Elwha Chapter Update

PUGET SOUND CHINOOK RECOVERY PLAN

December 2024

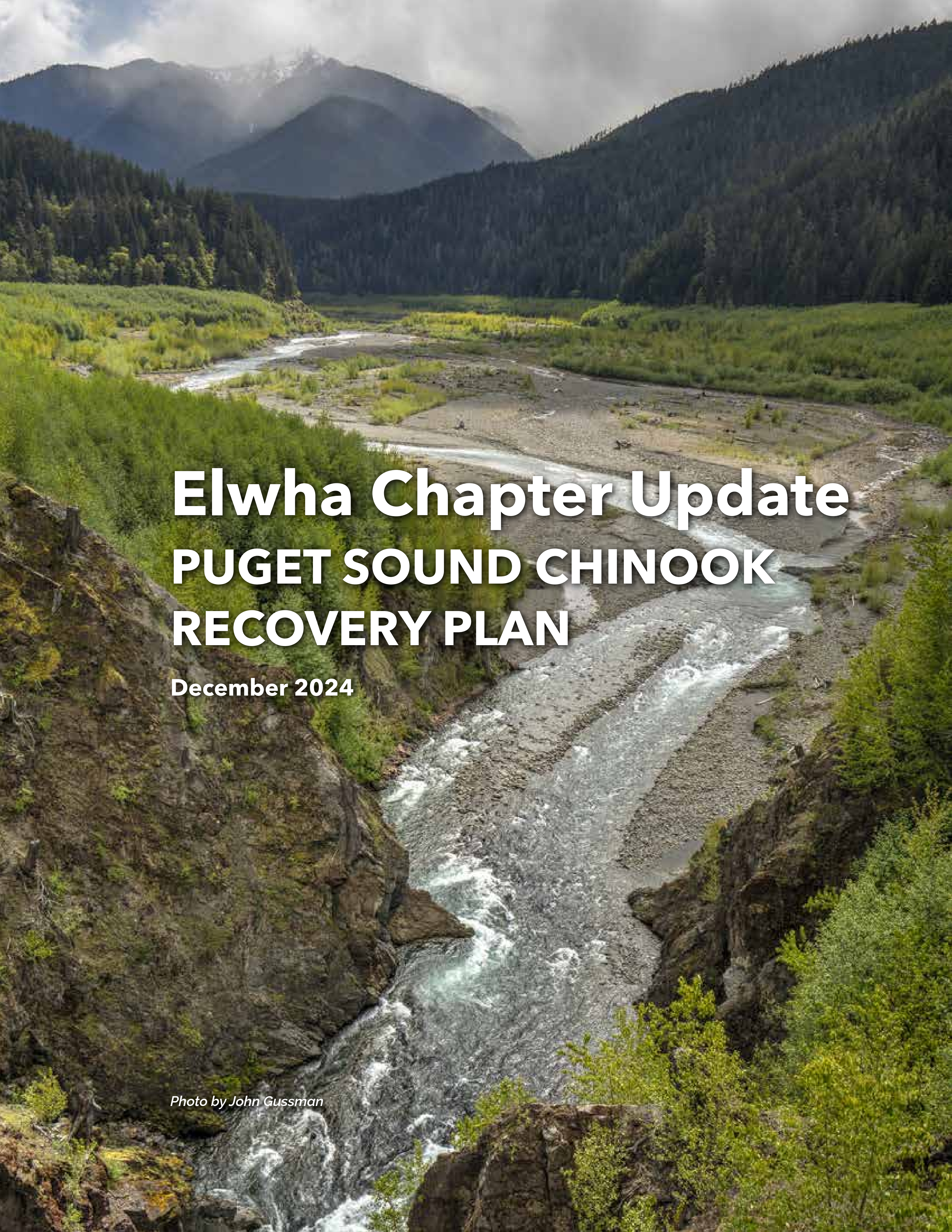

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Table of Contents

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Photo by Tom Roorda

Executive Summary

Chinook salmon, which call the Elwha River home, are an iconic part of the Olympic Peninsula landscape. Renowned as the river where king salmon were so prolific people crossed the river on the backs of salmon returning to spawn, the mighty Elwha River looms large. With its majestic headwaters in the Olympics, flowing 45 miles to the sea through much of Olympic National Park, it is a major river to behold. Located west of Port Angeles and emptying into the Strait of Juan de Fuca, the Elwha is the fourth largest river on the North Olympic Peninsula.

The Elwha River supported legendary fish runs that were greatly diminished when two hydroelectric dams were built without required fish passage in the early 1900's. The dams blocked salmon from 70 miles of habitat and damaged remaining fish habitat by altering hydrology and temperature, and limiting the transport of wood, sediment, and gravel, thereby altering habitat-forming processes. Combined with channelization of the lower river and estuary, this led to collapsing salmon populations. In 1999, Elwha Chinook were listed under the federal Endangered Species Act (ESA) as part of the overall Puget Sound Chinook population. Elwha Chinook are their own unique population and Puget Sound Chinook cannot be recovered or delisted under the ESA without the recovery of wild Elwha Chinook.

This document is an update to the Elwha Chinook Recovery Chapter developed as part of the Puget Sound Chinook Recovery Plan that was adopted by the federal government in 2007. Puget Sound Steelhead were listed under the ESA later that same year. Major changes have occurred in the Elwha River since the original chapter was written. The largest ecosystem restoration action in Puget Sound was completed with the removal of both dams by 2014. Since dam removal, the Elwha River has seen restored natural flow, improved fish habitat, and some positive fish recovery trends. Increased abundance of naturally spawning coho salmon allowed the Lower Elwha Klallam Tribe to hold their first ceremonial and subsistence fishery since dam removal in October of 2023.

In addition, extensive progress has been made on Elwha River habitat restoration and protection projects and other fish recovery efforts. Therefore, it is time to review what has been done, new science, and what is needed next as part of this update of the original Elwha Chapter of the Puget Sound Chinook Recovery Plan.

This Chapter Update was developed collaboratively by a group of practitioners working on Elwha River restoration and led by the North Olympic Peninsula Lead Entity for Salmon. The Chapter Update will be used as a road map by restoration partners and decision makers working to recover Elwha Chinook and the Elwha River ecosystem.

Photo credit John McMillan

The primary goal for recovery is a healthy Elwha Watershed ecosystem that supports a naturally occurring, wild Chinook salmon population at self-sustaining, harvestable levels. The Elwha Chapter Update details the specific Chinook salmon population goals to achieve recovery, also benefiting the other ESA listed fish species found in the Elwha River: Puget Sound Steelhead, Bull Trout, and Eulachon, as well as Coho, Pink, Chum, and Sockeye. These population goals were developed by the co-managers: the Lower Elwha Klallam Tribe and the Washington Department of Fish and Wildlife in cooperation with the National Park Service, United States Fish and Wildlife Service, National Marine Fisheries Service, and United States Geological Survey. To assess progress, the Elwha Chapter Update contains the latest information on stock status and population trends post dam removal for Elwha Chinook, Steelhead, and Bull Trout.


Photo by Olympic National Park

Along with the long-term habitat goals, shorter-term implementation targets were developed to track progress toward the goals. These include targets for freshwater, estuarine and nearshore habitats. The Elwha Chapter Update developed habitat strategies and actions needed for future restoration and recovery efforts, with specific details on the issues addressed, priority areas for implementation, and benefits to local fish populations. The strategies, actions, and approaches address the primary limiting factors to recovery and restore degraded habitats to functional ecological conditions.

In addition, a new Adaptive Management Framework was developed to help meet key data gaps, and to evaluate progress over time using the best available science. The Framework includes timelines and a restoration review process to apply new information, assess what is working, and identify where changes are needed.

Major Habitat Recovery Strategies include actions to:

- Restore freshwater channel habitat, including wood, pools, and spawning substrate
- Restore and protect floodplain and side channel connectivity
- Revegetate and restore the riparian floodplain forests of the former reservoirs
- Restore and protect freshwater riparian buffer habitat
- Maintain and fully restore unimpeded fish passage through the tributaries and former dam sites
- Restore and protect Elwha Estuary habitat and connectivity
- Restore and protect nearshore habitat, including intact shoreline, eelgrass and canopy forming kelp habitat, forage fish spawning substrate, and feeder bluffs
- Protect instream flow
- Address elevated summer stream temperature

As the Chapter Update shows, restoration progress and some improvements in fish populations have occurred since the 2007 Plan and following dam removal. But much work remains to be done. The Elwha Watershed has experienced more than 100 years of habitat loss and degradation. Some of that loss and degradation continues, along with climate change impacts and changing ocean conditions. It will take ongoing political will and financial support to make the tough choices needed to protect this river and enable the continued focused, strategic, and collaborative efforts needed to restore the Elwha River ecosystem and recovery of healthy populations of wild Elwha Chinook.

Introduction

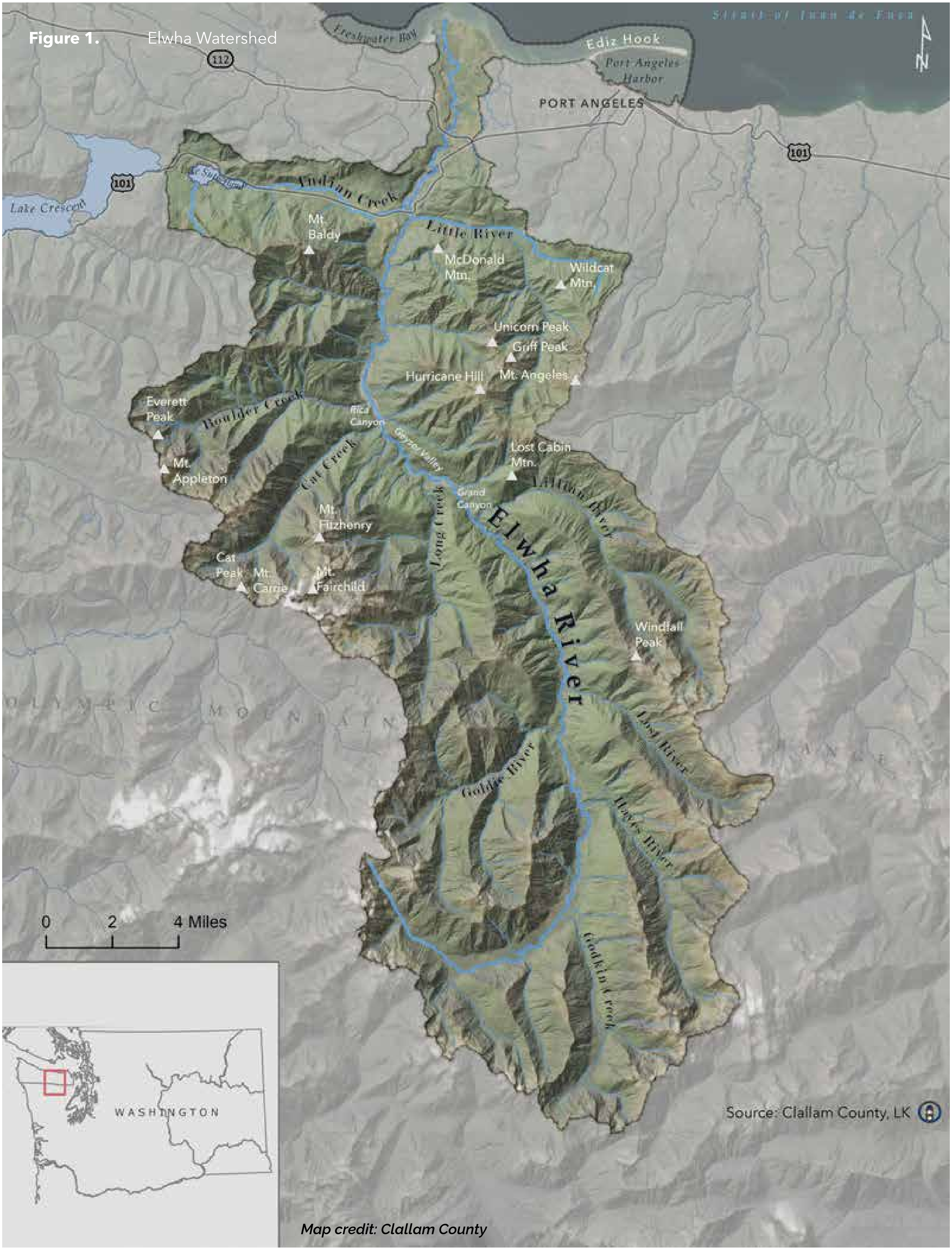
Plan Update Overview

This document is an update to the original Elwha Chapter of the Puget Sound Chinook Recovery Plan approved by the National Oceanic and Atmospheric Administration in 2007. It is one of 16 watershed chapters in the Puget Sound Chinook Recovery Plan guiding actions needed to recover Puget Sound Chinook salmon which are threatened with extinction. Puget Sound Chinook salmon cannot be taken off the Endangered Species List without recovery of natural origin, wild Elwha Chinook salmon, which is a unique, distinct population. Elwha Chinook salmon are in the Strait of Juan de Fuca biogeographical region, which is one of five biogeographical regions that were defined by the Puget Sound Technical Recovery Team based on distinct physical and habitat features (National Marine Fisheries Service Northwest Region, 2006). A map of the Elwha River shows the watershed area and associated nearshore habitat (Figure 1).

The plan is being updated now for numerous reasons. The initial Elwha Chapter content was written in 2004 and 2005. Much recovery work in the Elwha Watershed has occurred since then. Most importantly, two large dams on the Elwha River, which degraded the river and prevented salmon from accessing 70 miles (113 kilometers) of healthy habitat within Olympic National Park for more than 100 years, were removed. This was made possible by the Elwha River Ecosystem and Fisheries Restoration Act (PL 102-495), massive investments of National Park Service and other federal funding and was the most significant restoration action in the entire Puget Sound Chinook Recovery Plan to occur during this time. The original recovery planning effort emphasized the effects of the dams and the importance of their removal. Now that the dams are gone, an update is needed to describe current watershed conditions, summarize restoration progress, and revise priorities and strategies for recovery. In addition, the Update integrates an Adaptive Management Framework to track progress and make improvements as needed.

Beyond dam removal, numerous other recovery and restoration actions in the Elwha River have occurred. This includes the removal or replacement of fish blocking culverts, including the Indian Creek culvert on Highway 101 and the Griff Creek culvert on Olympic Hot Springs Road; multiple installations of large wood in the river and tributaries needed for habitat complexity; riparian plantings in tributaries; noxious weed control throughout the Elwha Watershed; sediment nourishment and coastal native backshore plantings on Ediz Hook; purchases of key parcels for infrastructure removal and ongoing conservation; and huge swaths of newly exposed floodplain that was replanted after dam removal.

Figure 1. Elwha Watershed



Map credit: Clallam County


Photo by Roger Peters

This Chinook Recovery Plan Elwha Chapter Update began in 2023 with the establishment of a working group led by the North Olympic Peninsula Lead Entity for Salmon. The Elwha Update Working Group includes representatives of local governments, state and federal agencies, and watershed partners in Chinook salmon recovery. The planning process integrated local and regional science, as well as lessons learned since 2005, into the Chapter Update. For example, climate change impacts to salmon were not well understood when the original plan was developed. Climate change science, nearshore use by juvenile salmonids, the effects of dam removal on the Elwha River, and numerous additional science and research findings are now included. In addition, habitat metrics were not part of the original Elwha Chapter but were developed as part of this process.

This work was also an opportunity for staff with long-term experience with Elwha River restoration to work with employees who will be doing this work in the future. In several of the Elwha River partner governments and organizations, there are numerous restoration staff facing retirement. Because it takes trained and committed staff to advance restoration, it is an important time to capture some of this institutional knowledge and include it here. Without staff capacity or the funding to hire such, restoration and recovery work cannot be advanced.

The primary uses of the Chinook Recovery Plan Elwha Chapter Update are to guide strategic priorities and implementation, including projects and programmatic actions, and to establish habitat goals and associated indicators for tracking progress toward habitat restoration and fish recovery goals over time. The Plan also describes key uncertainties, research, and monitoring needs for management decisions and integrates current scientific knowledge. As an Adaptive Management Framework, it includes a way to evaluate and review progress over time. It also provides a roadmap for Elwha Chinook recovery and is expected to be used by partners and decision makers to guide additional salmon restoration and recovery efforts.

Elwha Watershed Recovery Context

History, Culture, and Geography of the Elwha Watershed

The Elwha River is located on Washington State's rugged North Olympic Peninsula, with its headwaters formed by snowmelt and retreating glaciers high in the Olympic mountains (Riedel et al., 2015). It runs through Olympic National Park, private parcels, and Lower Elwha Klallam Tribal lands before emptying into the Strait of Juan de Fuca.

At 45 miles long from the mountains to the sea, and with its watershed covering 321 square miles and 15 main tributaries, the Elwha River is the fourth largest river on the North Olympic Peninsula. The river provides more than 70 miles of salmonid habitat when the tributaries are included. Historically, it was also one of the most productive rivers on the Olympic Peninsula, as it supported strong populations of all five species of Pacific salmon (Chinook, Chum, Coho, Pink, and Sockeye), as well as Bull Trout, Dolly Varden, winter and summer run Steelhead, and sea-run Cutthroat Trout. Prior to the installation of the Elwha and Glines Canyon dams, the Elwha River was renowned for the size of its returning salmon runs and for being home to some of the largest Chinook in Washington.

For the many Native American Tribes who have called Washington home since time immemorial, salmon is intricately connected with who they are and their way of life. This is true for the Lower Elwha Klallam Tribe. The Tribe has depended on the river and its salmon for their livelihood, sustenance, and as a core foundation of many cultural and spiritual beliefs. Many tribes, including the Lower Elwha Klallam Tribe, hold feasts and salmon ceremonies recognizing the first salmon to return each year. In treaties with the federal government, including the Point No Point Treaty that ensures the rights of the Klallam people, Native Americans retained their rights to fish and hunt in their usual and accustomed areas. This is indicative of the importance they placed on their ability to fish and hunt then, as well as their ability to do so into the future.

Eighty percent of the Elwha River has been largely protected within Olympic National Park. While this has limited development and preserved habitat conditions in the alluvial valleys, bedrock canyons, and well-vegetated side channels of the Elwha River, the dams prevented fish access to more than 70 miles (112 kilometers) of river mainstem and tributary habitat. This prevented salmon from accessing more than 90% of the river's watershed for over 100 years. Not only did the dams block fish access upstream, but they also prevented the movement of sediment and large wood downstream, further depleting the river and decreasing habitat used by salmon and other aquatic and terrestrial species. Salmon population declines began in the Pacific Northwest in the late 19th and early 20th centuries due to dams and other fish passage barriers, but also overfishing, and other human activities resulting in lost or degraded habitat. (Governor's Salmon Recovery Office, 2022) Decreased Chinook abundance has been documented since the Pacific Salmon Commission began tracking it in the 1980's (US Environmental Protection Agency, 2019). Tribes and Washington state government agencies were tracking the declines prior to that. The climate crisis and changing weather patterns are also now negatively impacting salmon (Northwest Fisheries Science Center, 2022).

In 1999, Puget Sound Chinook were officially listed as threatened, and have since been protected under the Endangered Species Act. This listing included distinct populations of Chinook salmon found in both the Elwha and the Dungeness Rivers. While the Recovery Plan for Puget Sound Chinook primarily focuses on ESA-listed Chinook, Steelhead, Bull Trout, and Eulachon are also listed as threatened. Both Steelhead and Bull Trout were addressed briefly in the original Recovery Chapter. Bull Trout recovery is managed by the United States Fish and Wildlife Service, but both Bull Trout and Steelhead also benefit from habitat recovery projects for Chinook. Additional considerations for Steelhead and Bull Trout are captured herein as needed. Eulachon, also known as candlefish, are an anadromous species of smelt. Chinook feed on Eulachon, as well as their eggs or larvae.

For further information, see **Appendix A: Strategy Context and Local Salmon History**.

Photo by Tiffany Royal, NWIFC

Dam Removal and Restoration

Since the original Puget Sound Chinook Recovery Plan for the Elwha Watershed was approved by the National Oceanic and Atmospheric Administration in 2007, the Elwha and Glines Canyon dams have been removed. After years of research and lobbying efforts, Congress signed the Elwha River Ecosystem and Fisheries Restoration Act in 1992, authorizing the US Department of the Interior to take ownership of the dam projects. The goal of the Elwha Act is full restoration of the Elwha River ecosystem and the native anadromous fisheries, including the re-establishment of viable salmonid populations and their habitats. Nearly two decades of restoration planning between the Lower Elwha Klallam Tribe, the National Park Service, the United States Fish and Wildlife Service, the Washington Department of Fish & Wildlife, the United States Geological Survey, the National Oceanic and Atmospheric Administration, and multiple other federal, state, and local partners occurred before the lower Elwha Dam was finally removed in 2012, and the upper Glines Canyon Dam was removed in 2014. The largest dam removal in the world at the time, this effort remains one of the largest dam removal projects in the United States and the world.

For further information, see **Appendix B: Dam Removal History**.

Listed Elwha River Salmonid Population Current Status Overview

Photo by John McMillan

Chinook Salmon *(Oncorhynchus tshawytscha)*

Elwha River Chinook salmon are a unique, distinct population that is part of the Puget Sound Chinook Evolutionarily Significant Unit (ESU). The Elwha River was historically known for producing Chinook of legendary size, with large-bodied salmon weighing more than 100 pounds observed in the river. The Elwha River Chinook population is comprised of two sub-populations: an early-timed (spring) population, and a late-timed (summer/fall) population. Dam construction and the ongoing harmful river impacts severely affected these populations. The Elwha Chinook population at the time of dam removal was dominated by hatchery produced salmon with summer/fall life histories. The historic spring-timed salmon life history that likely utilized the upper watershed was not well represented at the onset of dam removal (National Park Service, 2015a), and only small numbers of Chinook have entered the river during the historic spring entry time from dam removal to present.

In "Guidelines for Monitoring and Adaptively Managing Restoration of Chinook Salmon and Steelhead on the Elwha River" (EMAM) (Peters et al., 2014), outlines stages of recovery for during and after dam removal, including: Preservation, Recolonization, and Local Adaption. It also established triggers or numerical targets that need to be met before moving through the above stages. The triggers were established for abundance, productivity, spatial distribution, and diversity.

The triggers, which correlate to escapement goals for recovery, include Preservation (n=950), Recolonization (n=4340), and Local Adaptation (n=10,000) phases. These goals also reflect the intent that as natural origin fish increase and approach 10,000 fish, the corresponding hatchery origin fish will be reduced to zero. Chinook salmon escapement has historically been monitored by the Washington Department of Fish and Wildlife using spawning ground surveys, and more recently by the Lower Elwha Klallam Tribe using SONAR for the past 13 years. While the overall trend of Chinook escapement derived from SONAR has been positive since dam removal, numbers remain short of the Viable Salmonid Population (VSP) goal of 10,000 fish (Peters et al. 2014) but that was expected. The Guidelines for Monitoring and Adaptively Managing Restoration of Chinook Salmon and Steelhead does not anticipate achieving the VSP goals for at least 16 years after dam removal (2031), but realistically it may be closer to 25-30 years (2040-2045.)

