UPPER COLUMBIA SALMON RECOVERY BOARD

HARVEST

BACKGROUND SUMMARY

JUNE 2020

Compiled by:
Greer Maier
Upper Columbia Salmon Recovery Board

DRAFT

THIS DRAFT IS INTENDED FOREGON DISCU.S.SION AND REVIEW PURPOSES ONLY. ALL DISCUSSION AND ANALYSES SHOULD BE CONSIDERED PRELIMINARY. PLEASE DO NOT DISTRIBUTE.

On the cover (clockwise from left): *Lower Columbia recreational fishery (photo: NWPCC); Upper Columbia conservation fishery (photo: UCSRB); and Lower Columbia treaty platform fishery (photo: CRITFC)*

Citation: Maier, G. 2020. Upper Columbia Salmon Recovery Board Harvest Background Summary. Upper Columbia Salmon Recovery Board. https://www.ucsrb.org

Acknowledgements

Upper Columbia Salmon Recovery Board Members

Commissioner Doug England, Chair, Chelan County
Chuck Brushwood - Confederated Tribes of the Colville Reservation
Paul Ward – Confederated Tribes and Bands of the Yakama Nation
Commissioner Andy Hover - Okanogan County
Commissioner Marc Straub- Douglas County

Integrated Recovery Technical Advisory Group

Casey Baldwin - Confederated Tribes of the Colville Reservation
David Blodgett III - Confederated Tribes and Bands of the Yakama Nation
Roger Dick, Jr- Confederated Tribes and Bands of the Yakama Nation
Stuart Ellis – Columbia River Inter-Tribal Fish Commission
Jeromy Jording - NOAA National Marine Fisheries Service
Chad Jackson - Washington Dept. of Fish and Wildlife
Tom Kahler – Douglas Public Utility District
Lance Keller – Chelan Public Utility District
Ryan Lothrop - Washington Dept. of Fish and Wildlife
Keely Murdoch- Confederated Tribes and Bands of the Yakama Nation
Steve Parker – Confederated Tribes and Bands of the Yakama Nation (retired)
Anthony Siniscal - NOAA National Marine Fisheries Service
Tim Sipple - Washington Dept. of Fish and Wildlife
Mike Tonseth - Washington Dept. of Fish and Wildlife
Kirk Truscott - Confederated Tribes of the Colville Reservation
Justin Yeager- NOAA National Marine Fisheries Service

UCSRB Staff

This document was compiled and developed (analysis, writing, coordination) by Greer Maier with assistance from Melody Kreimes and Alicia Meier.

Data and Information

Data and information in this report was compiled from a variety of sources including peer-reviewed literature and reports. Much of the data on harvest was compiled from monitoring implemented by Washington Department of Fish and Wildlife, Oregon Department of Fish and Wildlife, the National Marine Fisheries Service, U.S. Fish and Wildlife Service, the *U.S. v. Oregon* Technical Advisory Committee (TAC), and the *U.S. v. Oregon* treaty tribes (Confederated Tribes of the Warm Springs Reservation of Oregon, the Confederated Tribes of the Umatilla Indian Reservation, the Nez Perce Tribe, and the Confederated Tribes and Bands of the Yakama Nation).

Contents

List of Figures

List of Tables

Key Points

- Salmon fishing has a long history in the Columbia River Basin, from ancient tribal fisheries at Celilo and Kettle Falls to the development and expansion of 19th-century commercial canneries in the Lower Columbia River.
- Many tribal fisheries have declined up to 80 percent and some have disappeared altogether. Harvest rates in the Columbia River ranged from 40 to 85 percent before the 1960s, declined until 1974, and thereafter averaged less than 10 percent (Chapman et al., 1995). In the last 20 years, harvest rates vary widely by species and return year but are generally less than 20 percent for ESA listed fish.
- The Columbia River now represents one of the most highly regulated fisheries in the world. Over the past several decades fishery managers have continued to improve the use of the various management actions to protect natural populations and target fisheries on hatchery-produced and healthy, harvestable populations.
- Strong limitations have been implemented on all fisheries with the continued low abundance of naturally-produced salmon and steelhead.
- Most mainstem fisheries in the Columbia River are managed under the terms of the *United States v. Oregon* (*U.S. v. Oregon*) Management Agreement. The Management Agreement provides for abundance based harvest rates for managed stock groups. Regional co-managers set annual harvest levels based on abundance of returning fish. Some Upper Columbia and most tributary fisheries are managed outside of the *U.S. v. Oregon* Management Agreement.
- While Upper Columbia spring Chinook and steelhead are listed under the Endangered Species Act, they are managed as part of the Upriver spring/summer Chinook Salmon and summer steelhead stocks within the context of harvest management. These stock groups used for fishery management are surrogates of the ESU/DPS. Harvest rates on stocks are an index of the actual harvest rate on the ESU/DPS affected by fisheries.
- Spring Chinook and steelhead with clipped adipose fin (hereafter referred to as clipped) are managed differently than those with an intact adipose fin (referred to as unclipped). Clipped (sometimes referred to as “marked”) fish are generally hatchery-origin and unclipped fish are generally natural-origin or are from hatchery programs with the goal of conservation. Many fisheries are “mark-selective” meaning they target hatchery-origin fish and release unclipped fish so they can escape to the spawning grounds. Ocean salmon fisheries are more commonly full retention fisheries.
- The number of fish that die as a result of a fishery is greater than the number of fish retained as catch. The proportion of this difference that die from the encounter is defined as incidental mortality. A large proportion of the harvest effect on natural-origin UC spring Chinook and steelhead is from incidental mortality in fisheries targeting other species, fisheries targeting stocks with both healthy and weak runs, and in fisheries targeting hatchery-origin fish. Only a small proportion of catches are from full retention fisheries, which keep all fish caught regardless of markings.
- Composite harvest impacts on unclipped Upper Columbia (UC) spring Chinook have ranged from <10% during periods of low returns to highs between 15-20% during periods of higher returns (average 12% since 2008). Overall, harvest and incidental mortality of UC spring Chinook has amounted to less than 500 fish per year on average since 2008.
- Harvest of Upper Columbia (UC) steelhead is not tracked outside the A-index Upriver summer steelhead stock. Composite harvest impacts on unclipped A-index steelhead have ranged from 7-16%

between 2008-2018. Average harvest impacts on unclipped fish was approximately 10% during this time period which accounted for an average of 7,500 fish.

- Nearly all harvest impacts are the result of exposure to fisheries in the Columbia River below the confluence with the Snake River (Highway 395 bridge), where the intensity of fisheries is greatest.
- UC full retention tribal fisheries and mark selective sport harvest for spring Chinook occur in the Columbia River downstream of the Snake River. Current mainstem non-treaty commercial fisheries are mark selective. Only clipped steelhead may be kept in recreational fisheries. Steelhead, both clipped and those with an intact adipose fin (hereafter referred to as unclipped) may be retained in any tribal fishery. Steelhead may not be retained in non-treaty commercial fisheries.
- The majority of salmon and virtually all steelhead harvested in non-treaty fisheries are produced in hatcheries and a large proportion of treaty fisheries are hatchery-origin.
- Fisheries management is inexact and there are many sources of uncertainty. The goal is to provide harvest opportunities while ensuring a minimum spawning population size in each unit, given the current and potential future range of environmental conditions and the range of error in assessments.
- The ability to regulate harvest to attain a given management objective can be an extraordinarily difficult and challenging task because of the biological characteristics of the stocks and complex patterns of harvest under the jurisdictions of multiple management agencies.

Introduction

This Harvest Background Summary is one of a four-part series summarizing the major management programs and their reported outcomes related to recovery of Upper Columbia River (UC) salmon and steelhead listed under the Endangered Species Act (ESA). The series covers each of the "H's" or sectors—habitat, hatcheries, hydropower, and harvest—affecting listed species in the region. The development of these summaries is the first step in the region's "Integrated Recovery Approach" that the Upper Columbia Salmon Recovery Board (UCSRB) adopted in 2017. This approach is part of the organization's mission to achieve recovery of UC spring Chinook salmon and steelhead, which will require coordinated actions in all management sectors affecting salmon. The UCSRB is engaging and collaborating with managers across the Columbia River System to identify issues and uncertainties related to long-term recovery. The background summaries serve an integral part of this process as a vehicle for compiling and synthesizing complex information that can be used to inform dialogue and progress toward achieving this overarching goal of recovery.

The background summary documents are intended to support "All-H" collaboration and can be used: a) to improve integrated decision-making; b) as a communication and outreach tool; c) to identify key uncertainties and gaps in knowledge and understanding; and d) to better track and understand progress toward integrated recovery. These documents are based on scientific information and data compiled from a variety of entities working within each sector. The first three documents in the series, the *2014 Habitat Report, 2017 Hatchery Background Summary, and 2019 Hydropower Background Summary*, are available at www.ucsrb.org. This summary provides background and information on fisheries in the ocean and the Columbia River and its tributaries, with a focus on how they impact listed Upper Columbia spring Chinook, steelhead, and bull trout.

Fishery impacts include direct harvest and indirect mortalities as a result of fisheries encounters. Harvest refers to fish that are caught and retained for cultural, ceremonial, subsistence, economic, and recreational purposes. Indirect mortalities are fish that are not kept but die as a result of handling or encounter in the fishery (often referred to as "catch-and-release mortalities"). Indirect mortality rates can vary depending on species, fish condition, gear type, location, and environmental conditions. Restrictive fisheries currently prevent large numbers of natural-origin Upper Columbia River (UC) spring Chinook, steelhead, and bull trout from being directly harvested in fisheries. Most mortality of natural-origin Upper Columbia listed fish occurs through incidental mortality in fisheries. Some harvest of unclipped, natural-origin fish occurs in treaty tribal fisheries in the Columbia River. Mortality of ESA-listed hatchery-origin UC salmon and steelhead occurs through both direct non-treaty and treaty tribal harvest and through incidental mortality. Managers have established limits for incidental take of ESA-listed species. These limits are based on estimates of incidental mortality developed by the *U.S. v Oregon* Technical Advisory Committee (TAC) and are updated whenever new information becomes available (TAC 2017). Although there are low levels of impacts to listed Upper Columbia fish for research, monitoring, and evaluation purposes and from adult management for hatchery programs, those effects are not considered "harvest" in the context of this report.

Significant management actions related to steelhead and spring Chinook conservation have occurred over the past 40 years. Non-treaty commercial harvest of steelhead has been prohibited since 1975. Non-treaty commercial harvest of Upriver spring Chinook during years of low returns has been limited in the mainstem

Columbia. Commercial selective fisheries along with time, area, and gear restrictions reduce handling and mortality of ESA-listed spring Chinook and steelhead. Recreational fisheries are required to release non fin-clipped steelhead and spring Chinook in the Columbia River. Treaty fisheries do not target steelhead directly and implement regulations to limit the mortality of natural-origin steelhead. Treaty harvest of Upriver spring Chinook is limited through strict harvest management based on escapement.

Over a million Chinook, steelhead, coho, and sockeye are caught every year in fisheries in the Columbia River (based on data from 2010-2017 from WDFW and ODFW 2019). Commercial and recreational fisheries have huge economic value in the Columbia Basin. Commercial fisheries under the current *U.S. v. Oregon* agreement have an estimated economic value in excess of $10.3 million ($7.7M in treaty fisheries and $2.6M in non-treaty fisheries) Commercial fisheries also generate $16.2 million in personal income and 419 full-time jobs. Recreational fisheries contribute $45.5 million in trip-related expenditures to local economies and generate close to $30 million in personal income and 672 jobs in the Columbia River region (NMFS 2017). Additionally, ceremonial and subsistence fisheries are essential to tribal culture, health, and well-being but cannot be qualified using economic measures.

Salmon fisheries are challenging to manage because of their geographic distribution, their metapopulation structure, and the fact that most fish spawn only once and then die. Because of this, harvest is governed by a complex network of federal and state laws, as well as international and tribal treaties. Unlike the Endangered Species Act (ESA) which views populations through the lens of evolutionarily significant units (ESU) and distinct population segments (DPS), groups of populations are managed as *stocks* in fisheries. A stock is a management unit grouped by genetic relationship, geographic distribution, or movement patterns. ESA- listed Upper Columbia spring Chinook are part of the upriver spring Chinook stock. ESA-listed Upper Columbia summer steelhead are part of a composite summer steelhead stock. The summer steelhead stock is further divided into stock groups and because UC steelhead are normally less than 78cm their harvest would be part of the A-Index stock group when encountered in fisheries downstream of the mouth of the Snake River.

The majority of UC spring Chinook and steelhead harvest takes place in the mainstem Columbia River. Salmon and steelhead fisheries in the Columbia River Basin include those in the lower Columbia River downstream of Bonneville Dam, in the middle and upper Columbia River and its tributaries, and the Snake River Basin. These fisheries are co-managed by the states of Washington, Oregon, and Idaho, treaty tribes, and other tribes that traditionally fished these waters. Fisheries from the mouth of the Columbia River upstream to the mouth of the Snake River, spring WDFW fisheries in the Snake River, any spring Chinook fisheries in the area of Ringold Hatchery, and fisheries upstream of the mouth of the Snake River impacting Upper Columbia spring chinook are managed by the states and treaty tribes subject to the terms of the 2018–2027 ***United States v. Oregon Management Agreement***. Oregon and Washington have concurrent state jurisdiction over fisheries in the mainstem Columbia River downstream of McNary Dam under the ***Columbia River Compact***, the congressionally-ratified compact between the two states. The Compact and associated Joint State sport hearings are used to coordinate mainstem fisheries in concurrent waters.

Upstream of Priest Rapids Dam, fisheries are carefully managed to minimize impacts on ESA-listed fish, while maximizing fishing opportunities on healthier stocks and hatchery fish. The National Oceanic & Atmospheric Administration's National Marine Fisheries Service (NMFS) limits impacts of fisheries on ESA-

listed fish and state fishery managers use time, area, and gear restrictions, as well as daily bag limits, to reduce these impacts and extend opportunities for non-ESA-listed fish.

Native Americans have been fishing for salmon along the Columbia River for thousands of years, long before Europeans arrived. Salmon has been, and continues to be, a staple of their diets and a fundamental part of their cultural identity and spiritual practices. Regional commercial and recreational fisheries have also depended on healthy and harvestable Columbia River salmon runs for decades. The regional economic impact of salmon and steelhead fishing in the Columbia is estimated to be about $142 million annually, according to a 2005 analysis by the Independent Economic Advisory Board. The ability of tribal nations and commercial and recreational fishermen to harvest salmon and steelhead has declined dramatically with the decline of the Columbia River populations.

Today there are several major fisheries directly targeting hatchery origin Upriver Spring Chinook and summer steelhead and which indirectly impact unmarked spring Chinook and steelhead through catch-and-release mortality and incidental harvest (Figure 1). The lower 145 miles of the river from Bonneville Dam to the estuary are open to a small amount of treaty fishing. From Bonneville Dam to McNary Dam fisheries are open to treaty commercial and C&S fishing and non-treaty recreational fisheries. Treaty fisheries are implemented by tribal nations with specific treaty rights (see *Harvest Management* Section below). There are no current mainstem Columbia River salmon and steelhead fisheries upstream of McNary Dam, but there could be in the future. There are limited tributary treaty fisheries upstream of McNary Dam. Non-treaty fisheries above McNary Dam are recreational. There are non-treaty tribal fisheries conducted by the Wanapum and Colville Confederated Tribes in various locations upstream of McNary Dam. There are also conservation fisheries above Rock Island Dam. A given fishery may be mark selective for adipose fin-clipped fish (hatchery-origin) or full retention (hatchery and natural-origin).

Harvest objectives for treaty and non-treaty salmon and steelhead fisheries are set by state and tribal agencies. Fishery limits in areas covered under the *U.S. v. Oregon* Management Agreement are established by state, tribal, and federal parties in *U.S. v. Oregon*. In developing management plans under *U.S. v. Oregon*, the parties recognized the necessity of managing the fisheries to provide spawning escapement to tributary production areas, including the Upper Columbia tributaries. At the same time, they seek to provide meaningful treaty and non-treaty fishing opportunities in mainstem fisheries, targeting the more productive natural and hatchery stocks, as well as providing additional fishing opportunities in tributaries and terminal areas whenever possible (UCSRB 2007).

Stock-specific estimates of fishery impacts are available for most fisheries because they are used as the basis for fishery management objectives and allocations. Direct harvest is typically estimated using landing records (commercial fisheries) or creel surveys (recreational and treaty fisheries), or angler catch record cards (recreational fisheries). Incidental mortality on listed stocks is in a variety of ways using landed catch-and-release data along with stock composition estimates.. Release mortality rates are an important component of determining ESA impact rates for non-treaty fisheries. These release morality rates are generated from scientific studies looking at different fishery methods occurring in similar locations. Specific estimates of indirect mortality may not be available for every fishery (Columbia Basin Partnership2020).

Management agreements have, on average, reduced impacts of fisheries on UC spring Chinook and steelhead over past practices (NMFS 2016; TAC 2011-19). The most significant harvest occurs in the

mainstem Columbia River in fisheries directed at hatchery spring and summer Chinook salmon and steelhead. Harvest rates have remained relatively low, generally below 15 percent. Some increases in the last 10 years have resulted from increased allowable harvest rates under the abundance-driven sliding scale harvest rate strategy (NWFSC 2015).

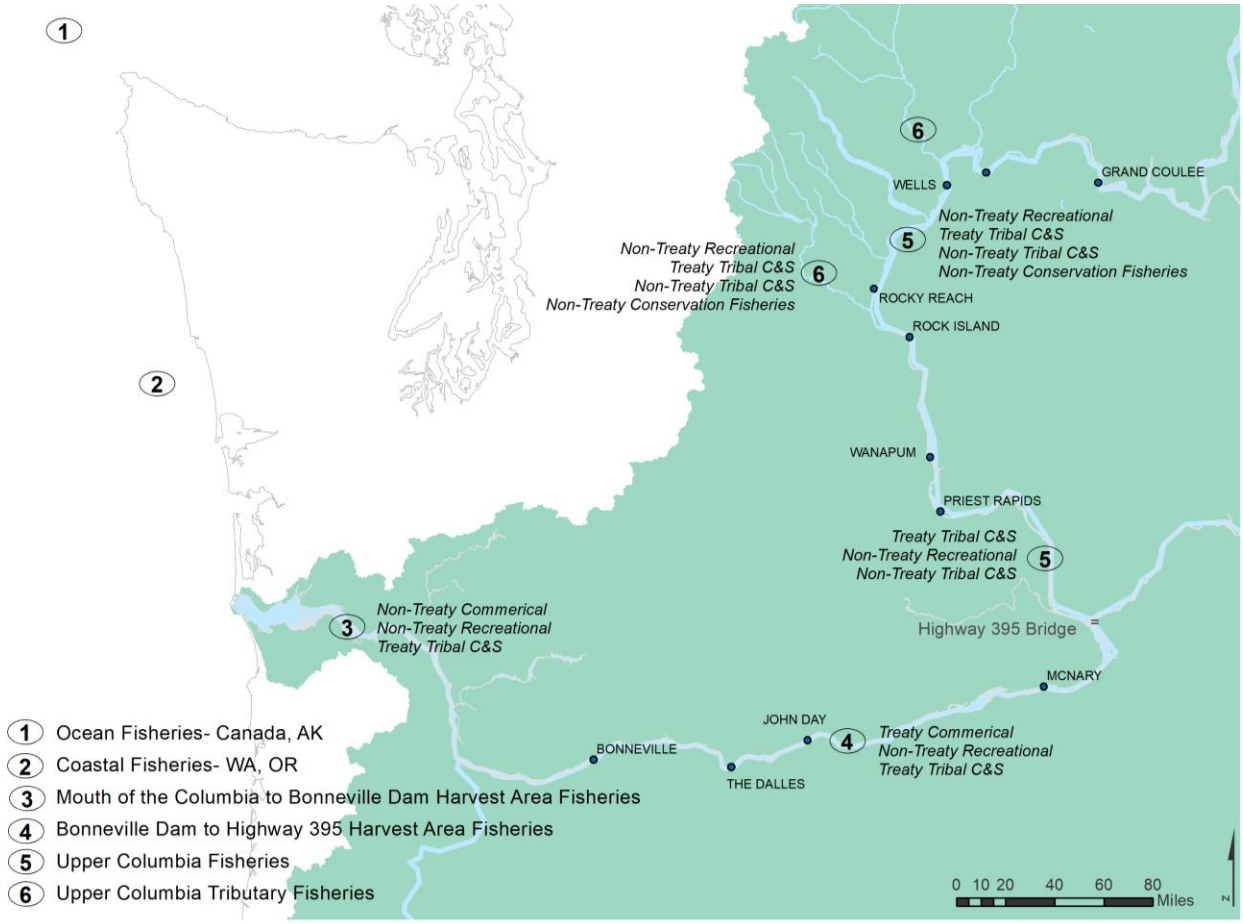


Figure 1. Map showing harvest areas and fisheries and with potential direct or indirect harvest of Upper Columbia spring Chinook and steelhead. C&S= Ceremonial and subsistence.

Harvest managers have implemented substantial reductions in harvest for Upper Columbia spring Chinook and steelhead since the time of listing in the late 1990's. Current management plans for these species recommend ancillary and precautionary measures to ensure that harvest does not adversely affect conservation and recovery in the future. Harvest rates in some years may need to be lower in some years to reduce the risks of critically low escapements during poor ocean conditions and to protect local populations.

Although much progress has been made to better understand and improve stocks and the fisheries that rely on them, uncertainties still exist. Approximating the size of returning stocks is extremely difficult to do but incredibly important to being able to set limits on fisheries. Upriver fisheries do have the advantage of waiting for a run update to plan fisheries (aligning either direction to the run size). Lower river fisheries rely more on the forecast and have less time to react. In addition to the uncertainties related to predicting the number of fish that will return and can be harvested, there is uncertainty related to the outcomes of management decisions on specific populations. Fisheries under the *U.S. v. Oregon* Management

Agreement are managed using actual run sizes determined in season, not simply on pre-season forecasts. Furthermore, most fisheries simultaneously exploit a mixed stock of salmon populations, and the catch from each specific population is usually unknown and must be estimated. In practice, the ability to achieve a specific management target for any given population is inherently challenging. For salmon originating in the Columbia River system, harvest management decisions are made by many different entities, both domestic and international. No single entity has the authority and responsibility for ensuring that management objectives are met for a given population, rather responsibility is shared among management agencies and authorities (ISAB 2005). As with other management sectors, the relative importance of these uncertainties and their role in making management decision may be viewed differently by entities having different technical perspectives, management objectives, and public policy responsibilities.

Upper Columbia Salmon and Steelhead Recovery Strategy – Harvest

The NMFS formally approved *The Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan* (Recovery Plan) in 2007 (UCSRB 2007). The Upper Columbia Salmon Recovery Board (UCSRB) developed the Recovery Plan for Upper Columbia spring Chinook ESU (Evolutionarily Significant Unit) (listed as *endangered* on March 24, 1999), Upper Columbia summer steelhead DPS (Distinct Population Segment) (listed as *endangered* on August 18, 1997; reclassified as *threatened* on January 5, 2006; and as a result of a legal challenge, reinstated to *endangered* status on June 13, 2007; and finally on appeal by NMFS in the 9th Circuit reinstated in 2009 as *threatened*, where it stands today), and bull trout (the coterminous U.S. population was listed as *threatened* on November 1, 1999). Although the Recovery Plan includes strategies for bull trout, it is not the official recovery plan for bull trout, which was drafted by the U.S. Fish and Wildlife Service and finalized in 2015. The Recovery Plan was the culmination of six years of collaboration among local governments, tribes, citizens, interest groups, and state and federal agencies facilitated by the UCSRB. Through this work, the UCSRB defined recovery of viable and sustainable populations of salmon, steelhead, and other at-risk species through collaborative, economically sensitive efforts, combined resources, and wise resource management of the Upper Columbia region.

The Recovery Plan recommends goals, objectives, and actions that address the primary factors within each "H" (Hydropower, Hatchery, Harvest, and Habitat) that limit the abundance, productivity, spatial structure, and diversity of naturally produced spring Chinook, steelhead, and bull trout in the Upper Columbia Basin. Each action is linked directly to a specific limiting factor. Recommended actions related to harvest are intended to reduce threats to listed spring Chinook, steelhead, and bull trout. Some of these actions and objectives have already been implemented since 2007 and continued implementation of the Recovery Plan will strengthen the likelihood that all actions associated with harvest throughout the Columbia River are consistent with recovery of Upper Columbia spring Chinook, steelhead, and bull trout.

The excerpts below from the *Recovery Plan* were written to balance the following harvest objectives with the federal government's trust obligations to Native Americans and to integrate efforts from the following harvest programs: Pacific Fishery Management Council, the Pacific Salmon Commission, and the Columbia River mainstem and tributary fisheries.

Upper Columbia Salmon and Steelhead Recovery Plan (UCSRB 2007)

Harvest Recovery Objectives:

Short-Term (0-15 years)

- Use selective harvest techniques to constrain harvest on naturally produced fish at the currently reduced rates in the Upper Columbia Basin.
- Use selective harvest techniques to preserve fishery opportunities in the Upper Columbia Basin that focus on hatchery produced fish that are not needed for recovery.
- Recommend that parties of U.S. v Oregon incorporate Upper Columbia viable salmonid population criteria when formulating fishery plans affecting Upper Columbia spring Chinook and steelhead.
- Increase effective enforcement of fishery rules and regulations.
- Appropriate co-managers/fisheries management agencies should work with local stakeholders to develop tributary fisheries management goals and plans.

Long—Term (50-100 years)

- Provide opportunities for increased tributary harvest consistent with recovery.
- Incorporate Upper Columbia viable salmonid population criteria when formulating fishery plans affecting Upper Columbia spring Chinook and steelhead.

