource Center, Salmon and Trout: <https://www.fs.usda.gov/ccrc/topics/salmon-and-trout>

- Climate News Article, *Global Warming is Pushing Pacific Salmon to the Brink, Federal Scientists Warn*: <https://insideclimatenews.org/news/29072019/pacific-salmon-climate-change-threat-endangered-columbia-river-california-idaho-oregon-study/>
- Guidelines for Considering Traditional Knowledge in Climate Change Initiatives: <https://climatetkw.wordpress.com/>
- IUCN general info 2009: <https://www.weadapt.org/sites/weadapt.org/files/legacy-new/placemarks/files/533ac6c85a5e0fact-sheet-red-list-salmon.pdf>
- NOAA 2019 vulnerability assessments: <https://www.fisheries.noaa.gov/feature-story/west-coast-salmon-vulnerable-climate-change-some-show-resilience-shifting-environment>
- US Climate Resilience Toolkit – 2018 – How vulnerable are salmon to a changing climate: <https://toolkit.climate.gov/case-studies/how-vulnerable-are-salmon-changing-climate>
- State of the Salmon – 2020: <https://stateofsalmon.wa.gov/> ; <https://wa-rco.maps.arcgis.com/apps/Cascade/index.html?appid=e16566d90b2144b58be852e67ef22ef8>
- NOAA Fisheries, *Warming Ocean Will Challenge Snake River Salmon Survival in Coming Decades*: <https://www.fisheries.noaa.gov/feature-story/warming-ocean-will-challenge-snake-river-salmon-survival-coming-decades-new-research>
- USFWS Fish and Aquatics Conservation: <https://www.fws.gov/fisheries/>
- USFWS Salmon in the Classroom Curriculum: <https://www.fws.gov/pacific/fisheries/FY16Highlights/FY16SalmonInTheClassroom.cfm>
 - Curriculum: <https://www.fws.gov/pacific/fisheries/documents/Salmon%20in%20the%20Classroom%20Final%202018.pdf>
- NOAA Curriculum, *An Incredible Journey*: <https://www.fisheries.noaa.gov/west-coast/outreach-and-education/incredible-journey-series-educational-resources-promote-salmon-stewardship>