The Tribe has also monitored smolt outmigration and redd counts since before dam removal. Redds are where salmon lay eggs in a stream in a nest made of gravel. Following the removal of the Elwha Dam, Chinook immediately moved past the former dam site to reoccupy the middle Elwha River, including the Little River and Indian Creek tributaries (McHenry et al., 2023a). Chinook redds have consistently been observed in the middle Elwha River, above the historic Elwha Dam site (River Kilometer [RKm] 7.9) and below the former Glines Canyon Dam site (RKm 21.7). Approximately 90% of the observed redds have been in the Elwha mainstem. Following the removal of the Glines Canyon Dam between 2011 and 2014, small to moderate numbers of Chinook redds have been identified upstream of the former dam site. Most of these fish have utilized the former Mills Reservoir for spawning sites. Few Chinook redds have been identified in the Elwha headwaters above the Grand Canyon to date.

Additionally, a question has arisen about fish passage following the discovery of low-flow barrier in Rica Canyon that is affecting upstream passage of Chinook. (McHenry et al., 2023c). Recovery objectives for Elwha Chinook may need to be revisited when additional information regarding Rica Canyon is available. Elwha Chinook are currently considered to be in the Preservation Phase of the previously established goals for abundance, productivity, spatial distribution, and diversity. The VSP parameters of abundance, productivity and spatial distribution are currently approaching the Recolonization Phase (Peters et al., 2014).

For further information, see **Appendix C: Chinook Salmon *(Oncorhynchus tshawytscha)* Population Status**.

Photo by John McMillan

Steelhead *(Oncorhynchus mykiss)*

The Elwha River is home to Steelhead and Rainbow Trout, both of which comprise the same species known as Oncorhynchus mykiss. Steelhead are anadromous, meaning they go out to sea where they spend time before returning to their natal streams to spawn. Some Rainbow Trout spend their entire lives in freshwater. Intermixing among life history strategies and cohorts is common once they reach spawning grounds, and a single redd can produce both resident and anadromous offspring (Ruzycki et al., 2003; Marshall et al., 2006). Other Rainbow Trout may remain for multiple years in freshwater, then go to sea well beyond a typical two-year smolt.

Historically, the Elwha River Steelhead had varied life history strategies, with fish entering the system throughout the year (Dick Goin, personal communication as cited in Denton et al., 2022). However, after dam construction, hatchery Steelhead broodstock supplementation, and directed harvest on those hatchery fish, the diversity of river entry and life history types were restricted. Fishing on this early-timed, non-native Chambers Creek stock negatively impacted the early native steelhead run by truncating their return. (Roger Peters, United States Fish and Wildlife Service, personal communication, 2024).

Despite this, all the genetic potential and legacy remained in the Rainbow Trout above the dams (Fraik et al., 2021). Prior to dam removal, the Steelhead populations of both winter and summer runs were severely depressed with an estimated annual escapement of the natural-origin Elwha River winter run Steelhead population at approximately 100 to 200 fish (Ward et al., 2008). Escapement estimates since dam removal have steadily increased, with the 2022 SONAR-based winter run Steelhead escapement estimated to be 2,519 (Denton et al., 2023). Steelhead smolt production in the Elwha River has generally increased since the Lower Elwha Klallam Tribe was able to generate its first production estimates from 2015 to 2019. This is supported by increasing numbers of Steelhead counted by SONAR and in snorkel surveys for summer Steelhead (McHenry et al., 2023c).

Spatial distribution of Steelhead by life history type is difficult to assess because the spawning distribution of winter and summer run fish appear to overlap (Roger Peters, United States Fish and Wildlife Service, personal communication, 2023). Additionally, access and water conditions during the winter and spring make it very difficult to conduct traditional spawning ground surveys above the former Mills Reservoir site. However, the general distribution of summer Steelhead has been documented (Duda et al., 2021), although their specific spawning distribution has not. The spatial extent of fish passage by adult summer Steelhead increased by 60 km after dam removal (Duda et al., 2021). Following dam removal, a growing number of summer Steelhead have been identified primarily in the upper river during the summer months (Duda et al., 2021). The spatial extent of Rainbow Trout has remained unchanged after dam removal (as they were widespread in the basin); however, their total abundance has increased, and densities shifted from the lower 25 km of the river to include the upper

40 km of the river (Duda et al., 2021). Summer Steelhead enter the river in March and spawn shortly after entering the river. They are migrating rapidly through the lower and middle river to spawn primarily in the upper river.

For further information, see **Appendix D: Steelhead and Rainbow Trout *(Oncorhynchus Mykiss)* Population Status**.

Photo by John McMillan

Bull Trout *(Salvelinus confluentus)*

Bull Trout occupy the mainstem Elwha River channel from the mouth to headwaters (DeHaan et al., 2011), and are also found in numerous tributaries below anadromous barriers. In the Elwha Basin, spawning has been observed from early October through November. Due to cold water requirements, it is presumed that the preferred spawning habitat would be found in the upper river basin above both dam sites, but Bull Trout were observed to spawn periodically in Hughes Creek and Griff Creek, tributaries to the Elwha River between the two dam sites, through 2020. Additionally, Bull Trout spawning was confirmed in Boulder Creek in 2020.

Prior to dam removal, Bull Trout were present upstream of the dams and in between the dams but in low numbers (DeHaan et al., 2011; Brenkman et al., 2019). Low abundance of Bull Trout (1–4 fish/km) persisted downstream of the Elwha Dam (Brenkman et al., 2019). However, radiotelemetry work and snorkel surveys post dam removal have shown a positive increase in numbers and spatial distribution (Duda et al., 2021). Snorkel riverscape surveys have found higher densities of Bull Trout in nearly every section of the river, with the highest densities shifting further upstream after dam removal.

Biologists have estimated that the total population of Elwha Bull Trout increased two to four times within a few years post dam removal (Duda et al., 2021). In addition to an apparent increase in abundance of Elwha River Bull Trout following dam removal, persistent distribution throughout the accessible basin, adequate genetic diversity, and the fitness of individual fish has improved with the restoration of the anadromous life history and increased abundance of other salmonid species above the former dam sites (Brenkman et al., 2019).This is an important point as bull trout became larger as their connection to marine food sources was reestablished. Also, the increased fitness seems to be leading to strong swimming ability which is allowing more bull trout to migrate through.

For further information, see **Appendix E: Bull Trout *(Salvelinus confluentus)* Population Status**.

Photo by Keith Denton

Elwha Chinook Salmon and Steelhead Population Goals

The Elwha Watershed has recovery goals for Chinook and Steelhead based on Viable Salmonid Population (VSP) parameters. VSP is defined as an independent population that has a negligible risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes over a 100-year time period (McElhany et al., 2000). The VSP parameters include abundance, productivity, spatial structure, and diversity. The most current Elwha Chinook and Steelhead goals are summarized in Tables 1-3 and are part of a management framework for fish populations, post dam removal (Peters et al., 2014).

Photo by John McMillan

Note that when the VSP parameters and management framework were created, assumptions were made about fish passage through canyons. Now that additional information has been obtained regarding actual available habitat, the abundance goals might need to be adjusted to be consistent with available habitat. Also note that if Rica Canyon is determined to be a natural barrier, it would not prohibit achieving long-term recovery goals.

The term abundance is the number of fish that return to the rivers, both juveniles and adults. Adult escapement is the number of adults that have returned to the river spawning grounds, escaping commercial and sport fisheries. Productivity is expressed as the number of out migrating smolts produced per female and the number of adults returning per adult. Spatial distribution refers to the geographical area where a given species is found. The VSP parameter of diversity captures the unique and varied life history strategies of a given salmonid stock and can involve factors such as timing, age, and size for smolt outmigration. Intrinsic potential is a term used in habitat modeling to measure the potential of specific stream characteristics for being suitable habitat for a given fish species.

Table 1. Elwha River Chinook Salmon Goals

VSP Parameter[a]	Indicator	Short-term Goal: Local Adaptation[b]	Long-term Goal: Viable Natural Population[c]
Abundance	Natural spawners	>4340 or <10,000	>10,000
Productivity	#Juvenile migrants/ female	200	200
	Pre-fishing recruits per spawner	>1.56	>1.85
	#Spawners/spawner	>1.0	~1.0
Spatial Distribution	Extent	Above former Glines Canyon Dam, 86% of Intrinsic Potential	100% of Intrinsic Potential
	Barriers	No 'artificial' migration barriers exist in former Mills reach	No 'artificial' barriers exist within Intrinsic Potential
Diversity	Stream-type proportion (yearling migrants returning to spawn)	Positive trend	Stable, >Preservation Phase
	Early type variance (variation in adult entry timing)	Positive trend	Stable, >Preservation Phase

a VSP: Viable Salmonid Population based on the parameters of abundance, productivity, spatial distribution, and diversity.

b Local adaptation short-term goal to reach local adaptation to the Elwha River and the trend must be met over 4-year period. The abundance goal is not only numbers of fish, but also includes an assumption that they are of natural origin at the end of the local adaptation phase, as opposed to hatchery fish spawning naturally. No timeframe was set, but adaptive management triggers are established and evaluated regularly (Peters et al., 2014).

c Viable Natural Population long-term goal to reach self-sustaining and exploitable population levels, once all VSP and habitat parameters are met, and the hatchery programs are no longer needed for protection, recovery, or exploitation. No timeframe was set, but adaptive management triggers are established and evaluated regularly (Peters et al., 2014).

Table 2. Elwha River Native Winter Steelhead Goals

VSP Parameter[a]	Indicator	Short-term Goal: Local Adaptation[b]	Long-term Goal: Viable Natural Population[c]
Abundance	Natural spawners	>969 or <2,619	>2,619
Productivity	#Juvenile migrants/ female	200	200
	Pre-fishing recruits per spawner	>1.56	>1.85
	#Spawners/spawner	>1.0	~1.0
Spatial Distribution	Extent	Above former Glines Canyon Dam, 74% of Intrinsic Potential	100% of Intrinsic Potential
	Barriers	No 'artificial' migration barriers exist in Mills reach	No 'artificial' barriers exist within Intrinsic Potential
Diversity	Entry timing	Fish returning in December	No change from previous phase

a VSP: Viable Salmonid Population based on the parameters of abundance, productivity, spatial distribution, and diversity.

b Local adaptation short-term goal to reach local adaptation to the Elwha River and the trend must be met over 4-year period. The abundance goal is not only numbers of fish, but also includes an assumption that they are of natural origin at the end of the local adaptation phase, as opposed to hatchery fish spawning naturally. No timeframe was set, but adaptive management triggers are established and evaluated regularly (Peters et al., 2014).

c Viable Natural Population long-term goal to reach self-sustaining and exploitable population levels, once all VSP and habitat parameters are met, and the hatchery programs no longer needed for protection, recovery, or exploitation. No timeframe was set, but adaptive management triggers are established and evaluated regularly (Peters et al., 2014).

Table 3. Elwha River Bull Trout Goals

VSP Parameter[a]	Indicator	Short-term Goal: Local Adaptation[b]	Long-term Goal: Viable Natural Population[c]
Abundance	Natural spawners	500	1000
Productivity	#Spawners/spawner	≥1.0	≥1.0

a VSP: Viable Salmonid Population based on the parameters of abundance and productivity.

b/c The Bull Trout short-term and long-term adaptation and productivity goals are from the United States Fish and Wildlife Service Draft Recovery Plan for Coastal-Puget Sound distinct population segment of Bull Trout (Salvelinus confluentus), vol. II (of II) (2004). Note: The Bull Trout recovery goals could be reevaluated with new information available post dam removal (e.g., the reawakening of anadromous life history, observed changes in body size, and Bull Trout passage from river mouth to headwaters). Also note that the United States Fish and Wildlife Recovery Plan developed goals based on levels needed to delist, as opposed to levels needed to achieve some other objective (e.g. ecosystem health, harvest, etc.). So, while the Elwha River may be able to support more Bull Trout than is stated in the Recovery Plan, the Recovery Plan goal was not habitat driven.

Elwha River Habitat Goals

This section details the freshwater, estuarine, and nearshore habitat goals for Elwha Chinook recovery. In many cases, achieving these habitat goals will also benefit Steelhead and Bull Trout, and is also likely to benefit Chinook from other Evolutionarily Significant Units (ESUs). NOAA Fisheries defines ESU's as a population substantially reproductively isolated from co-specific populations and represents an important component in the evolutionary legacy of the species. Habitat goals are defined as "a formal statement of the desired future condition for habitat attributes that the watershed aims to achieve to contribute to recovery of habitats and Chinook (Chinook Monitoring and Adaptive Management Toolkit, 2016)." Accordingly, the goals focus on the most essential habitat attributes for salmon recovery.

The original Elwha Chinook Recovery Plan did not have quantitative habitat goals. As part of the habitat goal setting process, the Elwha Chapter Update Working Group reviewed watershed publications, the WRIA 18 limiting factors analysis, and other relevant regional documents. This included selecting the most important habitat attributes for reaching Chinook Viable Salmonid Population goals, and detailing habitat function, desired habitat condition, and the goal timeframe. Salmon habitat use by different life stages, critical habitat bottlenecks and limitations, and current conditions were all factored into goal development. The goals cover salmon growth and survival needs during adult migration, freshwater spawning, juvenile stream and estuarine rearing, and nearshore juvenile migration and rearing. Implementation targets, shorter-term benchmarks to track progress toward the habitat goals, were also developed for the majority of the habitat goals.

Elwha River habitat goals are summarized below (Table 1). Implementation targets, to track progress toward goals on a shorter time frame, are also included. Monitoring and research will be needed to assess habitat condition, measure recovery progress, and address uncertainties. Research needs are noted in the habitat goal table when relevant, with a more detailed description of research and monitoring needs captured in the Adaptive Management and Monitoring section.

Table 4. Summary of Elwha River habitat goals and shorter-term implementation targets for freshwater, estuarine, and nearshore habitats, to support Chinook salmon recovery and intended to benefit Steelhead and Bull Trout populations.

Table 4. Elwha River Habitat Goals and Implementation Targets

Freshwater Habitat Attributes		Habitat Goals	Implementation Targets
Freshwater Access	Fish Access through the tributaries and former dam sites	Fish passage is fully accessible to historic salmonid range by 2075.	Fish passage through the former Elwha and Glines Canyon Dam sites is unimpeded and restored to historical condition* by 2030. * As close to historical condition as practical, as observed in photos (pre dam construction) Remnant Elwha Dam caisson and concrete is fully removed by 2030. Tributary fish passage, including culverts on Indian Creek and Little River, and two small culverts on Madison Creek and Griff Creek Jr. along the Hot Springs Road, is fully passable by 2033.
Floodplain Habitat	Floodplain Connectivity, including side channels	Greater than 80% of the historical* floodplain area is connected by 2075, with full riverine function restored to the Hot Springs Road and Ranney Reach areas of the floodplain. *A study is needed to evaluate the historical floodplain and the area needed for function. The ability of the Elwha River to form side channels is maintained over time.	To be determined, once a study on the floodplain area necessary for function is completed.
	Late-successional riparian forests in the former reservoirs and floodplain	The floodplains of the former reservoirs are progressing to late-successional native riparian forests, and the structure, diversity and tree species composition are within the range of variation observed in reference conifer communities, by 2075. Over the long-term, the floodplain condition reaches a forested island geomorphology, a multi-threaded channel with wood and mixed conifer forests for stability and fish longevity.	Floodplain riparian forests, in areas dominated by deciduous species, are treated for riparian noxious weeds and underplanted with conifers by 2033.

Table 4. Elwha River Habitat Goals and Implementation Targets

Freshwater Habitat Attributes		Habitat Goals	Implementation Targets
Freshwater Channel Habitat Condition	Instream Wood	Instream channel habitat area is functional* in 80% of the mainstem starting downstream of the Olympic National Park boundary, and including Little River and Indian Creek, by 2075. *Defined by functional amounts of instream wood, which provides pool habitat and spawning substrate. Instream wood function is defined by total pieces per mile for the tributaries (Fox and Bolton, 2007) and log jams per km for the mainstem (see Appendix F).	The amount of functional instream wood is increasing by 2033.
	Riparian Buffer Width and Composition	A riparian buffer of 200 feet along the mainstem and tributaries with functional riparian cover* in a mid- to late-successional stage, by 2075. *As measured from the outer edge of the Channel Migration Zone (CMZ). A funded CMZ study covering the area downstream from the Olympic National Park boundary will further define this.	The total length of streambank that has a functional riparian buffer is increasing by 2033.
Freshwater Quality and Quantity	Summer water temperature	All mainstem areas and tributaries meet summer temperature and daily maximum threshold standards for salmonids*. *Pacific salmon upper thresholds by life stage, 7-DADM (13-18 C) and weekly mean (10-16 C) (Beechie et al., 2013).	Former reservoir stream temperature is consistent with adjacent reference reaches of similar geomorphic condition, by 2033. Summer water temperature in Indian Creek is trending toward meeting water quality standards for salmon, by 2033.
	Low flow	The average 30-day summer low flow* in the Elwha River is stable or increasing. *A post-dam instream flow study is needed to inform numbers for the mainstem, Little River and Indian Creek.	Instream flow study for the Elwha River is completed by 2033.

Table 4. Elwha River Habitat Goals and Implementation Targets

Estuary and Nearshore Habitat Attributes		Habitat Goals	Implementation Targets
Estuarine Condition	Estuarine Habitat Connectivity	Elwha Estuary is fully tidally connected by 2075, providing full juvenile access and food production (e.g., forage fish).	Current and transforming estuarine habitat remains connected through 2033, as the delta continues evolving post dam removal. Plans are complete for addressing Place Road levee passage and connectivity issues by 2033. Parcels adjacent to the Place levee conserved as acquisition opportunities arise.
Nearshore Habitat Condition	Area of eelgrass and canopy forming kelp beds	The area of eelgrass and canopy forming kelp beds remains stable and does not decline within the Elwha drift cell and Port Angeles Harbor by 2075. *The beds are ephemeral, so the goal captures area in the nearshore geography overall.	Eelgrass and kelp bed area is stable by 2033 (Rubin et al., 2014).
	Intact Shoreline	No new and a decreasing amount of hard shoreline armoring and intertidal structures within the Elwha drift cell and Port Angeles Harbor to Morse Creek by 2075.	A net reduction in hard shoreline armoring and no new hard shoreline armoring by 2033. A net reduction in intertidal fill by 2033. 50% reduction in the number of creosoted piles in Port Angeles Harbor by 2033.
	Marine Riparian Vegetation	No net loss of established marine riparian vegetation with an increasing percent of vegetated shoreline in the Elwha drift cell and Port Angeles Harbor to Morse Creek by 2075.	Marine riparian habitat is revegetated by 2033 (amount to be determined).

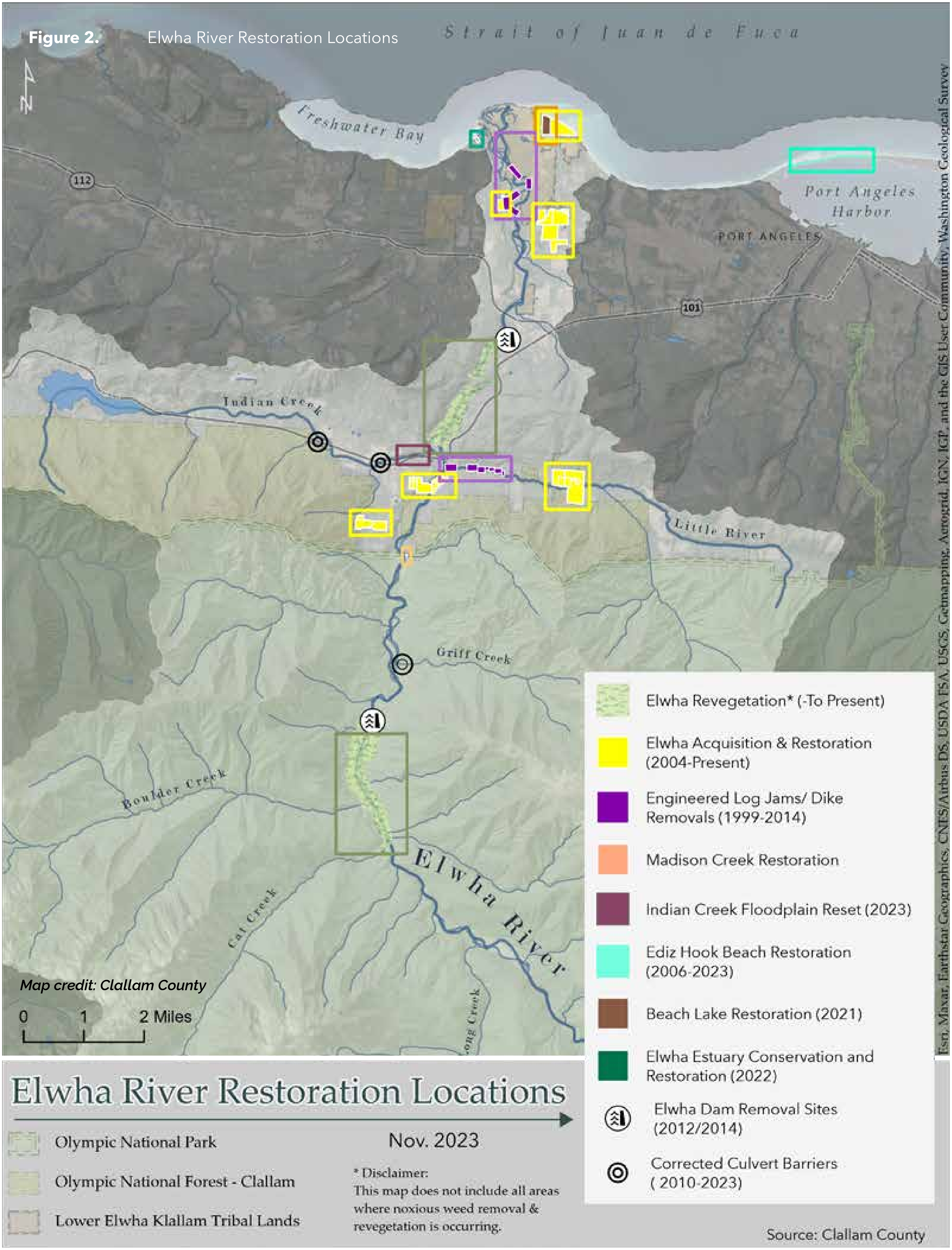


Figure 2. Elwha River Restoration Locations
Strait of Juan de Fuca
Freshwater Bay
Port Angeles Harbor
PORT ANGELES
112
101
Indian Creek
Little River
Griff Creek
Boulder Creek
Cat Creek
Elwha River
Map credit: Clallam County
0 1 2 Miles
Elwha Revegetation* (-To Present)
Elwha Acquisition & Restoration (2004-Present)
Engineered Log Jams/ Dike Removals (1999-2014)
Madison Creek Restoration
Indian Creek Floodplain Reset (2023)
Ediz Hook Beach Restoration (2006-2023)
Beach Lake Restoration (2021)
Elwha Estuary Conservation and Restoration (2022)
Elwha Dam Removal Sites (2012/2014)
Corrected Culvert Barriers (2010-2023)
Elwha River Restoration Locations
Olympic National Park
Olympic National Forest - Clallam
Lower Elwha Klallam Tribal Lands
Nov. 2023
* Disclaimer:
This map does not include all areas where noxious weed removal & revegetation is occurring.
Source: Clallam County
Esri, Maxar, Earthstar Geographics, CNES/Airbus DS, USDA FSA, USGS, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community, Washington Geological Survey

Pressures

The primary pressures affecting Elwha Chinook and their habitats were determined during the recovery update planning process. Pressures are defined as human activities causing or contributing to habitat degradation in the watershed, either currently or in the near future. Legacy issues are not included as pressures and are addressed by restoration actions.