Research and Monitoring Objectives

- Research and employ best available technology to reduce incidental mortality of non-target fish in selective fisheries.
- Monitor the effects of incidental take on naturally produced populations in the Upper Columbia Basin.
- Improve estimates of harvested fish and indirect harvest mortalities in freshwater and ocean fisheries. Initiate or continue monitoring and research to improve management information, such as the timing of the various run components through the major fisheries.

The *Recovery Plan* also includes objectives for harvest status and trend monitoring and evaluation (Appendix P). The Monitoring and Evaluation Plan noted that fisheries are currently implemented with monitoring and evaluation programs that are intended to measure compliance with the allowed impact rates, and that this level of monitoring should continue, as directed under the *U.S. v Oregon Management Agreement* . Additionally, the *Recovery Plan* called out four objectives for harvest monitoring. The sampling design, scale, variables and protocols, analysis, funding, implementation and coordination are described for each objective below (UCSRB 2007).

Objective 1: Improve understanding of stock composition in fisheries;

Objective 2: Improve modeling interface between Columbia River and ocean fisheries;

Objective 3: Determine if the total harvest of Upper Columbia spring Chinook and steelhead in ocean and river fisheries is affecting the ability to meet abundance and productivity goals of the *Recovery Plan*

Objective 4: Determine encounter rates and release mortality rates of Upper Columbia spring Chinook and steelhead in all fisheries.

History of Harvest

Salmon fishing has a long history in the Columbia River Basin, from ancient tribal fisheries at Celilo and Kettle Falls and numerous other tribal fishing sites, to the development and expansion of 19th-century commercial canneries in the Lower Columbia River. Salmon have nourished the communities in the Pacific Northwest, brought us together, created jobs, and are a continued symbol of strength and resilience.

Tribal Harvest

Kettle Falls circa 1900

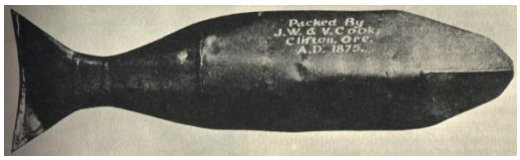
Native Americans have been fishing the Columbia River and its tributaries for thousands of years. Historically, salmon migrated as far inland as the headwaters of the Columbia River, 1,200 miles from the ocean. Along their migration routes they provided food to the people who lived along the river, and also to those who traveled far to trade for fish at established fisheries. Native communities of the Columbia River harvested salmon, sturgeon, lamprey, and eulachon (smelt) using a variety of tools such as spears, weirs, traps, nets, poles, hooks, clubs, weights, and drying racks. The annual return of salmon and steelhead has always had spiritual and cultural significance for tribes, and the fish provide economic support as a trade and food item. In the late 1700s and early 1800s, at the time of the first contacts with Europeans, Columbia River tribes had well-established fisheries using nets and traps. The abundant salmon runs of the Columbia River supplied a reliable and abundant source of protein for tribal communities. Farther inland, where salmon were less numerous, other forms of animal protein, from deer, elk, and waterfowl, supplemented salmon harvests. Throughout the basin, fishing became a more efficient way to secure protein, more so than through hunting land animals, as salmon runs appeared at predictable times and places throughout the year, every year (NWPCC 2020).

While the biggest and most important Indian fishing sites were at Celilo and Kettle Falls, there were hundreds of smaller but nonetheless important fishing sites on the Columbia and its salmon and steelhead-bearing tributaries. Historical records show that there were upwards of 1,000-2,000 fishers at Kettle Falls, 1,000-1,400 at Little Falls on the Spokane River, 1,000 at a site on the Little Spokane River, more than 1,000 at Spokane Falls and 250 on the Sanpoil River. There is archaeological evidence that fishing took place as long as 9,000 years ago at Kettle Falls on the Columbia in northeastern Washington. The Kettle Falls fishery was dominated by the Colville Tribe but other tribes including the Spokane, Sanpoil, Coeur d'Alene, Kalispel and Kootenai participated and shared in this fishery. During the peak of the run the average catch per day was 1,000 salmon for the communal fisheries. The most common technique was to use a basket net, a wicker basket with a backstop on it that was supported by long poles inserted into it and fixed in the rocks. (Scholz et al. 1985) Kettle Falls was considered one of the major trading centers of the Upper Columbia therefore, the Colville Tribe did not travel to trade because the trade came to them. (NPPC, 1986). Weirs across the Okanogan, Methow, and Sanpoil were recorded in 1870 where salmon fishing took place prior to going to Kettle Falls to catch the winter's supply. Total harvest has been estimates at approximately 644,000 fish per year by the Upper Columbia Tribes (Scholtz et al. 1985).

Total annual historic tribal harvest across the entire Columbia Basin is difficult to estimate. In 1940, researchers Joseph A. Craig and Robert L. Hacker estimated the catch at 18 million pounds per year. Other estimates are as low 4.4 million (Scholtz et al. 1985) and as high as 41 million pounds on average per year, an amount comparable to later commercial fisheries in the Columbia River (see NWPCC 2020). Approximately 14% of tribal harvest was by Upper Columbia Basin tribes (Scholtz et al. 2985). Beginning in the 1840's large numbers of non-Indian settlers began moving into the Columbia Basin and Indians began to be crowded out of their traditional fishing and village sites. Commercial harvest and dam building throughout the next century would lead to the loss of most of the traditional fishing sites and historic catches that tribes had relied on for time immemorial.

Early European Harvest

Commercial salmon harvest has been an important industry in the Pacific Northwest since the 1860s. With the abundant salmon runs, canning operations became the major industry of the Columbia River. In 1866, Eagle Cliff was the first salmon cannery opened on the Columbia River in southwest Washington. The number of canneries steadily increased over the next seventeen years to 39 canneries by 1883. During this peak year, 1883, a total of 629,400 cases of salmon were produced with a fleet of 1,700 commercial fishing boats. The salmon fishery and canning industry of the Columbia River provided many jobs and employed between 4,605 and 5,545 Oregonians and Washingtonians from 1889 to 1892 as fishermen, shoresmen and cannery employees (McDonald, 1894). The harvest up to this time was primarily spring Chinook and runs declined drastically by 1889. However, demand for canned salmon was high so the canneries turned to harvesting sockeye salmon and steelhead, then later added fall Chinook, coho and chum salmon to the operations (NWPCC 2019).



A Columbia River salmon canned and sealed in a tin made to fit (Pacific Fisherman, June 1929, p.30). Photo: University of Washington.

Columbia River Salmon Boats

In the early years of the cannery operations, commercial fishermen harvested salmon using small boats and nets that were rented from the canneries. Boats were powered by sail and oar, and fishing occurred at night by dragging long gillnets. Vast numbers of fishing boats crowded the river below Portland from May to August, their nets forming a formidable barrier to migrating salmon and steelhead. Other fishing gears used were seines, large nets equipped with floats along the top and weights along the bottom which can be set either form the shore or a boat for surrounding a certain area to harvest fish. Set nets, vertical walls of net that are not floating but staked to the ground to capture fish by their gills, and fish traps. Over time, the most efficient, and therefore deadliest, techniques were banned by the states of Washington and Oregon. By 1950, the only allowable gear for commercial fishing were drift gillnets (NWPCC 2019).

A fishwheel on the Columbia River in 1884

The fishwheel was introduced on the Columbia River in 1879 and, by 1881, these harvested between 1,500 and 4,000 salmon and steelhead each day. Most fishwheels were owned by canneries. Fishwheels were placed in shallow strong currents near a rapid or waterfall to move the paddles which were baskets made of wood and wire. The baskets caught fish migrating upstream which were then lifted out of the water, the fish slid out of the baskets into holding tanks to be later speared with a long pike and collected. To increase yields, weirs were often used to channel fish swimming upstream into the path of a fishwheel. By 1899, there were 79 fish wheels in operation. Fishwheels were efficient harvesting machines and it was reported that a single fishwheel in 1881, at Warrendale harvested 10,000 salmon in a 24-hour period and on another occasion, 30 tons of sturgeon. Fishwheels were prohibited in Oregon in 1926 and Washington in 1934.

Early fisheries were managed with much fewer restrictions than modern fisheries. When compared to modern management, historic harvest was often at a much higher level than modern management would deem appropriate. This was largely based on an incomplete understanding of salmon biology and productivity especially given productivity declines related to the significant habitat changes that were going on upstream with development for agriculture, irrigation, mining and timber exploitation. Commercial salmon fishers often caught more than the canneries could handle and excess fish were simply dumped back into the river. Canneries didn't set landing limits until the mid-1880s. Commercial fishing in the Columbia River reached its one-year peak, in terms of poundage, in 1911, when 49.5 million pounds of salmon and steelhead were landed. The following year, however, the catch dropped to 27.5 million pounds. It would increase above 40 million a few more times, but it never would surpass the peak of 1911 (NWPCC 2019). The U.S. Fish Commission investigation in 1894 of the Columbia River Basin concluded that the salmon fishery practices along the Lower Columbia River if continued would cause a serious deterioration in the product and value of the salmon fisheries. It was also noted that artificial propagation could not meet the current harvesting rates and would not be wise or expedient to increase work on artificial propagation of salmon. The initial attempt in restoring salmon fisheries was to restrict and regulate net fishing by shortening the season to May through July. Fishwheel restrictions were proposed to begin the middle of May and then closed from August 1st to September 10th (McDonald, 1894).

Commercial Trolling Ilwaco ca. 1950

During the turn of the century the creation of gasoline-powered boats and continued improvements to the jetty system allowed commercial harvest to expand into the mouth of the Columbia River as well as large areas of the ocean. In 1915 there were 500 trolling boats and a peak of 2,856 gillnet boats based in the lower Columbia, and the total catch during this year was 42.7 million pounds and the annual catch stayed above 40 million pounds per year through 1919. The commercial harvest of Columbia River salmon began to decline in the early 1930's after 70 years of intensive commercial fishing operations (Figure 2). Decline were due to a number of different factors including competition with imported fish products, depressed prices in the United States, and loss of habitat in the Columbia River Basin.

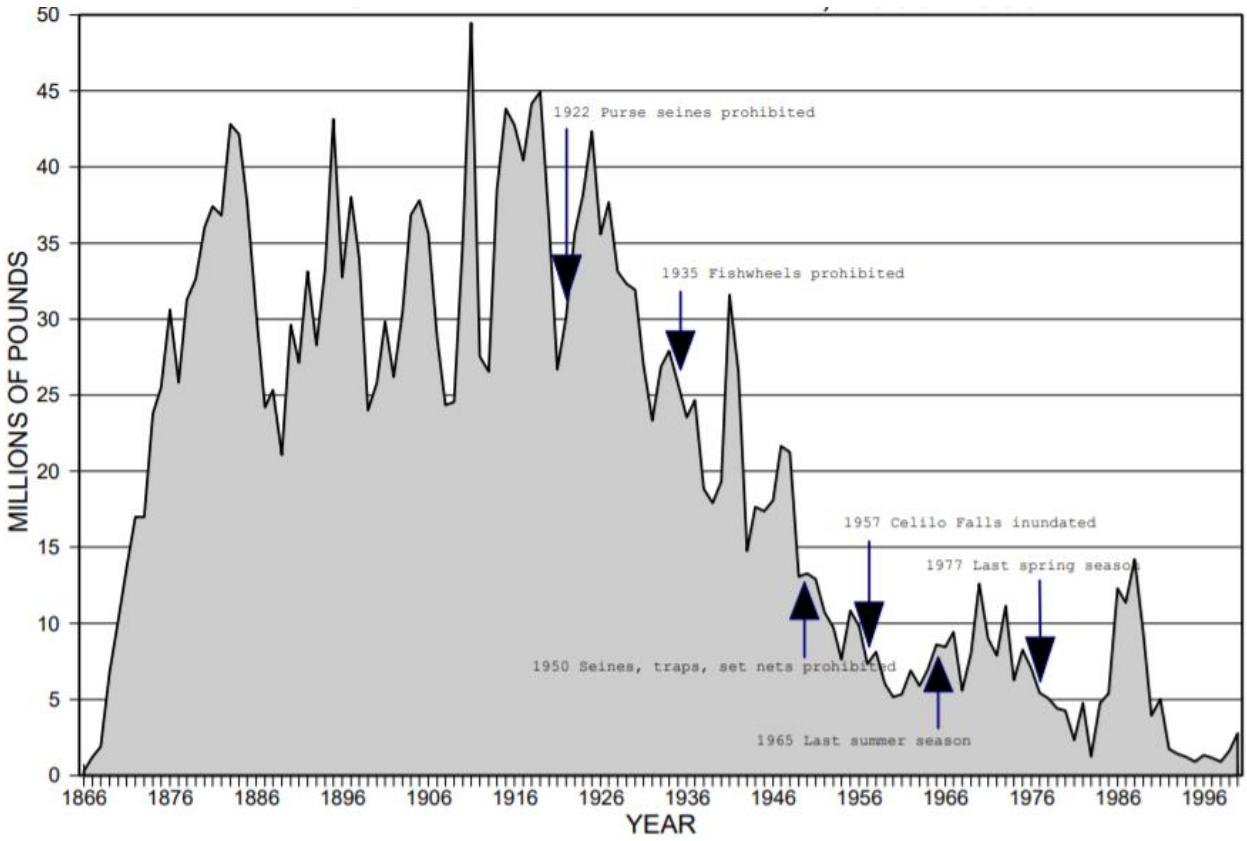


Figure 2. Decline in Columbia River commercial harvest rates from 1866-2001 (figure from WDFW and ODFW 2002).

Modern Harvest

Through the 1950s and 1960s the in-river commercial catch continued to decline, dropping below 10 million pounds for the first time in 1953 and staying there every year but one through 1969. In 1983, the commercial catch of salmon and steelhead in the Columbia River totaled just 1.25 million pounds, the lowest in the 30 years between 1960 and 1990. As the runs continued their steady decline in the early 1980s the state of Washington responded by setting shorter commercial fishing seasons. Ocean trolling and gillnet fishing for salmon off the mouth of the Columbia, and beyond, continued at a high levels into the early 1980s, according to annual fishery reports of the Oregon and Washington Departments of Fish

and Wildlife (NWPCC 2019). Beginning with legal cases in 1968 to enforce the reserved treaty fishing rights and continuing with listings of salmon and steelhead in the 1990's, modern fisheries reflect the need to balance legal, social, economic, and cultural obligations and values.

The *Sohappy v. Smith*, No. 68-409 (D. Or.), and *United States v. Oregon*, No. 68-513 (D. Or.) cases were first brought in 1968 to enforce the reserved treaty fishing rights of the Confederated Tribes of the Warm Springs Reservation of Oregon, the Confederated Tribes of the Umatilla Indian Reservation, the Nez Perce Tribe, and the Confederated Tribes and Bands of the Yakama Nation (collectively, "Columbia River Treaty Tribes"). At the time the original complaint was filed, the Columbia River Treaty Tribes were limited to approximately 16% of the annual salmon harvest, based on 1960-1968 averages. In 1988, the Columbia River Fish Management Plan (CRFMP) was agreed to by the Parties and adopted by District Court Order as a partial settlement of *U.S. v Oregon*. Fisheries in the Columbia River Basin were managed subject to provisions of the CRFMP from 1988 through 1998. Following 1998, fisheries were managed based on short term agreements among the Parties, the durations of which ranged from several months, covering a single fishing season up to five years. In 2005, the Parties negotiated a 3-year (2005 through 2007) Interim Management Agreement (2005 Agreement). Unlike some previous agreements, the 2005 Agreement covered fisheries year round (winter, spring, summer, and fall season fisheries). Most recently, the *U.S. v Oregon* fisheries have been managed subject to the 2008 Agreement (D. Oregon 2008) and now are managed based on a recently completed *U.S. v. Oregon* Agreement which will be in place until 2027.

In 1991, Snake River sockeye salmon were listed as endangered under the ESA, followed by the listing of Snake River spring/summer-run Chinook and Snake River fall-run Chinook in 1992. At the time the Parties had already curtailed harvest in an effort to protect declining populations. Since this time NMFS has consulted under section 7 of the ESA on proposed *U.S. v Oregon* fisheries in the Columbia River Basin (NMFS 1992). NMFS has continued to consider the effects of proposed fisheries as additional species have been listed, as new information has become available, and as fishery management provisions evolve to address the needs of ESA-listed species. In regard to impacts on ESA-listed species, harvest mortality has been reduced substantially in response to emerging conservation concerns (NMFS 2018). In response to the needs to balance treaty and ESA legal obligations while providing non-treaty commercial and recreational opportunities, the Columbia River now has one of the most highly regulated fisheries in the world.

TIMELINE OF EVENTS IN COLUMBIA RIVER HARVEST

Year	Event
1855	Treaties with Columbia River tribes signed (ceded land but reserved rights to fish)
1866	First salmon cannery opened on Columbia River
1879	First fishwheel on the Columbia River
1884	Columbia River Fishermen's Protective Union
1887	Salmon leading export
1899	Columbia River Packers Association formed
1899	Gang line banned (practice of catching sturgeons by their bodies with a series of hook)s
1905	Supreme Court U.S. v. Winans – upheld fishing rights as 1855 Treaties
1911	Commercial Fishing Industry peak 49.5 million pounds
1911	Little Falls Dam completed
1912	Ocean commercial trolling for salmon begins off the mouth of the Columbia
1915	Oregon & Washington formed Columbia River Compact (join regulations on commercial fisheries)
1917	Purse seines prohibited in the Columbia River
1923	Whip seines prohibited in the Columbia River
1926	Fishwheels banned in Oregon
1928	Peak chum salmon harvest 8.4 million pounds
1933	Rock Island Dam and Owyhee Dam completed
1934	Fishwheels, haul seines, traps and set nets are banned in Washington
1938	Bonneville Dam completed
1938	Peak steelhead harvest is 2.6 million pounds
1938	80% of spring chinook and 65% of fall chinook runs are harvested by commercial fishery
1940	Ceremony of Tears- last annual spring return of the Salmon at Kettle Falls
1941	Grand Coulee Dam completed
1953	McNary, Lookout Point, and Dexter Dams completed
1955	Chief Joseph Dam completed
1957	The Dalles Dam completed – Celilo Falls inundated
1961	Rocky Reach Dam completed
1964	Last summer commercial salmon season below Bonneville Dam
1965	Last summer commercial salmon season above Bonneville Dam
1967	Wells Dam completed
1968	*United States v. Oregon*
1968	Commercial Fishing reestablished above Bonneville Dam for treaty Indian fishers
1975	Columbia river sockeye salmon fishery is closed
1976	Fishery Conservation and Management Act
1980	The last cannery on the Columbia River closed
1980	Congress passes the Salmon and Steelhead Act
1991	First ESA listed on the Columbia River
1994	Ocean salmon fishing banned off the northern Oregon and Washington coasts due to low numbers
1997	Steelhead of the Upper Columbia River listed as endangered under the ESA
1997	Washington Department of Fish and Wildlife adopt the Wild Salmonid Policy
1999	Spring chinook in the Upper Columbia River are listed as endangered under the ESA
2007	Harvest agreement between the Confederated Tribes of the Colville Reservation and WDFW
2008	2008-2017 *U.S. v. Oregon* Management Agreement signed
2013	Washington and Oregon Department of Fish and Wildlife adopt harvest reform policy (2013-2023)
2018	2018-2027 *U.S. v. Oregon* Management Agreement signed

Harvest Management

Stocks

Fisheries for salmon and steelhead are managed based on the concept of "stocks," a term commonly used to describe one or more populations that are managed as a group and are exposed to similar fishery related impacts. Stocks generally represent the smallest unit of fish that can be counted and monitored in season. Stocks of fish include populations that are grouped because of similar run timing and spatial distribution. Fisheries managed in the Columbia River include several stocks that are generally not coincident with the ESA-listed species but instead serve as surrogates of ESUs (salmon) or DPSs (steelhead). Fisheries are managed based on the allocation and conservation needs for a stock, through a combination of management time periods, allowable harvest or impact rates, and within specific geographic areas. Harvest rates on stocks are an index of the actual impact rate on natural-origin fish in the associated ESU and DPS that are affected by fisheries. Table 1 below shows the stock descriptions and corresponding ESA-listed surrogates in the 2018 *U.S. v. Oregon* Agreement (*U.S. v. Oregon* 2018).

Table 1. Stock descriptions and corresponding ESA-listed surrogates in the 2018 *U.S. v. Oregon* Agreement (*U.S. v. Oregon* 2018).

***U.S. v. Oregon* Stock**		Description	ESU or DPS Represented
Upriver spring/summer Chinook Salmon		Chinook salmon entering the Columbia River destined to cross Bonneville Dam between January 1 and June 15	UC spring Chinook Salmon ESU
			Snake River spring/summer Chinook Salmon ESU
Upper Columbia Summer Chinook		Chinook salmon entering the Columbia River destined to cross Bonneville Dam between June 16 through July 31	UC summer Chinook Salmon ESU
Sockeye		Sockeye salmon entering the Columbia River	Snake River Sockeye Salmon ESU; Wenatchee/Okanogan ESU
Winter Steelhead		steelhead entering the Columbia River and harvested in the LCR (below Bonneville Dam) from November 1 through April 30 of the year following and those caught in the Bonneville Pool (Bonneville Dam to The Dalles Dam) from November 1 through March 31 of the year following	LCR Steelhead DPS (winter component)
			MCR Steelhead DPS (winter component)
			UWR Steelhead DPS
Summer Steelhead	**Skamania**	steelhead caught in the mainstem LCR (below Bonneville Dam) from May 1 through June 30 each year and those caught in the Bonneville Pool (Bonneville Dam to The Dalles Dam) from April 1 through June 30	LCR Steelhead DPS (summer component)
	A-Index	Steelhead destined to cross	MCR Steelhead DPS

U.S. v. Oregon Stock		Description	ESU or DPS Represented
		Bonneville Dam between July 1 through October 31 each year measuring less than or 78 cm fork length (<~30 inches)	UC Steelhead DPS
			Snake River Basin Steelhead DPS
	B-Index	steelhead destined to cross Bonneville Dam between July 1 through October 31 each year measuring greater than or 78 cm fork length (>~30 inches)	Snake River Basin Steelhead DPS (primary component)
			MCR Steelhead DPS (minor component)
			MCR Steelhead DPS (minor component)
Fall Chinook Salmon	**Lower River Hatchery (LRH)**	Tule fall Chinook salmon returning to hatcheries and spawning areas below Bonneville Dam	LCR Chinook Salmon ESU (tule component)
	Lower River Wild (LRW)	Late fall bright Chinook salmon returning to the North Fork Lewis and Sandy rivers	LCR Chinook Salmon ESU (bright component)
	Upriver Bright (URB)	Chinook salmon destined for the Hanford Reach section of the Columbia River and for the Deschutes, Snake, and Yakima rivers.	Snake River fall-run Chinook Salmon ESU
Coho	**Upriver**	Coho salmon destined to pass Bonneville Dam	LCR Coho Salmon ESU
	Lower River	Coho salmon entering the Columbia River not destined to pass Bonneville Dam	LCR Coho Salmon ESU
Chum		Chum salmon returning to the Columbia River	Columbia River Chum Salmon ESU

Three major races of Chinook salmon (spring, summer, and fall) are recognized in the Columbia River Basin. Chinook salmon from the Columbia River are divided into eight stock groups for management purposes. Upper Columbia spring Chinook are managed as part of the "upriver spring Chinook" stock. The upriver spring Chinook stock comprises stocks from several ESUs and hatchery programs in three geographically separate production areas: 1) the Upper Columbia), 2) the Snake River system, and 3) other Columbia River tributaries between Bonneville Dam and the Yakima River. Along with Upper Columbia spring Chinook, Snake River spring/summer Chinook are also listed under the ESA. Within the Upriver spring Chinook stock, the first to arrive in the river are the UC spring Chinook and most of the fish returning to the Snake River. The later component is fish returning to the Pahsimeroi, Imnaha, and South Fork Salmon Rivers that are all part of the Snake River spring/summer-run Chinook Salmon ESU. The median run timing of the late group is 2 - 4 weeks later than early group.

Most wild spring Chinook entering the Columbia River are listed under the federal ESA. On average, the UCUC spring Chinook return has represented 15% of the aggregate upriver spring Chinook run since 1980 but has dropped to 12% based on the recent 10-year average due to declines in Upper Columbia populations in comparison with those in the Snake (ISAB 2018; ODFW & WDFW 2019).

Harvest management for steelhead is necessarily complex with harvest impacts spanning seasons and even calendar years over the prolonged migration season. The Columbia River summer steelhead run includes populations from throughout the basin. When steelhead first enter the Columbia they are managed as an aggregate stock but are sorted by DPS as they move upstream There are two major stock groups (summer and winter steelhead) that contribute in varying degrees to five steelhead DPSs (Table 1). Summer steelhead are further divided into three stocks- Skamania, A-Index, and B-Index. The Skamania stock is based on fishery timing and location. The A-Index and B-Index groups are based on timing and size. Some are only present in the lower river while others return to the head waters of the Snake and upper Columbia rivers. Steelhead run timing is complex so that harvest impacts on some stocks occur in different seasons and even different calendar years. Upper Columbia steelhead are primarily part of the "upriver summer steelhead" A-Index stock but also comprise a minor part of the B-Index stock. Upriver A-Index summer steelhead include steelhead that pass Bonneville Dam between July 1 through October 31 each year measuring less than or 78 cm fork length (<~30 inches) and also include steelhead from the Middle Columbia River steelhead and Snake River Basin Steelhead, both of which are also listed under ESA. Snake River Basin steelhead are the primary component of the B-Index summer steelhead stock. B-Index summer steelhead include hatchery and wild steelhead that pass Bonneville Dam between July 1 through October 31 each year measuring greater than 78 cm fork length (>30 inches).