Photo by North Olympic Lead Entity for Salmon

The pressures assessment considered the primary factors or issues limiting Chinook salmon, either directly impacting different life history stages or via habitat degradation. A description for each of these pressures follows.

Culverts, Roads, and Other Fish Passage Barriers

Fish passage barriers are of utmost importance as they block migration for native fish species and their access to crucial historical habitat. While the greatest barriers to fish passage were eliminated with the removal of the Elwha and Glines Canyon dams, additional impediments remain in the tributaries and the former dam sites are not yet back to pre-dam conditions. The primary areas to address include the former dam sites and existing culverts on Indian Creek and Little River; there are also two undersized culverts on Madison Creek and Griff Creek Jr. along the Hot Springs Road. Concrete remnants continue to erode at both dam sites and have the potential to impede adult fish migration at times. There are significant cascades at the dam sites; however, all species of salmon have been observed upstream of Glines Canyon. In contrast, historic pre-dam construction photos show Elwha Canyon as a low gradient pool. Rica Canyon and the Grand Canyon of the Elwha represent potential passage issues. The former is suspected to be a low-flow barrier for Chinook, and possibly an any-flow barrier to Coho. A list of priority culverts for removal is included in Appendix G. Roads located in or along floodplains and other areas which encroach on the river also limit natural processes and functions needed for healthy watersheds. The most significant example of this is the Olympic Hot Springs Road.

Levees and Dikes

Levees and dikes are embankments that are used to retain water and prevent flooding, but they are problematic for salmonids because they impede natural habitat forming processes and block access to habitat, especially to tributary and side channel areas. They also inhibit tidal exchange, limit the broader connectivity of floodplains, and can impact riparian vegetation, all of which are necessary for healthy Chinook and other salmonid populations. Priority levees to address include the area immediately downstream from the old Glines Canyon Dam powerhouse site where riprap remains on the left bank for approximately 100 meters, resulting in the loss of floodplain habitat; the spur dike downstream from the McDonald gage; the channelized reach at the City of Port Angeles's water diversion to Ranney well; and the Place Road levee. Alternative Ranney Well protection methods that are salmonid-friendly need to be explored to protect both the regional water supply and ecosystem function. Removal of the levees mentioned above would reconnect the floodplain and estuary and allow for natural processes that could result in the development of additional floodplain and estuarine habitats beneficial to salmon.

Photo by North Olympic Lead Entity for Salmon

Photo by Lindsey Aspelund

Photo by North Olympic Lead Entity for Salmon

Port Angeles Harbor

Port Angeles Harbor has a variety of commercial and residential development affecting nearshore salmon habitat. This includes extensive areas of fill and armoring, an existing industrial pipeline, overwater structures, abandoned mills, and the City of Port Angeles wastewater infrastructure. The industrial pipeline, which brings water to the McKinley Paper Company, leaks and repair and rerouting should be considered. Also, while the City of Port Angeles has completed considerable upgrades to its wastewater treatment system, there were two major overflow events into the Port Angeles Harbor in 2020 and 2021 related to storm surges. With higher flows and more precipitation during winter storms predicted as part of climate change impacts, additional assessment of system vulnerabilities and the necessary follow up is in order.

In addition, overwater structures in the Harbor owned by the Port of Port Angeles, which are built with creosoted timber, need to be addressed.

Shoreline Hard Armoring

Shoreline armoring, the building of bulkheads and rock walls to protect infrastructure, disrupts sediment processes that maintain and nourish beaches. This reduces nearshore habitat for forage fish and eelgrass beds, both of which are essential for Chinook and other salmon rearing and migration. While there is less hard armoring immediately adjacent to the Elwha River mouth than many other rivers in Puget Sound, significant armoring remains in Port Angeles Harbor and on the north side of Ediz Hook (Northwest Indian Fish Commission Member Tribes, 2020). Approximately 11 miles of nearly continuous armor begins less than 2.5 miles from the river mouth, beginning at Dry Creek and extending east to Morse Creek.

In addition, the north side of Ediz Hook is completely armored, as is the industrial water pipeline. Significant shoreline nourishment occurred with the delivery of sediment from the Elwha River following dam removal (Warrick et al., 2019). This resulted in most, but not all, of the water pipeline being covered with sediment.

A nearshore assessment of the entire area would provide information on potential restoration opportunities. The Lower Elwha Klallam Tribe has restored approximately three miles of nearshore habitat along the south shore of Ediz Hook during four phases of restoration since 2002. This involved the removal of shoreline armoring and associated derelict infrastructure and the placement of beach nourishment to support forage fish (Miller et al., 2017), the installation of large wood, and back beach plantings. The Tribe has also conducted eelgrass planting along the southern shore of Ediz Hook since 2017. Approximately 20,000 eelgrass turions have been planted, with another 10,000-15,000 planned for 2024-2025. See the Clallam County Shoreline Master Program for more information on shoreline regulations (Clallam County, 2021).

Water Withdrawals

Currently, most of the Elwha River water rights are held by the City of Port Angeles, though they only use a portion of these rights. The industrial supply water right is 150 Cubic Feet Per Second (CFS) (permit 1328), and the municipal water withdrawal permit is 50.13 cfs (permit G2-21950-P). Current need comes in far below, even during high demand: between 40.69 cfs and 59.72 cfs for the industrial system, and between 3.09 cfs and 6.19 cfs for the municipal potable system. The City water rights could greatly impact the Elwha River system if they were fully utilized, especially during summer low flow periods, which coincide with upstream migration of adult Chinook. With the increasing impacts of climate change, lower summer flows and resulting water temperature increases over an extended period are predicted. When climate change predictions and potential future population growth in the area are factored into current water use, withdrawals could become a greater threat. A post-dam removal instream flow analysis is needed as a first step to setting and enforcing low flow targets. Additional efforts to encourage, educate, and notify residents about water conservation, and to support further conservation measures such as limiting lawn watering and promoting native vegetation that does not require as much water as manicured lawns would also help, particularly as drought-related climate change impacts water availability in the Elwha River.

Photo by Lower Elwha Klallam Tribe

Invasive Species

The primary invasive species affecting Chinook salmon are plants in freshwater and estuarine habitat. Invasive plants degrade these habitats and outcompete native plants in riparian restoration zones. Invasive plants that are problematic in the Elwha Watershed and estuary include reed canary grass, white sweetclover, yellow flag iris, Scotch broom, Eurasian milfoil, Everlasting Pea, Herb Robert, knotweed, and Himalayan and evergreen blackberry. Early detection and rapid response are keys to preventing new invasive plant species from gaining a foothold in the Elwha Watershed. The Lower Elwha

Klallam Tribe is active with planting, stewardship of previous plantings, and noxious weed removal in both the previous Elwha reservoir areas and throughout the stream corridor.

Invasive fauna to consider are the New Zealand mud snail, which has been identified in Lake Crescent and is believed to be in the lower Elwha River. Similarly, Asian clams were recently observed in Lake Crescent as well. If they are transported to Lake Sutherland, they will rapidly colonize the Elwha River. Further, Yellow Perch and Green Sunfish were recently observed in Lake Sutherland.

In the summer of 2023, an adult female European green crab was found in the TseWhitZen lagoon adjacent to the McKinley Paper Mill. The Lower Elwha Klallam Tribe and Washington Department of Fish and Wildlife staff made the discovery during three days of monitoring activities using shrimp and crab traps. The Tribe and the Washington Department of Fish and Wildlife will continue monitoring for European green crab in Port Angeles Harbor on an annual basis to ensure that this invasive species does not become established in the harbor.

Fish Pathogens

Current pathogens in Chinook salmon and Steelhead juvenile hatchery production include Costia and Trichodina. Enteric redmouth disease exists in Chinook salmon (Robert Blankenship, Lower Elwha Klallam Tribe, personal communication, 2023). Cold water disease is also present. There is low mortality currently and juvenile treatment for these pathogens is underway. In conditions with summer low flows and higher water temperatures, fish pathogens and pre-spawning mortality increase. Pathogen types and frequency are also expected to rise with climate change. Bacterial kidney disease has also been confirmed in the Elwha, which led to changes in the hatchery operations to prophylactically inoculate returning adults with erythromycin. While this has been successful in the hatcheries, work by the United States Fish and Wildlife Service noted that while they did not identify fish with clinical signs of bacterial kidney disease in the work done prior to dam removal, they identified naturally rearing fish that screened positive for the disease (Brenkman et al., 2008). Dermocystidium has not been a significant problem for many years, but it did result in very high pre-spawning mortalities of Chinook in the 1980s and '90s. High mortality rates seemed to be related to warm water/low flow conditions, when the fish were stressed by high water temperatures and crowded together due to the low flow. In order to reduce risk, the State and Lower Elwha Klallam Tribe worked with the dam operators to release water from the dams when flows got too low and/or temperatures got too high (>70 degrees Fahrenheit). While there was never an official study done regarding the success of that effort, there were no outbreaks of Dermocystidium after those steps were taken. Further, now that the dams are out, water temperatures in the river have generally remained below 65 degrees Fahrenheit. Thus, while Dermocystidium does not seem to be a problem currently, it or other diseases could become a problem again under climate change, when water temperatures are expected to rise and summer flows are expected to decrease (Pat Crain, Olympic National Park, personal communication, 2023).

Photo by Tiffany Royal, NWIFC

Photo by Olympic National Park

Forest Fires

The risk of forest fires has increased due to predicted hotter and drier summer conditions caused by climate change. Significant forest fires would reduce forest habitat, eliminate riparian buffers leading to increased water temperatures, accelerate erosion, and further degrade conditions for Elwha River salmon. Clallam County has developed a Community Wildfire Protection Plan under the guidance of the Washington Department of Natural Resources that seeks to minimize the impact of fire to residential areas (McDonald and Barry, 2009). Part of this human response to climate change involves vegetation clearing around homes and properties and may affect how riparian buffers are managed near residences. This is something to track as there are no clear guidelines for other applications yet. The Olympic National Park, as the largest landowner in the basin, has a Fire Management Plan that is currently under review by both National Oceanic and Atmospheric Administration's National Marine Fisheries Service and the United States Fish and Wildlife Service. Essentially, the Park's policy is that natural fires will be allowed to burn, while human caused fires will be aggressively fought. However, the Park will attempt to prevent any fire from damaging infrastructure or moving outside the Park boundary (National Park Service, 2017).

Photo by Olympic National Park

Climate Change Impacts to Chinook Salmon

One of the primary challenges to Elwha Chinook recovery is the effect of climate change on salmon and their habitats. Since the original Elwha Recovery Plan was written, extensive science on climate impacts has been developed locally and regionally (Petersen et al., 2015; University of Washington Climate Impacts Group). Elwha Chinook are highly vulnerable to climate change, in all phases of their life cycle. Recent reports on climate vulnerability in the Elwha River and Olympic National Park summarize the major environmental exposures of habitats and natural resources to climate change (Adams and Zimmerman, 2023; Halofsky et al., 2011; Lower Elwha Klallam Tribe, 2022).


Photo by North Olympic Lead Entity for Salmon

The most significant impacts to Elwha Chinook are increased peak flows during winter, changes to tributary flow timing and amount, reduced snowpack resulting in decreased summer flows, warming water temperatures, and altered marine conditions. The severity of change in conditions, along with the timing and associated salmon life stage, are all important in determining the effect on salmon populations. Alignment of the change in climate condition with the timing of the salmon life cycle in the Elwha River demonstrates Chinook salmon vulnerability and where additional actions may be useful (see Figure 4 from the Lower Elwha Klallam Tribe Vulnerability Assessment and Beechie et al., 2013). The primary shift in environmental conditions from climate change affecting Chinook are further detailed, as follows. The effects of climate change on Elwha Chinook life history stages are summarized in Table 2.

Table 5. Summary of Major Climate Impacts to Elwha Chinook Salmon
(Mantua et al., 2010; Abdul-Aziz et al., 2011; Halofsky et al., 2011; Atcheson et al., 2012; Pfister et al., 2018; Calloway et al., 2020; Lower Elwha Klallam Tribe, 2022).

Climate Impact	Chinook Salmon Impact	Primary Geographic Area
Peak Flows	Increased winter peak flows, which are expected to increase mortality of salmonid eggs and juveniles due to redd scour and loss of refugia habitat. High flows and storms may displace juveniles out of the river and into the estuary too early.	Spawning habitat, primarily in the Elwha mainstem (McHenry et al. 2023).
Flow Timing	Earlier snow melt and less snowpack volume, resulting in a change to the timing and magnitude of mainstem and tributary flow regimes. Likely to influence spawning and migration patterns, with a potential flow mismatch with adult and juvenile migration, and further exacerbate summer low flow impacts.	Upstream migrations through the various canyons in the Elwha River. Downstream migration below the primary spawning areas.
Summer low flows and higher temperature	Reductions in summer low flows and increased water temperatures, with less cooling baseflow. Expected to increase mortality of juvenile and adult salmon in the lower river, with reduced spawning and rearing habitat. Additionally, more mid-channel spawning where redd scour is greater. Temperature may also increase fish predators and pathogens.	Yearling Chinook rearing locations, downstream from Rica Canyon.
Nearshore and Marine Conditions	Warmer marine water stresses kelp beds and impacts forage fish. Sea level rise shifts available eelgrass and kelp habitat and may reduce forage fish habitat and migratory corridors for salmon. Higher acidity decreases food availability and marine survival. Altered upwelling timing may also affect nearshore food availability for juvenile salmon.	Elwha nearshore and Pacific Ocean

Peak Flows/Increased Winter High Flows

Pacific Northwest climate change predictions include increased winter precipitation on average, with more rainfall and major storms (Miller, 2018). This leads to higher winter and spring flows and peak flow events, causing channel migration, erosion, and scour (Halofsky et al., 2011). Figure 3 shows trends in Elwha River peak stream flow over time. The influence of scour could be exacerbated by Chinook spawning closer to the lowest points of a stream or thalweg because of reduced flows. Extreme storm events and large rains can force fish out of the river and into the estuary and destroy spawning grounds.

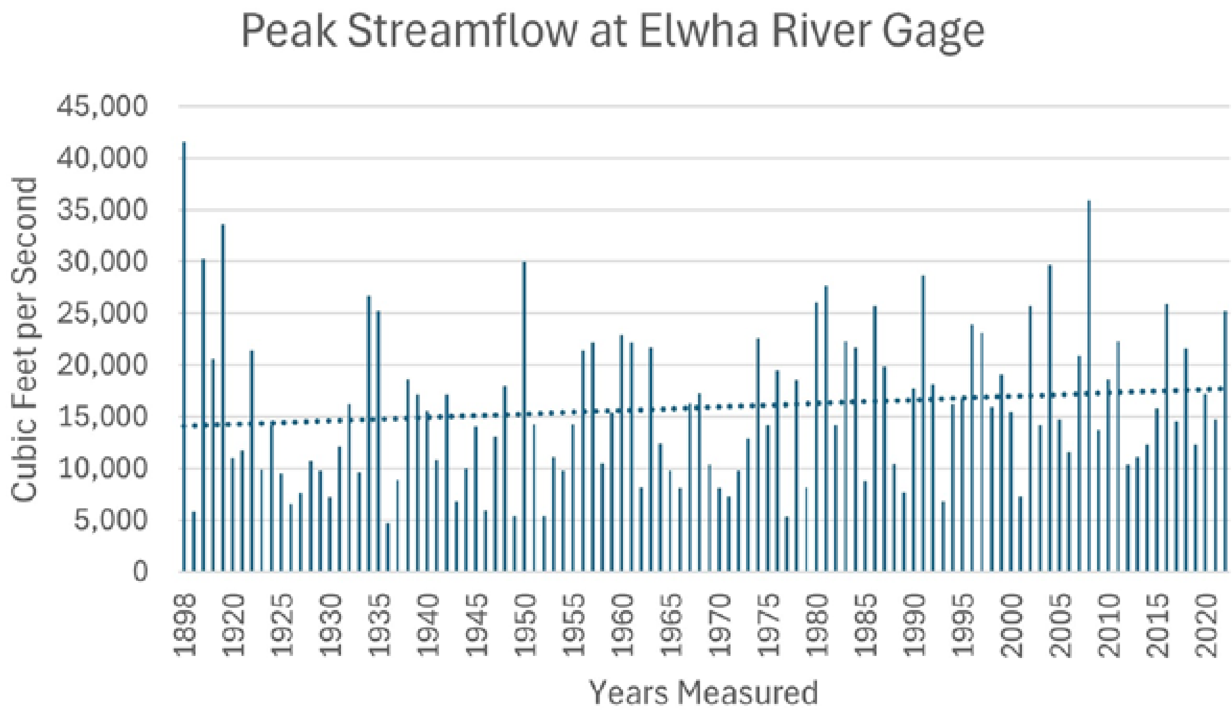


Figure 3. Peak Streamflow, Elwha River Gage at McDonald Bridge (data source: United States Geological Survey, 2024)

Shifts in Flow Timing/Loss of Snow Melt, Reduced Snow-water Equivalent

A combination of a greater proportion of precipitation falling as rain and warmer air temperatures is predicted. This results in a reduced snowpack and an earlier snow melt (Crozier, 2015; Lower Elwha Klallam Tribe, 2022). Less snowpack in turn affects both the amount of baseflow in the Elwha River and the input of cool water, particularly in the late summer, when air temperatures are at their highest.

Summer Low Flows

Snow melt will occur earlier and provide less flow input, due to reduced snow-water equivalent from increased temperature and changes to precipitation patterns (Halofsky et al., 2011; Mantua et al., 2010). The changes to snow melt are predicted to result in a significantly lower streamflow in the summer and early fall. Elwha River minimum flows will also be reduced, by "56% under the RCP [Representative Concentration Pathways] 8.5 scenario, by the year 2099 (Lower Elwha Klallam Tribe, 2022)."

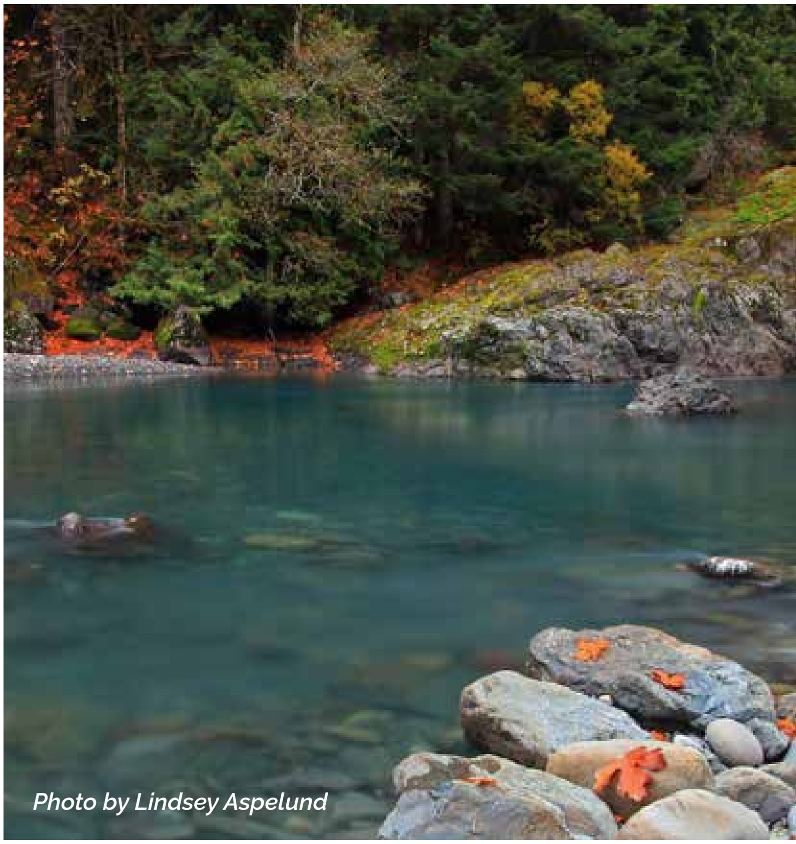


Photo by Lindsey Aspelund

Photo by Tom Taylor

Elevated Freshwater Temperature

As air temperature increases in the summer months, stream temperatures reach stressful conditions for salmon (Mauger et al., 2015). "August stream temperature in the Lower Elwha River is projected to increase from 60.8 to 64.4 degrees Fahrenheit under the moderate emission scenario for 2099 (Lower Elwha Klallam Tribe, 2022)." Stream temperature increases are predicted to be the most severe in the lower reaches of the Elwha River.

Nearshore and Marine Conditions

Additional changes predicted to impact salmon habitat include sea level rise and increased marine water temperature. Sea level rise is "likely to rise by 1.2 to 2.5 feet from the 1991-2009 sea level average by 2100 (Lower Elwha Klallam Tribe, 2022; Miller at al., 2018)." Marine water temperature is increasing, and trends are expected to continue (PSEMP Marine Waters Workgroup, 2022). An increase in marine water temperature along with marine heatwaves stress salmon and kelp beds (Calloway et al., 2020). Shifts in timing can also lead to diminishing nutrients to support food for the salmon prey when salmon enter the nearshore, so they have no food when migrating (PSEMP Marine Waters Workgroup, 2022).

Photo by NOAA Northwest Fisheries Science Center

Photo by John McMillan

Climate Change and Elwha Chinook Salmon

These shifts in freshwater and nearshore environmental conditions from climate change affect Chinook at different phases in their life history (Table 2). In addition, the timing of the climate impacts related to the concurrent fish life history stages determines the impact on Chinook populations (Figure 4). Additional impacts that are not listed here include changes to floodplain connectivity related to water flow and altered food web cycles (Lower Elwha Klallam Tribe, 2022). Climate change may also exacerbate existing challenges, such as forest fires, invasive species, and fish pathogens (Mauger et al., 2015).

Successful recovery will necessitate addressing these impacts, through a combination of increasing climate adaptability and minimizing exposure. The removal of the Elwha dams and the healthy nature of much of the watershed increase the ecosystem's resiliency. Restoration and revegetation projects have also enhanced habitat function and resiliency for salmon. In addition, climate change is incorporated into recovery actions as part of this Elwha Recovery Chapter Update. These actions are designed to address the most significant climate change impacts to Elwha Chinook and increase resiliency. While these climate adaptation actions do not address mitigation, they improve ecosystem function (e.g., increasing riparian buffers for greater shading for fish) and have the added benefit of sequestering carbon.