Seasons

Fisheries occur nearly year-round in the Columbia River. The annual management cycle is divided into time periods that roughly correspond to the migration timing of salmon and steelhead. The "Spring" period lasts from January 1- June 15, the "Summer" period is from June 16-July 31, "Fall" is from August 1- December 31st. Some stocks and populations migrate entirely within one management period while others cross multiple management periods. Harvest regulations (e.g. gear restrictions, target species, limits) vary by season (Figure 3).

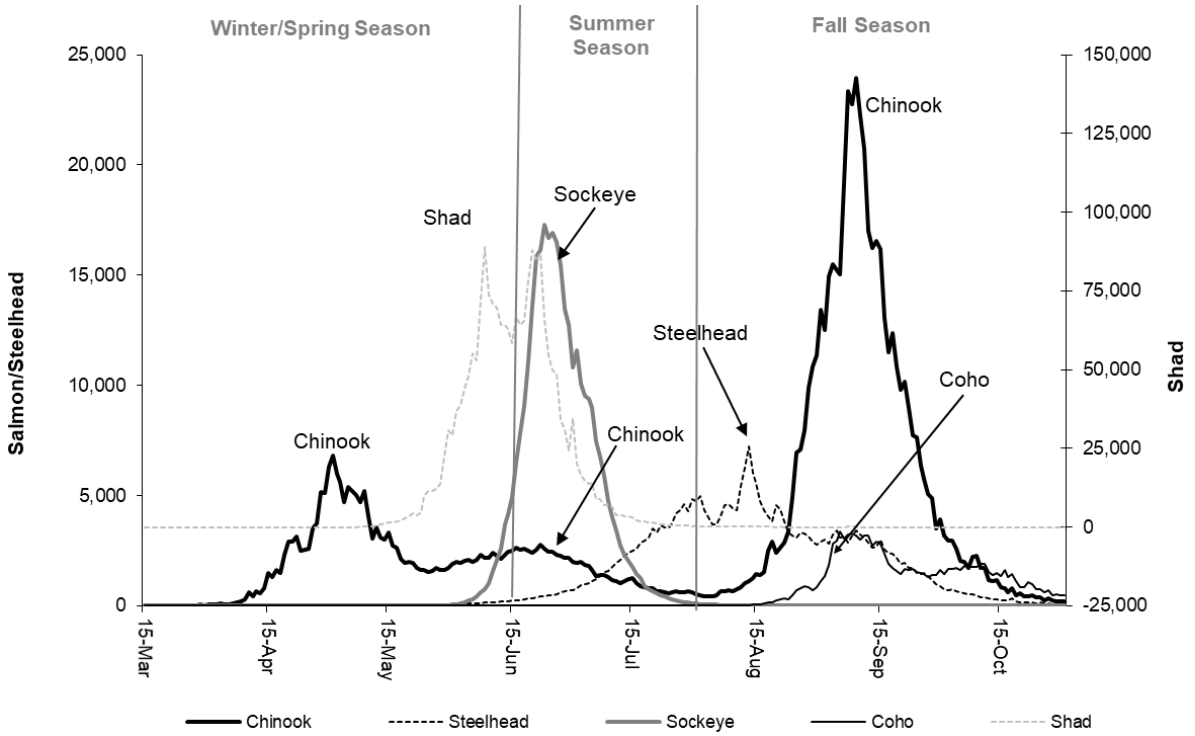


Figure 3. Average daily counts of salmon, steelhead, and American Shad at Bonneville Dam, 2008–2018 (figure from WDFW and ODFW 2019).

Chinook salmon return to the Columbia River between March and October. The Chinook run is divided by run timing in spring Chinook, summer Chinook, and fall Chinook. Some runs overlap these periods and are called spring/summer Chinook or summer/fall Chinook. Upriver spring Chinook of all ages returning to areas upstream of Bonneville Dam begin to enter the Columbia River in substantial numbers after mid-March and generally reach peak abundance at Bonneville Dam in early May. Upper Columbia spring Chinook are some of the earliest arriving populations in the Columbia Basin. The Methow, Entiat, and Wenatchee all peak before May 15th in their arrival at Bonneville Dam. Median date of arrival at Bonneville Dam is 3 May (SD 15.4 d) (Crozier et al. 2016). Within-year variability of median arrival at Bonneville is generally lower in hatchery fish compared with wild fish. The majority of UC spring Chinook detected at Bonneville Dam passed between late April and June, during the spring management period which extends from January 1 through June 15. However, a subset of UC spring Chinook (particularly from the Wenatchee and Entiat populations) have been found to migrate past Bonneville Dam after June 16th which is considered the summer harvest management period. PIT tag analysis for spring and summer Chinook from the Upper Columbia is complicated by generally low numbers of PIT tagged fish and possible uncertainties in identifying spring and summer natural origin juveniles during tagging. The size of this subset is largely dependent on environmental conditions in the river and its effect on flow and temperature.

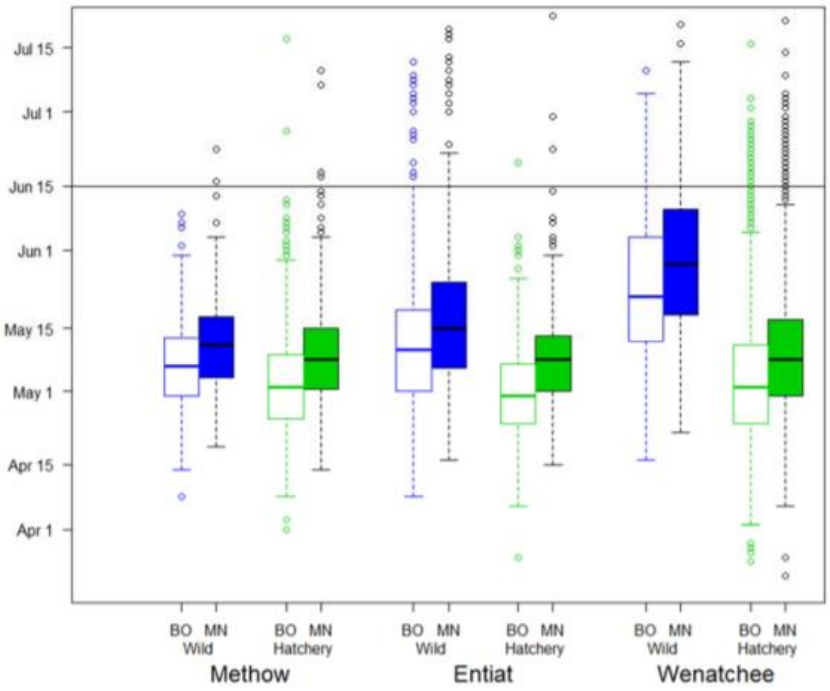


Figure 4. Arrival day at Bonneville (BO, open boxes) and McNary (MN, shaded boxes) Dam using PIT tag data for wild (blue) and hatchery (green) fish from the three populations in the upper Columbia including all data from 2004 to 2015. Boxes show the interquartile range with the solid line within each box showing the median. Whiskers are 1.5 times beyond the interquartile range, with data beyond this range shown individually. A line at 15 June is shown for reference for the change in fishery seasons (Crozier 2016)

Summer steelhead enter freshwater year-round, with the majority of the run entering from June through October. The lower Columbia populations (below McNary Dam) tend to have earlier run timing than the upriver stocks, with abundance peaking during May and June. Steelhead may have extended freshwater migration periods. Typically, steelhead that enter the Columbia in the summer and fall will not spawn until the following late winter or spring. Different populations of steelhead do not migrate through the Columbia at the same rate. All steelhead handled in fisheries downstream of Bonneville Dam during May and June are managed as lower-river Skamania stock (hatchery summer steelhead widely planted in lower Columbia tributaries and the Klickitat River). The upriver wild summer steelhead run includes three DPSs: 1) the middle Columbia River DPS, 2) the upper Columbia River DPS, and 3) the Snake River DPS. Summer steelhead passing Bonneville Dam between July 1 and October 31 are categorized as either A-Index or B-Index. A-Index steelhead are defined as any steelhead measuring less than 78cm fork length. A-Index steelhead are destined for tributaries throughout the Columbia and Snake basins and typically spend one or two years in the ocean. B-Index steelhead are defined as any steelhead measuring at least 78cm fork length. Most B-Index steelhead return to the Clearwater and Salmon rivers in Idaho, are typically later-timed than A-Index steelhead, and typically spend two or three years in the ocean. B-Index steelhead return to all tributaries throughout the basin (WDFW & ODFW 2019).

Steelhead from the Upper Columbia River DPS typically arrive early in the Columbia steelhead run, with an arrival at Bonneville Dam between July 6 and September 11 (Hess et al. 2016; Crozier et al. *in press*). Wenatchee steelhead arrive slightly later than the other UC populations. By 10 September, 75% of the

Upper Columbia DPS has passed McNary Dam. Crozier et al. (*in press*) found that the key factors that determined arrival day at Bonneville Dam (in order or importance) were July temperature, a discharge variable (flow or spill), hatchery origin, ocean years, and month at tagging. There is very little variation in arrival timing between UC populations (Figure 5). Unlike spring-run Chinook salmon, most UC steelhead do not move directly to tributary spawning streams. A portion of the returning run overwinters in the mainstem Columbia reservoirs above Priest Rapids Dam, passing into tributaries to spawn in April and May of the following year. Spawning occurs in the late spring of the year following entry into the Columbia River. Because of this life history, UC summer steelhead are exposed to fisheries in the lower river during the summer and fall management period and summer, fall, and winter fisheries in the Upper Columbia (NMFS 2019).

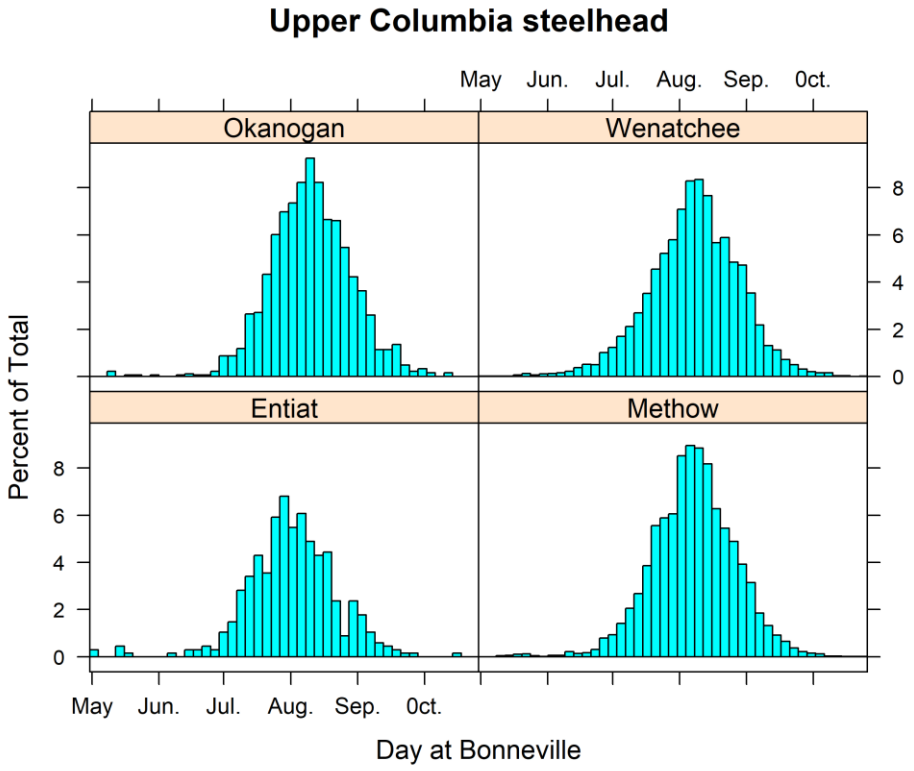


Figure 5. Run timing of Upper Columbia steelhead populations at Bonneville Dam based on PIT tag groupings. Bars represents percentages (figure from J.Sieggel, NMFS, 2019).

Fisheries

Fisheries can be categorized as either treaty fisheries or non-treaty fisheries and can be classified by type (commercial, recreational, and ceremonial and subsistence (C&S) fisheries). Treaty fisheries are conducted by tribes with treaty fishing rights. Commercial fisheries are conducted by both treaty and non-treaty entities, and C&S fisheries are conducted by treaty and some non-treaty entities. Recreational fisheries are exclusively non-treaty fisheries. Recreational fisheries take place in the ocean as do commercial fisheries including treaty and non-treaty ocean troll and various treaty and non-treaty net fisheries in Washington coastal bays. A complete list of fisheries in the Columbia River is provided in Table 2.

The mainstem Columbia River downstream of Highway 395 has been divided into geographically-defined management areas to facilitate treaty and non-treaty commercial, recreational, and ceremonial and subsistence fisheries. These defined areas are referred to as “Zones” and by some entities and as “catch areas” by other entities. Non-treaty commercial and recreational fisheries occur between Buoy 10 at the mouth of the Columbia River and Bonneville Dam (sometimes referred to as Zones 1-5) and in designated off channel Select Area Fishery Enhancement areas (SAFE fisheries). Non-treaty commercial fisheries use a combination of gear types including gill nets and tangle nets. Recently there have also been experimental fisheries using seine nets and a fish trap.

Treaty mainstem commercial and C&S fishing currently occurs from just downstream of Bonneville Dam upstream to McNary Dam (CRITFC 2019). The area upstream of Bonneville Dam to McNary Dam is sometimes referred to as Zone 6. Treaty salmon and steelhead fisheries are guaranteed treaties. Treaty tribes in the Columbia River include the Nez Perce, Umatilla, Yakama, and Warm Springs tribes. While treaty mainstem fisheries are clustered between Bonneville and McNary as a matter of ancestral use and modern administrative convenience, the tribes also retain rights to fish at other usual and accustomed places above Bonneville Dam. Treaty fisheries are implemented using four main types of fishing gear- hoop and dip nets that are tied onto scaffolds extending over the river and anchored to the bank, hook and line, set gillnets that are anchored to shore and extend up to 400 feet offshore, and drift gillnets that are deployed from a boat drifting with the current in mid-river. Platform and hook-and-line gears are used both for subsistence and commercial fishing , and gillnets are used primarily for commercial fishing. However, set gillnets also are typically used by permit to catch a specified number of fish for longhouse, Shaker church, and other ceremonial purposes. Setlines also can be set for white sturgeon during January and occasionally at other times of year. Setlines do not handle salmonids

Recreational fishing is done throughout the Columbia River basin using hook and line. There are four main areas for recreational fishing in the Columbia River mainstem- upstream of Priest Rapids Dam, one between Priest Rapids Dam and Bonneville Dam, one between Bonneville Dam and Astoria (the Astoria-Megler Bridge) and one between Astoria and Buoy 10, the last navigational buoy before the open ocean. Recreational fisheries primarily target spring, summer and fall Chinook, coho, and steelhead. The lowermost fishery targets spring and fall Chinook and coho from Buoy 10 upstream to Tongue Point/Rocky Point. From Tongue Point/Rocky Point upstream to Bonneville Dam the recreational fishery targets spring, summer and fall Chinook, summer steelhead, and coho in the mainstem Columbia River. The Hanford Reach fishery targets summer and fall Chinook and summer steelhead below Priest Rapids Dam. Smaller fisheries targeting Chinook, coho, and steelhead also occur near most tributary mouths on the mainstem Columbia River between Bonneville and McNary dams and in the mainstem upstream of McNary Dam. Significant fisheries for summer steelhead occur during the late fall and early winter in the mainstem between McNary Dam and the Highway 395 Bridge, targeting fish returning to the Snake River. Over the past decade, summer Chinook and sockeye fisheries have taken place almost every year upstream of Priest Rapids Dam In all of these fisheries, regulations require anglers to release all unclipped steelhead and spring Chinook (WDFW & ODFW 2019).

The Icicle Creek fishery is a unique terminal fishery in the vicinity of the Leavenworth National Fish Hatchery (LNFH) in the Wenatchee River watershed. Since 1940, the Leavenworth NFH has released unlisted, non-endemic (Carson stock) spring Chinook into Icicle Creek as a segregated harvest program

intended to mitigate for the construction of Grand Coulee Dam. Adult spring Chinook returns to LNFH provides for tribal and non-tribal harvest opportunity lost as a result of the Grand Coulee Project, primarily in Icicle Creek, as well as a backup broodstock source for the Chief Joseph Hatchery segregated spring Chinook harvest program operated by the Colville Confederated Tribes. Spring Chinook released from the LNFH are not part of the Upper Columbia spring Chinook ESU and are ad-clipped for harvest. The tribal fishery immediately below the hatchery is open to members of the Wenatchi Band of the Colville Confederated Tribes, the Ps'quosa people and to the Confederated Tribes and Bands of the Yakama Nation. Authorized tribal fishing gears include hoop nets, dip nets, or hook-and-line. The non-tribal recreational spring Chinook fishery occurs from the confluence with the Wenatchee River upstream to the lower Tribal fishery boundary five hundred feet below the barrier dam at LNFH as well as upstream from about the Sleeping Lady Resort to the Peshastin Irrigation Footbridge and is limited to hook-and-line angling gear. In years of exceptionally high LNFH returns, the fishery may extend downstream of the confluence to include the lower mainstem Wenatchee River. In addition to spring Chinook, the Yakama Nation raise and release coho from the LNFH as part of their Wenatchee River coho reintroduction master plan and to provide for tribal and non-tribal harvest opportunities during years of excess adult returns.

Fisheries also take place in association with Chief Joseph Hatchery, located at the base of Chief Joseph Dam. Spring Chinook released from this hatchery are not listed under the ESA and are intended for harvest. The tribal fishery in the Chief Joseph Dam tailrace targets returns to the hatchery and is mark-selective to minimize impacts to any stray ESA listed fish in the area. Starting in July each year, the Colville Tribal fishery in the Chief Joseph Dam tailrace targets Summer Chinook and it shifts to a full retention fishery because the primary method of harvest utilizes a snagging technique from the walls of the dam. The CJD tailrace fishery generally extends into late October or early November to target late arriving fall Chinook, but sometimes shifts back to a mark-selective fishery depending on impacts to steelhead. Since 2010, the Colville Tribes have been harvesting sockeye and hatchery Chinook salmon at the confluence of the Columbia and Okanogan Rivers using a purse seine fishing boat called the Dream Catcher. A small tangle net fishery also occurs at the mouth of the Okanogan, which primarily targets sockeye but also provides some opportunity to capture hatchery Chinook and release wild Chinook. A fish weir is set up in the Okanogan River each season and it provides an opportunity to remove some excess hatchery fish in years of high abundance and to collect natural and hatchery-origin broodstock for CJH. The weir is used to live-capture Chinook salmon, survey fish, and allows natural-origin salmon to continue upstream to the spawning grounds. Once the needs of CJH are met, any excess hatchery Chinook are distributed to the membership. Weirs are a traditional fishing method used by tribal fishermen (CCT 2020).

Conservation fisheries have been approved in the Upper Columbia for hatchery-origin (ad-clipped) spring Chinook and steelhead for the purposes of controlling the proportion of hatchery-origin and natural-origin adults on the spawning grounds (ESA-Section 10 Permit 18121 and 1395). These mark selective recreational fisheries are specifically designed to help maintain a high proportion of wild fish on the spawning grounds and enhance recovery of listed species. Most of the spawning areas in the Upper Columbia have high rates of hatchery fish in spawning areas and conservation fisheries can be a component of adult management in years with high numbers of hatchery-origin returns and adequate natural-origin returns to meet escapement goals on the spawning grounds (Maier 2017). Conservation fishery areas for steelhead included the mainstem Columbia from Rocky Reach Dam to Chief Joseph Dam (including the confluence of the Entiat River), and the Wenatchee, Methow, Okanogan, and Similkameen

Rivers. Fishery areas for spring Chinook have included two sections of the Wenatchee River between the Washington State Parks foot bridge at Confluence Park (just upstream from the confluence with the Columbia River), to the confluence with the Icicle Creek. WDFW is currently working on a permit to allow a conservation fishery for spring Chinook in the Methow River. Low hatchery- and natural-origin returns over the past 5 years have prevented WDFW from opening any conservation fisheries in the region. NMFS approved the use of conservation fisheries for steelhead in 2003 (NMFS Permit 1395) and approved spring Chinook conservation fisheries in the Wenatchee River in 2013 (NMFS permit 18121). Although Permit 1395 has been replaced, the new steelhead permits for the Methow do not preclude fisheries by the co-managers (via separate permits issued directly to the co-managers). WDFW had yet to initiate consultation with NMFS over a fisheries management plan for Methow steelhead and therefore Permit 1395 conservation fisheries provisions remain in effect.

The winter/spring fishing season extends from January 1 to June 15 (Table 2). During this management period fisheries in the mainstem Columbia River primarily target spring Chinook salmon stocks returning to the Snake River, Upper Columbia River, the Willamette River, and lower Columbia River tributaries. The summer season extends from June 16 to July 31. During this management period, fisheries target primarily unlisted Upper Columbia summer Chinook salmon and Upriver Columbia sockeye salmon, which includes the ESA-listed Snake River Sockeye Salmon ESU. The fall season fisheries begin on August 1 and extend to the end of the calendar year. During the fall management period fisheries target primarily harvestable hatchery and natural-origin fall Chinook and coho salmon, and hatchery steelhead. Fall season fisheries are constrained by specific ESA related harvest rate limits for listed Snake River fall-run Chinook salmon, and both A-Index and B-Index components of the listed UCUC and Snake River steelhead DPSs. Additional treaty fisheries are directed at shad and walleye.

Tributary fisheries are generally considered terminal fisheries and target fish returning to those tributaries. One exception is steelhead. Steelhead can often exhibit a wandering behavior and enter tributaries other than their natal tributary. Higher mainstem river temperatures (most often during the summer and fall migration period) are thought to be one factor influencing this behavior. Fish that do this are referred to by managers as “dip-In” fish. Because of this phenomena, some tributary fisheries especially tributaries between Bonneville and McNary have impacts on non-local steelhead.

Unclipped and clipped hatchery-origin and natural-origin fish are managed differently in mark selective fisheries (MSF). These fisheries target fish which are externally marked with an adipose fin clip (“clipped”). Fish with an intact adipose fin (“ad-present”) can be either natural-origin fish or an unmarked hatchery-origin. Mark selective fisheries release ad-present natural- and hatchery-origin fish and keep ad-clipped hatchery fish. The intent is to allow natural-origin fish to escape to their natal spawning areas to spawn while keeping hatchery-origin fish that were intended for harvest. Mark selective fisheries are one tool to control the number of hatchery fish on the spawning grounds and can help reduce the impact of fisheries on ESA-listed species (Maier 2017). In 2002, mark-selective regulations for spring Chinook were permanently adopted by the states of Washington and Oregon for non-treaty fisheries in the lower Columbia River. In 2004, the states adopted a regulation prohibiting the removal of unmarked fish from the water to provide additional protection for released fish.

For most hatchery programs, the rates at which fish are adipose fin clipped are outlined in the *U.S. v. Oregon* agreement. Non-treaty commercial and recreational fisheries are, most often, mark-selective when they target stocks with ESA-listed component. Treaty fisheries are generally managed allowing the retention of all fish caught (full retention), but under some circumstances the tribes may choose to implement species selective fisheries (Table 2; NMFS 2018).

Upper Columbia listed salmon and steelhead include both marked and unmarked components. Based on the 2020 production target for Upper Columbia hatchery-origin steelhead, approximately 60% are unmarked (ad-present). Up to 45% of Upper Columbia hatchery-origin spring Chinook releases are unmarked according to the production tables in the 20182027 *U.S. v. Oregon* management agreement. Marking strategies are dependent on the goals of the individual hatchery programs with the aim to return more unmarked hatchery-origin adults to the spawning grounds in programs aimed at supplementation or conservation rather than have them caught in mark-selective fisheries. Oftentimes, unmarked hatchery-origin fish are the progeny of natural-origin parents produced in a conservation program and intended for supplementation of the natural population (Maier 2017).

Table 2. Salmon and steelhead fisheries in the Columbia River by season (adapted from NMFS 2018). Selection type is classified as MSF (mark-selective fishery) or Full Retention (non-mark-selective fishery) (information from R. Lothrop, WDFW, pers. comm).