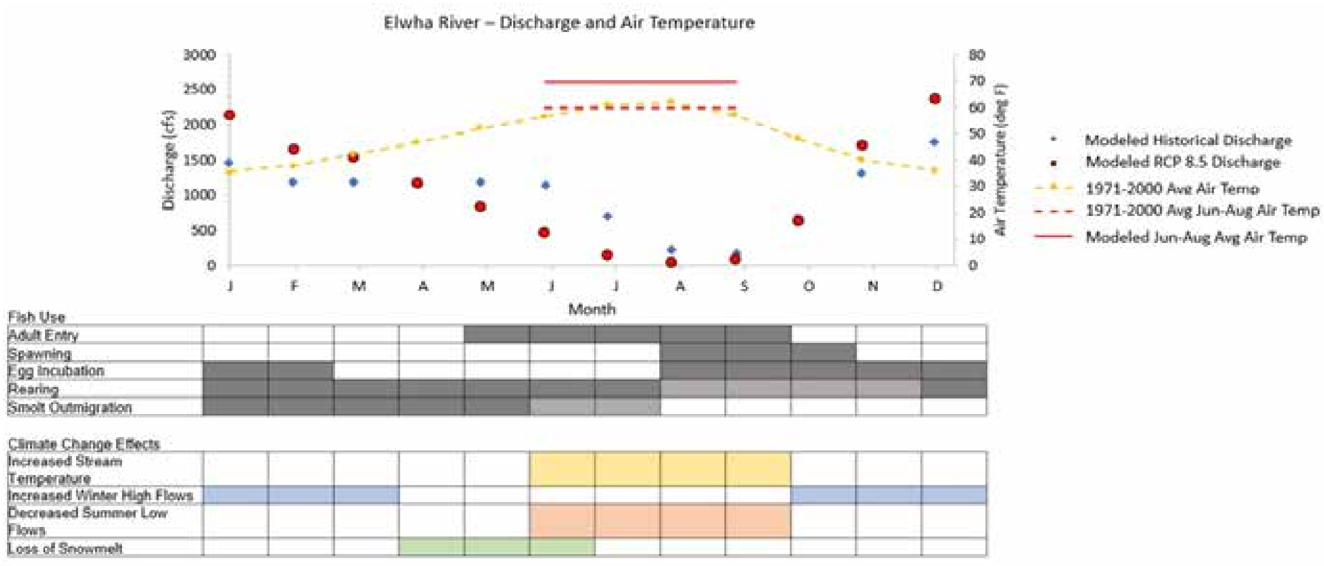


Figure 4. Effects of increased air temperature and winter high flows and decreased summer low flows on Chinook salmon life stages (Lower Elwha Klallam Tribe, 2022).

Elwha River Recovery Strategies and Actions

This section summarizes the primary strategies and actions needed to achieve Elwha River habitat goals and Chinook salmon recovery. The strategies were developed collaboratively by the Elwha Chapter Update Working Group to recover Chinook most effectively in the watershed, while also benefiting Steelhead and Bull Trout populations. The emphasis is on freshwater, estuarine, and nearshore habitat protection and restoration, and includes actions to address regulatory measures, education and outreach, scientific studies, and climate adaptation based on the current understanding of how these habitats will be impacted by climate change.

Priority Recovery Strategies

- Restore freshwater channel habitat, including wood, pools, and spawning substrate
- Restore and protect floodplain and side channel connectivity
- Revegetate and restore the riparian floodplain forests of the former reservoirs
- Restore and protect freshwater riparian buffer habitat
- Maintain and fully restore unimpeded fish passage through the tributaries and former dam sites
- Restore and protect Elwha Estuary habitat and connectivity
- Restore and protect nearshore habitat, including intact shoreline, eelgrass and canopy forming kelp habitat, forage fish spawning substrate, and feeder bluffs
- Protect instream flow
- Address elevated summer stream temperature

Photo by John Gussman

In general, the strategies and actions are designed to help recover Chinook populations as the priority, and to also meet habitat and recovery requirements for Steelhead and Bull Trout when possible. Steelhead and Bull Trout have specific needs (e.g., using more of the upper watershed and tributaries), so the strategies and actions do not address all aspects of their recovery. Rather, these species benefit from habitat restoration and protection as part of Chinook salmon recovery.

The Elwha Chinook recovery strategies are further described in this section, with details that connect the strategies to associated habitat goals and implementation targets, fish life history stages, priority areas for implementation, and primary actions.

In addition, implementation of the Elwha Chinook Recovery Plan relies on detailed information on adult abundance and distribution, juvenile abundance, hatchery contributions to the naturally spawning population, and run timing. Long-term monitoring, research, and sufficient funding and staffing are essential components for success. Current scientific monitoring needs for Elwha River fish populations and their habitats are detailed in the Adaptive Management and Monitoring section of this document. Emerging and ongoing issues related to strategy implementation will also be tracked for compliance and sufficiency of existing regulations, including forestry practices, floodplain and shoreline development, mining quarry development, and clearing and grading ordinances (part of the stormwater ordinance). Regulatory strategies to address these issues may be developed in the future, as needed, by increasing compliance and integrating salmon recovery priorities into planning processes and associated regulations.

Strategies that contribute to Elwha Chinook recovery but are addressed in separate processes and plans include harvest and hatchery management, advancing Ennis Creek restoration, and Port Angeles Harbor toxic clean-up. A brief description of these strategies follows.

Harvest Management

Photo by Tiffany Royal, NWIFC

The focus of the harvest management strategy is managing and regulating fisheries to ensure that ocean harvests of Elwha Chinook do not preclude recovery. There are currently no in-river fisheries targeting Elwha Chinook. However, Elwha Chinook are intercepted in fisheries in Southeast Alaska, Northern British Columbia, West Coast Vancouver Island, and the Strait of Juan de Fuca. The Pacific Salmon Treaty governs catch of Puget Sound Chinook in Canadian waters. It captures the commitment by both Canada and the United States to carry out salmon fisheries in a manner that prevents over-fishing and optimizes production. It was last negotiated in 2018 with a ten-year agreement in effect from 2019 through 2028. There is funding made available through the Northern and Southern Restoration and Enhancement Funds allocated for restoration and recovery as part of this negotiation (Pacific Salmon Commission, 2023).

The National Oceanic and Atmospheric Administration works to ensure that fisheries conducted under the Pacific Salmon Treaty under the auspices of the Pacific Fisheries Management Council (as guided by the Comprehensive Management Plan for Puget Sound Chinook) do not inhibit recovery of ESA-listed Chinook.

The Comprehensive Management Plan for Puget Sound Chinook: Harvest Management Component (2022) was developed by and guides Washington's co-managers, Puget Sound Indian Tribes and the Washington Department of Fish and Wildlife, in planning annual harvest regimes for Puget Sound Chinook. While the Plan guides the implementation of fisheries in Washington, it also considers impacts of other fisheries impacting Puget Sound Chinook including those mentioned above in Alaska and British Columbia.

The current in-river salmon fishing moratorium on Chinook in the Elwha River will continue until monitoring data suggests that harvest can occur without impairing progress toward full Chinook recovery.

Of note, there is hope for this Chinook recovery in the future as the Lower Elwha Klallam Tribe lifted its moratorium on Coho salmon in 2023 and held its first Coho subsistence fishery in over a decade.

Photos by Tiffany Royal, NWIFC

Hatchery Management

Hatchery management programs are designed to help recover the Elwha Chinook salmon population, supporting healthy, natural production of self-sustaining wild Chinook. Hatcheries, as part of recovery, are overseen by the co-managers, the Lower Elwha Klallam Tribe and the Washington State Department of Fish and Wildlife; they are guided by a monitoring and adaptive management framework, Hatchery Genetic Management Plans (HGMPs), which have been approved by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (Washington Department of Fish and Wildlife, 2012a). As the current HGMP addresses only the Preservation and Recolonization phases of Chinook salmon and Steelhead Recovery, progression of the hatchery programs into the Local Adaptation and Viable Population phases would be subject to reinitiation of ESA consultation with the National Oceanic and Atmospheric Administration's National Marine Fisheries Service. The monitoring and adaptive management framework is titled "Guidelines for Monitoring and Adaptively Managing Restoration of Chinook Salmon and Steelhead on the Elwha River" (EMAM) (Peters et al., 2014). It includes decision-making triggers based on Chinook salmon and Steelhead population parameters known as Viable Salmonid Population. Minimizing the impacts of hatchery fish on natural origin fish is also important for recovery. This includes addressing competition for food in the estuary and nearshore, fish pathogens, attraction of predators and the associated increase in predation on natural origin fish, predation by hatchery fish, and the delay of local adaptation of natural origin fish through interbreeding of hatchery and natural origin fish on the spawning grounds.

Ennis Creek and Port Angeles Harbor

Both the Ennis Creek Restoration and Port Angeles Harbor toxic clean-up are important for Elwha Chinook salmon recovery. The role of the Elwha Chinook Recovery Chapter is to support their advancement and implementation.

The WA State Department of Ecology addresses toxics cleanup under Washington's environmental clean up law, the Model Toxics Control Act. (MTCA). The Port Angeles Harbor cleanup is being addressed through two cleanup sites-the Western Port Angeles Harbor site and the former Rayionier Mill site. Both the Ennis Creek and Port Angeles Harbor projects are currently managed as part of the Port Angeles Harbor Natural Resources Damages Trustee Council, whose members include the WA Department of Ecology, US Fish and Wildlife Service, National Oceanic and Atmospheric Administration, Lower Elwha Klallam Tribe, Jamestown S'Klallam Tribe, and Port Gamble S'Klallam Tribe and the respective trustee councils as part of the Natural Resource Damage Assessment (NRDA) processes. The Port Angeles Natural Resource Trustee Council evaluates harm to natural resources from release of oil and other hazardous substances. The Trustree Council determines what activities are needed to restore or replace those damaged natural resources and how to compensate the public for those losses.

These are separate and distinct efforts overseen by the WA State Department of Ecology and the Port Angeles Natural Resource Trustee Council, respectively. Both efforts are working with the potentially liable parties.

The Port Angeles Harbor Natural Resource Trustee Council is negotiating a potential Ennis Creek Restoration project for settlement of natural resource damages. The recent settlement of natural resource damages for the Western Port Angeles Harbor site provides opportunities for one or more multimillion dollar restoration projects within the Port Angeles Harbor.

Photo by Tiffany Royal, NWIFC

Restore Freshwater Channel Habitat

Functional freshwater channel habitat is essential for productive fish populations, including sufficient wood, pools, and spawning gravels. In-channel wood creates pools for fish refuge and feeding, increases floodplain connectivity, and provides structure for the accumulation of spawning gravels. Wood also helps to control and redirect flows. Pools increase hyporheic exchange, which results in groundwater exchange and cooling.

Since dam removal, the Elwha River has been self-restoring in terms of recruiting wood, particularly in the lower river. The Lower Elwha Klallam Tribe has been implementing wood placement projects in the lower mainstem, Little River, and Indian Creek. However, the shift from incision to aggradation takes time, and many more log jams are needed for overall function, to retain fine sediments, reduce incision, and store gravel. There was little spawnable gravel available prior to dam removal because sediment had been blocked for 100 years, but the dam removal released stored sediment that generally filled the channels. This strategy will focus on continued freshwater channel restoration, through natural wood recruitment from riparian habitats and engineered log jam installation. See Appendix F: Instream Wood Mainstem for more information.

Focal areas

Reaches of focus include Fishermen's Bend to the former Aldwell Reservoir, Ranney Reach and Indian Creek.

Life stages

Chinook salmon freshwater rearing and spawning, and Steelhead and Bull Trout populations

Habitat goal

Instream channel habitat area is functional in 80% of the mainstem starting downstream of the Olympic National Park boundary, and including Little River and Indian Creek, by 2075.

Implementation target

The amount of functional instream wood is increasing by 2033.

Actions and approach

Site specific projects are focused on restoring instream wood at priority locations in the middle river, former Aldwell and Mills reservoirs, and the lower mainstem, including the Ranney Reach, Little River, and Indian Creek. This includes the additional wood placement, as needed, to trap and store spawning gravels.

Photo by North Olympic Lead Entity For Salmon

Restore and Protect Floodplain and Side Channel Connectivity

Connected floodplains allow for channel formation and provide side channel habitat access for salmon rearing. Young salmon benefit from off-channel refuge, which protects them from predation and during high flow events. Off-channel refuge habitat will be even more important with climate change due to predicted increases in winter peak flows. Connected and functional floodplains also provide numerous water quality benefits, creating cold water refugia for salmon during summer months and recharging groundwater.

The removal of the Glines Canyon and Elwha dams resulted in a massive influx of sediment, which reconnected the river with the floodplain. The Elwha River continues to evolve, filling, connecting, and forming side channels. However, there are areas that have remained disconnected due to the long-term effects of the dams and existing barriers. Options for reducing floodplain-restriction infrastructure located within the Ranney Reach need to be evaluated and addressed through restoration and infrastructure relocation projects (see actions for additional details). In addition, side channel reconnection and wood placement are needed in the former Mills Reservoir due to limited floodplain forest habitat for wood recruitment. Future residential and commercial floodplain development needs to be limited by protecting priority areas and using regulatory measures to maximize floodplain extent and function.

Focal areas

Restoration Priority Areas: Ranney Reach and associated physical infrastructure including the state hatchery, industrial water diversion, and treatment plant; the Place Road levee; a levee downstream from the old powerhouse site; the spur dike below the McDonald gage; and portions of the Hot Springs Road.

Protection Priority Area: Prevent the development of any new infrastructure in the entire floodplain.

Life stages

Chinook salmon freshwater rearing and spawning, migration, and Steelhead and Bull Trout populations

Habitat Goals

Greater than 80% of the historical floodplain area is connected by 2075, with full riverine function restored to the Hot Springs Road and Ranney Reach areas of the floodplain.

The ability of the Elwha River to form side channels is maintained over time.

Implementation targets

To be determined once a study on the floodplain area necessary for function is completed.

Actions and approach

- Assess, address, and remove where possible current floodplain restrictions, including those at Hot Springs Road and within the Ranney Reach.
- Remove and address the spur dike below the McDonald gage and the Place Road dike. Acquire necessary parcels and properties to complete the restoration projects.
- Acquire and protect key parcels for floodplain connectivity, based on assessments of priority areas for floodplain function. Focus on unconstrained reaches of the Elwha River where lateral migration can occur, and the stream corridors on Little River and Indian Creek, to protect against future floodplain development.
- Provide fish access to side channels, lower reaches of tributaries, and other refuge habitats, preferably with instream cover for fish to use during high flow events and drought, and to help mitigate the impacts of increased winter peak flows and extreme summer low flows from climate change.
- Prevent future development in the floodplain via regulatory measures and compliance enforcement, including effectiveness of shoreline and critical areas buffer enforcement.
- Use future scenarios of floodplain channel migration and floodplain boundaries that factor in climate change, to inform protection efforts against future development in areas critical to watershed function and that may put people in harm's way.
- Advocate for the relocation of current structures out of the floodplain, especially those located around the water intake and other City of Port Angeles water treatment infrastructure.

Photo by Olympic National Park

Photo by Tiffany Royal, NWIFC

Revegetate and Restore the Floodplain Forests of the Former Reservoirs

Revegetation and restoration of the former reservoirs is essential for recovery. The Elwha Project Revegetation Plan (2011) details long-terms goals and actions for achieving functional riparian forests. The three goals for revegetation in the former Aldwell and Mills reservoirs following removal of the dams on the Elwha River were to: minimize invasive, exotic species; restore ecosystem processes; and establish early successional native forests. Significant revegetation and restoration progress has been made since dam removal. The Lower Elwha Klallam Tribe, Olympic National Park, and additional organizations and volunteers led a massive replanting effort, covering almost 800 acres of land. The focus is now on invasive species management and increasing the conifer component, with underplanting of culturally significant plants in open areas (Chenoweth et al., 2011). The long-term goal is to reach a self-sustaining, multi-threaded channel with downed wood and mature mixed conifer forests that provide stability and natural wood loading. The former Aldwell Reservoir is a particularly important area for invasives management and conifer planting, which speed the formation of forested islands and establish true riparian zones that are essential for wood supply and shade for temperature management. Monitoring for success of riparian health and effectiveness of noxious weed removal is also an important component of this goal.

Focal areas

Former dam reservoirs at Aldwell and Mills

Life stages

Chinook salmon freshwater rearing and spawning, migration, and Steelhead and Bull Trout populations

Habitat goals

The floodplains of the former reservoirs are progressing to late-successional native riparian forests, and the structure, diversity and tree species composition are within the range of variation observed in reference conifer communities, by 2075.

Over the long-term, the floodplain condition reaches a forested island geomorphology, a multi-threaded channel with wood and mixed conifer forests for stability and fish longevity.

Implementation target

Floodplain riparian forests, in areas dominated by deciduous species, are treated for riparian noxious weeds and underplanted with conifers by 2033.

Actions and approach

- Manage invasive species of concern in the former reservoirs as part of the Elwha Project Revegetation Plan. This is currently focused on corridor revegetation and weed control with an emphasis on culturally significant plants (See Table 3 from Chenoweth et al., 2011 for the primary list of invasive exotic species of concern).
- Restore the former reservoirs via additional conifer planting, particularly the former Mills Reservoir, for revegetation and temperature management.


Photo by John Gussman

Restore and Protect Freshwater Riparian Buffer Habitat

Healthy riparian vegetation provides numerous benefits for salmon, including shade to keep streams cool, and a source of aquatic insects and nutrients for food. It also contributes large wood to the river and provides erosion control and water filtration. Riparian buffers should cover the extended channel migration zone (CMZ) and floodplain and include a self-sustaining mix of native trees and vegetation. Although the majority of the Elwha Watershed is protected within Olympic National Park boundaries, restoration and protection of riparian buffer habitat, particularly in the lower river, is still needed. Riparian plants to shade and moderate summer water temperature, especially with increased temperatures from climate change, and sources of wood recruitment are both of particular importance for salmon recovery and watershed function. Outside the National Park, existing forest practices (Department of Natural Resources) and shoreline management rules (Clallam County and Department of Ecology) are often inadequate, so increased protection is needed through property acquisition and conservation easements. In addition, incentives for voluntary stewardship, coordinated management of invasive species, and enforcement of current regulations are all critical components to establishing and maintaining functional riparian buffers.

Focal areas

Lower Elwha River, Indian Creek, and Little River riparian buffer habitat

Life stages

Chinook salmon freshwater rearing and spawning (with shade for egg incubation where most needed for water temperature), migration, and Steelhead and Bull Trout populations

Habitat goal

A riparian buffer of 200 feet along the mainstem and tributaries with functional riparian cover in a mid- to late-successional stage by 2075.

Implementation target

The total length of streambank that has a functional riparian buffer is increasing by 2033.

Actions and approach

- Restore riparian buffer forest habitat. Along the mainstem, this includes the entire CMZ and associated buffer habitat. Along the tributaries and stable side channels, this includes an emphasis on native vegetation providing shade and long-term large wood recruitment potential.
- Acquire priority parcels and establish conservation easements on private property for riparian buffer habitat. Note on priorities: see river corridor parcel prioritization that was developed by the North Olympic Land Trust in partnership with the Lower Elwha Klallam Tribe.
- Minimize the impact of increased winter flows, extreme summer low flows, and summer stream temperature from climate change by restoring riparian forests. Select areas that provide the greatest benefit in reducing runoff rates and limiting impervious surface in riparian zones, and areas that are most important for shading fish habitat.
- Minimize invasive species of primary concern for Elwha River salmon habitat.
- Enforce riparian buffer regulations and compliance (Clallam County enforcement of Critical Areas Ordinance, state forest plans). Determine if additional protection is needed and/or a request for tracking permits and variances.
- Landowner outreach and education on best management practices for riparian areas, including incentives and stewardship programs such as invasive species removal.
- Work with the Department of Natural Resources to enhance protection requirements of adjacent mature forests, tributaries, and forested water retention areas, which help to promote a balance between maintaining economic and environmental goals.


Photo by Rebecca Mahan

Maintain and Fully Restore Unimpeded Fish Passage through the Tributaries and Former Dam Sites

Significant progress has been made restoring fish passage in the Elwha River with the removal of the Elwha and Glines Canyon dams. This effort was the largest dam removal project in the world at the time and reopened over 70 miles of habitat to fish. Even with this massive undertaking, additional restoration is needed for full fish access. The focus is now on maintaining and restoring access by addressing any remaining barriers, including priority culverts on Indian Creek and Little River, and residual issues at the former dam sites. Removing the remnants at the Elwha Dam site and evaluating the lower Glines Canyon Dam site are urgent priorities as there are still many boulder-sized fragments with rebar present. High flow events at these sites will mobilize trapped sediment and leftover dam remnants and reinitiate erosion, resulting in redd scouring and undermining downriver revegetation efforts. Although all species of salmon have currently accessed areas above both dams, the concern is that because the caisson and base of dam were not fully removed, a barrier might develop in the future. Additionally, assessment is necessary at Rica Canyon to determine whether a natural or anthropogenic condition exists, which may restrict fish passage through the canyon at certain flows.

Focal areas

The former Elwha Dam site, former Glines Canyon Dam site and associated rock fall, and barrier culverts at Indian Creek and Little River

Life stages

Chinook salmon access to freshwater rearing and spawning habitat, migration, and Steelhead and Bull Trout populations

Habitat goal

Fish passage is fully accessible to historic salmonid range by 2075.

Implementation targets

Fish passage through the former Elwha and Glines Canyon Dam sites is unimpeded and restored to historical condition by 2030.

Remnant Elwha Dam caisson and concrete is fully removed by 2030.

Tributary fish passage, including culverts on Indian Creek and Little River, and two undersized culverts on Madison Creek and Griff Creek Jr. along the Hot Springs Road, is fully passable by 2033.

Actions and approach

- Address fish passage barriers at Indian Creek, Little River, and two undersized culverts on Madison Creek and Griff Creek Jr. along the Hot Springs Road, and all culverts on the Elwha Culvert List (see Appendix G for complete list).
- Remove Elwha remnant dam caisson retaining structure and concrete.
- Maintain fully unimpeded fish passage through former Elwha and Glines Canyon dam sites, ensuring that a barrier does not develop in the future, for all Chinook, Steelhead, and Bull Trout life stages.
- Evaluate fish passage for various salmon life stages at Rica Canyon.

Photo by John Gussman

Restore and Protect Elwha Estuary Habitat and Connectivity

Availability of estuarine habitat in the Elwha Estuary is directly linked to juvenile Chinook salmon survival, providing channels and refuge for rearing and growth prior to outmigration to the Strait of Juan de Fuca and Pacific Ocean. Chinook salmon fry and smolts use tidal channels and subtidal refugia from adverse conditions as well as predation for extended periods. The estuary and delta have changed dramatically and continue to evolve, in size and channel morphology, following the release of millions of cubic yards of sediment from dam removal. Estuarine connectivity and habitat access remain limited by the Place Road levee, which blocks tidal influence and fish access on the estuary's west side. Addressing or modifying the Place Road and other estuarine levees is a priority, given the loss of access to important rearing areas. Increased estuarine habitat area and connectivity also provide greater resiliency to changing water levels from climate change. In addition, invasive plants in the estuary (e.g., Scotch broom) need to be managed.

Focal areas

The entire Elwha Estuary, with an emphasis on addressing estuarine habitat access limited by the Place Road levee.

Life stages

Chinook salmon estuarine rearing and migration and Steelhead and Bull Trout populations

Additional Puget Sound ESU salmonids during outmigration

Habitat goal

Elwha Estuary is fully tidally connected by 2075, providing full juvenile access and food production (e.g. forage fish).

Implementation targets

Current and transforming estuarine habitat remains connected through 2033, as the delta continues evolving post dam removal.

Plans are complete for addressing Place Road levee passage and connectivity issues by 2033.

Parcels adjacent to the Place levee are conserved as acquisition opportunities arise.