Run (Fishing Period)	Jurisdiction	Fishery	Target Species and Selection Type	Location
Winter/Spring Jan 1 – June 15 (Upper Columbia Spring Chinook migration season)	Non-Treaty	Commercial gillnet	Spring Chinook, Full Retention	Mouth of Columbia (buoy 10) to Bonneville Dam
		Commercial tangle net	Spring Chinook, MSF	Mouth of Columbia (buoy 10) to Bonneville Dam
		Select Areas commercial gillnet	Select Area hatchery-origin spring Chinook, Full Retention	Select Areas near mouth of Columbia
		Recreational hook and line	Spring Chinook, MSF	Mouth of Columbia (buoy 10) to Hwy 395 Bridge near Pasco, WA
		CCT tribal spring Chinook	Chief Joseph Hatchery unlisted hatchery-origin spring Chinook, MSF	Tailrace of Chief Joseph Dam
		Recreational spring Chinook- Ringold Area	Spring Chinook, MSF	Hwy 395 Bridge to Priest Rapids Dam
		Wanapum tribal spring Chinook	Spring Chinook, Full Retention	Mainstem Columbia from Priest Rapids Dam to Wanapum Dam
		Icicle Creek recreational and tribal	Leavenworth NFH unlisted hatchery-origin spring Chinook, MSF	Icicle Creek

Run (Fishing Period)	Jurisdiction	Fishery	Target Species and Selection Type	Location
		Conservation spring Chinook	Spring Chinook, MSF	Upper Columbia above Rock Island Dam and tributaries
	Treaty	Ceremonial and Subsistence (C&S)	Spring Chinook, Full Retention	Mainstem Columbia River and tributaries
		Commercial winter/spring Gillnet	Spring Chinook, Full Retention	Bonneville Dam to McNary Dam
		Platform and Hook and Line	Spring Chinook, Full Retention	Buoy 10 to McNary Dam
		Icicle Creek C&S	Spring Chinook, MSF	Icicle Creek
Summer June 16-July 31 (Upper Columbia Summer Steelhead and late arriving Spring Chinook migration season)	Non-Treaty	Recreation hook and line	Summer Chinook and summer steelhead(MSF), and sockeye (Full Retention)	Mouth of Columbia to Hwy 395 bridge
		Wanapum tribal summer Chinook	Summer Chinook, Full Retention	Mainstem Columbia from Priest Rapids Dam to Wanapum Dam
		Commercial Gillnet	Summer Chinook, Full Retention	Mouth of Columbia (Buoy 10) up to Bonneville Dam
		Select Area commercial Gillnet	Select Area hatchery-origin spring Chinook, non- MSF	Select Areas off mainstems Columbia River near mouth
		CCT tribal summer Chinook and sockeye	Summer Chinook (MSF and Full Retention depending on area), sockeye (Full Retention)	Chief Joseph Dam tailrace, Okanogan River
	Treaty	C&S	Summer Chinook, Sockeye, Full Retention	Mainstem Columbia River and tributaries
		Commercial gillnet	Summer Chinook and sockeye salmon, shad, Full Retention	Bonneville Dam to McNary Dam
		Platform and Hook and Line	Summer Chinook and Sockeye, Full Retention	Bonneville Dam to McNary Dam
		Permit gillnet	Summer Chinook, Full Retention	Bonneville Dam to McNary Dam
		McNary- Hwy 395 bridge	Summer Chinook and Sockeye, Full Retention	Bonneville Dam to McNary Dam
Fall Aug 1 – Dec 31	Non-Treaty	Commercial gillnet	Fall Chinook and coho salmon, Full Retention	Mouth of Columbia (buoy 10) to Bonneville Dam
		Commercial tangle net	Coho salmon, MSF	Mouth of Columbia (buoy 10) to Bonneville Dam

Run (Fishing Period)	Jurisdiction	Fishery	Target Species and Selection Type	Location
(Upper Columbia Summer Steelhead migration season)		Select Area commercial gillnet	Select Area hatchery-origin fall Chinook and coho salmon, Full Retention	Select Areas off mainstems Columbia River below Bonneville Dam
		Recreational hook and line	Fall Chinook (Full Retention/Rarely MSF), coho salmon (MSF), and steelhead (MSF)	Mouth of Columbia River to Hwy 395 bridge
		Recreational select tributary	Fall Chinook (Full Retention below Hood River Bridge, Full Retention upstream), coho salmon (MSF), and summer steelhead (MSF)	Klickitat, Deschutes, John Day Rivers
		Conservation steelhead	Hatchery-origin summer Steelhead, MSF	Upper Columbia above Rock Island Dam and tributaries
		Wanapum tribal fall fishery	Fall Chinook and coho, Full Retention	
		CCT tribal summer/fall Chinook	Summer/Fall Chinook, Full Retention	Chief Joseph Dam tailrace
	Treaty	Ceremonial and Subsistence (C&S)	Fall Chinook and/or Steelhead, Full Retention	Mainstem Columbia River and tributaries
		Commercial gillnet	Fall Chinook Salmon, Full Retention	Bonneville Dam to McNary Dam
		Commercial and C&S Platform and Hook and Line	Fall Chinook Salmon, Full Retention	Buoy 10 to McNary Dam
		Late Fall Commercial gill net	White Sturgeon, Full Retention	Bonneville Dam to McNary Dam
		McNary-Hwy 395 Bridge Hook and Line	Fall Chinook and coho salmon, Full Retention	McNary to Hwy 395 Bridge

Policy and Management

Ocean, mainstem Columbia, and tributary fisheries are all managed differently and by different groups but have the same goal of maximizing harvest while allowing adequate natural-origin escapement to the spawning grounds and/or minimizing take of ESA-listed species. Objectives for harvest management include biological, legal, and socio-economic considerations (ISAB 2005). Biologically, harvest impacts must be constrained according to the productive capacity of the populations on which they rely. Legally, harvest management must comply with requirements set forth in federal, state, and tribal laws as well as international and Tribal treaty obligations. Socially, harvest management must distribute the benefits and responsibilities for conservation in a way that is acceptable to the public and defensible against legal challenge. The suite of harvest management objectives affecting Columbia River salmon is embodied within management plans and legal requirements, such as the Pacific Salmon Treaty agreements, the Pacific Fishery Management Council's Pacific Coast Salmon Plan, the Magnuson-Stevens Fishery Conservation and Management Act (MSA). No single entity has the authority and responsibility for ensuring that management objectives are met for a given population, though in principle one entity, NMFS,

has the authority and responsibility for ensuring that recovery objectives are met for populations listed under the ESA. Therefore, cooperation and coordination are necessary across management jurisdictions to meet harvest goals and objectives (ISAB 2005).

The federal government has a trust responsibility to Northwest tribes to ensure ceremonial and commercial fishing opportunities. A number of treaties between the United States and various Washington, Oregon and Idaho tribes (1854 through 1856) describe the reserved tribal fishing rights in common with citizens of the territory or in some cases with Citizens of the United States. Tribal fishing rights in the Columbia River have been established and upheld through the legal provisions of *U.S v. Oregon and U.S. v. Washington* court cases. The *U.S. v. Oregon* caser defines the Columbia River Treaty Tribes' right to take fish at "all usual and accustomed places" on the Columbia River and its tributaries, establishes a limitation, and prevents discrimination under the State of Oregon's regulation of Tribal fishing. At the time of the original complaint from which the case originated the Treaty Tribes were limited to approximately 16% of the annual salmon harvest, based on 1960-1968 averages (U.S.FWS 2018).

Every year, federal, state, and tribal agencies up and down the Pacific Coast and within the Columbia River make plans for the commercial, recreational, and tribal salmon harvest. NMFS plays a key role in managing ocean and in-river fisheries, setting overall in-river and ocean catch rates with the goal of preventing overfishing and distributing the catch. Rates are based on forecasts of adult salmon abundance, species conservation, and the ESA. Fishery managers continually review population abundance and marine survival conditions and adjust harvest rates and timing to minimize impacts to natural-origin stocks. The time frame for decision making can range from several years for international agreements, like the negotiated Pacific Salmon Commission (PSC) to just a few hours for in-season management actions, such as opening or closing a fishery. Typically, harvest management planning decisions are made on an annual cycle coinciding with the availability of information on the status of individual populations and domestic fishery planning process (ISAB 2005).

In mixed stock fisheries (multiple species or multiple stocks), harvest managers use a "weak stock" management approach to protect the weakest stocks while targeting the stronger stocks and use abundance based harvest rates. They generally try to manage fisheries using a combination of gear, timing, area, and mark-selective regulations to optimize the harvest of hatchery-origin fish and strong natural stocks and protect weaker natural-origin stocks. The capacity to constrain harvest requires: (1) consistent quality-assured data for pre-season planning and in-season monitoring; (2) clear management objectives and timely in-season decision processes; and (3) management accountability (ISAB 2005).

Fundamentally, harvest management involves decisions based on 1) information regarding the status of the resource and its productive capacity; and 2) a social imperative to balance preservation and utilization of the populations to be harvested, as well as the resources that affect their productivity, such as the quality and quantity of habitat. The decisions made by individual jurisdictions on matters pertaining to harvest, production, and habitat protection respond to the needs of their own constituencies within the constraints of applicable law (ISAB 2005).

Ocean Fisheries

Columbia River salmon are caught in three distinct ocean fisheries – Southeast Alaska, Canada, and off the coasts of California, Oregon and Washington. Upper Columbia spring Chinook and steelhead are a negligible portion of these catches, however, in some part because of the robust management of these fisheries across jurisdictional territories. Ocean fisheries are thought to have little to no effect on UC listed species at least in part due to current management. A brief summary of the management of these fisheries is provided as background.

Harvest management decisions for ocean fisheries affecting salmon from the Columbia River are made by tribal and state managers, Fisheries and Oceans Canada, and the U.S. Secretary of Commerce. The tribes manage tribal fisheries in coordination with the **Pacific Fishery Management Council (PFMC).** The PFMC is one of eight regional fishery management councils established by the Magnuson-Stevens Fishery Conservation and Management Act of 1976. The PFMC is comprised of representatives from the States of Washington, Oregon, California and Idaho, a tribal representative, and representatives of NMFS and the U.S. Fish & Wildlife Service.

The PFMC has jurisdiction over the 317,690 square mile exclusive economic zone (EEZ) off the Washington, Oregon and California coasts and manages fisheries for about 119 salmon, groundfish, coastal pelagic, and highly migratory species. The PFMC uses Cape Falcon, Oregon as the southern management boundary for Columbia River Chinook and to implement harvest allocation schedules for non-treaty commercial and recreational fisheries off the coasts of Washington and Oregon. **The North of Cape Falcon Forum**, sponsored by state and tribal co-managers, convenes the co-managers and representatives of the commercial and recreational fishing sectors during the Council's preseason planning process to determine allocation and conservation recommendations for fisheries north of Cape Falcon. In addition to the institutional structures of regional councils, the **MSA** sets forth a set of national standards that must be attained for ocean salmon fishery management (ISAB 2005).

Ocean fisheries for salmon outside coastal areas are guided by the **Pacific Salmon Commission (PSC)** which was established in the 1985 **Pacific Salmon Treaty** between the United States and Canada. Except for sockeye and pink salmon returning to the Fraser River, the PSC has no regulatory or management authority of its own but is empowered to develop fishery regimes or agreements that will govern the regulation of fisheries by the domestic managers of the U.S. and Canada. The primary PSC agreements affecting Columbia River salmon involve Chinook management and a general Pacific Salmon Treaty obligation not to initiate new intercepting fisheries (those that harvest fish produced in the rivers of the other country). Fisheries under the jurisdiction of the PSC are managed according to the provisions of a long-term **Salmon Fishery Management Plan** that identifies conservation objectives for individual stocks and allocation requirements between non-Tribal fishery sectors. As part of the annual planning process, agreements are made to equitably distribute the conservation responsibility and allowable fishery impacts, and to coordinate harvest measures to meet resource management objectives for individual stocks (ISAB 2005).

Columbia River Fisheries

After individual populations pass through ocean commercial troll and recreational fisheries, adult fish return to the Columbia River where they may encounter a series of commercial, tribal, and recreational fisheries. Harvest management regulations are designed to comply with applicable laws, policies, and

conservation goals embodied in Treaty fishing rights case law, the ESA, and fishery management plans. Regulations are issued by state and tribal governments having statutory or court-ordered authorities to regulate their respective fisheries. Fisheries can be broken down geographically in terms of management into the Lower River Fisheries, which are guided by the *U.S. v. Oregon* Management Agreement and the Upper Columbia. Lower River fisheries for steelhead extend from the mouth of the Columbia up to the Highway 395 bridge below the confluence with the Snake River. Fisheries for spring Chinook extend further upstream to Priest Rapids Dam to include the Wanapum tribal and Ringold Spring recreation fisheries.

Lower Columbia

(Mouth to Highway 395 Bridge for Steelhead and Mouth to 395 Bridge plus Wanapum and Ringold sport fishery for spring Chinook)

Harvest in treaty and non-treaty fisheries in the mainstem Columbia River from its mouth upstream to Priest Rapids Dam is guided and bound by the 2018-2027 ***U.S. v Oregon*** **Management Agreement (*U.S. v. Oregon*)**. The parties to *U.S. v. Oregon* include: the states of Washington, Oregon, and Idaho; the United States; the Shoshone-Bannock Tribes, the Confederated Tribes of the Warm Springs of Oregon, the Confederated Tribes of the Umatilla Indian Reservation, the Nez Perce Tribe, and the Confederated Tribes and Bands of the Yakama Nation (NMFS 2019). Relevant treaties include the Walla Walla treaties with the Yakama Nation, Warm Springs, Umatilla, and Nez Perce, and the Ft. Bridger treaty with Shoshone-Bannock.

There are numerous cases before and after *U.S. v. Oregon* that established the scope and nature of treaty fishing rights. Through these cases the federal courts have determined that these tribes, through their treaties with the United States, reserved the right and are entitled to 50% of the harvestable number of fish originating in, or passing through, their "usual and accustomed" fishing places. The courts have further held that the state is limited in its power to regulate treaty Tribe fisheries. Among other things, the state may only regulate when reasonable and necessary for conservation. While the general principles for quantifying treaty Tribe fishing rights are well established, their application during the annual fishing seasons is complicated. Annual calculations of allowable harvest rates depend on factors such as estimated run sizes, stock composition, application of the ESA to mixed-stock fisheries, application of the tenets of the "conservation necessity principle" for treaty Tribe fisheries, and the effect of both the ESA and the conservation necessity principle on treaty and non-treaty allocations. The term "conservation" has a specific legal meaning when applied in the context of treaty fishing; the courts have ruled that conservation actions must be reasonable and necessary for the perpetuation of a species of fish (NMFS 2019).

The *U.S. v. Oregon* agreement provides a framework within which the Parties may exercise their sovereign powers in a coordinated and systematic manner in order to protect, rebuild, and enhance Columbia River fish runs while providing harvests for both treaty and non-treaty fisheries. The primary goals of the Parties are to rebuild weak runs to full productivity and fairly share the harvest of upper river runs between treaty and non-treaty fisheries in the ocean and Columbia River Basin. The harvest policies in the Management Agreement include abundance-based management, fixed harvest rate, and fixed escapement goal policies. The management agreement also incorporates hatchery programs that provide harvest opportunities and that are important to the conservation of salmon or steelhead runs above Bonneville Dam. In addition to specifying harvest policies for salmon and steelhead stocks bound for upriver areas, the agreement

establishes procedures to facilitate communication and to resolve disputes fairly. These procedures permit the Parties to resolve disputes outside of court through good-faith efforts to settle disagreements through negotiation (FWS 2018).

Commercial fisheries in the Columbia River are adopted by the **Columbia River Compact**, which was created by Congress in 1918 and is charged by federal and state statutory authority to ensure consistency in Oregon and Washington regulations for fisheries in the shared boundary waters of the Columbia River. The Compact must consider the effect of commercial fishing for salmon, steelhead, and sturgeon in the Columbia River on escapement, treaty rights, and recreational fisheries, as well as the impact on ESA- listed species. Currently, the directors of ODFW and WDFW (or their delegates) serve on the Compact, representing the Oregon Fish and Wildlife Commission (OFWC) and the Washington Fish and Wildlife Commission (WFWC). In addition, the Columbia River treaty tribes have authority to regulate treaty fisheries, but tribal regulations are adopted into state law by the Compact to allow non-tribal wholesale buyers to purchase tribally-caught fish. By law, the Compact can regulate treaty fisheries only when it can demonstrate that a proposed tribal regulation would imperil the future existence of the resource.

Scientific advice to the Compact is provided by the Joint Staff comprising technical staff from ODFW and WDFW. The Joint Staff participate in and coordinate with the **Technical Advisory Committee (TAC)**, an advisory body formed by the *U.S. v Oregon* fishing rights case and comprising technical staff representing each of the parties to the case. The purpose of the TAC is to reach consensus, if possible, on the fishery statistics and basic data needed by the fishery co-managers to establish regulations. The TAC reviews forecasts of stock abundance, monitors abundance and fisheries in-season, and makes recommendations for harvest management to the co-managers who then propose regulations to the Compact (ISAB 2005). When addressing commercial seasons for salmon, steelhead, and sturgeon, the Compact must consider the effect of the commercial fishery on escapement, treaty rights, and recreational fisheries, as well as the impact on ESA-listed species. Although the Compact has no authority to adopt recreational fishing seasons or rules, it is an inherent responsibility of the Compact to address the allocation of limited resources among users.

Conservation objectives for fisheries are guided by species recovery plans, Biological Opinions, and Incidental Take Statements issued under **the ESA**. Often, the primary limiting factor in structuring fisheries is ensuring compliance with the ESA. Almost all fisheries occurring in the Columbia River encounter at least some ESA-listed fish and therefore must be carefully managed to minimize impacts on ESA-listed fish. Federal ESA impact limitations are developed and mandated by NMFS and have been incorporated into the terms of the *U.S. v Oregon* Management Agreement. One challenge is that under the ESA, listings and recovery plans are made at the level of the ESU while harvest management typically operates on aggregates of independent populations. In spring Chinook fisheries, mark-selective (adipose fin-clip only) rules are used in recreational and commercial fisheries in order to minimize impacts on ESA-listed wild fish. Of the fish that are caught and released, a conservative guideline is that 10% will die from resulting injuries based on scientific recommendation by the *U.S. v Oregon* TAC (TAC 2017; Table 5). The *U.S. v. Oregon* parties must ensure that sharing agreements are upheld based on total allowable shares of available ESA impacts that are allotted to treaty and non-treaty fisheries at various run sizes using abundance-based harvest management.

As part of the *U.S. v. Oregon* agreement the parties agreed to performance measures associated with harvest indicator stocks that can be used to monitor progress toward rebuilding upriver stocks of salmon and steelhead. Harvest indicator stocks are those used directly for managing the fisheries. Abundance indicator stocks provide more detailed information about natural-origin stocks or populations that currently limit fisheries. Upper Columbia spring Chinook, natural-origin Upper Columbia steelhead, and natural-origin A-Index steelhead are listed as harvest indicator stocks. Upper Columbia River natural-origin spring Chinook (Wenatchee, Entiat, Methow) and Upper Columbia natural-origin steelhead (Methow and Wenatchee) are listed as abundance indicator stocks (*U.S. v. Oregon* 2018). The TAC publishes information on the abundance of indicators stocks in their annual reports (e.g. dam counts and subbasin run sizes and redd counts). The intent of abundance-based management is to provide more protection when runs are weak and the conservation need greatest, and more harvest opportunity when runs are strong. This model allows management to adapt to the inherent year-to-year variability of salmon stocks.

Accurately forecasting fish returns is important to successful fisheries management, but since in-river fisheries are managed based on actual run sizes, determining actual run sizes as early and as accurately as possible is key to successful management. To develop forecasts, fish biologists collect information on smolt migrations in previous years, ocean conditions, and returns in recent years then use models to estimate current year returns by stock. Harvest seasons are set based on the predictions then adjusted in-season as fish return. Within the context of the Columbia River, the TAC develops preseason estimates of the projected return and updates these estimates weekly during the run based on in-season information, such as dam counts and catch. These updates can result in increased estimates of run size, which may result in additional fishing opportunity, or can result in decreased estimates of run size, which may lead to emergency closures. In 2018, fishery managers met 28 times to adjust fisheries, with the goal of balancing conservation of the salmon and steelhead runs while providing fishing opportunities (NWPCC 2019).

Once co-managers have an idea of how many fish are available for harvest, they refer to the harvest rate schedule of the 2018–2027 *U.S. v. Oregon Management Agreement* to plan fisheries for the coming year (Table 3). This harvest rate schedule is based on a sliding scale, with increasing or decreasing allowable impact rates dependent on the total upriver spring Chinook run size. This harvest rate schedule along with the preseason forecast for upriver spring Chinook are used to plan fisheries based on the available impacts allocated to treaty and non-treaty fisheries. Beginning in 2010, changes were implemented, which required non-treaty fisheries to meet the catch balance provisions in the Agreement for upriver spring Chinook. Under these provisions, non-treaty fisheries must be managed to remain within acceptable ESA impacts while not exceeding the total allowable catch available for treaty fisheries. Recreational harvest is mostly estimated from creel surveys (WDFW and ODFW 2019).

Fisheries are planned based on estimated and in-season run sizes. While the treaty and non-treaty spring Chinook fisheries are managed on the total run size at Columbia River mouth, early season non-treaty fisheries are planned on a buffered run size forecast, essentially a decrease of the forecast artificially each year by 30%. Actual fisheries are managed based on the actual estimated run size at the river mouth for Chinook and Bonneville Dam for steelhead. This is a conservative way to plan fisheries as the majority of non-treaty fishing occurs downstream of Bonneville Dam and prior to when an in-season run size estimate generally occurs, so it provides some level of built in conservatism for years when a returning forecast of fish might be higher than the actual return. The buffer increase could be up to 40% if the Parties agree that

that level of increase is necessary. Table 3 reflects the new catch-balancing provisions implemented in 2010 (2018-2027 *U.S. v. Oregon Management Agreement*). The harvest rate schedule also provides that in the case of a very low run size for natural origin UC spring chinook, mainstem harvest rates would have additional restrictions. In certain cases, and by agreement of the Parties, unused ESA impacts may be transferred between the non-treaty and treaty fisheries (e.g. catch exceeding share allocations or if re-distribution of unused ESA impacts would better meet the mutual objectives of the Parties).

Table 3. Harvest Rate Schedule for Chinook in Spring Management Period (*U.S. v. Oregon* 2018-2027; Table A1).

Total Upriver Chinook Run Size[6]	Snake River Natural Spring/Summer Chinook Run Size	Treaty Harvest Rate [2,5]	Treaty Catch Guideline	Non-Treaty Natural Harvest Rate[3]	Non-Treaty Mortality Guideline	Total Natural Harvest Rate[4]	Non-Treaty Natural Limited Harvest Rate[4]
<27,000	<2,700	5.0%		<0.5%		<5.5%	0.5%
27,000	2,700	5.0%	1,350	0.5%	1,350	5.5%	0.5%
33,000	3,300	5.0%	1,650	1.0%	1,650	6.0%	0.5%
44,000	4,400	6.0%	2,640	1.0%	2,640	7.0%	0.5%
55,000	5,500	7.0%	3,850	1.5%	3,850	8.5%	1.0%
82,000	8,200	7.4%	6,068	1.6%	6,068	9.0%	1.5%
109,000	10,900	8.3%	9,047	1.7%	9,047	10.0%	
141,000	14,100	9.1%	12,831	1.9%	12,831	11.0%	
217,000	21,700	10.0%	21,700	2.0%	21,700	12.0%	
271,000	27,100	10.8%	29,268	2.2%	29,268	13.0%	
326,000	32,600	11.7%	38,142	2.3%	38,142	14.0%	
380,000	38,000	12.5%	47,500	2.5%	47,500	15.0%	
434,000	43,400	13.4%	58,156	2.6%	58,156	16.0%	
488,000	48,800	14.3%	69,784	2.7%	69,784	17.0%	

1. If the Snake River natural spring/summer forecast is less than 10% of the total upriver run size, the allowable mortality rate will be based on the Snake River natural spring/summer Chinook run size. In the event the total forecast is less than 27,000 or the Snake River natural spring/summer forecast is less than 2,700, Oregon and Washington would keep their mortality rate below 0.5% and attempt to keep actual mortalities as close to zero as possible while maintaining minimal fisheries targeting other harvestable runs.
2. Treaty Fisheries include: ceremonial, subsistence, and commercial fisheries from January 1-June 15. Harvest impacts in the Bonneville Pool tributary fisheries may be included if TAC analysis shows the impacts have increased from the background levels.
3. Non-Treaty Fisheries include: Commercial and recreational fisheries below Bonneville Dam and mainstem recreational fisheries from Bonneville Dam upstream to the Hwy 395 Bridge in the Tri-Cities and commercial and recreation SAFE (Selective Areas Fisheries Evaluation) fisheries from January 1-June 15; Wanapum tribal fisheries, and Snake River mainstem recreational fisheries upstream to the Washington-Idaho border from April through June. Harvest impacts in the Bonneville Pool tributary fisheries may be included if TAC analysis shows the impacts have increased from the background levels.
4. If the Upper Columbia River natural spring Chinook forecast is less than 1,000, then the total allowable mortality for treaty and non-treaty fisheries combined would be restricted to 9% or less. Whenever Upper Columbia River natural fish restrict the total allowable mortality rate to 9% or less, then non-treaty fisheries would transfer 0.5% harvest rate to treaty fisheries. In no event would non-treaty fisheries go below 0.5% harvest rate.
5. The Treaty Tribes and the States of Oregon and Washington may agree to a fishery for the Treaty Tribes below Bonneville Dam not to exceed the harvest rates provided for in this Agreement.
6. If the total in river run is predicted to exceed 380,000, the Parties agree to consider increasing the total allowed harvest rate and to reinitiate consultation with NMFS if necessary.

Once catch shares are calculated for the states and treaty tribes, each manage their allocation according to their own priorities for harvest. The states of Washington and Oregon split their allocation amongst non-treaty commercial and recreational fisheries. The most recent split for 2020 only is 25% commercial/75%

recreational but in the past it has fluctuated and is subject to change in the future due to Washington Policy/Oregon Rule review of the Columbia River policy. These individual catch shares can be even more specific, for instance, there may be separate sub-quotas for the Buoy 10 recreational fishery and the upstream mainstem Columbia River recreational fisheries; or for commercial salmon fisheries in different areas of the river. Because of these individual quotas and sub-quotas, it is common for one fishery (commercial or recreational) to continue after others have been closed. Allocations to commercial and recreational fisheries is done through the **Columbia River Salmon Management Plan (WDFW Policy C-3620)** and allocations reflect the policies of the states**.** The plan was established by the Washington and Oregon fish and wildlife commissions in 2013 with the intent of promoting orderly fisheries, advancing wild salmon and steelhead recovery, and enhancing the economic stability of the state's fishing industry (WDFW 2019).

Treaty fisheries in the Columbia Basin are managed to achieve three priority needs which, in order, are: traditional cultural ceremonies, personal subsistence, and commercial livelihood. In a given year, an allowable catch quota is calculated from a pre-season estimate of run size. For spring Chinook, a portion of the quota is set aside to sustain subsistence fishing through the spring management period and the majority portion is divided among the Treaty tribes to support the ceremonial needs of longhouses and Shaker churches. After ceremonial fisheries are completed and subsistence needs are judged to be met, the subsistence catch may be offered for commercial sale. In rare instances, the spring Chinook run size may be large enough to support a few days of commercial fishing with gillnets. The predicted run size is validated weekly in-season and adjustments to the allowed catch are made as necessary. Intensive catch monitoring produces weekly estimates of tribal catch that are compared against the allowable catch quota to determine whether or what adjustments to the fishery are required to stay within the quota. Commercial gillnet fishing for non-ESA listed summer and fall Chinook may be allowed subject to meeting both conservation (escapement) goals and restrictive ESA take limits for Snake River sockeye, UC steelhead, Snake River fall Chinook, and Snake River steelhead (*S. Parker, Yakama Nation, pers. comm*).

The 2018–2027 *U.S.. v. Oregon*, as well as the expired CRFMP, identify a minimum cultural and subsistence (C&S) annual “safety net” to the Columbia River treaty tribes defined as the opportunity to harvest 10,000 spring and summer Chinook or be provided with hatchery fish of equivalent quality. After spring and summer fisheries are accounted for, the balance of the “safety net” is to be provided to the tribes by the states of Oregon and Washington.

Recreational fisheries that cross state waters are managed under Joint State action Washington and Oregon. While there is not an overriding agreement requiring cooperative action, as in the case of the Compact, the states generally seek agreement on recreational fisheries issues and establish concurrent season structures. Once the non-treaty catch share is calculated, Washington and Oregon further allocate ESA-impacts or numbers of fish amongst the various recreational and commercial fisheries in the jointly managed portion of the Columbia River. Allocations are guided by separate, but concurrent state policies. Allocations of salmon and steelhead to the UC are also considered in this process. As runs materialized in-season, Washington and Oregon meet routinely to adjust fisheries as needed. As defined in *U.S. v Oregon*, Chinook fisheries in the Columbia River are managed for three time periods: Upriver spring and Snake River summer Chinook from January 1 to June 15; Upper Columbia River summer Chinook from June 16 to July 31; and fall Chinook from August 1 to December 31. Harvest rates (which are converted to allowed catch

depending on run size) and ESA impact rates are determined for each time period. Steelhead harvest is estimated for all treaty and non-treaty fisheries. In recreational fisheries, steelhead harvest is estimated with creel surveys in the mainstem Columbia River. Preliminary steelhead and Chinook harvest estimates in the Tribal fishery area between Bonneville Dam and McNary Dam are made on a weekly basis beginning June 16. This allows managers to adjust seasons to keep steelhead impacts and harvest of summer and fall Chinook within the limits that are outlined in *U.S. v Oregon*. Final harvest estimates are reported by *U.S. v. Oregon* TAC at the conclusion of the Tribal fishery (Byrne et al. 2018).

Across all of the fisheries, monitoring and evaluation activities occur throughout the year in the Columbia River to assess the stock status of salmon and steelhead returns and to monitor fishery effort, catch, and impacts to ESA-listed species (TAC 2017). Fishery sampling is conducted by the co-managers to estimate landed catch and to collect representative and unbiased samples. These monitoring activities result in harvest estimates that are statistically based (TAC 2019).

Upper Columbia

(Upstream of the Hwy 395 Bridge)

Fisheries upstream of the Highway 395 Bridge (e.g., outside of *U.S. v Oregon* jurisdiction) are governed solely by Washington state. Fish managers use dam counts (Priest Rapids to Wells) to estimate total abundance and distribution. In years when run sizes are moderate to large, dam count information is less critical because allocations of salmon above Priest Rapids Dam are larger than recreational and non-treaty tribal fishers can harvest. When runs sizes of salmon are low to moderate, fish managers use dam count information to more strategically open fisheries on segregated hatchery-origin stocks returning to a specific hatchery (e.g., Chelan Falls Hatchery, Wells Hatchery, etc.). Conservation fisheries on ESA-listed Upper Columbia spring Chinook and summer Steelhead are prosecuted in-season and are based off Priest Rapids Dam counts. Abundances of spring Chinook and steelhead are further refined based off dam counts and/or PIT detections. When spring Chinook and steelhead meet certain abundance thresholds and ratios of natural- to hatchery-origin fish, recreational angling is permitted as an adult management tool to help meet PNI objectives in spawning tributaries For Summer Chinook, the majority of the in-river non-treaty harvest is provided to fisheries above Priest Rapids Dam, with the majority for the Colville Confederated Tribe. This is an abundance-based matrix, so allocations change based on the run size.

Two non-treaty tribes, Colville Confederated Tribes and Wanapum Band, conduct C&S fisheries in the Upper Columbia. The Colville Confederated Tribes is a federally recognized, whereas the Wanapum Band is state recognized through state statutes (RCW 77.12.451). Neither tribe is party to the *U.S. v Oregon* or have a treaty harvest allocation for salmon and steelhead. Allocations of salmon and/or steelhead for both tribes are part of the non-treaty share. Allocation for the Colville Confederate Tribes (CCT) is detailed in a formal harvest share agreement between the tribe and WDFW. In general, the agreement preserves CCT C&S fisheries in years with low to moderate runs sizes while recreational fisheries are minimal or closed. In years with moderate to high run sizes harvest sharing is equal amongst tribal and recreational fisheries. Allocation for the Wanapum Band is detailed in the Wanapum Fishing Framework document. Once allocations are determined for Wanapum Band fisheries, the director (or his/her designee) issue fishing permits to tribal members.

Conservation fisheries are managed according to escapement goals and goals associated with hatchery programs in the Upper Columbia. Hatchery programs for listed UC spring Chinook and steelhead aim to enhance the number of adult fish for the purposes of conservation but must ensure that there are not too many hatchery fish on the spawning grounds in relation to natural-origin fish. Goals related to the proportion of hatchery-origin spawners (pHOS) and the proportion of natural influence (PNI) are outlined in the Hatchery Genetic Management Plans (HGMPs) and associated ESA permits, which take into consideration that hatchery-origin produced in these conservation programs are both listed under ESA. Hatchery programs aid in recovery by maintaining more-or-less constant number of returning spawners. In years of high abundances and adequate abundance of unmarked fish, managers implement adult management. Adult management includes removal of marked hatchery fish via weirs, dams, traps, and recreational fishing. Adult management helps meet PNI goals on the spawning grounds. Conservation fisheries are highly regulated and monitored to keep impacts to natural origin fish within ESA permit limits.

For UC sport fisheries on spring Chinook and steelhead, harvest regulations are enacted and provided for retention of only adipose fin-clipped hatchery fish. Creel census activities are conducted to monitor the fishery and to estimate the fishery impacts so as to keep the impacts below established thresholds for take of listed species (WDFW 2009; WDFW 2015). ESA Section 10 permits for the conservation fisheries outline how many natural-origin and hatchery-origin fish must be present in the run year to allow WDFW to open conservation fisheries. WDFW uses a three tiered approach to managing impacts from the conservation fisheries for steelhead and a similar approach for spring Chinook. These tiers are based on natural-origin returns to specific population areas in the Upper Columbia. Conservation fisheries do not open unless natural-origin returns are adequate to allow a fishery. Beyond that, impacts are tiered to allow greater impacts (more fishery effort to remove hatchery-origin adults) when natural-origin returns are greatest WDFW uses a 5% hooking mortality rate to estimate morality of released natural-origin fish (WDFW 2009).

Table 4. Management regulations for determining natural-origin impacts during the recreational fishery on steelhead (top) and spring Chinook (bottom) in Upper Columbia tributaries above Rock Island Dam (WDFW 2011). NO= natural-origin returns.

Steelhead Conservation Fishery Guidelines

Tributary Area	Priest Rapids Dam Count	Estimated Escapement to Tributary Area	Maximum Allowable Mortality Impact
Wenatchee River and Columbia River above Rock Island Dam			
	<837	<599	0%
Tier 1	838	600	2%
Tier 2	2,146	1,700	4%
Tier 3	3,098	2,500	6%
Methow River and Columbia River above Wells Dam			
	<908	<499	0%
Tier 1	804	500	2%
Tier 2	2,224	1,600	4%
Tier 3	3,386	2,500	6%
Okanogan River Basin upstream of the Highway 97 Bridge			
	<175	<119	0%
Tier 1	176	120	5%
Tier 2	180	120	7%
Tier 3	795	600	10%

Spring Chinook Conservation Fishery Guidelines

NO run size to Wenatchee River	HOR Run Size Required to Consider Implementation of a Conservation Fishery[3]	Management Objective[4]
<511	<4,000	**No Fishery**
<511	≥4,000	**<u>Escapement Ratio Mgt Option</u>** Fishery may be considered depending on the composition of the HOR's
≥511	≥4,000	**<u>Escapement + PNI Mgt Option</u>** Fishery may be considered depending on the composition of HOR's. For NO run size <631 total runs above TWD will be managed for an escapement of 2, 077 fish.
700[5]	<4,000[6]	**<u>PNI Mgt Option</u>** NO abundance level required before population is managed for PNI>0.67. Fishery may be implemented at <4,000 HOR's and managed at the NO take limit.

[3]HOregon run size includes Icicle Creek fish and conservation and safety net fish from above Tumwater hatchery programs.

[4]Any mainstem Wenatchee spring Chinook conservation fishery only targets the Icicle and safety net components.

[5]Approximate level when PNI goals are at or above the 0.67 level and fewer HOR are required for conservation objectives. Beyond NOR level, the number of HOregons required to initiate a conservation fishery may be unreasonable.

[6]In the event a fishery is implemented when pHOR is ≤85%, take limits on NOR will be managed to ≤2%.

Harvest Effects

Upper Columbia steelhead and spring Chinook listed under the ESA (both hatchery and natural-origin) encounter a number of different fisheries during their migration and can be affected by these fisheries through a number of different pathways. The most straightforward outcome is that a fish is caught and kept (direct mortality event). However the number of adult fish that encounter fishing gear and are retained as catch is much less than the number of fish that encounter fishing gear. Fish that encounter fishing gear and escape or fish that are caught and release can also die as a result of the fishery. Understanding how many fish die as a result of their fishery encounter is difficult but important to understand the total effect of the fishery. Numerous studies have been done to better understand how fish respond to a fishing encounter, including factors related to both the fishery (e.g., gear type) as well as the environment (e.g., water temperature) and the fish itself (e.g., fish size). These factors can elicit different fish responses that can lead to the different types of effects, including mortality. Figure 6 shows a diagram of the types of fates that can result as a result of encountering a fishery. Sublethal effects are not outlined but can result even if a fish survives its encounter. The fate of a fish following a fishing encounter can be categorized into five possible outcomes (Patterson et al. 2017):

- *Survival* – A fish mounts a successful adaptive stress response and survives the fishing encounter with no change to their future fitness
- *Sub-lethal effect* – A fish survives the fishing encounter for the foreseeable future, but suffers sub-lethal effects that reduce their future fitness (e.g., reduction in growth or direct detrimental effects on reproductive development)
- *Acute mortality* – A fish dies during or shortly after the fishing encounter (e.g., within 24 h) from either an inability to recover from a severe physiological response (e.g., acidosis), or from a severe wound (e.g., exsanguination)
- *Latent mortality* – A fish dies days to weeks after the fishing encounter from the inability to overcome the stress, injury, or resulting infection
- *Predation* – A fish is preyed upon either during or after capture, contributing to both acute and latent mortality

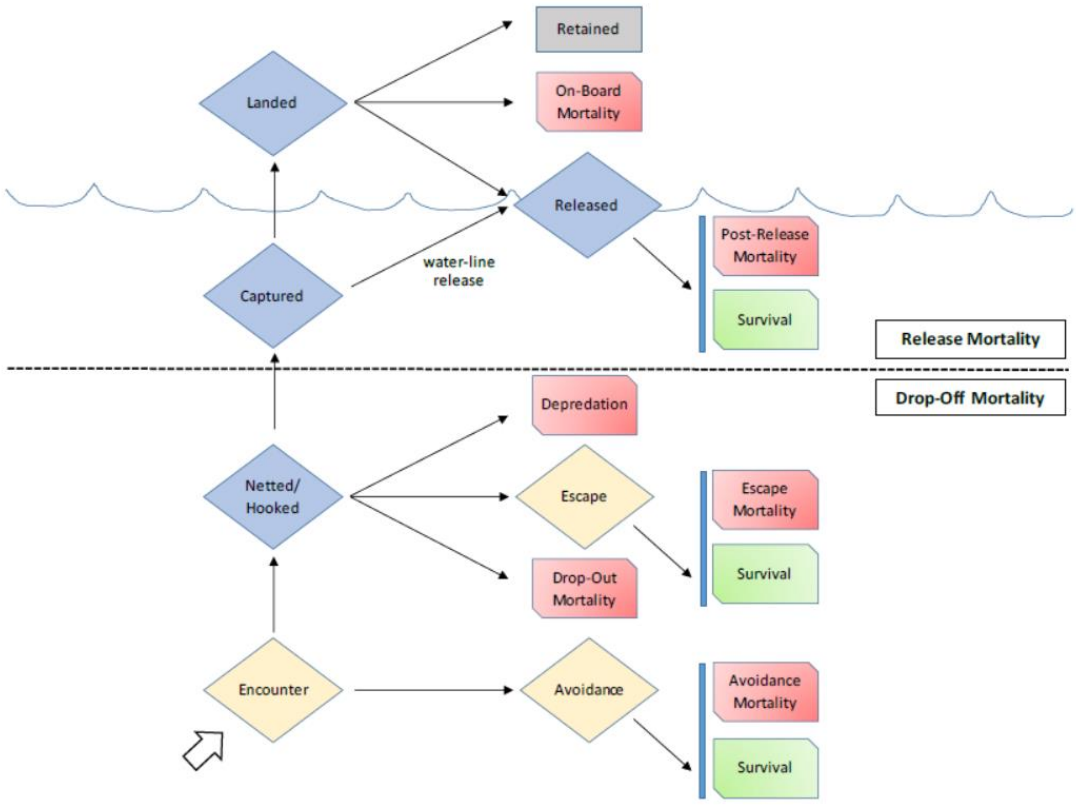


Figure 6. Diagram showing the types of fate (all rectangles represent mortality or survival) resulting from a general fishing event. The diamonds depict the general progression of fishing activities (blue) and fish responses (yellow). The components of fishing-related incidental mortality are shown in red rectangles. The escape, avoidance and post-release mortality rectangles include acute and latent mortality (e.g., predation, infection). Note that the post-release mortality rectangle represents both the short-term (i.e., < 24 hours) and delayed (i.e., > 24 hours) mortality components. Survival (green rectangles) can also include sub-lethal effects (Diagram from Patterson et al. (2017).

Impacts on natural-origin steelhead and spring Chinook from most recreational fisheries and non-tribal commercial fisheries result from incidental mortality rather than from directed harvest since releasing unmarked adults is required in those fisheries. Directed harvest and retention of unmarked steelhead and spring Chinook are currently permitted in treaty tribal fisheries in the Columbia River but occurs at low rates. Directed harvest of ad-clipped hatchery-origin spring Chinook and steelhead that are part of the ESA-listing occurs in mark-selective fisheries and conservation fisheries aimed at controlling the number of hatchery fish that spawn.

Single-stock fisheries are the most effective method for targeting a specific stock and occur in terminal harvest areas where one stock is known to be present. In mixed-stock fisheries in the Columbia River, the management challenge is to harvest from mixed populations having various available surpluses for harvest (including some populations with no surplus) as the populations move through the fishery at various rates and abundances. Harvest of a specific stock in a mixed-stock fishery can be achieved through management decisions (e.g., fishery openings that use time and area to target stocks when and where they are abundant relative to other stocks), fishery adaptations (e.g., gear designed to target specific stock/species), or fishery regulations (e.g., prohibitions against retaining certain species) (NMFS 2013). For the mixed Columbia River steelhead fishery, little information is available to develop population-specific mortality rates. Although

aggregate handle rates and impacts are calculated, if certain populations are handled disproportionately due to migration timing, migration routes, or body size (e.g., net selectivity), their true mortality rates may differ considerably from reported aggregate rates (Cram et al. 2017).

Although managers employ various methods to ensure fisheries target a specific stock; incidental catch—the harvest of nontargeted stocks—still occurs, largely because various stocks intermingle during their upstream migration. All Columbia River fisheries have specific reporting requirements with limits for incidental catch that are intended to minimize impacts to non-targeted stocks. Federal, state, and tribal harvest managers also employ catch-and-release regulations that allow anglers to retain hatchery-origin salmon and steelhead but require them to release natural-origin fish in some cases. Extensive research on incidental mortality has shown that it can vary widely (Patterson et al. 2017). Factors such as gear type, capture and handling, environmental conditions, and fish condition, size, sex, and species among others may all play a role in determining the fate of a fish after capture (e.g. Patterson et al. 2017a and 2017b; Raby et al. 2015; Teffer et al. 2018). So-called "drop out mortality" can also occur when fish encounter commercial fishing gear but escape prior to landing. There are no data on actual drop-out mortality in Columbia River fisheries. Incidental mortality has been researched to inform models and estimates of total harvest mortality (see PSC 2004). Table 5 shows the mortality rates adopted by TAC for various types of fisheries affecting UC spring Chinook and steelhead.

Table 5. Release Mortality Rates Adopted By TAC for Mainstem Columbia River Fisheries Affecting ESA Listed Upper Columbia Spring Chinook and Upper Columbia Steelhead (table from S.Ellis, CRITFC, *pers. co*mm; data from TAC 2020).

Species	Management Period	Fishery Area	Gear Type	Gear Detail	Fishery Target Species	Release Mortality Rate
Steelhead	Winter; Spring	Mainstem	Hook & Line	Barbed & barbless	Chinook	10.0%
Steelhead	Winter; Spring	Mainstem	Gillnet	Mesh: 8-9.75"	Chinook	30.0%
Steelhead	Winter; Spring	Mainstem	Tangle Net	Mesh: 4.25"	Coho	18.5%
Steelhead	Winter; Spring	Mainstem	Gillnet	Mesh: 5.375-6.25"	Shad	60.0%
Steelhead	Summer; Fall	Mainstem	Hook & Line	Barbed & barbless	Chinook	10.0%
Steelhead	Fall	Mainstem	Gillnet	Mesh: 8-9.75" (8" min.)	Chinook	44.8%
Steelhead	Fall	Mainstem	Gillnet	Mesh: 9-9.75" (9" min)	Chinook	38.3%
Steelhead	Summer	Mainstem	Gillnet	Mesh: 8-9.75"	Chinook	59.0%
Steelhead	Fall	Mainstem	Gillnet	Mesh: 6"	Chinook	66.0%
Steelhead	Fall	Mainstem	Pound Net		Chinook	6.0%
Chinook	Winter; Spring	Mainstem	Hook & Line	Barbed & barbless	Chinook	10.0%
Chinook	Winter; Spring	Mainstem	Tangle Net	Mesh: 4.25"	Coho	14.7%
Chinook	Winter; Spring	Mainstem	Gillnet	Mesh: 8-9.75"	Chinook	40.0%
Chinook	Winter; Spring	Mainstem	Gillnet	Mesh: 5.375-6.25"	Shad	18.6%

Harvest may affect the population traits of Upper Columbia salmon and steelhead by selectively removing fish based on size, age, sex, distribution, or run timing. This affect depends on the gear, timing, and location of the fishery. The resulting selection pressures can affect the reproductive success, genetics, structure, and biodiversity of populations. Gear or run timing selectivity may influence population productivity by removing older, larger individuals, or by removing too many individuals of one sex, or the larger females carrying the most eggs. Fishery-influenced changes in the average sizes and ages of salmon populations have been well documented (Ricker 1981). Productivity of a population can be impacted because body size is related to redd digging success (Beacham and Murray 1987), fecundity, and the

number of eggs a female carries (Sandercock 1991). When too many individuals with high reproductive potential are removed, the population's productivity is reduced. A fishery might also disproportionately harvest one portion of a run. Run timing is heritable (Garrison and Rosentreter 1981), so when fish that run at a certain time are selectively removed, the run timing of the entire population can potentially shift. Specific data to evaluate these types of effects on Columbia River populations is not available.

Lastly, the removal of adult salmon and steelhead through harvest activities can impact the ecological integrity of the stream where the fish originate. Adult salmon carcasses in streambeds promote primary production (Wipfli et al. 1999) and rearing fish (Bilby et al. 1996). This creates a biological feedback loop that benefits future salmon production. The chronic depression of salmon biomass to freshwater ecosystems may be contributing to reduced carrying capacity for salmon (Cederholm et al. 1999, Knudsen 2002). By reducing the number of spawners, harvest plays a role, along with all other mortality factors.in diminishing the amount of nutrients provided to the system. This impact is offset to some extent by the increase in hatchery fish in the Columbia Basin to support fisheries and the increase in adult biomass overall.

A number of different fisheries operate in the ocean, mainstem Columbia, and upriver tributaries that either directly or indirectly impact Upper Columbia spring Chinook and steelhead to some degree (). The fisheries are for commercial, recreational, and ceremonial and subsistence purposes and are carried out by both tribal (treaty and non-treaty) and non-tribal entities. Below we describe the fisheries and harvest of UC listed species in the ocean, mainstem Columbia, and tributary and terminal areas.

Ocean Fisheries

Columbia River salmon are caught in three distinct ocean fisheries – Southeast Alaska; Canada; and, off the coasts of California, Oregon and Washington. Columbia River Chinook salmon make up a large portion of catches off the coast of Alaska, British Columbia, and Washington and Oregon. However, Upper Columbia spring Chinook are a negligible proportion of those Chinook. The effects of ocean Chinook fisheries on listed Upper Columbia spring Chinook has been evaluated multiple times by NMFS and their impacts have been found to be too low to quantify (NMFS 1996; NMFS 2001; NMFS 2019). Based on catch data Upper Columbia spring Chinook are rarely caught in ocean fisheries and the effect on the population is impossible to measure or detect given the rarity of the event one is caught in fisheries (NMFS 2018).

In most cases, regulations prohibit the retention of steelhead in marine fisheries. Any harvest effects are the result of catch-and-release mortality or illegal retention of misidentified fish, which is quite rare (NMFS 2019). NMFS has reviewed available information related to the distribution of steelhead from the Upper Columbia and the information from catch records and found that they are rarely landed (NMFS 2001; 2018).

Columbia River Fisheries

Most harvest of Upper Columbia spring Chinook and steelhead occurs in the mainstem Columbia River in tribal and non-tribal fisheries below Priest Rapids Dam. Upper Columbia spring Chinook and steelhead are not directly targeted in fisheries in this area however these fish pass through the lower river as part of aggregate stocks which are the target of mainstem fisheries. Spring Chinook fisheries are primarily directed at hatchery spring Chinook salmon from the Columbia and Willamette Rivers and steelhead fisheries are

directed at hatchery steelhead. Since 1992, all fisheries below Bonneville Dam have been reduced in response to ESA listings and are closely managed to minimize impacts to Upper Columbia spring Chinook and Upper Columbia summer steelhead. In the Upper Columbia, directed fisheries on hatchery-origin UC spring Chinook and steelhead are implemented as an adult management strategy for hatchery programs and are authorized under ESA-Section 10 Permit 18121 and 1395.

Non-Treaty Fisheries

Non-Treaty Commercial Fisheries

Non-treaty commercial fisheries in the Columbia River occur only below Bonneville Dam in the mainstem Columbia and "select areas." Select areas are areas where fish are released from pens and/or hatcheries as juveniles and return to these areas as adults, where they are fished commercially. This Select Area Fishery Enhancement is meant to remove fishing pressure from the weaker runs returning upriver in the mainstem (NWPCC 2019). The Select Areas are off-channel and terminal areas in the Lower Columbia River and include Youngs Bay, Blind Slough/Knappa Slough, and Tongue Point/South Channel in Oregon and Deep River in Washington (WDFW & ODFW 2019).

Commercial fisheries are a mix of mark-selective and non-mark selective, meaning they target both natural (adipose present, unmarked) and hatchery-origin (adipose fin-clipped) adults. Time, area, and gear restrictions have been imposed to reduce the incidental catch and mortality of non-target species and unmarked fish. Commercial fishers currently use gill nets, tangle nets, and beach and purse seine nets depending on the species they are targeting (WDFW 2019) and are in the process of testing pound nets. Beach and purse seine and pound nets are currently illegal in Washington statute, but can be used under the 'emerging fisheries' exception and are undergoing review during 2020 to legalize the gear (WDFW 2020). With some types of gear used in commercial fishing it is difficult to remove unmarked fish unharmed. While the post-release mortality rate (per fish) for gill nets is higher than that of tangle nets (14.7% tangle net vs 40% for gill net), gill nets can be used selectively to reduce encounters of non-target species such as steelhead by time/area and mesh size. Tangle nets are used less during periods of high steelhead abundance as encounter rates of these non-target species are higher with the smaller nets. Spring Chinook and steelhead that are caught in tangle nets are caught by the teeth or mouth and have a lower post-release mortality rate. Regulations during the spring live-capture commercial fisheries include the use of recovery boxes to resuscitate fish, reduced drift times, mandatory training for fishermen and onboard observation (WDFW & ODFW 2019). The goal is to pull fish from the nets alive and release them back into the river if they are a non-target species (NWPCC 2019).