Actions and approach

- Remove or modify Place Road levee to restore estuary habitat connectivity and provide fish access (Environmental Science Associates and Natural Systems Design, 2022). This includes the acquisition of parcels from willing sellers for restoration.
- Acquire priority estuary habitat for habitat protection, restoration, and for levee removal and/or modification.
- Increase estuarine resiliency to climate change by removing or modifying levees to allow for adaptation to changing water levels. Prevent new or retrofitted (e.g., raised levee) modifications in the estuary.
- Address invasive species in the estuary affecting salmon such as white sweet clover, yellow flag iris, Scotch broom, Himalayan blackberry, and Eurasian milfoil.

Figure 5. Elwha Estuary (Environmental Science Associates and Natural Systems Design, 2022)

Photo by John Gussman

Restore and Protect Nearshore Habitat

After leaving the Elwha River, Chinook and other salmon rely on the nearshore as they make their way to the ocean. The nearshore is the area from the bluffs to the shallow water shelf along the shoreline, measured relative to mean lower low water. Nearshore habitat includes salt marshes, lagoons, and sandy and rocky beaches, and supports various species from shorebirds to juvenile salmon and Steelhead. Juvenile salmon use kelp forests and eelgrass beds in the nearshore for important rearing, refuge, and migratory habitat. During dam removal, significant sediment deposition occurred along the drift cell. This delivered substrate for nearshore sand and gravel beaches, benefiting eelgrass, forage fish spawning habitat, and ESA-listed Eulachon. Local forage fish include Pacific herring, sand lance, and surf smelt, which together form the bulk of juvenile Chinook salmon smolt diets (Northwest Indian Fish Commission Member Tribes, 2020).

Feeder bluffs in the area are also important as consistent sources of sediment supply. Feeder bluffs are eroding coastal bluffs that deliver sand and sediment to the beach below. Functional nearshore habitat with limited development will benefit salmon and increase resiliency to sea level rise. Major challenges to local nearshore salmon habitat are residential and commercial development with associated shoreline armoring, an old industrial water line along the shoreline, and development overlooking Port Angeles Harbor. Shoreline armoring still occurs on feeder bluffs, including beside the Port Angeles transfer station and on local private properties. Protection from development of the functional nearshore, which includes kelp, eelgrass, forage fish habitat, and feeder bluffs, is a priority. Restoration of existing armoring and infrastructure and advocacy for soft armoring or other techniques where appropriate are also needed. In addition, extensive clean-up and restoration are needed in Port Angeles Harbor and the associated lagoon habitat.

Focal areas

Forage fish habitat, eelgrass and kelp bed habitats, intertidal lagoons, and feeder bluffs are important in the Elwha nearshore. The nearshore geography of focus is defined as the nearshore area from Freshwater Bay to the Morse Creek Estuary (Figure1).

Life stages

Chinook salmon juvenile migration and nearshore rearing (forage fish), Steelhead and Bull Trout populations

Additional Puget Sound ESU salmonids during outmigration

Habitat goals

Ensure the area of eelgrass and canopy forming kelp beds remains stable and does not decline within the Elwha drift cell and Port Angeles Harbor by 2075.

No new and a decreasing amount of hard shoreline armoring and intertidal structures within the Elwha drift cell and Port Angeles Harbor to Morse Creek by 2075.

No net loss of established marine riparian vegetation with an increasing percent of vegetated shoreline in the Elwha drift cell and Port Angeles Harbor to Morse Creek by 2075.

Implementation targets

Eelgrass and kelp bed area is stable by 2033 (Rubin et al., 2014).

A net reduction in hard shoreline armoring and no new hard shoreline armoring by 2033.

A net reduction in intertidal fill by 2033.

50% reduction in the number of creosoted piles in Port Angeles Harbor by 2033.

Marine riparian habitat is revegetated by 2033 (amount to be determined).

Actions and approach

- Protect priority nearshore habitat parcels via acquisition and conservation easements (priority for intact shoreline, feeder bluffs, kelp, eelgrass, and forage fish habitat and substrate). Use local and regional science to inform action priorities (e.g., local kelp, eelgrass, and forage fish monitoring, and regional Salish Sea Marine Survival Project [Pearsall et al., 2021] results). Note: forage fish habitat may shift, so ongoing monitoring is necessary to inform priority habitat areas (see kelp, eelgrass, and forage fish monitoring in the Adaptive Management and Monitoring section). Use this data to inform protection strategy and priorities.
- Restore nearshore habitat by removing hard armoring and employing soft armoring or other techniques where applicable and minimizing encroachment when possible (by removing lower elevation armor).
- Explore options to restore historical forage fish spawning beds lost in the past couple of decades.
- Incorporate sea level rise predictions and sea level rise monitoring into restoration projects and local nearshore planning.
- Acquire and restore priority parcels to enhance resilience to sea level rise for eelgrass, kelp, and forage fish habitat by minimizing coastal squeeze and allowing for habitat adaptation.
- Assess the impacts of the old and leaking industrial water line. Depending on the assessment results, relocate and replace the industrial water line away from the shoreline, moving it upland (note: would also need to address bluff erosion and existing houses).
- Restore and minimize the impacts of shoreline hardening, nearshore infrastructure, commercial development, derelict creosote pilings, and associated overwater structures in Port Angeles Harbor.
- Advocate for the restoration and advanced implementation of cleanup of the lagoon in Port Angeles Harbor. Modify the channel connecting the lagoon to the harbor from the current vertical walls to a more natural configuration. Control and eliminate lagoon invasives.
- Encourage education for shoreline owners about sea level rise and coastal flooding vulnerability, soft armoring alternatives, and available assistance programs.
- Education and outreach about possible relocation and set-back of houses close to the shoreline via available programs such as the Northwest Straits Shore Friendly Landowner Outreach program.
- Increase the effectiveness of regulations and enforcement through the existing Shoreline Master Plan. Ensure no new hard armoring via permitting and compliance monitoring for existing hard shoreline armoring by Clallam County, including the recently updated policies in the Washington Administrative Code.
- Restore and protect marine vegetation with a priority on kelp and eelgrass, especially along potential forage fish spawning beaches.

Photo by Lindsey Aspelund

Protect Instream Flow

Low instream flow limits side channel rearing habitat, fragments existing habitat, causes migration barriers, and has been identified as one of the primary risks to Chinook recovery in the Elwha Watershed (Mike McHenry, Lower Elwha Klallam Tribe, personal communication, 2023). Currently, the City of Port Angeles holds most of the water rights in the Elwha River. Even though these rights are not fully used, diversion of water from the Elwha River exacerbates summer low flow conditions as does climate change induced drought, which has occurred during the past few summers and is expected to increase. Furthermore, future increases in population in the City of Port Angeles could increase water usage. The City is currently exploring additional water alternatives. Instream flow is impacted by climate change, with a decreasing snowpack affecting the timing, amount, and temperature of flows. The low flow season has become more variable in recent years, sometimes extending into spring and fall, and causing a significant run time issue for salmonids. An instream flow analysis is urgently needed to set a minimum instream flow for salmon. The results will inform local policy decisions and be used in Elwha River water resource plan development and associated strategies.

Focal areas

All Elwha freshwater habitats with a focus on the lower river located downstream of the City's water diversion.

Life stages

All Chinook salmon freshwater life stages (focusing on rearing and egg incubation), and Steelhead and Bull Trout populations

Habitat goal

The average 30-day summer low flow in the Elwha River is stable or increasing.

Implementation target

Instream flow study for the Elwha River is completed by 2033.

Actions and approach

- Conduct an instream flow study, using Instream Flow Incremental Methodology or similar, to set minimum instream flow for the Elwha River and its tributaries, post dam removal. Incorporate predicted climate change impacts to water flows. Use study results to evaluate current water use and water rights, both municipal and industrial.
- Depending on the flow study results, acquire funding and support to initiate the Elwha River water planning process (Elwha-Dungeness Planning Unit, 2005), integrating protection for salmon. Plan may further evaluate existing water use regulations and rights and implement domestic and municipal water conservation projects, as well as how far Elwha River water can be transferred. Management triggers should be included.
- Use flow study results to inform actions to best minimize the impacts of reduced flows and shifts in flow timing from climate change.
- Work with the City of Port Angeles on reviewing its existing water conservation strategy for low flow periods based on minimum flows needed for fish health. Determine if any changes are needed and if additional outreach can be supported. Encourage increased voluntary conservation until the flow study is complete.
- Encourage industrial water conservation and expand the use of reclaimed water.
- Increase natural water storage via instream wood restoration and increasing floodplain habitat connectivity.
- Apply tree thinning forest management practices in younger forests when applicable, to minimize the extensive water use of rapidly growing young trees.

Photo by John Gussman

Address Elevated Summer Stream Temperature

Elevated stream temperature is currently an issue in the Elwha River during summer months and is predicted to become more problematic in the future due to climate change. Portions of the Elwha River are on the 303(d) list for temperature, as is a portion of Indian Creek. In addition, there are areas of the Elwha Watershed that are included on the 303(d) list for other factors, such as pH and dissolved oxygen. The result is a decrease in the amount and quality of juvenile rearing habitat and increased fish vulnerability to predation and disease. Elevated summer stream temperatures are expected to increase juvenile and adult mortality and are exacerbated by many factors, including low flows and lack of vegetation in riparian zones. Areas of concern in the watershed include the lower mainstem, Indian Creek, Lake Sutherland, and the former reservoirs, as well as the estuary. Water temperature monitoring associated with dam removal has been ongoing and future monitoring will be needed to inform projects and priorities. Riparian buffers for shade, cold water refugia, and identifying and protecting groundwater inputs and storage will be important in mitigating increasing temperatures.

Focal areas

The lower mainstem, Indian Creek, Lake Sutherland, the former reservoirs, and the estuary

Life stages

Chinook salmon freshwater rearing and spawning, migration, and Steelhead and Bull Trout populations

Habitat goal

All mainstem areas and tributaries meet summer temperature and daily maximum threshold standards for salmonids.

Implementation targets

Former reservoir stream temperature is consistent with adjacent reference reaches of similar geomorphic condition, by 2033.

Summer water temperature in Indian Creek is trending toward meeting water quality standards for salmon, by 2033.

Actions and approach

- Monitor summer water temperature and use results to inform additional actions (projects and priorities) and identify areas of cool water refugia and elevated summer stream temperature. Incorporate predicted climate change impacts. Include an evaluation of summer stream temperatures following dam removal, particularly in the former reservoirs.
- Engage the Department of Ecology in remedying the problems according to 303(d) listing guidelines.
- Restore and protect riparian habitat in sensitive areas for elevated temperature mitigation (see Restore and Protect Freshwater Riparian Buffer Habitat Strategy).
- Address and mitigate summer water temperatures in the former reservoirs via revegetation in these areas (see Revegetate and Restore the Floodplain Forests of the Former Reservoirs Strategy).
- Identify, protect, and increase access to cold water refugia (e.g., wetland complex and the associated cooling waters downstream).
- Research to identify sources of cool water input and groundwater influence to guide protection projects (e.g., imagery above and below ground-level in river).
- Investigate opportunities for increasing hyporheic flow and groundwater storage for cool water input to decrease temperature, including adding instream wood to recruit spawning gravel and reconnect side channels.

Adaptive Management and Monitoring

Adaptive management of this recovery chapter involves evaluating progress, project implementation and our trajectory toward meeting habitat goals and ultimately Chinook recovery, as well as benefits for Steelhead and Bull Trout. An adaptive management process provides the structure to use monitoring results to inform decision making, future strategies, and the best approach for further implementation. This includes identifying the key issues and strategies, the monitoring that will occur to evaluate implementation success and effectiveness, and the approach for learning from those results and revising the action plan as necessary.

Figure 6 details the major steps in a typical adaptive management process. Currently, fish population monitoring indicators and management triggers detailed in "Guidelines for Monitoring and Adaptively Managing Restoration of Chinook Salmon and Steelhead on the Elwha River" (EMAM) (Peters et al., 2014) guide fish management decisions. The Elwha Recovery Chapter will be adaptively managed using the framework and information in this plan and the existing fish population and habitat indicators and triggers. The overarching monitoring priorities and an adaptive management framework for the Elwha Recovery Chapter are described below.

Figure 6. A general adaptive management cycle for recovery plans.

Current Monitoring Priorities

Current monitoring in the Elwha River includes Chinook and Steelhead population monitoring (Table 3). This table includes all ongoing monitoring that is relevant to Chinook recovery and informs decision making. For each monitoring program, a program lead is listed. Chinook and Steelhead population monitoring are the highest priority for continued monitoring.

As a side note, extensive monitoring and research programs were associated with dam removal in the Elwha Watershed. These programs had a major role in preparing for and documenting the effects of dam removal. While the publications are not included here, they are well documented.

Photo by Tiffany Royal, NWIFC

Table 3. Current monitoring in the Elwha River on Chinook, Steelhead, Bull Trout and their habitats, to inform plan implementation and progress toward recovery.

Monitoring Program /Plan	Program Lead
Fish Population Monitoring	
Chinook Salmon Population Monitoring	
• Spatial Distribution of Chinook salmon Spawning in the Elwha River	LEKT/WDFW/ONP
• Elwha River Chinook salmon Escapement (SONAR)	LEKT
• Smolt Enumeration (Estimates natural production of Chinook salmon (and coho, Steelhead, pink and chum))	LEKT
• Chinook salmon Carcass Surveys	WDFW/ONP/LEKT
Steelhead Population Monitoring	
• Spatial Distribution of Steelhead Spawning in the Elwha River	LEKT/WDFW/ONP
• Elwha River Steelhead Escapement (SONAR)	LEKT
• Elwha River Steelhead pHOS monitoring	USFWS
Bull Trout Population Monitoring	
• Relative Abundance of Adult and Sub-Adult Bull Trout	USFWS/NPS
• Juvenile Fish Movement and Monitoring	NOAA/LEKT
• Monitor Distribution and Abundance	ONP

Acronyms for Table 3 are as follows: Lower Elwha Klallam Tribe (LEKT), National Oceanic and Atmospheric Administration (NOAA), Olympic National Park (ONP), Proportion HOR Winter Steelhead Spawners (pHOS), Sound Navigation and Ranging (SONAR), United States Geological Survey (USGS), United States Fish and Wildlife Service (USFWS), and Washington Department of Fish and Wildlife (WDFW).

Monitoring Program /Plan	Program Lead
Habitat and Water Quality / Quantity Monitoring	
Monitoring Associated with the Revegetation and Restoration Plan for Lake Mills and Lake Aldwell	ONP/LEKT
Wood and Side Channel Habitat	NOAA/LEKT
Forage Fish Monitoring	NOAA/LEKT
Freshwater Quality	LEKT/NOAA
Water Quantity (at McDonald Bridge gage Site)	USGS
Habitat Restoration Effectiveness Monitoring (includes ELJ monitoring and restoration treatments)	LEKT
Sub-tidal Dive Surveys (nearshore habitat including algae, invertebrate and fish species, and sediment type)	USGS/LEKT/Washington Sea Grant
Food Web Studies (freshwater food web)	NOAA/LEKT
Shoreline Morphology and Grain Size Monitoring on Elwha Delta and Ediz Hook	Washington Sea Grant

Data Gaps and Uncertainties

As part of the Elwha Recovery Chapter Update process, data gaps and uncertainties were discussed. The list below summarizes primary research and information needs beyond current monitoring efforts. The results of these studies and analyses would be used to guide the successful recovery of Elwha Chinook in relation to fish and their habitats, strategy implementation, and restoration and protection priorities. Programs and funding sources will need to be developed to address many of these data gaps and uncertainties. In general, monitoring with associated protocols will also be necessary to track the habitat indicators associated with the freshwater, nearshore, and estuarine habitat goals.

Photo by Tiffany Royal, NWIFC

Water Flows and Inputs

- An Instream Flow Incremental Methodology (IFIM)-type study is needed to set minimum instream flow for the Elwha River and its tributaries, post dam removal. In addition, climate change impacts to water flows should be incorporated. This study will be used to inform water regulations and associated planning.
- Install flow gauges, potentially with basic water quality sampling, in key tributaries.
- Research is needed to identify sources of cool water input and groundwater influence to guide protection projects such as imagery above water column sampling, and below ground-level in river.

Freshwater Habitats

- LiDAR analysis to inform strategy and actions for riparian buffer restoration and protection, and status of riparian buffer percent vegetated cover of mid-late successional forests.
- LiDAR analysis needed to help define historical floodplain area.
- Define the Elwha Channel Migration Zone. Clallam County Department of Community Development has just been funded to do this work, which will be completed by June 2025.
- Analysis of wood amount and placement in the freshwater channel (initiated from aerial photos, repeat analysis) was done in 2023 but needs to be repeated every decade to inform wood goal and future restoration actions. See Appendix F: Instream Wood Mainstem for more information.
- Evaluate whether a natural or partial barrier exists at Rica Canyon at various salmon life stages and flow levels, and why Chinook are not moving upstream of Rica Canyon in any significant numbers. This evaluation should be followed by annual fish passage assessments above Rica Canyon, and visits to the site every five years, unless fish distribution changes suddenly.
- Assess whether toxic materials, such as PCBs and nickel levels, are still present in the river post dam removal cleanup efforts.

Additional Research and Monitoring Needs

- A sediment monitoring study is needed in the nearshore, as sediment provides better habitat (i.e., grain size) for diversity of fish, including forage fish. Note: pre and post dam removal sediment monitoring through 2019 has been completed (Peters et al., 2017). It was found that sediment transport was in equilibrium and sediment releases from the former reservoirs were only triggered by larger flows.
- Long-term monitoring of fish passage through Elwha and Glines Canyons.
- Monitor summer water temperature. Include a thermal imaging flight with strategic tidbit monitoring for verification. Use the results to identify areas of elevated summer stream temperature and to inform actions and project locations.
- Monitor climate change impacts and the effect on fish and their habitats (e.g., increase in fish pathogens).
- Monitor trends in eelgrass and canopy forming kelp bed area.
- Assess predator-prey dynamics in the Elwha Estuary region, including seals and possibly porpoise. Monitor forage fish distribution and abundance drivers including sand lance, smelt, and herring. Research is also needed on the impact on salmon of forage fish abundance and presence of spawning beds. This is covered in the current monitoring list (Table 3).
- Track the following issues to potentially address in the future for their impact, compliance with existing regulations, and/or for implementation opportunities: emerging contaminants, especially those associated with wastewater and stormwater (O'Neill et al., 2015); impervious surface trends and related policies; City of Port Angeles stormwater and sewage runoff from overflow events and septic systems; Port Angeles Transfer Station runoff; Lake Sutherland runoff and septic systems; aquaculture and increased predation on fish; and floodplain road construction and emergency repairs.
- Monitoring salmon use in the nearshore, non-salmonid species, predator/prey dynamics, and competition for resources.


Photo by North Olympic Lead Entity for Salmon

Elwha River Adaptive Management Process

The adaptive management process for the Elwha Recovery Chapter will be led by the North Olympic Peninsula Lead Entity for Salmon. The North Olympic Lead Entity is a consortium which includes representatives from the Lower Elwha Klallam Tribe, Jamestown S'Klallam Tribe, Makah Tribe, Cities of Port Angeles and Sequim, Clallam County, citizen representatives, and area non-profits. The Puget Sound Partnership, which is responsible for Puget Sound Chinook recovery, looks to the Lead Entity to oversee implementation of both the Elwha and Dungeness Chinook watershed recovery chapters. It is also in their scope of work from the Governor's Salmon Recovery Office. (insert logos or photo of management team)

Elwha Recovery Chapter strategy and project implementation is overseen by the Lead Entity, with technical support from their Technical Review Group. Watershed data and information are reviewed by the Technical Group, which then makes recommendations to the broader Lead Entity Group regarding priorities, updates, and projects as needed.

The Lead Entity will host a biennial Elwha Chinook Recovery Plan meeting during odd years. Alternate years may have briefer meetings to discuss a particular topic, issue, or research theme. The meeting will be held to review progress toward habitat and fish goals, discuss project and strategy successes and challenges, evaluate emerging issues and opportunities as needed, and determine necessary decision-making actions. This process will address uncertainty by discussing key unknowns and research needs. Existing Elwha Recovery Chapter habitat and implementation indicators will be used to inform these discussions and associated outcomes, as follows:

- Habitat indicators and overall habitat status for tracking progress toward habitat goals that will be compiled and discussed every five to 10 years.
- Tracking progress toward implementation targets to determine strategy progress is linked to decision-making triggers. This will help inform focal areas, changes to strategies and actions, project funding allocations, and where additional investments are needed. This data will be gathered from recovery partners, those engaged in monitoring, PRISM, and the Salmon Recovery Portal to inform adaptive management regularly in two to five -year cycles.

Photo by John Gussman

- Fish goal updates from co-managers including abundance and productivity data for Chinook, Steelhead, and Bull Trout summarized within existing phases of fish recovery (Peters et al., 2014).

While not all indicators will be reported on annually, results will be shared at regular intervals and as data and information are available. Additional monitoring results and updates from the co-managers, federal and state partners, and other local salmon recovery partners will be shared as they become available and used to guide decision making and plan strategies. Current monitoring programs for Elwha Chinook salmon, Steelhead, and Bull Trout and their habitats, along with the program lead(s), are summarized in Table 3. It will be important to include all monitoring results that may affect the Recovery Chapter implementation and progress in the North Olympic Lead Entity -led forum. This will ensure a better understanding of the full recovery picture and will help link monitoring to the Elwha Chapter's adaptive management and decision making.

Results from the Elwha Recovery Chapter progress meeting will also be integrated into the four-year work planning process. Projects will be linked to implementation targets and ultimately habitat and fish recovery goals. Major updates to the work plan occur every four years, with minor updates on an annual basis. New and existing projects will be developed to maximize success in reaching these targets and goals and will be modified in the adaptive management and work planning processes based on progress and monitoring results.

As part of the Elwha Dam removal project, extensive and rigorous monitoring and adaptive management plans were developed by the co-managers and federal partners. This includes long-term monitoring of Chinook salmon, Steelhead, and Bull Trout population abundance and productivity, the former reservoir revegetation plan implementation, and invasive species (see complete list of Elwha River monitoring programs in Table 3). Now that dam removal is complete, most of the federal funding supporting these monitoring programs is ending. It will be important to secure funding for essential monitoring needed in the Elwha River to know whether habitat or fish goals needed for recovery are being met. Elwha River monitoring results will be important in informing regional progress to recovery at the ESU level. The Puget Sound Ecosystem Monitoring Program Salmonid Group, the Puget Sound Salmon Science Advisory Committee and the Puget Sound Salmon Recovery Council all have monitoring and adaptive management programs to include local salmonid data. Additionally, research and expertise from these regional groups and programs can inform local recovery such as studies like the Salish Sea Marine Survival Project (Pearsall et al., 2021).

Appendices

Appendix A: The Decline of Puget Sound Chinook Salmon, Strategy Context, and Local History

In Washington State in the late 1990s, various stocks of Chinook salmon, also known as King Salmon, were struggling across Puget Sound. Chinook salmon populations were crashing in the Nisqually, Nooksack, Green, Hood Canal rivers, and Skagit, among elsewhere, including in both the Elwha and Dungeness rivers. These losses were racking up even in places like the North Olympic Peninsula, which was still relatively rural and remote with a limited population and extensive natural areas. Since the late nineteenth century, salmon were declining for many reasons, including watershed and habitat destruction, logging practices, damming rivers, clearing the land for farming at river mouths, and overharvest.