Harvest of spring Chinook below Bonneville Dam in commercial fisheries includes Willamette River spring Chinook, Clackamas River spring Chinook, Sandy River spring Chinook, Washington Lower River spring Chinook, Select Area spring Chinook, and Upriver Spring Chinook. Upriver spring Chinook populations originate from Snake and Upper Columbia populations, including endangered Upper Columbia spring Chinook. All non-treaty commercial harvest of Upriver spring Chinook is mark-selective, targeting hatchery-origin adults. Estimated harvest of Upriver spring Chinook in mainstem and Select Area commercial fisheries has averaged 3,570 adults annually since 1999. During this time capture of upriver spring Chinook non-treaty commercial fisheries has ranged from a low of 28 adults in 1999 to a high of 10,070 adults in 2010 (Figure 7). Catches over the past two decades reflect both the changes in the number of returns each

year, the ESA take restrictions, and changes in the harvest allocations adopted by the fish and wildlife commissions. Starting in 2017, the Washington and Oregon Fish and Wildlife Commissions prioritized the use of ESA impacts to Select Area commercial fisheries to reduce impacts to ESA-listed fish. Therefore, there has not been a mainstem fishery for upriver spring Chinook since 2016. Capture of upriver spring Chinook in Select Area fisheries has ranged from 250 to 1,500 fish between 2008-2018 based on the total landings and the percentage of upriver spring Chinook in the catch (average 460 fish per year) (WDFW & ODFW 2019). Upriver spring Chinook make up approximately 3.4% of select area catches overall (2000-2018 average) and therefore total catches of Upriver spring Chinook in commercial fisheries below Bonneville Dam has gone down since the shift toward fisheries in these Select Areas (WDFW & ODFW; Table 3).

As previously mentioned, the UC spring Chinook return represents close to 12% of the aggregate Upriver spring Chinook stock. Of this subset of Upper Columbia spring Chinook, only about 5-20% are ESA-listed natural-origin Upper Columbia spring Chinook, the rest are unlisted. Between 1999-2018 between 28-10,070 Upriver Chinook were caught in non-treaty commercial fisheries below Bonneville Dam (mainstem and select area combined). In the last eight years, TAC reported between 5-74 were natural-origin UC spring Chinook incidental mortality impacts in these fisheries (TAC 2012-2019). Based on run sizes of UC spring Chinook at the mouth of the Columbia this represents <1% of the total run (TAC 2019).

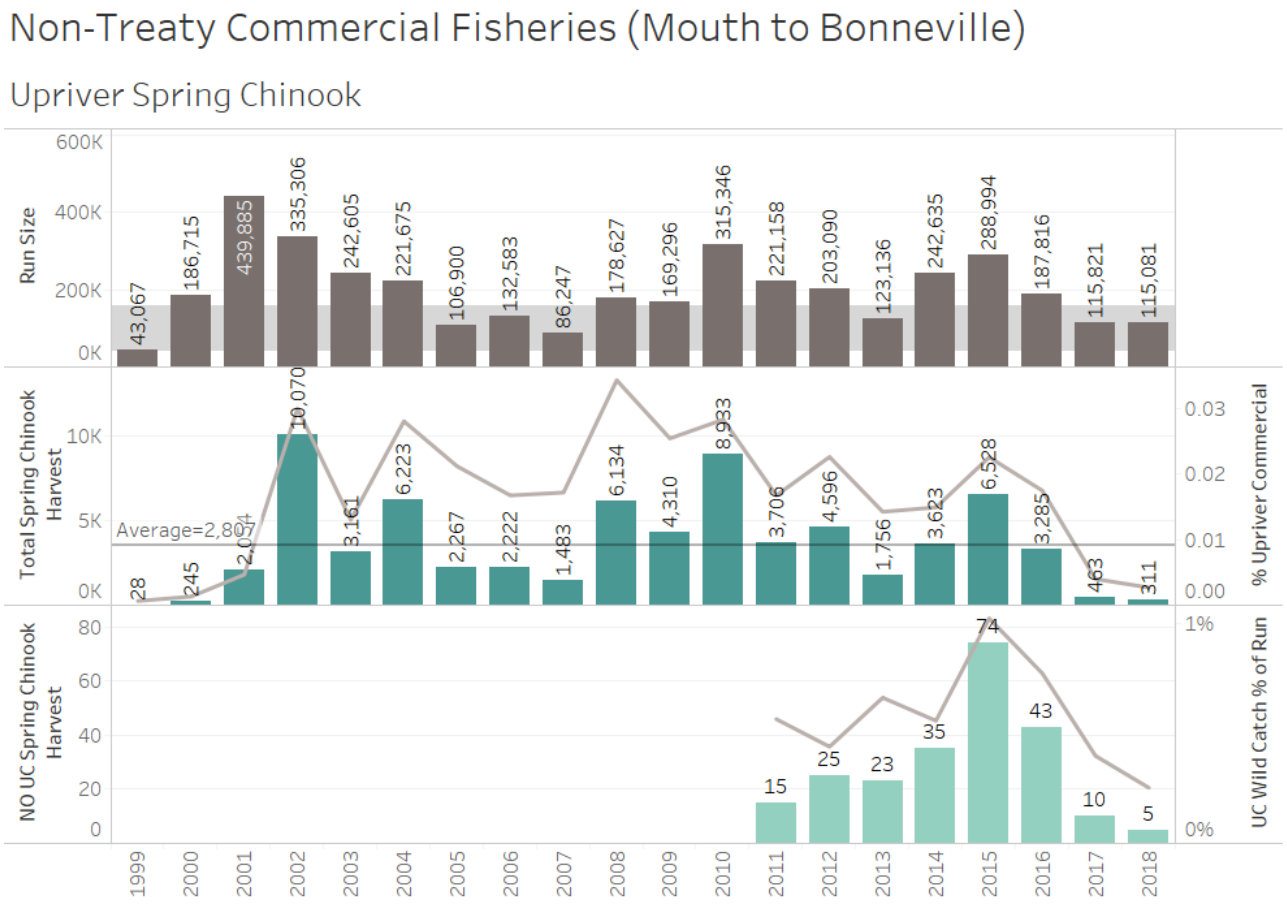


Figure 7. Total Upriver spring Chinook run size (at the mouth of the Columbia) along with estimated non-treaty commercial harvest, harvest rate, and indirect mortality of natural-origin (NO) UC spring Chinook (1999-2018) in the Lower Columbia below Bonneville Dam (WDFW & ODFW 2019; TAC 2019).

Non-treaty commercial and recreational fisheries are managed on a total harvest rate on the river mouth run size (Table 6). In their annual report the TAC summarizes outcomes for the previous year including how well non-treaty commercial and recreational fisheries met the harvest rate schedule in *U.S. v Oregon* for that year's run size. They compare the allowable harvest to the actual harvest and ESA impacts based on how well treaty and non-treaty fisheries met ESA limits. Based on data from 2008-2017, non-treaty fisheries have stayed within their allowable harvest in all but one year (2008) when returns were low.

Table 6. Non-treaty harvest impacts and harvest rates for unclipped (natural and hatcher-origin) Upriver spring Chinook as compared with *U.S. v. Oregon* allowed harvest rates (TAC 2019). Shading indicated years where actual rates exceeded allowed take.

Year	Upper Columbia natural origin River Mouth Run Size	Non-treaty harvest impacts on UC natural origin	Allowed Non-treaty Harvest rate (ESA Rate)	Actual Non-treaty natural origin Harvest Rate
2008	833	18	1.9%	2.2%
2009	1,099	20	1.9%	1.8%
2010	3,110	62	2.2%	2.0%
2011	2,655	37	2.0%	1.4%
2012	5,686	71	1.9%	1.2%
2013	3,472	47	1.7%	1.4%
2014	6,276	105	2.0%	1.7%
2015	7,235	141	2.2%	1.9%
2016	5,563	93	1.9%	1.7%
2017	2,514	34	1.5%	1.4%
2018	1,974	18	1.7%	0.9%

It is illegal to retain steelhead in Lower Columbia non-treaty commercial fisheries. The TAC reports mortality of clipped and unclipped A- Index summer steelhead in summer and fall fisheries, based on the number of released steelhead in non-treaty fisheries and release mortality rates shown in table x (TAC 2017). The majority of A-Index steelhead are caught in the fall fisheries (97%; July 31-December 31) with very few in the summer fisheries (June 1- July 31). Between 2008 and 2018 TAC reported that a total of 68 unclipped fish died from hooking mortality in the non-treaty summer commercial fisheries (6 adults per year on average; TAC 2019). In summer and fall fisheries an average of 651 adult summer steelhead are harvested and 20-30% of these are unclipped natural or hatchery-origin steelhead (TAC 2019). On average, less than 200 unclipped A-Index steelhead die as a result of the non-treaty commercial fisheries (TAC 2019; Figure 8).

No information exists on how many of the unclipped A-Index steelhead caught in summer and fall non-treaty commercial fisheries are from the Upper Columbia summer steelhead DPS. Any incidental harvest of steelhead in non-treaty commercial fisheries are accounted for in the total ESA-limit for non-treaty fisheries (TAC 2019). From July 1 to July 31, a 2% harvest rate limit for non-treaty fisheries begins on natural-origin A- and B-Index steelhead in fisheries upstream from the mouth of the Columbia River. Because a portion of the annual steelhead run is unclipped hatchery-origin fish, the total catch of unclipped fish is corrected for the actual natural-origin steelhead return (TAC 2017). Beginning August 1

there is a separate 2% harvest rate limit on the natural-origin component of the A-Index. Non-treaty commercial fisheries have remained within their natural-origin mortality take limit established through catch shares established by the Fish and Wildlife Commissions based on the NMFS Biological Opinion for *U.S. v. Oregon* (NMFS 2018) (see composite section for more information).

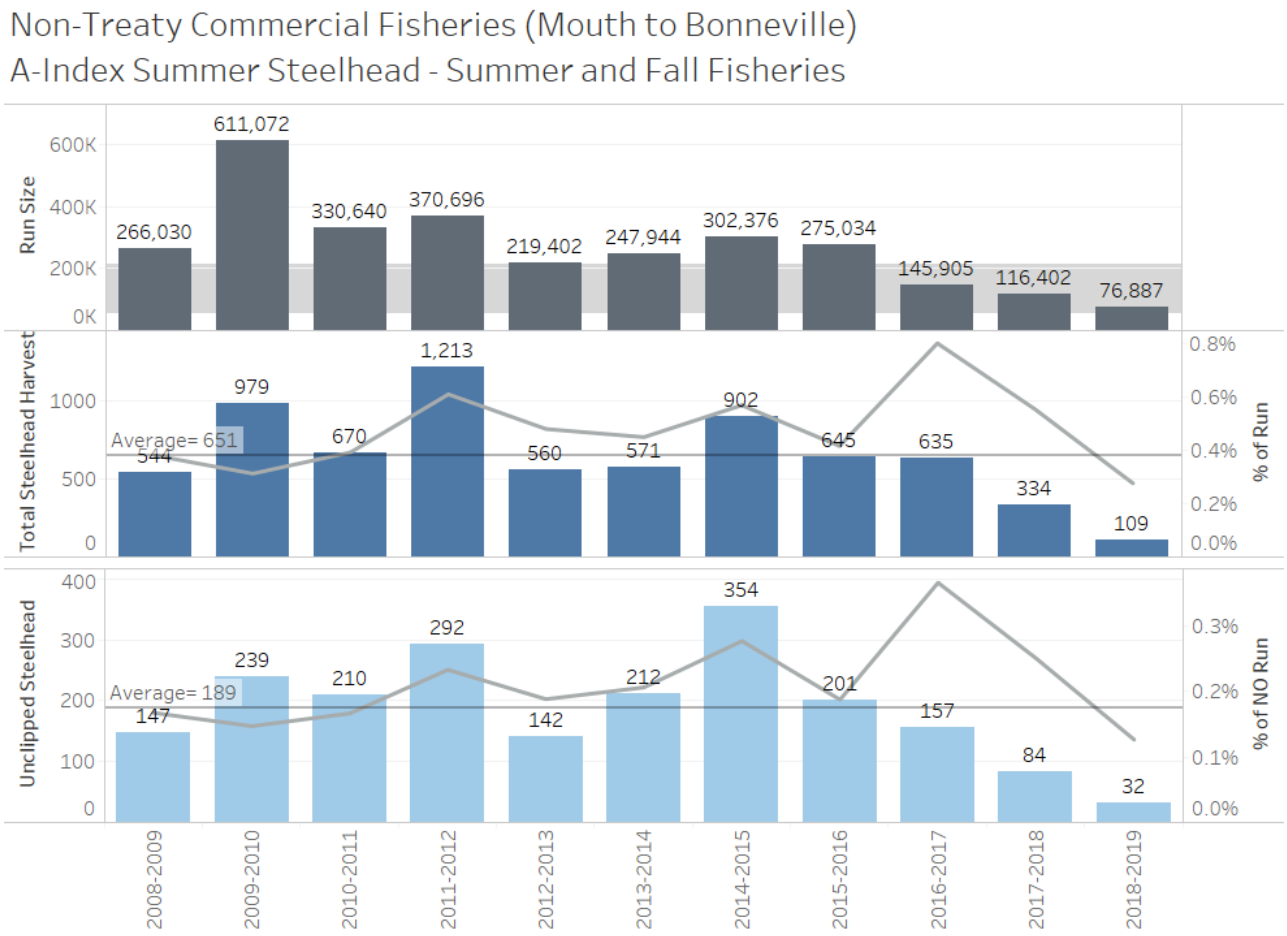


Figure 8. Total A-Index summer steelhead estimated run size (at the mouth of the Columbia) along with commercial harvest impacts and harvest rates (2008-2019) in the Lower Columbia below Bonneville Dam in summer and fall fisheries) (WDFW & ODFW 2019). Run size at mouth is based on counts at Bonneville Dam and harvest below Bonneville. The Upriver A-Index steelhead group includes UC summer steelhead among other DPS. Unclipped fish includes natural and hatchery-origin fish but is primarily natural-origin steelhead.

Recreational Fisheries

Recreational fisheries occur throughout the Columbia River basin from the mouth to headwater tributaries. Mainstem recreational fisheries are broken down by the following areas: 1) below Bonneville Dam; 2) between Bonneville Dam and McNary Dam; 3) “dip-in” fisheries at mouths and lower reaches of certain tributaries below McNary where migrating fish may hold prior to continuing their upstream migration; 4) between McNary Dam and Highway 395 Bridge in Pasco, Washington; 5) from McNary Dam to Priest Rapids Dam; and 6) upstream of Priest Rapids Dam in the mainstem and tributaries.

Under the Columbia River Compact, sport hearings are used to direct mainstem fisheries in concurrent waters of the states. The purpose of these regulations is to target early-migrating Willamette spring Chinook and reduce the catch of upriver spring Chinook. Openings after March 31 during the spring

management period are subject to run sizes of the Upriver spring Chinook stock and are always mark-selective, targeting hatchery-origin adults. These fisheries are subject to a post-release mortality rate of 10% that is applied to mainstem recreational fisheries for salmon and steelhead during the spring management timeframe. In-season management has been necessary in most years to maintain the recreational catch within ESA guidelines, non-treaty harvest-sharing allocations, and/or catch-balancing agreements with the Columbia River treaty tribes.

Since 1999, recreational fisheries in the Lower Columbia (mouth to Highway 395) have harvested an average of 12,265 Upriver spring Chinook. Total harvest has ranged from lows under 20 in the late 1990's to a high of 27,227 in 2010. Variability in catch rates over the past two decades reflect both the changes in the number of returns each year and changes in the harvest allocations adopted by the fish and wildlife commissions (WDFW and ODFW 2019). The majority of recreational harvest for Upriver spring Chinook occurs below Bonneville Dam. Over 80% of recreational harvest occur in this catch area most years. The TAC tracks the incidental mortality of UC natural-origin spring Chinook in recreational fisheries below the Highway 395 bridge and reported impacts of between 13-57 between 2011-2018 (TAC 2019). Based on run sizes of UC spring Chinook at the mouth of the Columbia this represents <0.5% of the total run (TAC 2019). As previously noted, non-treaty fisheries (commercial and recreational fisheries combined) have stayed within their ESA-take limits in all but one year (2008) over the past decade (TAC 2019).

Chelan Falls summer Chinook recreational fishery.

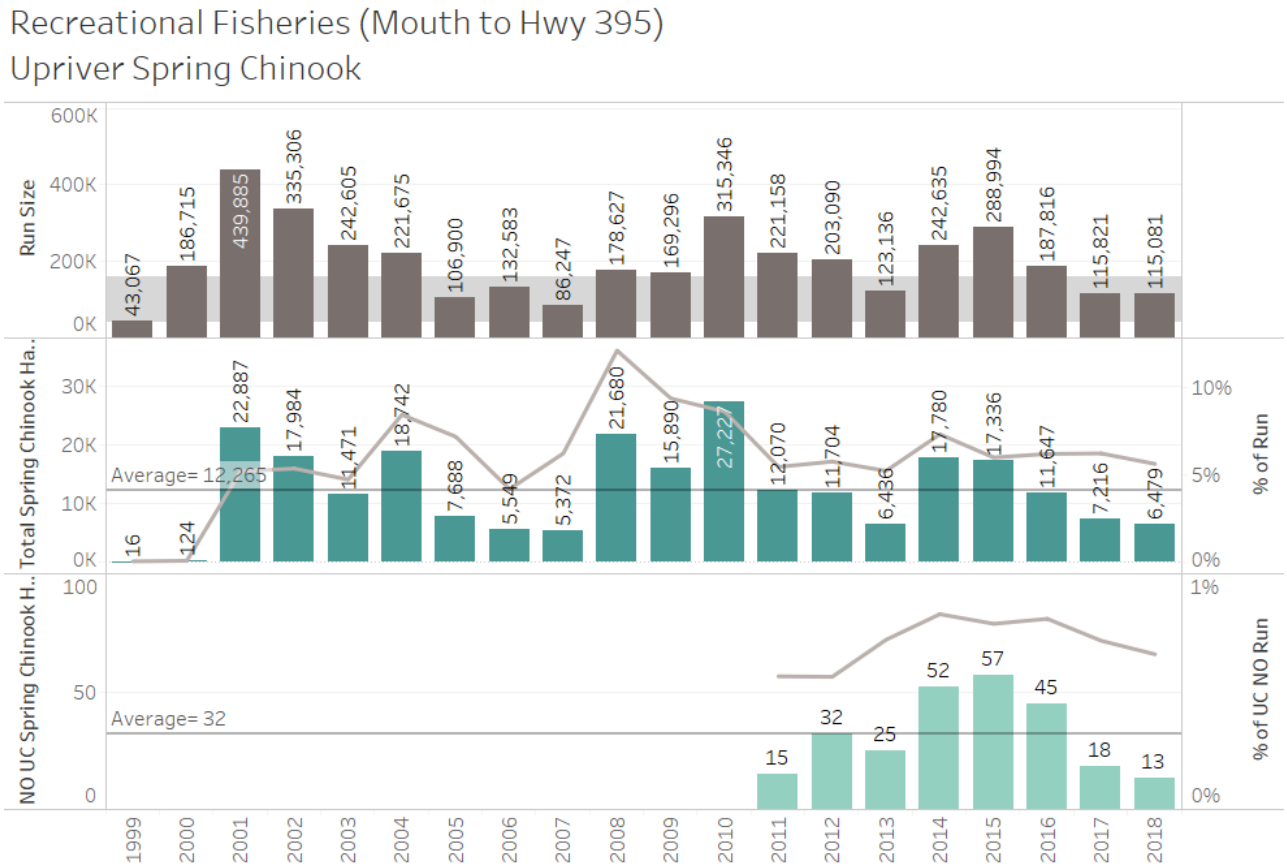


Figure 9. Total Upriver spring Chinook run size (at the mouth of the Columbia) along with estimated recreational harvest and harvest rate (1999-2018) in the Lower Columbia (Bonneville to McNary) as well as impacts to UC natural-origin spring Chinook lost to recreational fisheries in this area (WDFW & ODFW 2019).

Only marked (ad-clipped) steelhead may be kept in recreational fisheries in the Columbia River. Average harvest from 2008-2018 of summer A-Index steelhead in summer and fall fisheries below McNary Dam was 22,521 adults with the majority being caught during the fall fishery period (70% an average). Of the total harvest, only 1,262 (5%) were unclipped steelhead that died due to incidental mortality. Harvest ranged from highs close to 50,000 fish in the 2009-2010 season and lows below 5,000 fish in recent years (Figure 10). The majority of summer steelhead harvest is below Bonneville Dam and the majority of fall steelhead harvest is above Bonneville Dam as the fish move up the river and hold in the mainstem Columbia and its tributaries. Individual impacts on Upper Columbia summer steelhead are not tracked. No information exists on how many of the unclipped A-Index steelhead caught in summer and fall recreational fisheries are from the Upper Columbia summer steelhead DPS.

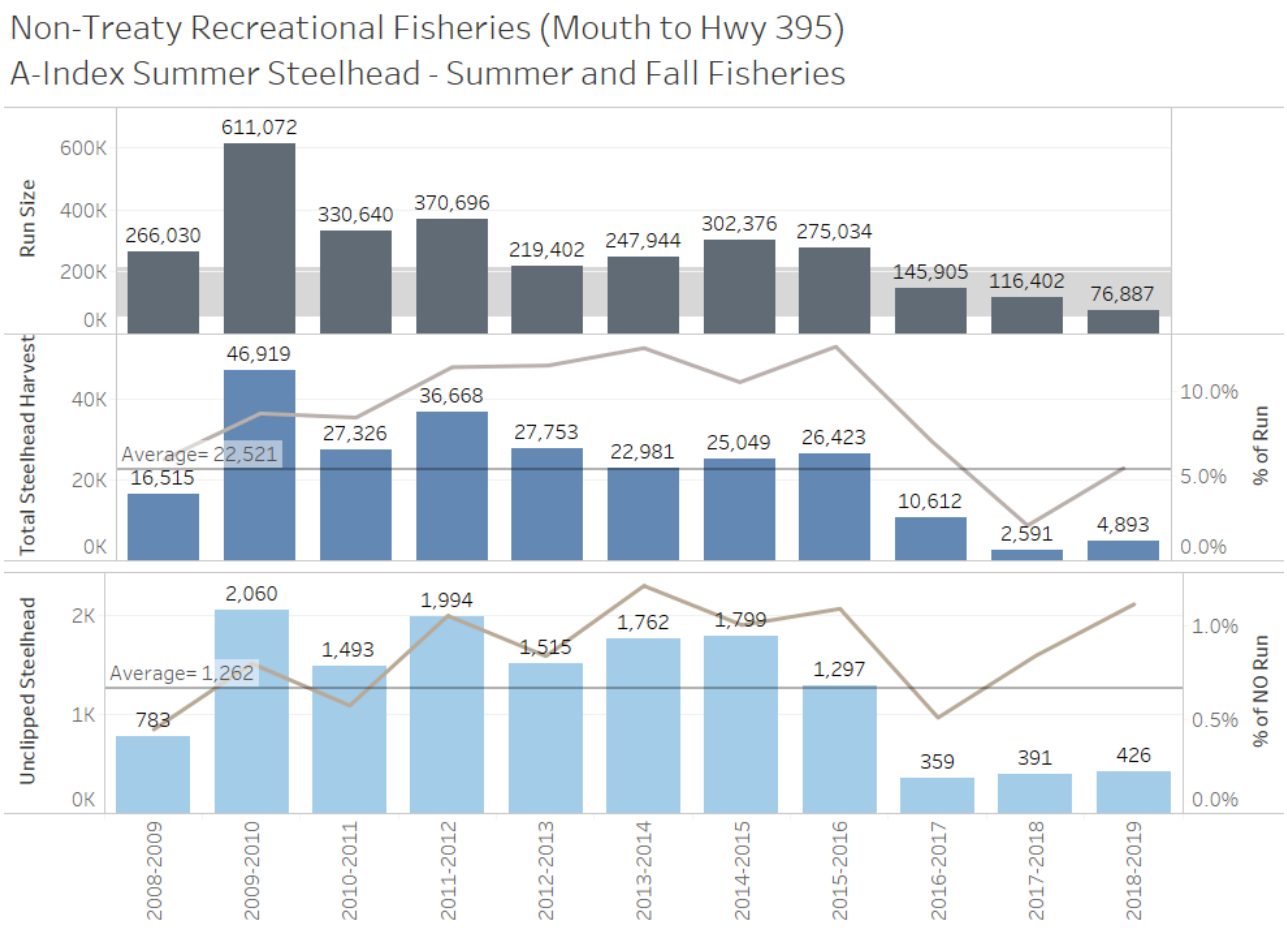


Figure 10. Total A-Index summer steelhead estimated run size (at the mouth of the Columbia) along with recreational harvest impacts and harvest rates (2008-2019) in the Lower Columbia below Bonneville Dam and between Bonneville and Highway 395 (WDFW & ODFW 2019) in summer and fall fisheries. Run size at mouth is based on counts at Bonneville Dam and harvest below Bonneville. The Upriver A-Index steelhead group includes UC summer steelhead. Unclipped fish includes natural and hatchery-origin fish but is primarily natural-origin steelhead.

Recreational fisheries during the summer and fall period above the Highway 395 bridge have the potential to impact UC steelhead and spring Chinook. These fisheries are outside of the *U.S. v. Oregon* management agreement area and are therefore managed for ESA-listed species take under separate Biological Opinions. Any impacts to UC listed spring Chinook and steelhead are included in the total non-treaty impact allocation for the state of Washington. These fisheries primarily target Fall Chinook in the Hanford Reach, Ringold Springs summer fall Chinook and steelhead, and Upper Columbia summer Chinook and sockeye. The TAC estimated the total harvest of 131 Upriver spring Chinook and impacts of just 1 natural-origin UC spring Chinook as a result of recreational fisheries upstream of the Snake River between 2011-2018 (TAC 2012-2019). Data from WDFW shows that most of the fisheries above the Highway 395 bridge do not report catches of UC spring Chinook because fish that are caught during this time are considered summer Chinook. Late returning fish may be inadvertently caught in the summer Chinook fishery but they would not be reported as such (WDFW 2020).

Most impacts from recreational fisheries above Highway 395 are to UC steelhead because they take place during the summer and fall migration period (Table 7). Between 120 and 436 UC steelhead were caught

and released between 2010-2019 in the four major fisheries- Hanford Reach summer fishery, Hanford Reach fall fishery, Icicle River fishery, mainstem above Priest Rapids Dam fishery, and Lake Wenatchee sockeye fishery. Applying an incidental mortality rate of 10% for these fisheries the total impact to UC steelhead has been between 12-43 fish across all the fisheries. The majority of these fish are inadvertency caught in the Hanford Reach fall fishery which averaged over 300 steelhead released up until 2016 when it was reduced to around 100 fish per year released in the last four years. Few UC steelhead and spring Chinook are caught in the Lake Wenatchee and Icicle River fisheries in the Wenatchee (WDFW 2020).