Hatcheries for salmon production in Washington began in 1895. The first dam on the Elwha River was completed in 1914. Building a hatchery at the same time allowed the dam owner to avoid installing fish ladders as required by law at the time. However, the hatchery was closed in 1922. Glines Canyon Dam was built above it in 1925. Explosives used in construction damaged the canyon area of the Elwha River, while also greatly decreasing salmon spawning habitat, flooding riparian areas, and destroying wetland habitat. The timing of when hatcheries and dams originated speaks volumes about how long salmon have been in decline, along with habitat destruction, which continues today.

With the ongoing decline of salmon populations, Salish Sea Chinook salmon populations were tracked by the Pacific Salmon Commission starting in 1984 (US Environmental Protection Agency, 2019) and were ultimately listed as threatened in 1999 under the Endangered Species Act (ESA). As the formal ESA listing of Puget Sound Chinook salmon appeared certain, elected officials in Washington State faced a major decision: Should the recovery of Puget Sound Chinook salmon be led by the state, or should it be managed by the federal government? State leaders decided that the state, tribes, and local communities were well positioned to lead the recovery effort. To help stem the decline of Puget Sound Chinook salmon, in 1998 the Washington State Legislature created the Salmon Recovery Funding Board (SRFB). The same law also spelled out the need to create local Lead Entities or watershed councils to bring together citizens, biologists, fisheries experts, tribes, and other government representatives to work together on salmon recovery. Along with other responsibilities, Lead Entities run an annual grant round to allocate state funding approved by the SRFB and monies from the federal Pacific Coast Salmon Recovery Fund to local sponsors who implement needed salmon restoration projects.


Photo by John McMillan

Shared Strategy was a creative and groundbreaking grass roots organization led by former US Environmental Protection Agency Director, Salmon Recovery Funding Board Chair, and Presidential Medal of Freedom recipient William Ruckelshaus, and others that supported local tribes, governments, citizens, environmental non-profits, and salmon advocates in creating a specific Recovery Plan Chapter for each distinct population of Puget Sound Chinook salmon. That resulted in both a Dungeness and Elwha Chapter of what became the Puget Sound Chinook Recovery Plan. Using the best scientific knowledge and local input, these Recovery Plans laid out strategies and actions needed to save Chinook salmon populations across the Puget Sound.

This innovative approach became known as "The Washington Way," where tribes, counties, municipal governments, landowners, nonprofit conservation and environmental organizations, state and other government representatives work collaboratively to advance salmon restoration in high priority watersheds. These efforts continue today. The work of Shared Strategy also resulted in significantly increased investments in salmon recovery and protection efforts by the Washington State Legislature. This funding, known as the Puget Sound Acquisition and Restoration Fund, allowed Lead Entities and project sponsors to tackle much more complex, larger scale restoration actions listed in the Puget Sound Chinook salmon Recovery Plan. This funding continues to support key recovery efforts along the Elwha River and across Puget Sound. It also led to the formation of the state agency known as the Puget Sound Partnership, which is the regional organization responsible for the recovery of Puget Sound Chinook salmon. The Puget Sound Partnership looks to Lead Entities and their partners to advance restoration work needed locally to recover Puget Sound Chinook.

For the many Native American Tribes who have called Washington home since time immemorial, salmon is intricately connected with who they are and their way of life. This is true for the Lower Elwha Klallam Tribe. For tens of thousands of years, the Lower Elwha Klallam Tribe has depended on the river and its salmon for their livelihood, sustenance, and as the source of many cultural and spiritual beliefs.

Many tribes, including the Lower Elwha Klallam Tribe, hold feasts and first salmon ceremonies. In treaties with the state and federal governments (including the Point No Point Treaty) Native Americans, including the Klallam, retained their rights to fish and hunt in their usual and accustomed areas, which prioritized their ability to do so into the future.

Salmon have also long been a food source for other community members. Longtime residents talk about how salmon helped feed their families during the depression. In Port Angeles, which gets its water from the Elwha River, the community celebrated the annual Salmon Derby within the Derby Days Festival. The lack of salmon in later years meant the end of the annual Summer Salmon Derby.

Salmon also looms large in Washington's economy through ecotourism, and commercial and recreational fishing. Commercial harvest and fish sales generate an average of $1.6 billion annually for Washington State's economy (National Marine Fisheries Service, 2007), with an estimated 16,374 jobs in the commercial and recreation fishing industries (Washington Department of Fish and Wildlife, 2012b). Sport fishing is estimated to provide another $1.1 billion annually into the state's economy (United States Fish and Wildlife Service, 2022). In addition, healthy watersheds help draw significant numbers of hikers, kayakers, bicyclists, photographers, and others who enjoy being out in nature and exploring natural areas. Many families and individuals enjoy going out in the fall on the Elwha River pedestrian bridge or the Elwha Estuary to watch salmon headed up the river to spawn. Functioning fluvial systems also benefit people as there are fewer detrimental impacts from flooding, manmade river channelization, and the prevention of healthy sediment flow.

Appendix B: Dam Removal History

For more than 100 years, the Elwha River and its mighty salmonid populations were negatively impacted by two large dams that were built by Canadian developer Thomas Aldwell to generate electricity to support industry and residential development in Port Angeles. The dams were built without fish passage ladders, even though they were required by law at the time. Construction on the lower Elwha Dam, located at river mile 4.9 (RKm 7.9), began in 1910; the upper Glines Canyon Dam, at river mile 13 (RKm 21.7), was built in 1927. For decades afterwards, salmon still returned yearly, and without fish ladders or passage in these systems, fish were blocked from accessing their natal habitats. Prior to dam construction, the Elwha River was known for its legendary salmon populations, including 100-pound Chinook. The river, which is home to all five species of salmon: Chinook, chum, coho, sockeye and pink salmon, as well as Bull Trout and Steelhead, was renowned as a river with returning salmon so thick that one could cross the river by walking atop them. What has set the Elwha apart, aside from large-bodied Chinook, was that it had sizeable, healthy populations of all five salmon species. Pink and chum salmon populations on the coastal rivers tended to be smaller due to a lack of estuarine habitat. Also, with Lake Sutherland, the Elwha could support a sockeye population.

Photos by John Gussman

Damming the river also negatively impacted the people of the Lower Elwha Klallam Tribe. The Elwha River has always held great significance for the Tribe and other nearby S'Klallam Tribes. The Lower Elwha Klallam Tribe is named for their villages being located along the lower portions of the Elwha River since time immemorial. The lower lands surrounding the Elwha River, including the river mouth, were and remain the lands of the Elwha Klallam People. The Tribe opposed the blocking of the river by the dams and resulting detrimental impacts. The dams forced the river to be constrained, changing the natural flow, and prohibiting sediment flow through, which limited salmon spawning and rearing habitat as well as natural riverine processes. The Tribe's sacred creation site, a significant cultural place for the Elwha Klallam People, was also forced underwater and inaccessible for more than a century.

The Tribe maintained a steady call for dam removal. That voice continued to grow from the Tribe and environmentalists towards the end of the 1980's, as Chinook salmon stocks dwindled in the Elwha River and elsewhere across Puget Sound and the Salish Sea. Around the same time, the dams were nearing the end of their lifecycle. The cost of replacing the aging dams with new infrastructure and needed fish passage was enormous, and the electricity generated by the dams was replaceable by other sources.

The United States Department of the Interior and the National Park Service, along with the Lower Elwha Klallam Tribe and environmental groups, challenged the Federal Energy Regulatory Commission's authority to relicense the two dams in court, as the Glines Canyon Dam was located entirely within Olympic National Park and the Mills Reservoir actually flooded Park lands.

It took continued leadership and advocacy by the Lower Elwha Klallam Tribe, the Department of the Interior and the National Park Service, government officials, environmental groups, citizens, and others to encourage Congress to pass the Elwha River Ecosystem and Fisheries Restoration Act in 1992. The Act itself was essentially an out-of-court settlement of the earlier court challenge, removing the dam relicensing decision-making process from the Federal Energy Regulatory Commission and giving it to the Secretary of the Interior. Dam owners agreed to a buyout which allowed dam removal to proceed.


Photo by John Gussman

While the Elwha Act authorized dam removal and full restoration of the Elwha ecosystem and the salmon found there, new federal funding to pay for the full removal of both dams was not forthcoming.

The National Park Service's budget was not increased to pay for dam removal, but early planning and design funding in 1995 and subsequent years came from the National Park Service's line-item construction budget. This meant that National Park Service leadership made the decision that Elwha Dam removal was the highest priority within the National Park Service. As a result, other National Park Service projects across the country like construction of visitor facilities and other capital needs were put on hold for years to dedicate the funding needed for dam removal to proceed.

With that funding, the National Park Service, in coordination with the Lower Elwha Klallam Tribe and other federal partners, began working on the plans, permits, and studies needed prior to dam removal.

An additional funding allocation came in 2009, when the approximately $325 million still needed for dam removal was approved as part of a federal stimulus bill known as the American Recovery and Reinvestment Act. The Recovery Act, intended to create new jobs following the recession of 2008, was passed by Congress, and signed by President Barack Obama.

Dam removal began in September of 2011 with the Lower Elwha Dam gone within six months. Work on the upper Glines Canyon Dam followed and was finished in 2014, allowing the Elwha River to flow freely once more. At that time, it was the largest dam removal project of its kind in world history. The removal of the dams began the process of restoring natural flow and habitat, but recovery of salmon species and complete ecosystem restoration will take some time.

Appendix C: Chinook Salmon (Oncorhynchus tshawytscha) Population Status

Life History Summary

Elwha River Chinook salmon are a unique, distinct population which is part of the Puget Sound Chinook Evolutionary Significant Unit (ESU). Puget Sound Chinook salmon, including those inhabiting the Elwha Watershed, were listed as threatened under the Endangered Species Act in 1999. The Puget Sound Chinook Salmon Recovery Plan approved in 2007 includes a chapter focused on the Elwha River. Puget Sound Chinook cannot be delisted without recovery of Elwha River Chinook salmon.

The Elwha River Chinook salmon population was historically comprised of two sub-populations displaying different life history strategies: an early-timed spring population, and a late-timed summer/fall population. The early timed fish spawned in the upper reaches of the Elwha River and would spend a full year in the river prior to emigrating to the sea as yearling smolts, but this population has not been well represented since dam removal. The late-timed summer/fall population has been the dominant Elwha River Chinook salmon population since before the removal of the dams.

The National Marine Fisheries Service has defined a Viable Salmonid Population (VSP) as an independent population with a negligible or less than 5% risk of extinction in their natural habitat over a 100-year period (McElhany et al., 2000). Four VSP parameters are critical to determining viability status: abundance, productivity, spatial distribution, and diversity. The parameters, which can be measured over time as part of a recovery strategy, are addressed below.

Abundance

The term abundance is the number of fish that return to the rivers, both juveniles and adults. Adult escapement is the number of adults that have returned to the river spawning grounds, escaping commercial and sport fisheries. This includes hatchery and natural origin fish. The Elwha River Restoration Plan (Ward et al., 2008) included a Chinook restoration escapement goal of 6,900 spawners. In a separate management document, "Guidelines for Monitoring and Adaptively Managing Restoration of Chinook Salmon and Steelhead on the Elwha River" (EMAM) (Peters et al., 2014), restoration targets or "Chinook salmon triggers" were developed for abundance of natural fish following Elwha Dam removal. The triggers correlated to levels of recovery including Preservation, Recolonization, and Local Adaptation Phases and have corresponding escapement goals of 950; 4,340; and 10,000 respectively. These goals also reflect the intent that as natural origin fish increase and approach 10,000 fish, the corresponding hatchery origin fish will be reduced to zero.

Chinook escapement has historically been monitored by the Washington Department of Fish and Wildlife using spawning ground surveys, and more recently by the Lower Elwha Klallam Tribe using SONAR for the past 13 years. Escapement estimates of modeled potential Chinook spawners for the past 13 years are provided in Figure C1, which also identifies Chinook triggers for the Recolonization and Local Adaptation phases.

Photo by John McMillan

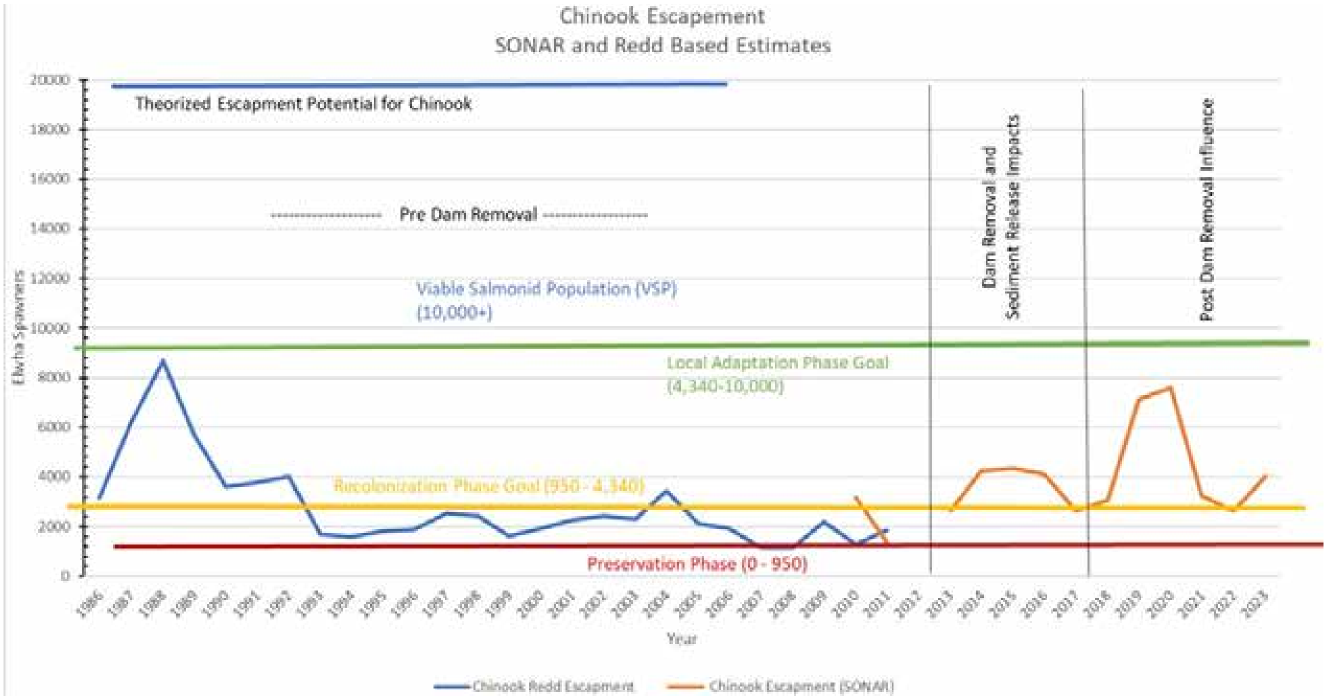


Figure C1. [1] Elwha River Chinook Salmon Escapement, derived from redd surveys and SONAR counts (Denton et al., 2023)

The 2022 Elwha River Chinook escapement estimate of 3,998 fish was the sixth highest return in the 13 years of SONAR data. The recent trend has been somewhat erratic, but when compared to pre-dam removal levels the overall trend has been positive. However, numbers are still short of the 10,000+ VSP goal.

Productivity

Questions regarding the recovery and trajectory of Elwha River salmon populations can be estimated through smolt enumeration. The Lower Elwha Klallam Tribe has monitored smolt outmigration of Chinook and other salmon species for the past 17 years. Based upon their data, one cannot only estimate abundance and productivity of recruits per spawner, but also gain insights into life history traits such as smolt outmigration timing and smolt size at outmigration (McHenry et al., 2023b). The juvenile Chinook productivity, expressed as the number of smolts produced per female, has increased in the Elwha River following dam removal: the pre-dam removal, during dam removal, and post-dam removal annual averages for smolts per female are 97, 66, and 172 smolts per female respectively (McHenry et al., 2023b). The four-year geometric mean for years 2019 – 2022 was 230 smolts per female. The four-year mean exceeds the productivity goal of 200 smolts per female for all phases of recovery. The overall abundance of Elwha River subyearling Chinook smolts in the pre-dam removal period was 48,185. The abundance during dam removal averaged 58,694 while average abundance has increased since dam removal to 311,357 (McHenry et al., 2023b). The trends over time are represented in Figure C2.

1 Note that the years 1986-1989 were aberrations, and that in years prior Chinook salmon redd escapement was in the 2000-3000 range (Pat Crain, Olympic National Park, personal communication, 2023).

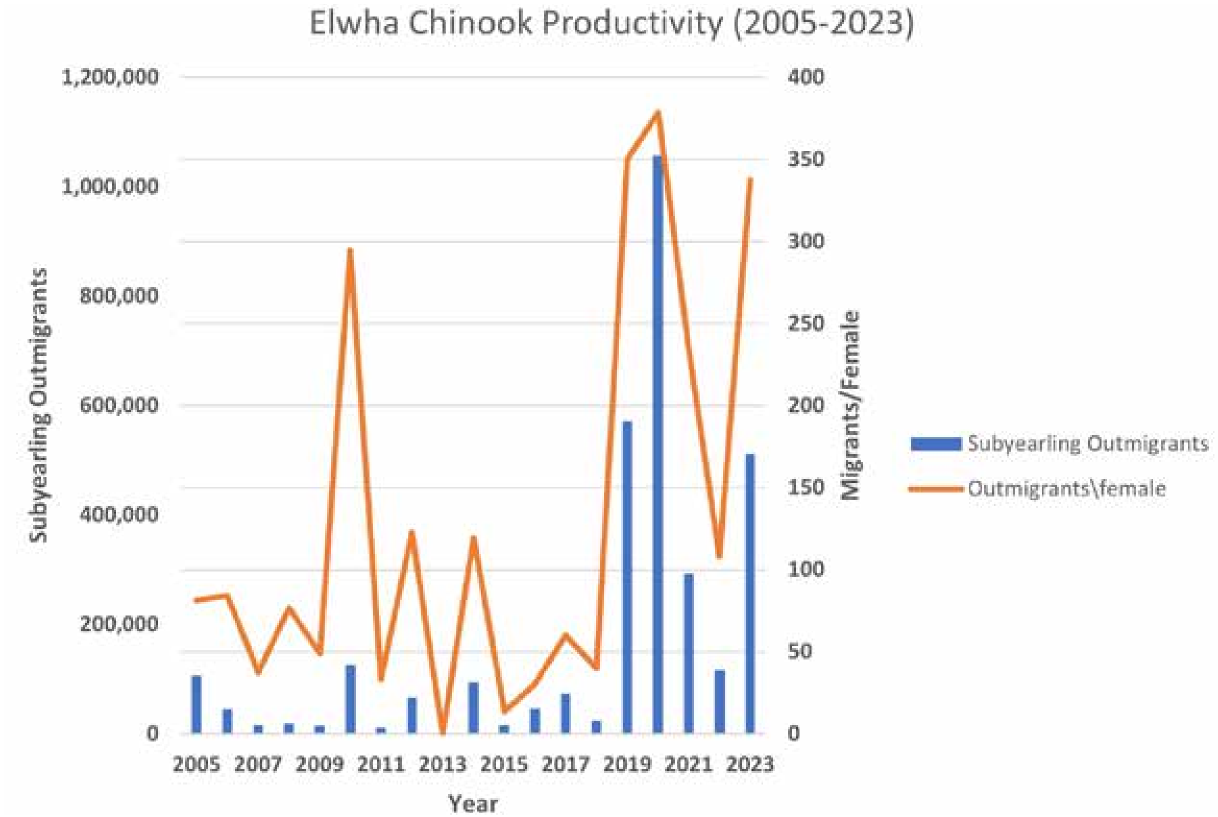


Figure C2. Elwha River Chinook Salmon Productivity (recruits per female) (McHenry et al., 2023b, used with permission)

Spatial Distribution

Monitoring the location of Chinook redds provides a useful metric for documenting re-occupancy success of adult salmonids to newly available habitat above the former dam sites. After removal of the Elwha Dam (River Kilometer [RKm] 7.9) and Glines Canyon Dam (RKm 21.7), there was uncertainty as to how quickly salmonids would reoccupy habitats above these former barriers. The Elwha Chinook population at the time of dam removal was dominated by hatchery-produced summer/fall life histories. The historical spring-timed life history that likely utilized the upper watershed was not well represented at the onset of dam removal (National Park Service, 2015a). Chinook salmon immediately migrated upstream past the former Elwha Dam site to reoccupy the middle Elwha River, including Little River and Indian Creek (McHenry et al., 2023a). Chinook salmon redds have consistently been observed in the middle Elwha River, above the historical Elwha Dam site (RKm 7.9), below the former Glines Canyon Dam site (RKm 21.7), and in the reach occupying the former Lake Mills above Glines Canyon (RKm 21.5). Approximately 90% of the observed redds have been in the Elwha mainstem, with the areas of greatest density of redds occurring in the Elwha Ranger Station Reach (RKm 17.8); downstream of the Glines Canyon Dam powerhouse (RKm 21); the former Aldwell Reservoir (RKm 8.8 - 11.0); and Indian Creek (RKm 12.1), a tributary to the Elwha that drains Lake Sutherland.

Following the removal of Glines Canyon Dam, which occurred between 2011 and 2014, small to moderate numbers of Chinook salmon redds have been identified upstream of the former dam site. The majority of these fish have utilized the former Mills Reservoir for spawning sites. Few Chinook salmon redds have been observed in the Elwha headwaters above the Grand Canyon to date. Additionally, a new issue has been identified in Rica Canyon, where a low flow barrier exists for Chinook (McHenry et al., 2023c); more research is needed to determine whether this is a natural barrier.

Work performed by Duda et al. (2021) using eDNA sampling and analysis techniques has also documented the spatial distribution of Elwha River salmonids. This method looks for residual DNA in the water samples and provides a snapshot of presence or absence in the reach and does not indicate density. The results for historic, pre-dam, and post-dam removal geographical distribution of Chinook in the Elwha River are provided in Figure C3.