Table 7. Summary Of UC Spring Chinook And Summer Steelhead caught and released in Non-ESA listed salmon fisheries as estimated/expanded based off creel surveys. SpCHN=UC Spring Chinook, SH=UC Summer Steelhead, >PRD SUMMER/FALL=Includes mainstem fisheries from PRD to CJD and the Wenatchee, Entiat, Chelan, Okanogan, and Similkameen rivers. Capture of UC spring Chinook in summer and fall Columbia River mainstem fisheries are not reported because Chinook caught during these fisheries are considered summer Chinook based on run timing (WDFW 2020).

	Hanford Reach Summer[1]		Hanford Reach Fall		Icicle River		>PRD Summer/Fall[5]		Lake Wenatchee	
YEAR	SpCHN	SH	SpCHN[5]	SH[4]	SpCHN	SH	SpCHN[6]	SH	SpCHN	SH
2010	--	--	NA	314	0	5	NA	44	0	0
2011	--	--	NA	324	0	8	NA	90	--	0
2012	--	--	NA	309	0	0	NA	90	0	0
2013	--	--	NA	314	0	14	NA	38	0	0
2014	--	--	NA	340	0	0	NA	96	11	0
2015	--	--	NA	331	0	0	NA	90	18	0
2016	--	--	NA	103	0	2	NA	30	2	0
2017	NA	17	NA	99	0	0	NA	25	--	0
2018	NA	28	NA	99	NA	NA	NA	19	--	0
2019	NA	0	NA	99	0	0	NA	21	--	0

[1]Sampling has only occurred in the last three years.
[2]Total catch-and-release of UC spring Chinook is unknown because it cannot be determined if released Chinook are NO/unmarked summers or UC springs. Encounters of UC spring Chinook are expected to be low.
[3]No UC spring Chinook migrating during fall Chinook fishery. However, there five jacks, four adults, seven adults, size adults, and 12 adults harvested during the Hanford Reach fall fishery in 2011, 2014, 2015, 2018, and 2019, respectively. CWT data indicated those were primarily Yakima River origin fish as well.
[4]Total releases of steelhead in this fishery includes natural-origin/unmarked, hatchery-origin, and unknown (i.e., angler didn't determine the mark status). Of the hatchery-origin fish, most are reported to be Ringold Springs Hatchery origin-fish because of the presence of a secondary fin clip (right ventral).
[5]Includes mainstem and tributary fisheries for primarily summer Chinook and Sockeye. Also includes a two month non-marked selective fishery for fall Chinook in the Priest Rapids and Wanapum pools
[6]See comment #2 above. Supporting evidence in >PRD summer/fall fisheries is of the CWT (N = 3,411) recovered from harvested fish between 2010-2019, a total of seven were spring Chinook (safety-net marked Chinook from Winthrop National Fish Hatchery).

Non-Treaty Tribal Fisheries

Several non-treaty tribal fisheries operate in the mainstem Columbia and terminal areas and have the potential to either directly or indirectly affect UC listed species. The Wanapum Band C&S fishery is primarily on the mainstem Columbia River between Priest Rapids Dam and Vernita Bridge and targets spring Chinook, sockeye, summer Chinook, and fall Chinook salmon. The spring Chinook fishery runs from April to May, targeting Upriver spring Chinook. Through direct harvest and incidental mortality the Wanapum Tribal fisheries resulted in impacts of 29 natural-origin Upper Columbia spring Chinook between 2011-2018. Annual mortality ranged from 0-10 UC spring Chinook (TAC 2012-2019).

Additionally, the Colville Confederated Tribes (CCT) implement a C&S fishery for spring Chinook, summer Chinook, sockeye salmon, and steelhead above Wells Dam using a variety of gears in both mark selective and full retention fisheries. The Colville Confederated Tribes implement a spring Chinook fishery in the tailrace of Chief Joseph Dam that targets unlisted Chief Joseph Hatchery spring Chinook. ESA take authorization for incidental encounters of ESA-listed UC spring Chinook is authorized through their Tribal Resource Management Plan. An abundance-based sliding scale is used to limit impacts to listed hatchery and natural-origin fish. Encounters of steelhead are extremely rare at the mouth of the Okanogan purse seine and tangle net fisheries. Colville confederated Tribal members do encounter steelhead in the tailrace of Chief Joseph Dam while targeting summer Chinook. In years when there are excess steelhead hatchery fish then CCT opens a fishery as well, but this has not occurred for several years and tribal participation in steelhead fisheries in the Okanogan River is very low (C. Baldwin, CCT*, pers. comm*). Impacts to UC steelhead are also covered under the Tribal Resource Management Plan utilizing an abundance based sliding scale.

Tribal members from the Wenatchi Band of The Colville Confederated Tribes and Yakama Nation also participate in terminal fisheries in the Upper Columbia. Spring Chinook salmon harvest in Icicle Creek targets unlisted spring-run Chinook salmon produced by the Leavenworth National Fish Hatchery. The fishery is full-retention. The U.S.FWS Mid-Columbia Fish and Wildlife Office tracks the number of fish that return to LNFH each year and the number that are caught in fisheries in the Icicle Creek terminal fishery. They do not, however, track the number of unclipped spring Chinook that are caught and released in the fishery. There are likely very few natural-origin spring Chinook from outside of Icicle Creek that are caught in the Icicle Creek fishery given its location as a terminal fishery. Any unclipped spring Chinook that are caught are likely from Icicle Creek, which is not considered park of the Upper Columbia ESU. Approximately 500 fish are caught each year in the Icicle Creek fishery, 10% of these are caught through recreational harvest and the remaining 90% in treaty and non-treaty tribal harvest. Hatchery-origin LNFH spring Chinook are caught in fisheries in the mainstem Columbia, however the fish caught in the terminal fishery represent 10% of the run on average (2006-2018) (Muir et al. 2019).

Platforms for fishing in the Icicle River, Upper Columbia.

Conservation Fisheries

Conservation fisheries for marked, hatchery-origin UC summer steelhead and UC spring Chinook occur during some years. These fisheries are focused on reducing hatchery surplus returns for the purpose of reducing potential impacts to natural-origin fish (Maier 2017). Removal occurs through hook and line fisheries in the mainstem Columbia and Upper Columbia tributaries. An average of 16,150 anglers participated in the Upper Columbia steelhead conservation fisheries and 1,700 anglers in the Wenatchee spring Chinook conservation fishery when it was open. Other types of adult management (e.g. removal at dams, weirs, and hatcheries) are not considered "harvest" in the context of this summary. The incidental take of ESA-listed natural-origin spring Chinook salmon in conservation fisheries is strictly limited based on the abundance of natural-origin spring Chinook and steelhead returning to spawn. Maximum incidental mortality (including catch-and-release hooking mortality) is 2% of the annual natural-origin run (NMFS 2013; NMFS 2003).

Benefits from removal of hatchery fish as a result of these conservation fisheries are discussed in depth in the UCSRB Hatchery Background Summary (Maier 2017). An analysis of the Winthrop NFH spring Chinook in 2016 showed that some years, like 2015, when natural runs are moderate or good, upwards of 80% of Methow Hatchery returns and 90% of Winthrop NFH returns may need to be removed from the population to help meet pHOS and PNI goals for the population (Humling 2016). The ability to remove hatchery-origin fish through adult management is a challenge in some areas like the Methow due to the lack of an appropriate control point (e.g. dam or weir) at which to remove hatchery-origin fish from the run at large. Coupled with low natural-origin returns, managers struggle to meet pHOS and PNI goals for a population most years. Conservation fisheries are an important tool for conservation, especially in removing adults from safety-net programs, which are meant to be removed from the population unless needed to meet broodstock or escapement goals in low abundance return years (Maier 2017).

Conservation fisheries for steelhead began in 2003. Spring Chinook conservation fisheries began being permitted in 2014 and have only occurred in 2014 and 2015 in the Wenatchee subbasin. A conservation fishery in the Methow for spring Chinook has not been permitted but is stipulated in the hatchery genetic management plans (HGMPs) for hatchery programs in the Methow. Between 2003-2015 steelhead conservation fisheries were opened consistently. In the last four years all conservation fisheries have been restricted or eliminated in the Upper Columbia due to poor hatchery- and natural-origin returns.

In the two years that the Wenatchee spring Chinook conservation fishery was open (2014 and 2015), a total of 1,042 spring Chinook were caught, 913 (88%) of which were clipped hatchery-origin fish (Table 8). The remaining 129 were unmarked natural and hatchery origin fish that were released. WDFW estimated hooking mortality of released natural-origin adults as 6 in 2014 and 7 in 2015, representing less than 1% of the total estimated natural-origin run size (WDFW 2015a and 2015b).

Steelhead conservation fisheries took place in various fishery areas in the mainstem Columbia, Wenatchee, Methow, Okanogan, and Similkameen between 2001-2016 during which an average of approximately 12,500 anglers caught 5,000 steelhead of which half (2,500) were ad-absent hatchery-origin fish and half were clipped hatchery and natural-origin steelhead. Anglers kept approximately 70% of the clipped hatchery fish that were caught and released all non-clipped fish. Total annual harvest mortality was estimated at 1,720 steelhead of which 133 were ad-clipped hatchery-origin fish and 44 clipped natural-

origin steelhead lost to conservation fisheries due to hooking mortality. An average of 2% of the natural-origin steelhead run to the Upper Columbia was lost to conservation fisheries (WDFW 2001-2016; Table 8). When conservation fisheries have been opened, ESA impacts have remained within the natural-origin population mortality take limits established through the NMFS Biological Opinion specified in all but 1 year when it was slightly over the 2% limit (ESA-Section 10 Permit 18121 and 1395).

Steelhead conservation fishery on the Wenatchee River.

Table 8. Projected run sizes and estimated anglers, catch, mortality, allowable take, and impact rates for conservation fisheries between 2001-2019 (WDFW 2009-2016). Blanks indicate the information was not reported that year.

Run	Total Estimated Run Size[1]	Estimated NO Run Size[1]	Total Anglers	Total Catch	Ad-Absent Catch	Ad-Present Catch (NO and HO)	Ad-Present HO Catch	Ad-Present NO Catch	Total Mortality	Ad-Present Mortality (NO and HO)	NO Mortality[2]	Allowable NOR Take	Total % Impact Rate[3]
SPRING CHINOOK (WENATCHEE)													
2014	3,263	931	2,296	665	603	62		62	609		6	12	0.6%
2015	9,851	935	1,071	377	310	67		67	317		7	13	0.7%
2016	No Fishery												
2017	No Fishery												
2018	No Fishery												
2019	No Fishery												
STEELHEAD (MAINSTEM COLUMBIA, WENATCHEE, METHOW, OKANOGAN, AND SIMILKAMEEN)													
2001-2002			3,059	767	581	186	581	73	38	9	4		
2002-2003			8,297	2,788	1,022	3,182	558	464	853	159	24		
2003-2004	10,016	962	6,701	3,201	1,295	1,646	1,340	306	1,034	87	16	24	1.6%
2004-2005	9,317	829	14,446	4,245	1,839	2,020	1,686	334	1,649	100	16	20	1.9%
2005-2006	7,107	661	11,623	3,323	2,033	958	626	332	1,629	47	17	17	2.6%
2006-2007	10,766	1,766	7,475	1,874	1,369	387	269	118	1,394	20	3	3	0.2%
2007-2008	14,564	2,296	10,258	4,403	2,557	1,846	1,015	832	2,380	98	44	46	1.9%
2008-2009	17,379	3,232	10,818	3,614	2,308	1,306	791	515	2,027	40	26		0.8%
2009-2010	34,888	5,682	29,461	15,586	8,816	6,770	4,470	2,300	4,809	339	115	153	2.0%
2010-2011	24,474	7,078	23,910	11,610	5,219	6,391	3,937	2,454	4,257	320	136	212	1.9%
2011-2012	17,322	4,092	15,510	5,898	2,816	3,082	1,732	1,350	1,886	154	67	92	1.6%
2012-2013	13,981	2,709	15,639	5,740	2,906	2,834	1,748	1,086	2,995	141	56	65	2.1%
2013-2014	12,628	4,211	11,535	4,238	1,703	2,535	1,527	1,008	1,654	127	51	98	1.2%
2014-2015	15,791	5,218	13,636	4,101	1,659	2,444	1,412	1,032	1,534	122	52	114	1.0%
2015-2016	11,525	2,829	8,210	3,202	1,601	1,601	579	1,022	659	80	51	57	1.8%
2016-2017	No Fishery												
2017-2018	No Fishery												
2018-2019	No Fishery												

[1]*Run sizes were calculated at Priest Rapids Dam for steelhead and at Tumwater Dam for spring Chinook.*

[2]*Natural-origin mortality was estimated based on a hook and release mortality of 5% for steelhead and 10% for spring Chinook.*

[3]*WDFW implements the steelhead fisheries according to mortality rate specified in ESA Permit 1395 for NO steelhead in the Methow (2% mortality) and Okanogan (5% mortality)*

Treaty Fisheries

Treaty Tribe fisheries for commercial, subsistence, and ceremonial (C&S) purposes operate between Bonneville Dam upstream to McNary Dam in the mainstem Columbia River and tributaries to the Columbia River. Treaty fisheries are managed to first meet the needs for traditional cultural ceremonies, then personal subsistence and commercial livelihood. Treaty mainstem fisheries are full-retention to meet these needs. As previously mentioned, treaty tribes are legally entitled to half the harvestable surplus of fish retuning to or passing through their Usual and Accustomed fishing areas. To meet that requirement, Oregon and Washington manage their fisheries below Bonneville Dam to leave enough fish for harvest in treaty fisheries upstream (CRITFC 2019). On average approximately 92% of the run of Upriver spring Chinook makes it from the mouth of the river to Bonneville Dam (WDFW and ODFW 2019). Treaty Tribe fisheries are managed in accordance with harvest rate schedules in the 2018-2027 *U.S. v Oregon* Management Agreement and for compliance with ESA limits for harvest of natural-origin spring Chinook and steelhead. Warm Springs and Yakama Nation tribes, from time to time, also authorize subsistence and ceremonial fishing immediately below Bonneville Dam and retain claims to the right to fish all the way to the mouth of the Columbia River (S. Parker, YN, *pers. comm*).

Tributary spring Chinook fisheries are also conducted by the treaty tribes in the Wind, Little White Salmon (Drano Lake), Hood, Klickitat, Deschutes, John Day, Umatilla, and Yakima rivers, as well as in Icicle Creek in the Wenatchee River, and various Snake River Basin tributaries. These Treaty Tribe fisheries in "terminal areas" typically don't have mixed stocks of weak and strong populations returning at the same time.

Estimated harvest of Upriver spring Chinook in mainstem treaty commercial and ceremonial and subsistence (C&S) fisheries has averaged 18,473 fish annually since 1999 (Figure 11). Harvest has ranged from a low below 2,000 in 1999 to highs above 40,000 in 2001 and 2010. During years of high abundance treaty tribes can operate commercial gillnet fisheries. In years of low returns (e.g. 2016 and 2017) priority for tribal harvest goes to tribal ceremonial and subsistence fisheries. In these years there is no commercial harvest. Although there can be treaty harvest downstream of Bonneville Dam in some years, the majority takes place upstream of Bonneville Dam (90-100% most years) (WDFW and ODFW 2019). The TAC estimates between 160 and 839 natural-origin UC spring Chinook were harvested or lost to incidental mortality as a result of the treaty fisheries between 2011-2018.

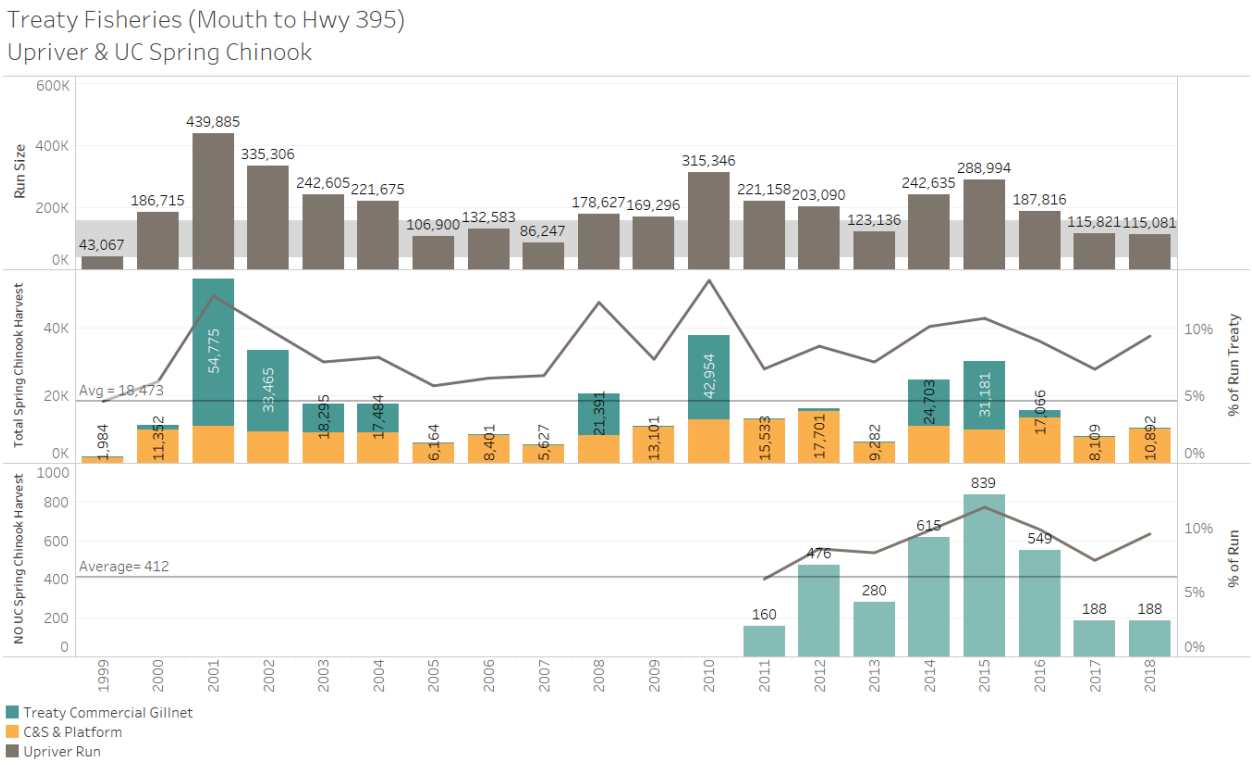


Figure 11. Total Upriver spring Chinook run size (at the mouth of the Columbia) along with estimated treaty tribal harvest (C&S and commercial) and harvest rate (1999-2018) in the Lower Columbia (Mouth to McNary) as well as impacts to UC natural-origin spring Chinook lost to treaty tribal fisheries in this area (WDFW & ODFW 2019).

As previously mentioned, treaty fisheries are managed on a total harvest rate on the river mouth run size (Table 3). However, the effect of fisheries on natural-origin fish can be slightly higher than the total harvest rate. This is because mark selective fishing below Bonneville Dam modifies the hatchery- to natural-origin ratio of fish that eventually cross Bonneville Dam by removing a disproportionate number of marked, hatchery-origin fish. Fisheries above Bonneville Dam, within the treaty fishery catch area, are therefore selecting from a higher proportion of natural-origin fish passing Bonneville Dam as compared to the ratio that entered the river at the mouth of the Columbia River. This results in an average 0.7% higher harvest rate on natural-origin salmon in the spring management period treaty Tribe fisheries since the implementation of mark selective fisheries in 2000 (TAC 2017). TAC uses a conservative average 0.8% higher harvest rate to account for this effect on natural-origin in its annual calculations, but the actual average effect has been slightly lower.

In *U.S. v. Oregon* there are limits outlined for the percentage of natural origin upriver spring Chinook that can be taken in mainstem fisheries. NMFS evaluated these for compliance with the ESA and determined in 2018 that applying the limits proposed for incidental mortalities associated with the fisheries were not likely to jeopardize the continued existence of the UC Spring Chinook ESU or steelhead DPS.

In their annual report the TAC summarizes outcomes for the previous year including how well fisheries met the harvest rate schedule in U.S. v Oregon for that year's run size. They report on compliance for

both biological limits, but also include harvest-sharing limits described in the Management Agreement as well. When evaluating ESA compliance, they compare the allowable harvest to the actual harvest to determine how well treaty and non-treaty fisheries met ESA limits. Treaty fisheries and non-treaty fisheries have separate rates of proposed limits in order to meet harvest-sharing principles. Based on data in the most recent report (TAC 2019), treaty fisheries have exceeded their allowable harvest in five of the last ten years and exceeded their ESA limits on fisheries in three of the last ten years. In each instance the overage was less than 5%. While this occurred in treaty fisheries, the combined harvest rate of all fisheries is the measure by which ESA compliance is measured.

Table 9. Harvest of natural origin Upper Columbia Spring Chinook and Natural origin Snake River Spring/summer Chinook 2008-2018. *U.S. v. Oregon* (2008-2018; TAC 2019). Shading indicated years where actual rates exceeded allowed take.

Year	Upper Columbia Wild River Mouth Run Size	Non-treaty harvest impacts on UC Wild	Treaty harvest impacts on UC Wild	Allowed Non-treaty Harvest rate	Allowed Treaty Wild Harvest Rate [1]	Combined Total Allowed Wild Harvest Rate [1]	Actual Non-treaty Wild Harvest Rate	Actual Treaty Wild Harvest Rate	Actual Total Wild Harvest Rate
2008	833	18	114	1.9%	9.1-9.9%	11.8%	2.2%	13.7%	15.8%
2009	1,101	20	94	1.9%	9.1-9.9%	11.8%	1.8%	8.6%	10.4%
2010	3,110	62	461	2.2%	10.8-11.6%	13.8%	2.0%	14.8%	16.8%
2011	2,659	37	195	2.0%	10.0-10.8%	12.8%	1.4%	7.3%	8.7%
2012	5,871	73	545	1.9%	9.1-9.9%	11.8%	1.2%	9.3%	10.5%
2013	3,475	47	272	1.7%	8.3-9.1%	10.8%	1.4%	7.8%	9.2%
2014	6,287	105	680	2.0%	10.0-10.8%	12.8%	1.7%	10.8%	12.5%
2015	7,246	141	831	2.2%	10.8-11.6%	13.8%	1.9%	11.5%	13.4%
2016	5,111	85	491	1.9%	9.1-9.9%	11.8%	1.7%	9.6%	11.3%
2017	2,527	33	189	1.5%	7.0-7.8%	9.3%	1.3%	7.5%	8.8%
2018	1,974	18	197	1.7%	8.3-9.1%	10.8%	0.9%	10.0%	10.9%

1. *Incidental Take Statement presumes treaty wild harvest rates may be up to 0.8% higher than allowed total harvest rates.*

Treaty Tribe commercial fisheries do not directly target summer steelhead and the tribes have implemented measures to reduce incidental harvest of steelhead during other fishing periods. Steelhead, both clipped and un-clipped fish may be retained in any tribal fishery (Byrne et al. 2018). The majority of the treaty Tribe catch of steelhead occurs during the fall gillnet fishery; catch also occurs in treaty platform and hook-and-line fisheries. Since the 1990s, the tribes have reduced catch of natural-origin steelhead during fall treaty Tribe gillnet seasons by two thirds (S.Parker, YN, *pers. comm*). Total treaty harvest of A-Index summer steelhead during the fall fisheries has averaged 14, 437 since 2008 (TAC 2019). Between 20-30% of these steelhead are unclipped, natural- or hatchery-origin steelhead. In addition to the fall fisheries there is some harvest of UC summer steelhead during the summer fisheries. No natural-origin steelhead have been caught in the terminal treaty fisheries in Icicle Creek in the past 10 years (TAC 2019). Although there has been no impact observed, there is a limit of 0.50% impact to Icicle Creek steelhead in this fishery.