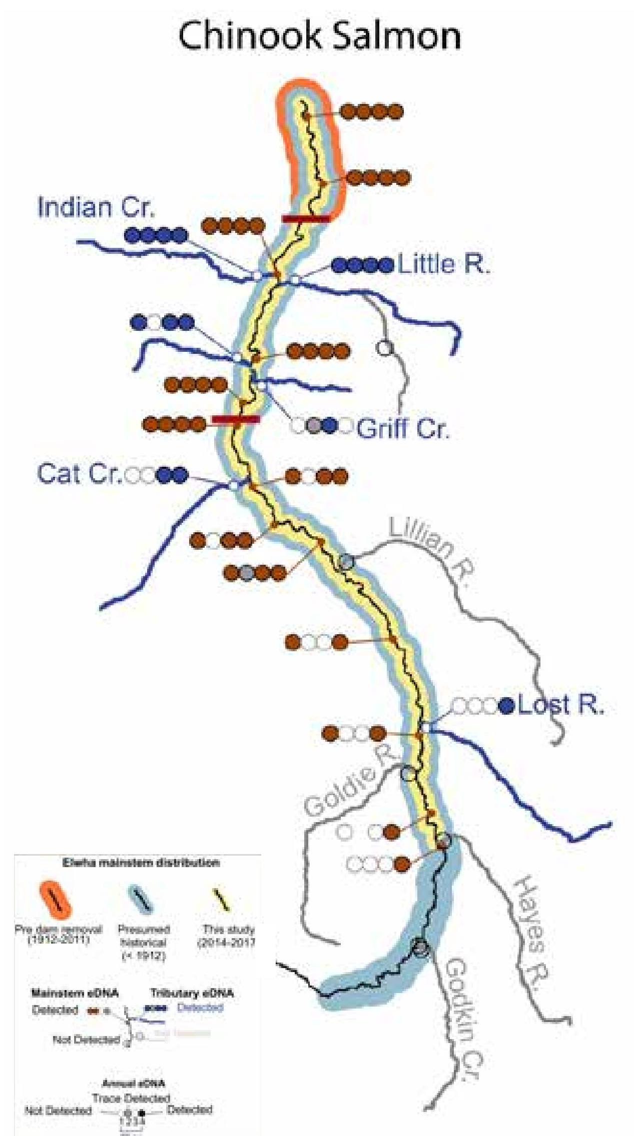


Figure C3. Chinook Salmon Geographical Distribution in Elwha River (Duda et al., 2021, used with permission)

Diversity

The VSP parameter of diversity captures the unique and varied life history strategies of a given salmonid stock. It can involve factors such as timing, age, and size for smolt outmigration. As previously mentioned, the Chinook salmon of the Elwha River expressed two outmigration strategies. An outmigrating juvenile that has recently hatched and emerged from the redd gravels and immediately heads downriver on the journey to the ocean is called a 0-age ocean smolt or subyearling. This contrasts with a juvenile that spent a year rearing in the river prior to beginning its journey to the ocean, which is referred to as a 1-year smolt or yearling. Interestingly, the Salish Sea Marine Survival Project (Pearsall et al., 2021) found that Chinook salmon yearlings migrating out at 1 year have higher marine survival rates than subyearlings (Pearsall et al., 2021). Based on research conducted in other Puget Sound river systems, this life history strategy may increase early marine survival and overall life history diversity (Pearsall et al., 2021).

During ocean residence and migration, salmon can express different ages at maturity. Most Elwha River Chinook return at age three or four. However, some fish return to the Elwha River as two-year-olds (jacks) and some as five-year-olds. A very small proportion return at age six years (Weinheimer et al., 2018).

During the 1950's, the Washington Department of Fish and Wildlife Hatchery complex manager recorded harvesting a number of fish from the Elwha River in excess of 100 pounds (Roni and Quinn, 1995). Today's fish typically range in size from approximately 20 - 30 pounds, with the occasional fish of more than 50 pounds and several fish estimated at around 75 pounds only a few years ago. The size distribution before the dams is still unknown. It is anticipated that natural rearing, exposure to natural selection, and access to cold condition rearing in the upper watershed will result in the re-expression of a broader range of life history strategies and resulting phenotypes, which may include large body size being expressed over time. However, the likelihood of older and larger fish returning to the river is reduced by harvest and adverse ocean conditions. It is interesting to note that work by Roni and Quinn (1995) found no apparent differences in size (mean length at marine age) between stream-type (yearling) and ocean-type (subyearling) life histories with variations up to 26 centimeters. This indicates that the final size and date of ocean entry of outmigrating smolts (0-age and one-year smolt) did not necessarily correlate with adult size. However as noted above, research from other regional salmon stocks indicates that yearlings (one-year smolts) do have a higher rate of marine survival (Pearsall et al., 2021).

Another unique attribute of the Elwha River Chinook salmon is their place in the Puget Sound Chinook salmon ESU and linkage to the Coastal Chinook ESU. An ESU is a population or group of populations of Pacific salmon that is "substantially reproductively isolated from other conspecific populations and that represents an important component of the evolutionary legacy of the species" (NOAA, 2022). Elwha River Chinook salmon exhibit certain traits that are attributable to both the Puget Sound and Coastal ESUs but have been determined by NOAA to be more closely related to the Puget Sound Chinook salmon ESU (NOAA, 2023). Migration behavior is similar to both the Coastal ESU and the Puget Sound ESU, with some of the Elwha River fish migrating far north in the Eastern Pacific Ocean while others are more resident in nature (Shared Strategy for Puget Sound, 2007).

Morse Creek, a smaller river located a few miles east of the Elwha River, also once supported a Chinook salmon early spring return timing, although that stock is now extirpated (Mike McHenry, Lower Elwha Klallam Tribe, personal communication, 2023). It is unknown whether the Morse Creek population was linked to the Elwha River population, but the co-managers have listed the Morse Creek and Elwha River stocks as a single population (WDFW and WWTIT, 1994). During dam removal, Morse Creek was used as an Elwha River Chinook salmon safety net, in that a temporary rearing and egg-take facility was established. In this way, the distinct Elwha River Chinook salmon species was protected in case the release of sediment during dam removal was fatal to Chinook salmon in the river (see Figure C4 for turbidity levels). The Chinook salmon that returned to Morse Creek were captured at a weir site near the facility and were incorporated as brood stock for the Elwha River Hatchery program. The weir was maintained for several years after the final release to ensure no adults from the Elwha River program made it upstream to spawn in Morse Creek, keeping the Elwha River Chinook salmon species unique.

The data provided in Figure C4 illustrates the turbidity levels over time of the dam deconstruction and removal at the surface water diversion station in Formazin Nephelometric Units (FNU), a measure of Total Suspended Solids (TSS). Values above 1,000 and 100 FNU were used as the standard to measure levels that were directly lethal or harmful to fish, respectively. Also, it is interesting to note the equipment used to measure FNU maxed out at 1,500 FNU, and from the graphic it is evident that on more than one occasion FNU values exceeded quantification. From 2011 through 2016 (smolt year 2017), there were extended periods of time when the FNU/TSS were above lethal levels for fish, and except for the summer months, TSS exceeded harmful levels. These high levels were due to the release of sediment during and after the dam removal, which occurred between 2011 and 2014 (Roger Peters, United States Fish and Wildlife Service, personal communication, 2023).

Photo by Dave Shreffler

Photo by John McMillan

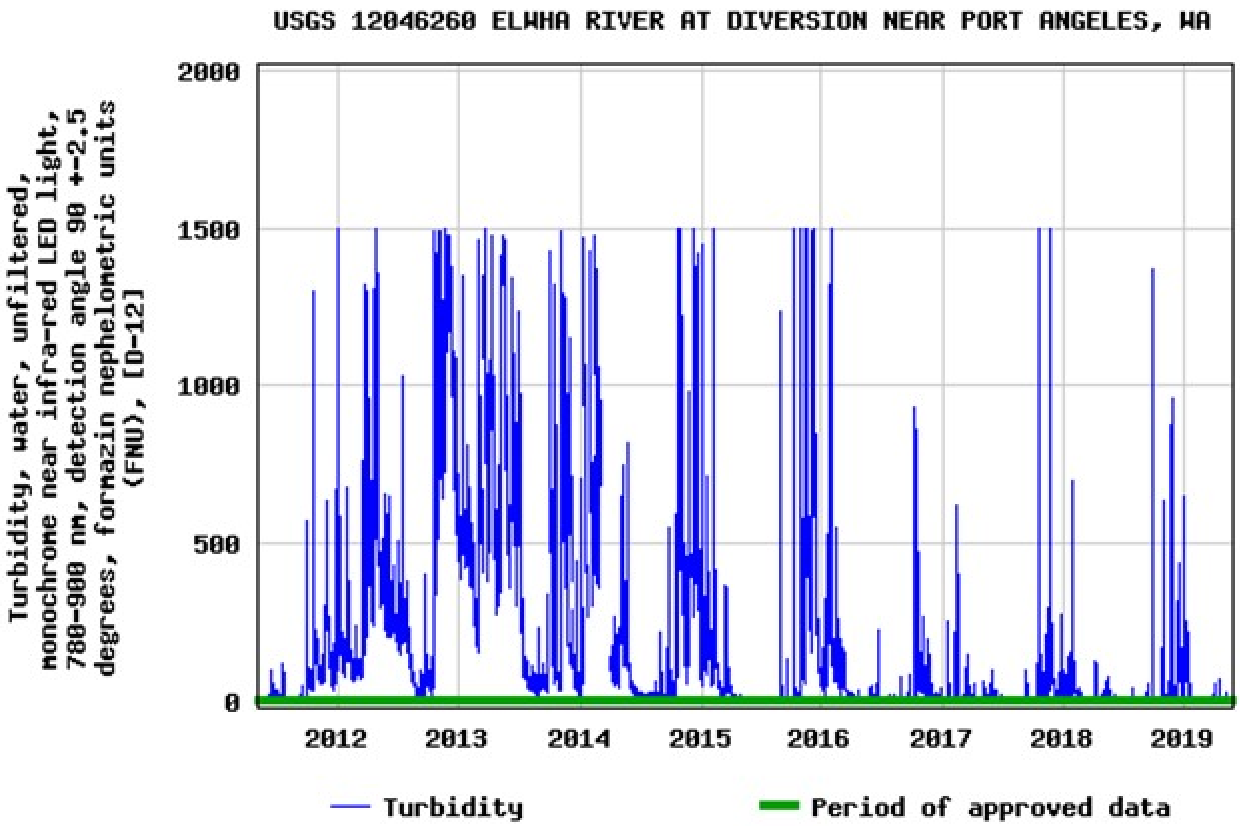


Figure C4. United States Geological Survey TSS Data

Chinook to date have achieved the Preservation Phase of the "Guidelines for Monitoring and Adaptively Managing Restoration of Chinook Salmon and Steelhead on the Elwha River" (EMAM) goals for abundance, productivity, spatial distribution, and diversity (Peters et al., 2014). The VSP parameters of abundance, productivity and spatial distribution are approaching the Recolonization Phase.


Photo by Rebecca Mahan

Appendix D: Steelhead and Rainbow Trout (Oncorhynchus mykiss) Population Status

Life History Summary

The Elwha Watershed is home to Steelhead and Rainbow Trout, both of which are parts of the same species known as Oncorhynchus mykiss. Steelhead are anadromous, meaning they go out to sea where they spend time before returning to their natal streams to spawn. Rainbow Trout spend their entire lives in freshwater. Steelhead and Rainbow Trout exhibit over 30 different life history strategies and run timings, including precocial freshwater maturation and in the case of Rainbow Trout, life-long freshwater residency (Shapovalov and Taft, 1954). In comparison, most other salmon species generally exhibit fewer life histories.

Both Steelhead and Rainbow Trout display variation in years to maturation. Once at sea, Steelhead may spend anywhere from a few months to five years before attaining maturity and returning to spawn (Pautzke and Meigs, 1940; Burgner et al., 1992; Busby et al., 1996). Intermixing among life history strategies and cohorts is common once they reach spawning grounds, and a single redd can produce both resident and anadromous offspring (Ruzycki et al., 2003; Marshall et al., 2006). Steelhead are known to migrate farther upstream into a river system than other salmonids (WDFW and WWTIT, 1994; Quinn, 2005). Steelhead also commonly spawn in gravel stream bottoms within the tailouts of pools and in riffles (Needham and Taft, 1934; Shapovalov and Taft, 1954).

Photo by John McMillan

Unlike other salmon that are semelparous, meaning they spawn only once in a lifetime, have high fecundity, and can return as adults in large numbers, Steelhead are iteroparous, meaning they have multiple reproductive cycles with numerous life history types, and typically do not return in large numbers. While most salmon generally return and spawn over a relatively short timeframe in spring or fall, Steelhead return to spawn throughout the year. While other salmon species use the nearshore habitats for rearing during their seaward migrations, Steelhead tend to pass through estuarine and nearshore areas relatively quickly, use offshore migration pathways, and are typically found near the surface of the water column (Blanton et al., 2011).

Historically, Elwha River Steelhead displayed varied life history strategies, with fish entering the system throughout the year (Denton et al., 2022). After dam construction and hatchery Steelhead supplementation, the diverse river entry timing and life history types were reduced and simplified. Despite this, all the genetic potential and legacy remained in the Rainbow Trout above the dams (Hiss and Wunderlich 1994; Phelps et al., 2001). During dam removal, the Elwha River Steelhead population was comprised primarily of a non-native, early timed summer hatchery run from Chambers Creek stock, and a very depressed native winter run (Denton et al., 2022), with the two runs overlapping from late December through March. In 2011, the Chambers Creek hatchery program was terminated and replaced with a native Elwha River broodstock program run by the Lower Elwha Klallam Tribe. There was also a hatchery supplementation of summer-timed Skamania stock of about 20,000 fish outplants per year, a program that has since been discontinued (Ward et al., 2008).

In terms of Distinct Population Segments, the Elwha River is home to both Puget Sound Steelhead, which are listed under the Endangered Species Act, and Olympic Coastal Steelhead, currently being reviewed for potential ESA listing.

Prior to dam removal, the Steelhead populations of both winter and summer runs were severely depressed with an estimated annual escapement of the natural-origin Elwha River winter run Steelhead population at approximately 100–200 fish (Ward et al., 2008). The estimate of summer run Steelhead was uncertain and noted that it was at critically low abundance levels (Ward et al., 2008).

The National Marine Fisheries Service has defined a Viable Salmonid Population (VSP) as an independent population with a negligible or less than 5% risk of extinction in their natural habitat over a 100-year period (McElhany et al., 2000). Four VSP parameters are critical to determining viability status: abundance, productivity, spatial distribution, and diversity. The parameters, which can be measured over time as part of a recovery strategy, are addressed below.

Abundance

WINTER RUN STEELHEAD ABUNDANCE

SONAR has been used to enumerate winter-timed (late January through early June) adult Steelhead abundance since 2013. In general, abundance has increased over this time (see Table D1 and Figure D1). The latest SONAR-based winter run Steelhead escapement estimate was 2,519 adults (Denton et al., 2022).

The table below shows the yearly escapement estimates for Elwha River winter run Steelhead with 95% confidence intervals. A confidence interval is a way to estimate a range of values that is likely to contain an unknown population parameter. For 2014 through 2018, the number of natural-origin recruits (NOR) and hatchery-origin recruits (HOR) adults in the return was calculated based on species composition sampling. These estimates are likely biased and do not accurately reflect the actual abundance of each group since sampling occurred near the hatchery where HOR Steelhead appear to congregate (Peters et al., 2022). However, the years 2019 through 2022 were based on a robust sampling protocol intended to estimate %NOR fish (Peters et al., 2022; Denton et al., 2022).

Year	Estimate	95% CI	NOR	HOR	% NOR
2013	385	NA	NA	NA	NA
2014	1,200	1,140 - 1,250	400	800	33%
2015	1,450	1,220 - 1,675	190	1,260	13%
2016	890	810 - 976	320	570	36%
2017	1,130	1,060 -1,226	375	755	33%
2018	1,625	1,489 -1,768	731	894	45%
2019	1,458	1,260 - 1,666	875 - 1,020	437 - 583	60% - 70%
2020	1,985	1,765 - 2,231	1,151 - 1,806	175 - 834	58% - 91%
2021	2,293	2,074 - 2,523	803 - 1,560	733 - 1,490	35% - 68%
2022	2,519	2,409 - 2,639	1,500 - 2,230	199 - 1,029	59% - 93%
2023	1,948	1,905 - 1,991	1,268	680	65%

Table D1. Winter Run Steelhead Escapement Estimates (Denton et al., 2022, used with permission)

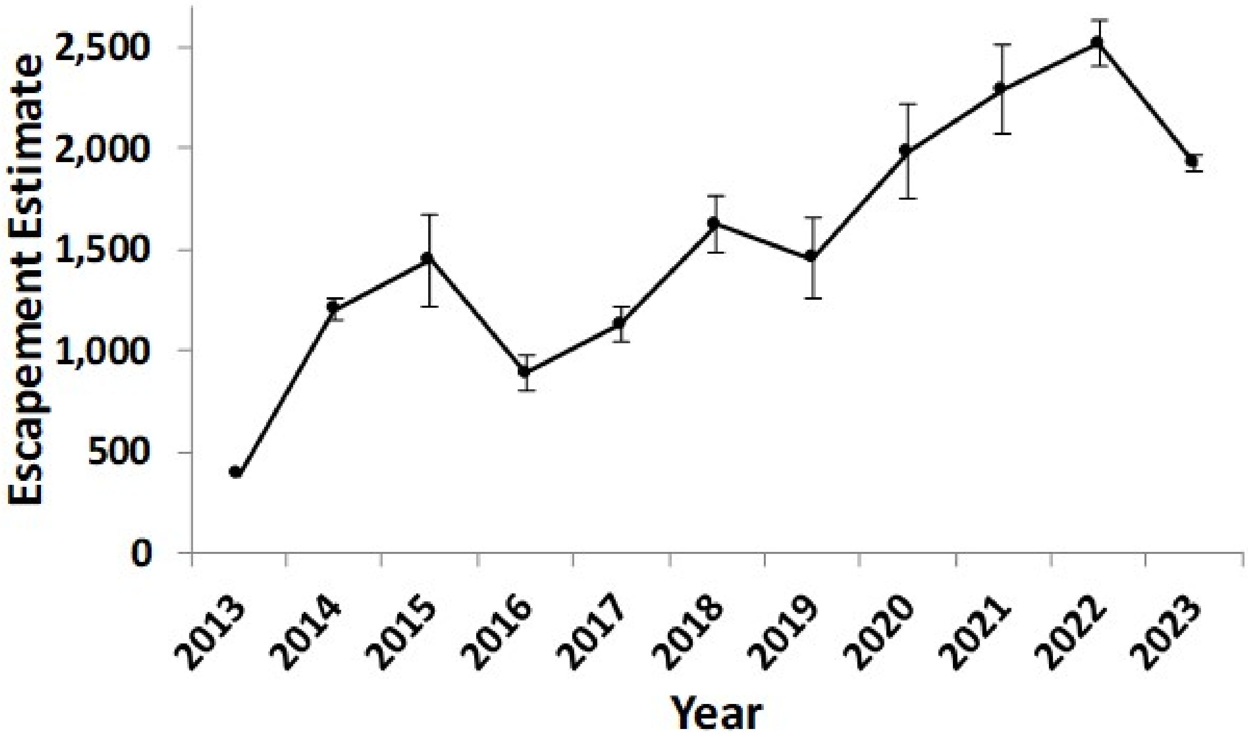


Figure D1. Winter Run Steelhead Escapement Estimate as measured with SONAR (Denton et al., 2022, used with permission)

The figure above shows winter run yearly escapement estimates at 95% confidence intervals for Steelhead in the Elwha River from 2013 through 2022. No confidence interval was calculated for 2013 (Denton et al., 2022).

SUMMER RUN STEELHEAD ABUNDANCE

Prior to the removal of the dams, summer run Steelhead were among the rarest anadromous fish in the river (Peters et al., 2021). However, in surveys that followed dam removal, significant numbers of summer run Steelhead were observed, with the highest densities found in the upper river above Grand Canyon (Peters et al., 2021). For the last several years, peak counts of between 200 and 300 summer steelhead were observed by snorkel survey above Rica Canyon (Pat Crain, Olympic National Park, personal communication, 2023). Contributing factors to their rapid recovery include the potential emigration from upstream Rainbow Trout, access to the cold-water habitat in the upper river, and the commercial and recreational fishing moratorium that was in place since 2011 (Peters et al., 2021).

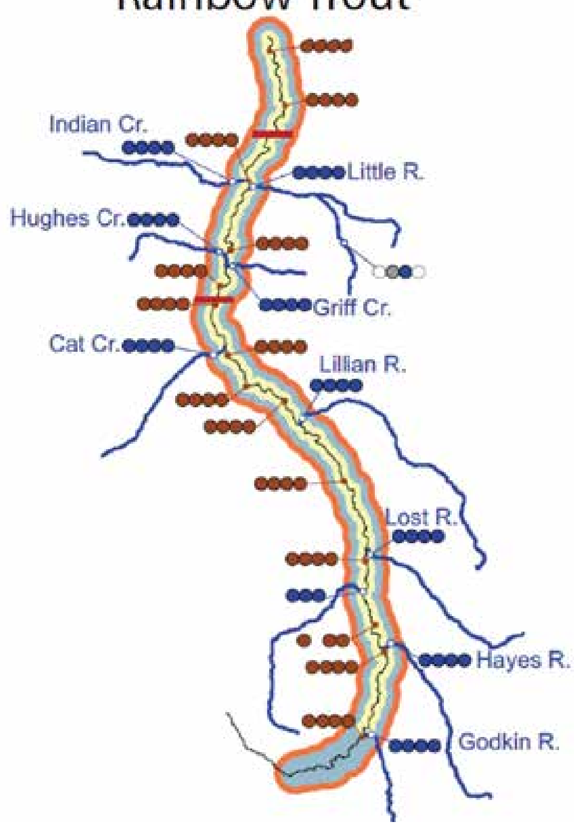
Productivity

Although occasionally caught in beach seine surveys, Elwha River mainstem Steelhead typically do not lend themselves to capture during their outmigration due to their larger size and ability to avoid screw traps. In addition, confounding factors regarding their life history diversity with the potential of both Steelhead and resident trout emerging from the same redd make classic recruits per spawner estimates difficult to calculate. Researchers from the Lower Elwha Klallam Tribe have had some success in capturing Steelhead outmigrants from Elwha River tributaries Indian Creek and Little River (Lower Elwha Klallam Tribe, 2023). Recent improvements to methodologies and trap site placement also look to be promising for future Elwha mainstem Steelhead outmigrant captures (Mike McHenry, Lower Elwha Klallam Tribe, personal communication, 2023). In 2022, Elwha River Steelhead smolt production was estimated at 4,741 (McHenry et al., 2023c). It was noted that this number should be considered as a minimum estimation due to the late date of trap installation, in addition to the number of missed days (McHenry et al., 2023c). Positive trends in Steelhead outmigrant numbers are indicated by positive trends in numbers of returning adults, as estimated by SONAR and snorkel surveys (McHenry et al., 2023c).

Spatial Distribution

Spatial distribution of Steelhead by life history type is difficult to assess because the distribution of winter run fish is clouded by summer fish spawning in the system (Roger Peters, United States Fish and Wildlife Service, personal communication, 2023). However, the general distribution of summer Steelhead has been documented (Duda et al., 2021), although their specific spawning distribution has not. The same would be true for resident Rainbow Trout (Roger Peters, United States Fish and Wildlife Service, personal communication, 2023).

The spatial extent of fish passage by adult summer Steelhead increased by 60 kilometers (km) after dam removal (Duda et al., 2021). In fact, following dam removal, an increasing number of summer Steelhead have been identified in the lower, middle, and upper river during the summer months (Duda et. al., 2021). The spatial extent of Rainbow Trout has remained unchanged after dam removal; however, their total abundance has increased, and densities shifted from the lower 25 km of the river to the upper 40 km of the river (Duda et al., 2021). The spatial distribution of Rainbow Trout has been documented by Duda et al. (2020) using eDNA sampling and analysis techniques.



Diversity

It is exciting to report that despite large population declines of Steelhead after dam construction, there was no shift detected in population genetic diversity or allele frequencies of commonly accepted positions involved in migratory phenotypic variation (Fraik et al., 2021). Allele frequencies are gene frequencies shown as a fraction or percentage and at a particular place in a population. Furthermore, Steelhead descendants from formerly below- and above-dam populations recolonized the river rapidly after dam removal, suggesting that dam construction did not significantly reduce genetic diversity underlying the Elwha River Steelhead life history strategies (Fraik et al., 2021). In fact, adult Steelhead cohorts returning to upstream areas of the Elwha River to spawn following dam removal were primarily descendants of below-dam populations (Fraik et al., 2021). However, outmigrating smolt cohorts had increased proportions of genetic ancestry from the above- and in-between-dam populations (Fraik et al., 2021). This is a tribute to the remarkable adaptability and life history diversity of Steelhead and Rainbow Trout, and evidence that the winter run Steelhead, summer run Steelhead, and Rainbow Trout appear to be spawning together and producing viable offspring. The recovery of Oncorhynchus mykiss in the Elwha River since the removal of the dams should also give hope to additional groups considering dam removal and associated restoration efforts on other rivers.

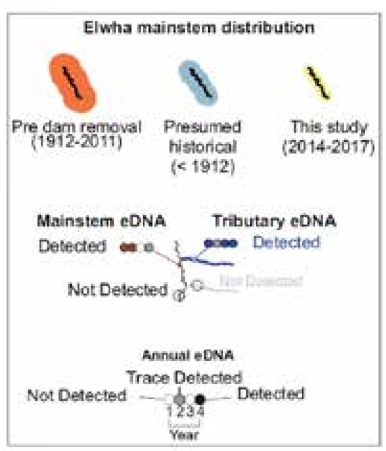


Figure D2. Rainbow Trout Geographical Distribution in Elwha River (Duda et al., 2020, used with permission)

Appendix E: Bull Trout (Salvelinus confluentus) Population Status

Life History Summary

Bull Trout occupy the mainstem Elwha River channel from the mouth to headwaters (DeHaan et al., 2011), and are also found in numerous tributaries below anadromous barriers. They were listed as threatened in 1999 and have since been protected under the Endangered Species Act (National Park Service, 2015b). Bull Trout recovery is managed by the United States Fish and Wildlife Service but benefits from restoration efforts for Chinook. It is important to note that the Coastal/Puget Sound distinct population segment of Bull Trout in Washington State is "considered to be significant to the species as a whole because it is thought to contain the only forms of Bull Trout in the coterminous United States that migrate to saltwater for a portion of their life cycle (United States Fish and Wild Service, 2015)." According to the Recovery Plan for the Coterminous United States Population of Bull Trout (Salvelinus confluentus) (2015), two requirements must be met for Bull Trout status to be considered recovered. The first is that a minimum number of adult spawners in the core area (defined as "the population units that are necessary to provide for bull trout biological needs in relation to genetic and phenotypic diversity, and to spread the risk of extinction caused by stochastic events") is required to avoid the deleterious effects from genetic drift, which speaks to the disappearance of particular genes as individual fish die or do not reproduce; the second is that the population size of the localized spawning populations must be sufficient to minimize inbreeding effects. The Elwha River Restoration Plan adopted the United States Fish and Wildlife minimum population size of between 500 and 1,000 individuals and a minimum population size of 50 to 100 adults for localized populations (Ward et al., 2008). Olympic National Park developed a Bull Trout protection and restoration plan (Crain and Brenkman, 2010), as required by the United States Fish and Wildlife Biological Opinion for the Elwha Project, which outlined a strategy to protect Bull Trout during the removal of the two Elwha River dams. This plan identified short-term objectives to minimize mortality and protect genetic diversity during dam removal and included a detailed monitoring program and action strategy. Additionally, a key goal of the Elwha Project was to restore anadromous passage for all fish species in the basin. However, detailed guidelines and performance indicators were not developed.

Bull Trout exhibit both resident and migratory life history strategies; these forms can occur together, and offspring can exhibit any life history strategy (fluvial, adfluvial, or anadromous, Brenkman et al., 2008). The resident form spends its entire life in the river, spawning and rearing in tributaries or upper reaches of mainstem rivers, and has been observed spawning in multiple mainstem channels on the Olympic Peninsula including the Elwha River, North Fork Skokomish, Hoh, and Quinault rivers. Migratory Bull Trout also spawn in tributary streams or upper mainstem rivers, but after rearing in the river for one to four years, they will migrate to a lake (adfluvial form, Downs et al., 2006), the main river (fluvial form, Fraley and Shepard, 1989), or to saltwater (anadromous form, Brenkman and Corbett, 2005). Radiotelemetry work in the Hoh River by Brenkman et al. (2005) demonstrated that anadromous Bull Trout would make use of estuary, freshwater, and marine habitats and would even dip into non-natal estuaries and rivers to optimize winter refugia and foraging opportunities. The adfluvial Bull Trout was present in the Elwha River and migrated to the reservoir


Photo by John Gussman

prior to dam removal (Brenkman et al., 2019). However, without natural lakes or reservoirs following dam removal, there are no longer adfluvial fish in the system. Since dam removal, Bull Trout anadromy has been documented (Quinn et al., 2017).

Bull Trout are apex predators, opportunistically feeding throughout their life cycle. When young their diet is varied, consisting of terrestrial and aquatic insects, macro-zooplankton, and small fish. As they get older and larger, they become increasingly more piscivorous or fish-eating, feeding upon resident and anadromous salmonid species (United States Fish and Wild Service, 2015), sculpins, and minnows (Lowery and Beauchamp, 2015). While in estuaries and nearshore marine waters, they may feed upon a variety of forage fish, including Pacific herring (Clupea pallasi), Pacific sand lance (Ammodytes hexapterus), and surf smelt (Hypomesus pretiosus) (United States Fish and Wild Service, 2015). Prior to dam removal, the diet of large adult Bull Trout in the Mills Reservoir consisted largely of insects, indicating low productivity of the system, and likely contributing to the poor fitness of Bull Trout in the basin (Brenkman et al., 2019).

The National Marine Fisheries Service has defined a Viable Salmonid Population (VSP) as an independent population with a negligible or less than 5% risk of extinction in their natural habitat over a 100-year period (McElhany et al., 2000). Four VSP parameters are critical to determining viability status: abundance, productivity, spatial distribution, and diversity. The parameters, which can be measured over time as part of a recovery strategy, are addressed below.

Abundance

Prior to dam removal, Bull Trout were present upstream of the dams and in between the dams but were in low numbers (DeHaan et al., 2011; Brenkman et al., 2019; Duda et al., 2021). Low abundance of Bull Trout (1–4 fish/kilometer [km]) persisted downstream of the Elwha Dam (Corbett and Brenkman, 2012). It was theorized that these fish were sustained by fish passing over the dams (Corbett and Brenkman, 2012). Snorkel riverscape surveys prior to dam removal counted 117 in 2007 and 86 in 2008 (Duda et al., 2021), but have found higher densities of Bull Trout in nearly every section of the river than before dam removal, 264 in 2018 and 399 in 2019, with the highest densities shifting further upstream post dam removal.

Biologists have estimated that the total population of Elwha Bull Trout increased two to four times within a few years post dam removal (Duda et al., 2021). While full basin surveys have not been conducted since 2019, surveys completed in the upper watershed have been consistent with the 2018 and 2019 surveys (Pat Crain, Olympic National Park, personal communication, 2023).

Photo by John Gussman

Productivity

Regarding productivity, the United States Fish and Wildlife Service Recovery Plan recognizes that the population should be stable or increasing for Bull Trout recovery. It states that the measured trend of the population (whether the status population is increasing, decreasing, or remaining stable over time) must include concomitant population growth rate or productivity estimates. That is, for a population to be considered viable, its natural productivity needs to be sufficient for the population to replace itself from generation to generation (Ward et al., 2008). Elwha River Bull Trout, unlike other salmonid species, are not intensively monitored by screw traps, SONAR, redd counts, or carcass surveys, among others. However, radiotelemetry work and snorkel surveys post dam removal have shown a positive trend of increasing numbers and spatial distribution (Duda et al., 2021).

Spatial Distribution

Bull Trout have very specific habitat requirements that are often referred to as "the four Cs:" cold, clean, complex, and connected habitat. Their preferred water temperatures are below 59 degrees Fahrenheit, with spawning temperatures below 48 degrees Fahrenheit. In the Elwha River Basin, spawning has been observed from early October through November, although detailed information on spawn timing in the river is not available. Due to cold water requirements, it is presumed that the preferred spawning habitat would be found in the upper river basin above both dam sites; however, Bull Trout were observed to spawn periodically in Hughes Creek and Griff Creek, tributaries to the Elwha River between the two dam sites, through 2020. Additionally, Bull Trout spawning was confirmed in Boulder Creek in 2020.

Work performed by Duda et al., 2021 using eDNA sampling and analysis techniques have also documented the spatial distribution of Elwha River salmonids, as illustrated in Figure E1. This method looks for residual DNA in the water samples and provides a snapshot of presence or absence in the reach and does not indicate density. This work identified the presence of Bull Trout throughout most of their presumed former range in the mainstem channel and upriver tributaries.

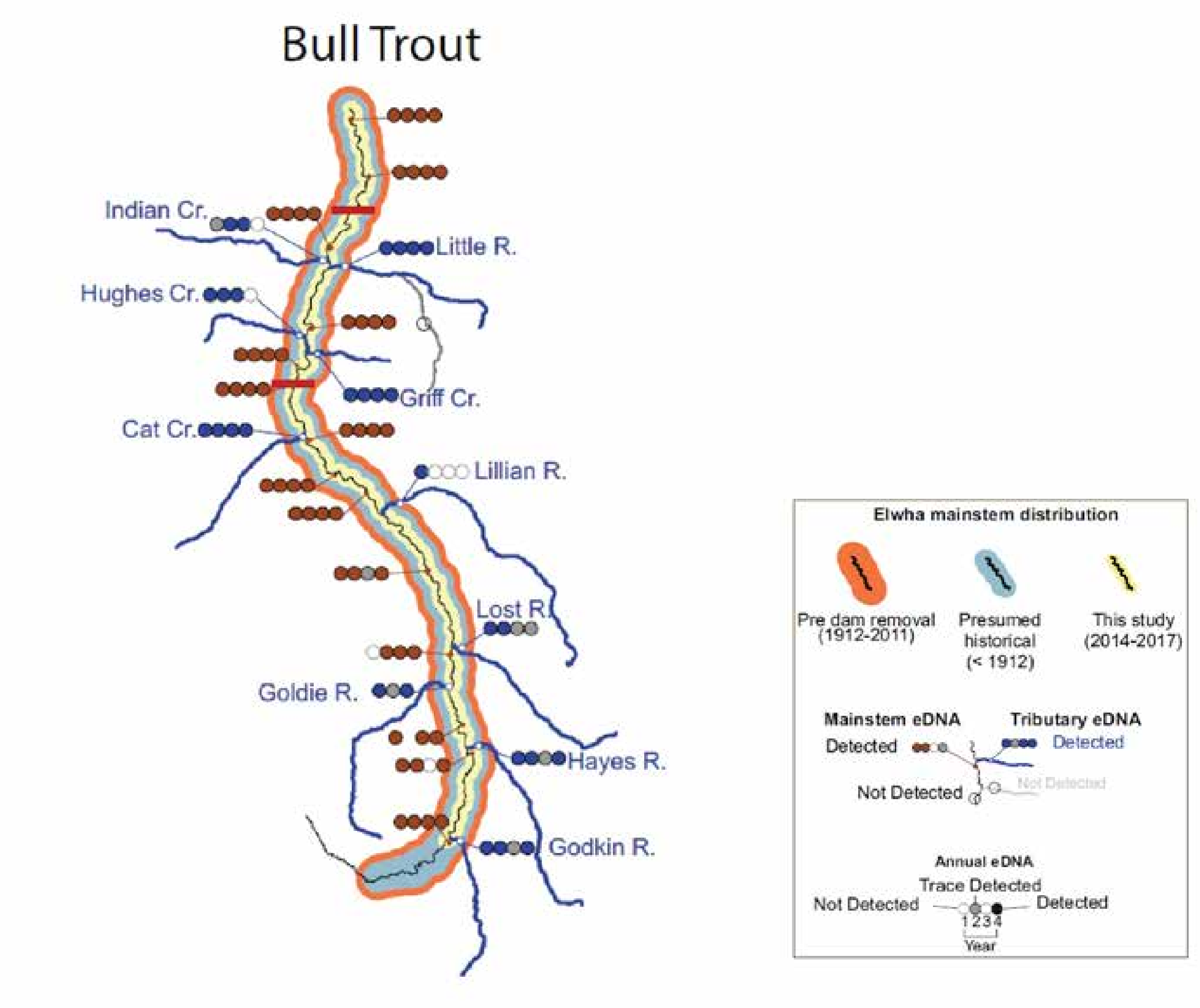


Figure E1. Bull Trout Geographical Distribution in the Elwha River (Duda et al., 2021, used with permission)

Bull Trout were among the first of the Pacific salmonids to access headwaters post dam removal (Brenkman et al., 2019). Telemetry data showed that spatial extent and mean distance traveled upriver has increased annually. Adult Bull Trout were recorded in headwaters within three years post dam removal (Brenkman et al., 2019). Furthermore, radio telemetry data recorded Bull Trout migrating between the estuary and river at a distance of up to 168 km (Brenkman et al., 2019).

Diversity

Bull Trout genetic studies have demonstrated that Elwha Bull Trout represent an independent spawning population and were highly differentiated from other populations on the Olympic Peninsula (DeHaan et al., 2011). Genetic research also showed that despite long-term fragmentation caused by the Elwha dams, there was no significant genetic variation among Elwha Bull Trout separated by the dams (DeHaan et al., 2011). After dam removal, stable isotopes of nitrogen and carbon were analyzed in Bull Trout to investigate their utilization of marine habitats. Despite the majority of the population being locked above the dams for over a century, Bull Trout rapidly resumed anadromy and foraged upon marine prey as an important component to their diet (Quinn et al., 2017). The size of Bull Trout (measured by length at age) significantly increased after dam removal (Brenkman et al., 2019). Researchers noted that Bull Trout captured before and after dam removal were larger at similar ages in comparison with migratory populations throughout their range (Brenkman et al., 2019).

In addition to an apparent increase in abundance of Elwha River Bull Trout following dam removal, persistent distribution throughout the accessible basin, and adequate genetic diversity, the fitness of individual fish has improved with the restoration of the anadromous life history and increased abundance of other salmonid species above the former dam sites (Brenkman et al., 2019). Fish fitness is strongly correlated with population viability, as healthier fish tend to be more fecund, produce larger eggs, have better swimming and leaping ability, express broader life histories, and have generally higher survival rates. For these reasons, Brenkman et al. (2019) indicated that Elwha River Bull Trout seem to be on the path to recovery following dam removal.


Photo by John Gussman

Appendix F: Instream Wood Mainstem

The graphic below describes the number of log jams/ kilometer for different levels of mean annual flow (cubic feet per second). The graphic is applicable to the Elwha mainstem and provides the numeric value of log jams for the Elwha instream habitat wood goal. The log jam values are for four different jam types. As an example, the box in the graph details specific values for Ranney Reach.

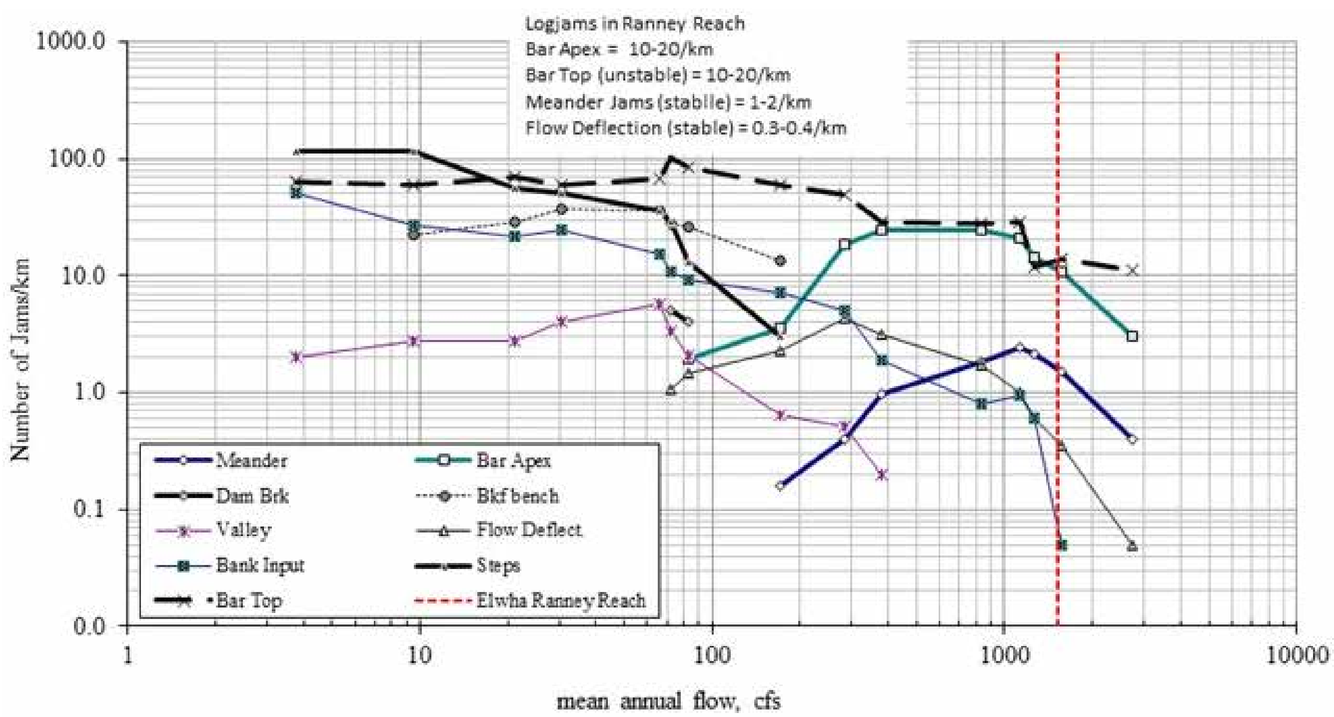


Figure F1. Number of Log Jams for Mean Annual Flow Levels (source: Tim Abbe at Natural Systems Design, used with permission)

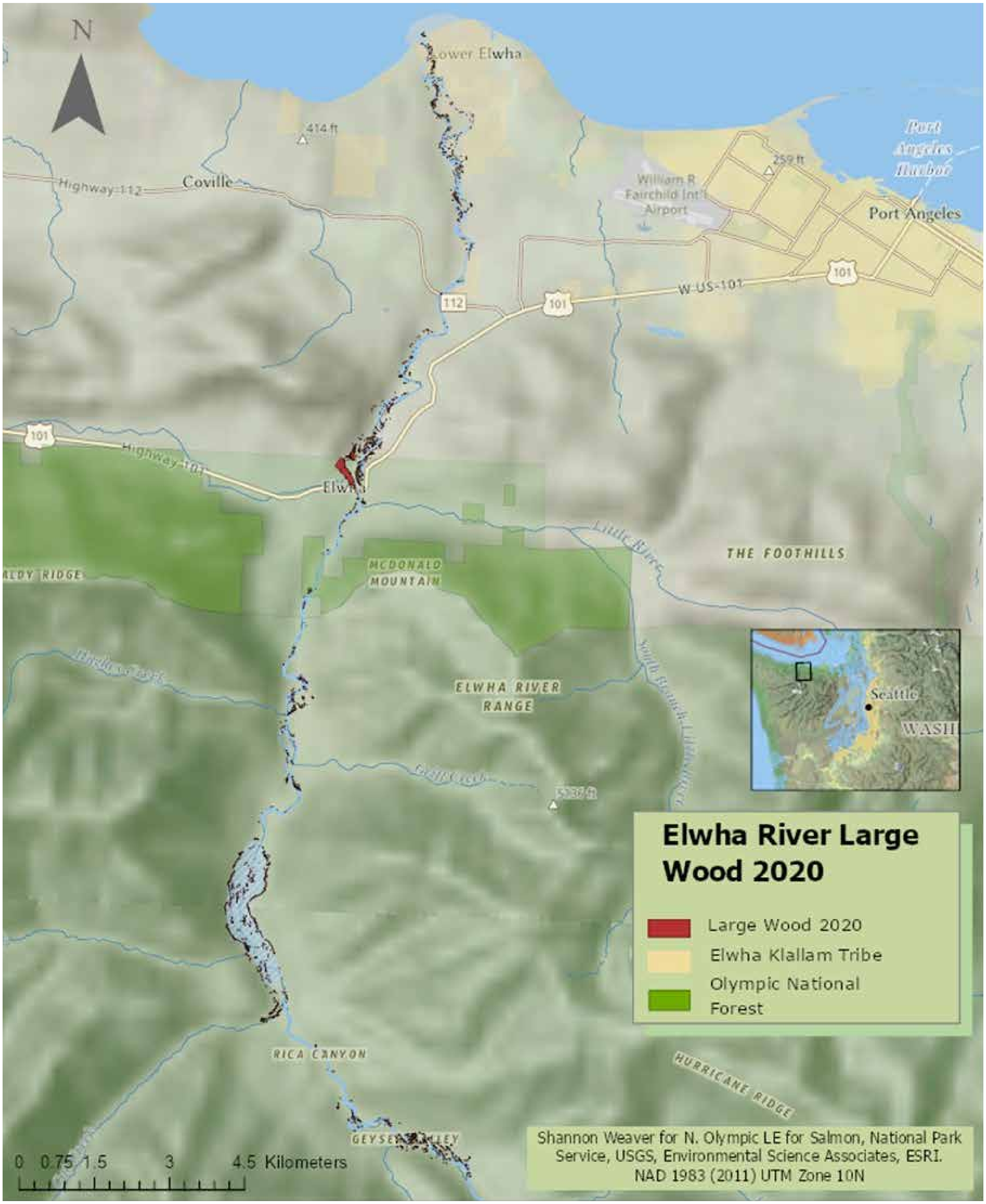


Figure F2. Elwha River Large Wood 2020 (source: North Olympic Lead Entity for Salmon)

Appendix G: Elwha Culvert List

Street Name	Tributary	Passability (%)	WDFW PI Index	Total Barrier Below? Y or N or U	Lineal Gain (m) of 2% Channel-Potential	Lineal Gain (m) of 4% Channel-Potential	Lineal Gain (m) of 16% Channel-Potential	Score	Habitat Assessment?	WDFW ID
Olympic Hot Springs Rd	Trib to Elwha River	33		N	300	360	1095	26.09	Yes	
Little River Rd	Trib to Little River	0		N	0	0	2490	24.39	No	
Olympic Hot Springs Rd	Madison Creek	0		U	0	138	138	18.84	No	
Power Plant Rd	Trib to Elwha River	0		Y	0	480	2600	6.62	Yes	931054
Okerman Rd	Trib to Elwha River	0	1.51	Y	0	0	1755	5.81	Yes	995556
Lower Dam Rd	Trib to Elwha River	0	2.57	Y	0	0	1545	5.79	Yes	995554
Old State Rd	Trib to Indian Creek	33		U	0	515	750	5.51	No	
Old State Rd	Trib to Indian Creek	33		Y	910	1125	1215	4.83	No	
Olympic Hot Springs Rd	Trib to Elwha River	0		N	0	0	50	4.52	No	
Herrick Rd	Trib to Elwha River	33		U	0	0	385	4.28	No	
Olympic Hot Springs Rd	Trib to Elwha River	0		N	0	0	40	4.28	No	
Little River Rd	Trib to Little River	0		Y	0	0	15	2.81	No	
Olympic Hot Springs Rd	Trib to Elwha River	67		N	0	0	15	2.54	No	

Figure G1. Elwha Priority Culvert List (source: North Olympic Peninsula Lead Entity for Salmon, Inventory of Clallam County Road Culverts)

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Photo by North Olympic Lead Entity for Salmon