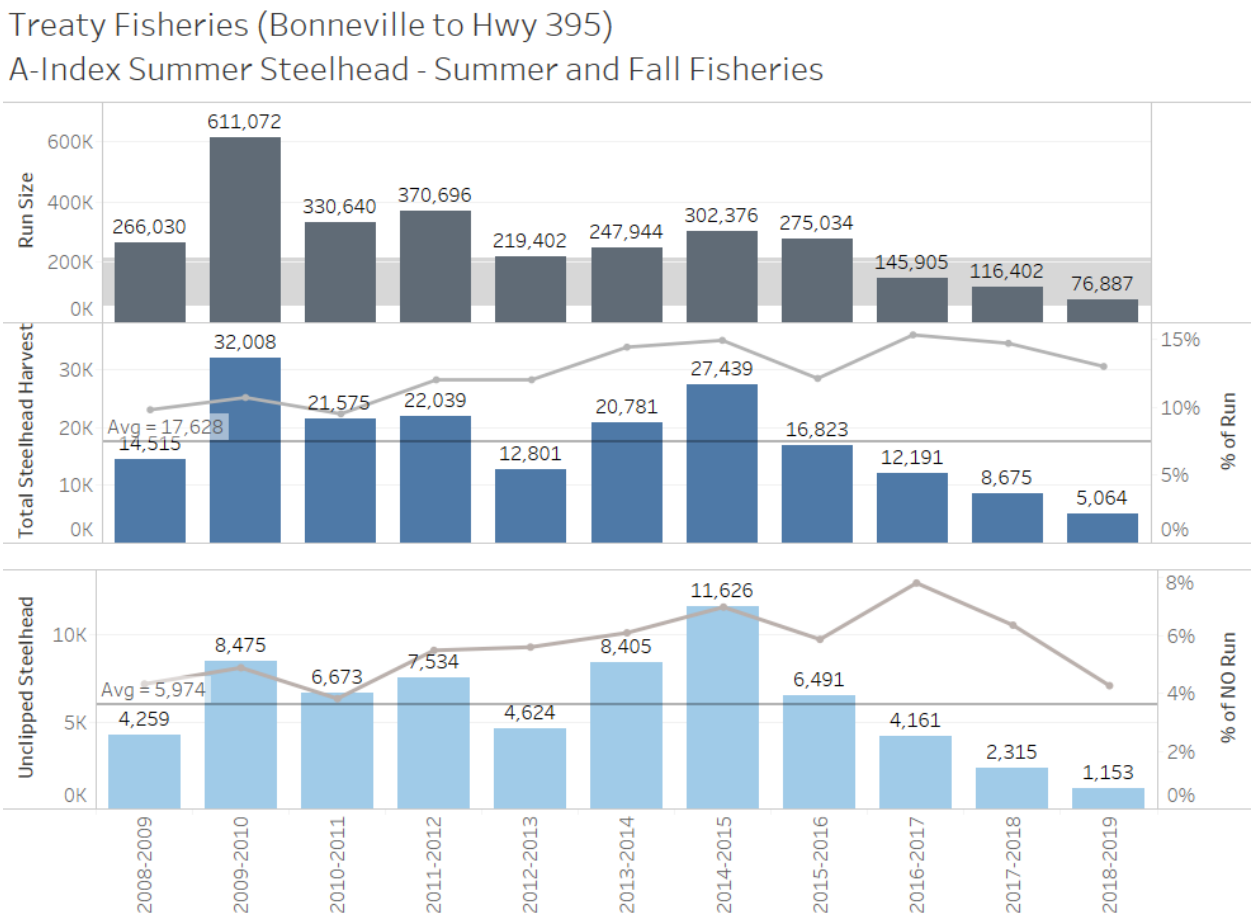


Figure 12. Total A-Index summer steelhead estimated run size along with treaty harvest impacts and harvest rates (2008-2019) in the Lower Columbia between Bonneville and McNary Dams (WDFW & ODFW 2019). Run size at mouth is based on counts at Bonneville Dam and harvest below Bonneville. The Upriver A-Index steelhead group includes UC summer steelhead. Unclipped fish includes natural and hatchery-origin fish but is primarily natural-origin steelhead.

The treaty incidental catch of unclipped steeled in the fall management period between 2008-2018 averaged 6.0% (TAC 2017). Catches of A-Index steelhead in summer fisheries is much smaller and averaged just 1,076 steelhead per year since 2008 (average harvest rate=1.25%). A-Index steelhead typically have an earlier run timing than B-Index steelhead and are smaller in body size; and thus less susceptible to catch in treaty fisheries than B-Index steelhead. Consequently, there are no specific management constraints in treaty fisheries for A-Index steelhead during any period. The total harvest rate on Unclipped steelhead was 7.2% with a high of 11.3% in 2016 and a low of 4.7% in 2018 when returns were low (

Table 10).

Table 10. Harvest impacts and harvest rates for unclipped (natural and hatcher-origin) Upriver A-Index steelhead in fall fisheries (TAC 2019).

Year	Upriver Summer Steelhead Run size	UC Unclipped Run Size	Fall Fisheries		Summer Fisheries		Total Treaty Natural-Origin Harvest Rate
			Unclipped A-Index Steelhead Harvest	Treaty Natural-Origin Harvest Rate	Unclipped A-Index Steelhead Harvest	Treaty Natural-Origin Harvest Rate	
2008	165,241	80,329	3,645	4.60%	614	0.8%	5.3%
2009	398,918	153,719	7,948	5.20%	527	0.3%	5.5%
2010	183,744	120,814	4,816	4.00%	1,857	1.5%	5.5%
2011	218,605	117,778	6,876	5.90%	658	0.6%	6.4%
2012	126,521	70,862	4,225	6.00%	399	0.6%	6.5%
2013	127,098	94,134	6,149	6.60%	2,256	2.4%	8.9%
2014	158,902	111,800	8,453	7.60%	3,173	2.8%	10.4%
2015	157,443	85,588	5,384	6.30%	1,107	1.3%	7.6%
2016	94,054	36,895	3,141	8.60%	1,020	2.8%	11.3%
2017	76,174	31,168	2,133	6.87%	182	0.6%	7.4%
2018	46,652	24,019	1,080	4.52%	46	0.2%	4.7%

Composite Harvest

The composite harvest of UC spring Chinook and steelhead in treaty and non-treaty commercial, recreational, cultural and subsistence, and conservation fisheries shows that exploitation rates on ESA-listed stocks have remained relatively low in recent decades under the agreements in *U.S. v. Oregon*. Although total harvest rates are generally low and remain much lower than they were a century ago, total harvest of UC spring Chinook is higher now than it was in the 1980's and 1990's when harvest rates were extremely low (NWFSC 2015). While harvest rates are higher overall, harvest impacts on natural-origin spring Chinook and steelhead has declined as mass marking of hatchery fish and mark selective fisheries have been implemented in the Columbia Basin (ISAB 2018).

Spring Chinook

Total harvest of Upriver spring Chinook has averaged between 10-30% since 2000 with year-to-year variation in harvested fish in treaty tribal and non-treaty fisheries. The total number of harvested Upriver spring Chinook across all fisheries has decreased since 2010 (Figure 13). Treaty commercial and C&S fisheries along with non-treaty recreational fisheries below Bonneville contributed the most to overall harvest of Upriver spring Chinook. Harvest in different fisheries has varied by year with commercial fisheries harvest very few fish during years of low returns.

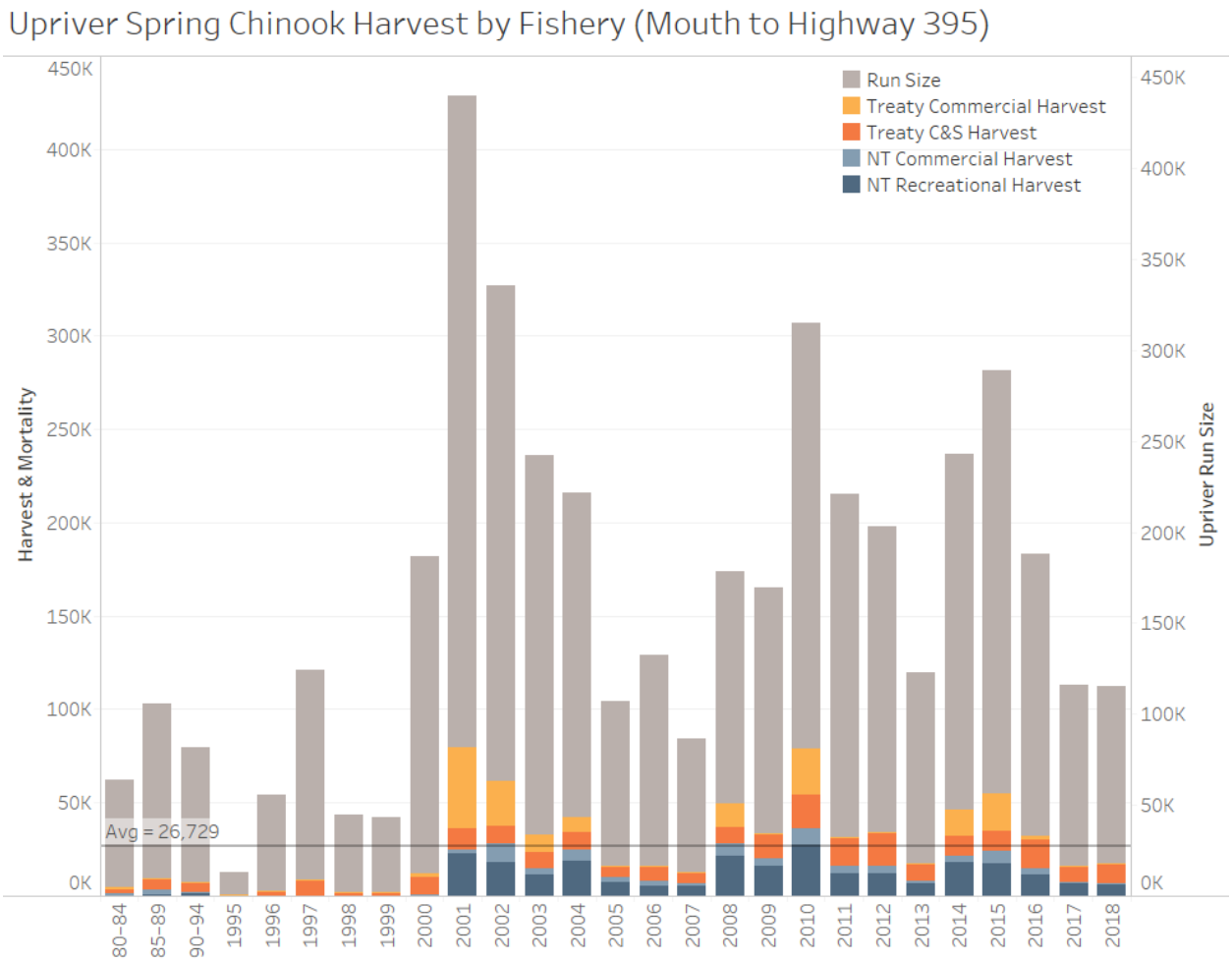


Figure 13. Upriver spring Chinook harvest from 1980-2018 by treaty and non-treaty fisheries in the Columbia River between the mouth and McNary Dam. Total Upriver spring Chinook run size is shown in shaded area for reference (data from WDFW and ODFW 2019 Table 5).

Harvest and incidental mortality of natural-origin UC spring Chinook is much lower than total harvest rates on the Upriver spring Chinook stock. Composite harvest impacts have ranged from <10% during periods of low returns, such as the late 1990's when UC spring Chinook were listed, to highs between 15-20% during periods of higher returns (Figure 14). The mean harvest rate on UC spring has been 11% since 1980. In the past 10 years it has been slightly higher at 13%. The greatest harvest impacts on UC spring Chinook occurs in treaty commercial and C&S fisheries. This includes both direct harvest and indirect mortality. Minimal impacts to UC spring Chinook occur as a result of non-treaty commercial and recreational fisheries, especially in the years since listing of this species. Overall, harvest and incidental mortality of UC spring Chinook has amounted to less than 500 fish per year on average since 2008 (WDFW and ODFW 2019).

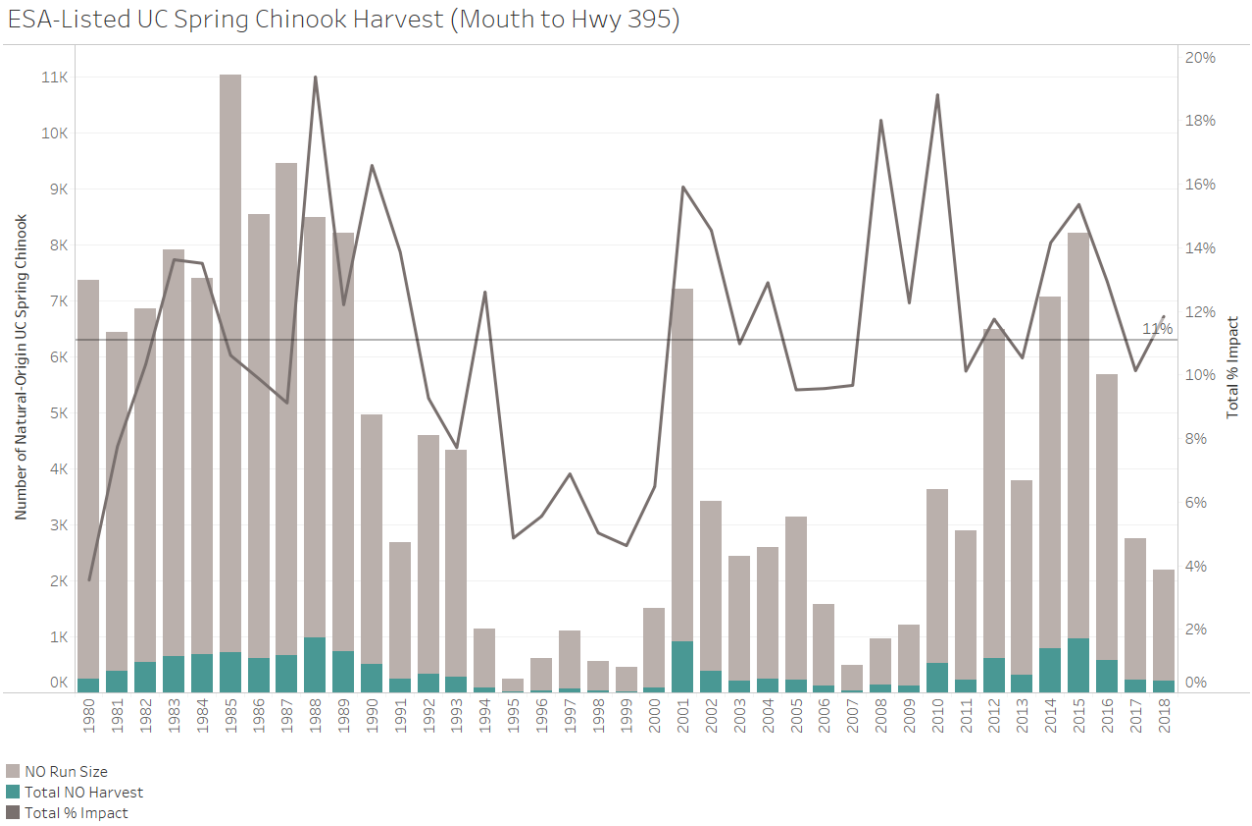


Figure 14. Estimated numbers of natural-origin UC spring Chinook entering the Columbia River 1980-2018 and subsequent harvest in treaty and non-treaty fisheries and total harvest rate below Highway 395 (data from WDFW and ODFW 2019 Table 6).

Harvest allocation and ESA take limits control the total number of fish that are harvested and the direct and incidental mortality of ESA-listed natural-origin fish. State and tribal-managed fisheries have generally stayed within the limits of those agreed-upon limits and continue to manage fisheries in a way that minimizes their impacts to ESA- listed UC spring Chinook and steelhead. Both treaty and non-treaty fisheries exceeded take limits in 2008 and both treaty and overall take limits were exceeded in 2010 (

Table 11). Since 2010 impacts to UC spring Chinook have stayed within the allowable limits (TAC 2019).

Table 11. Actual and allowed level of incidental take (as a proportion of total run-size) of listed natural-origin UC spring Chinook for fisheries implemented from 2008-2017 (TAC 2019). Shading indicates years when allowable rates were exceeded.

Year	UC NO Run Size	Non-Treaty Impacts	Treaty Impacts	Actual NT NO Harvest Rate	Allowed NT Harvest rate (ESA Rate)[1]	Actual Treaty NO Harvest Rate[2]	Allowed Treaty NO Harvest Rate[1,2]	Actual Total NO Harvest Rate	Combined Total Allowed NO Harvest Rate[1]
2008	833	18	114	2.2%	1.9%	13.7%	9.1-9.9%	15.8%	11.8%
2009	1,099	20	94	1.8%	1.9%	8.6%	9.1-9.9%	10.4%	11.8%
2010	3,110	62	461	2.0%	2.2%	14.8%	10.8-11.6%	16.8%	13.8%
2011	2,655	37	195	1.4%	2.0%	7.3%	10.0-10.8%	8.7%	12.8%

2012	5,686	71	527	1.2%	1.9%	9.3%	9.1-9.9%	10.5%	11.8%
2013	3,472	47	271	1.4%	1.7%	7.8%	8.3-9.1%	9.2%	10.0%
2014	6,276	105	679	1.7%	2.0%	10.8%	10.0-10.8%	12.5%	12.8%
2015	7,235	141	830	1.9%	2.2%	11.5%	10.8-11.6%	13.4%	13.8%
2016	5,563	93	534	1.7%	1.9%	9.6%	9.1-9.9%	11.3%	11.8%
2017	2,514	34	188	1.4%	1.5%	7.5%	7.0-7.8%	8.8%	9.3%
Average	3,844	63	389	1.7%	2%	10%		11.7%	12%

[1]*Allowable take depends on run size*

[2]*Impacts in treaty fisheries on listed wild fish can be up to 0.8% higher than the river mouth run size harvest rates (indicated in table above) due to the potential for changes in the proportion of natural-origin fish between the river mouth and Bonneville Dam*

In addition to looking at total harvest and estimated incidental mortality, several studies have looked at harvest in the context of total mortality during upstream migration in the mainstem Columbia. Many of these studies use PIT tag-based estimates of survival and mortality which is difficult to compare to harvest rates. However, they do provide an estimate with which to understand harvest in the context of other sources of mortality in the reaches where fisheries are occurring. A full discussion of conversion rates is included in the UCSRB Hydropower Background Summary (Maier 2019). PIT tag-based conversion rates cannot be directly compared to harvest rates calculated for fisheries by utilizing dam counts. Although comparisons can be made between PIT tag-based mortality rates and reported harvest rates, it is unclear what the other sources of mortality are and how many of the unaccounted-for losses can be tied to fishery-related impacts.

Rub et al. (2019) looked at survival of Upriver and Upper Columbia spring Chinook in the reaches below Bonneville Dam between 2010-2018. This study was intended to look at sources of non-harvest mortality, but the data is informative in understanding the context for factors related to morality in this area, including harvest. Survival for Upriver spring Chinook below Bonneville Dam was between 44-73% (average 61%). Upper Columbia /Mid-Columbia Spring Chinook had similar survival rates as the composite stock group of Upriver spring Chinook. Looking at published harvest rates in this area during the same time frame (WDFW and ODFW 2019), harvest could account for between 12-46% (average 22%) of this mortality for clipped fish and 27% for unclipped Upriver spring Chinook. The study did go into depth on the sources of remaining non-harvest related mortality (specifically pinniped predation) but did detail how substantial it can be. The authors noted that there may be a small component of predation that is related to harvest through depredation from fishing gear (see section below on predation for more information on this topic). They noted that unreported harvest has been raised as an additional source of unaccounted-for mortality but reported that there is currently no reason to believe that harvest is being underreported (Rub et al. 2019).

Crozier (2016) has calculated the survival of UC Spring Chinook as they pass through the reaches upstream of Bonneville Dam using PIT tag estimates and summarized the factors that contribute to mortality (including harvest). Survival of UC spring Chinook between 2006-2015 ranged from 79%-86% (average 82%). Harvest rates are not available for specific ESU but if harvest rates are similar to the Upriver spring Chinook stock then harvest in this area was between 7-15% of the run passing Bonneville Dam (TAC 2019). Year-to-year comparisons show that harvest could account for as little as 36% to as much as 91% of the mortality in the area between Bonneville and McNary Dam. On average, it could account for over half of the mortality in these reaches. Years with the highest harvest rates during this

time did not correspond with years with the lowest survival and vice versa, years with low harvest did not correspond with high survival. There was also no clear pattern associated with run size. It is unclear what other factors are contributing to mortality in this area.

During their review of spring Chinook, the ISAB evaluated conversion rates above McNary dam for known-origin fish and found very high conversion rates for spring Chinook (ISAB 2018). Using data from 2010-2017, they calculated a conversion rate of 94% for McNary to Rocky Reach Dam for spring Chinook (DPUD 2017; ISAB 2018). Harvest effort for spring Chinook and steelhead is minimal in these reaches of the mainstem Columbia and high conversion rates reflect this.

Based on the combination of radio telemetry and PIT-tag detection histories with genetically-based stock assignments, Keefer et al. (2015) calculated precise estimates of dam-to-dam and multi-dam reach conversion estimates for upstream-migrating salmonids in the lower Columbia River. The study accounted for self-reported harvest, tributary turnoff, and straying rates, along with the analysis of covariate effects. The study reported reach conversion rates for radio tagged Chinook in the Lower Columbia River from 2013-2014 (Figure 15). Final detections indicated that 65-69% of adult Chinook salmon and 76-83% of jack Chinook salmon survived to pass McNary Dam with the majority of these fish ultimately detected in tributaries or at dams in the Snake or upper Columbia River basins. Conversion rates in dam-to-dam reaches were lowest between Bonneville and The Dalles dams, the reach with the most fisheries effort. Conversion rates were generally highest between John Day and McNary dams. The majority of the fish not detected at the next upstream dam were ultimately harvested or detected in tributaries or at dams in the Snake or upper Columbia River basins. The study was able to use PIT-tag movement and fishery data to correct conversion rates for a more accurate estimate of survival. Using this method, Keefer et al. (2015) calculated adult spring Chinook (not UC-specific) survival from Bonneville to McNary as 85%. Jack spring Chinook had higher survival (average=93%) likely because of lower fishing pressure on these smaller fish. Jacks make up an average of 16% of the spring Chinook run (DART 2018). In reaches with less fishing pressure survival was calculated at above 96%.

Salmon fishing in Lower Columbia (photo from ODFW 2020).

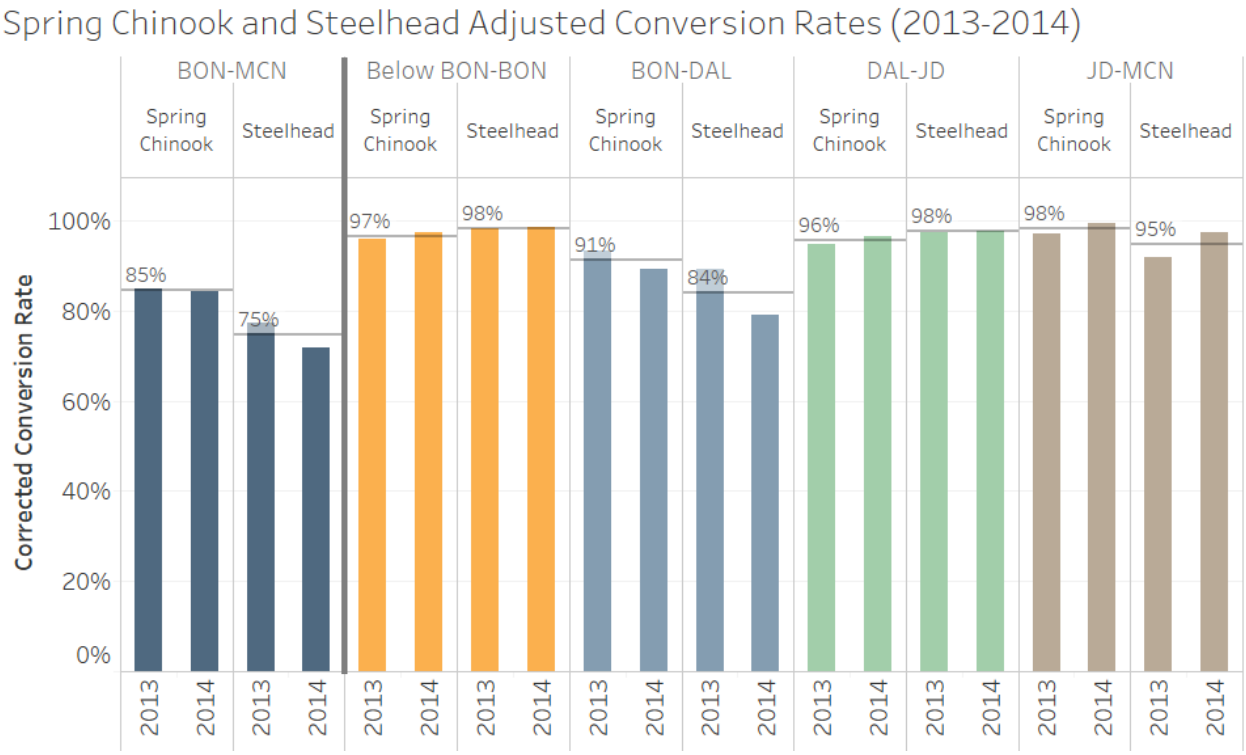


Figure 15. Adjusted conversion rates for adult spring Chinook and "early-run" steelhead through different reaches of the Lower Columbia River (Keefer et al. (2015); Figure from Maier (2019)). NOTE: Fish were tagged and released below Bonneville Dam and survival was measured to Bonneville Dam (Below-BON to BON in graph). Conversion rates do not reflect survival through then entire reach below Bonneville Dam.

The ISAB summarized the relative impact of harvest on returns of Upper Columbia Spring Chinook compared with other factors for mortality using a life cycle model analysis in their evaluation of Upper Columbia spring Chinook. The Wenatchee spring Chinook lifecycle model evaluated a scenario of reduced harvest and found that harvest effects were less than those of estuarine adult survival and hatchery operations (Jorgensen et al. 2017). Modeling analysis of the relative differences in mortality attributable to marine mammal predation and fisheries harvest of Chinook salmon found that predators can affect survival more than fisheries harvest (Chasco et al. 2017; ISAB 2018). Rub et al. (2019) looked specifically at pinniped predation of spring Chinook in the Lower Columbia below Bonneville Dam and found it to be highly variable. Between 2010-2015 the study found that non-harvest mortality ranged from a low of 51,751 fish in 2012 (20% of the run) to a high of 224,705 in 2015 (44% of the run). The authors believed that much of this non-harvest mortality was linked to predation. In comparison, harvest of Upriver spring Chinook was between 10,202-37,956 (average of 20,275 adults or 8.5% of the run) during the same years in the Lower Columbia below Bonneville Dam.

Steelhead

Total harvest and incidental mortality of A-index Upriver summer steelhead has averaged between 5-17% since 2008 with fairly consistent harvest up until the last several years, when low returns have necessitated low harvest rates to allow for adequate natural-origin escapement (Figure 16). Treaty fisheries impacts (primarily incidental mortality) along with non-treaty recreational fisheries impacts contributed the most to harvest-related mortality of A-index summer steelhead.

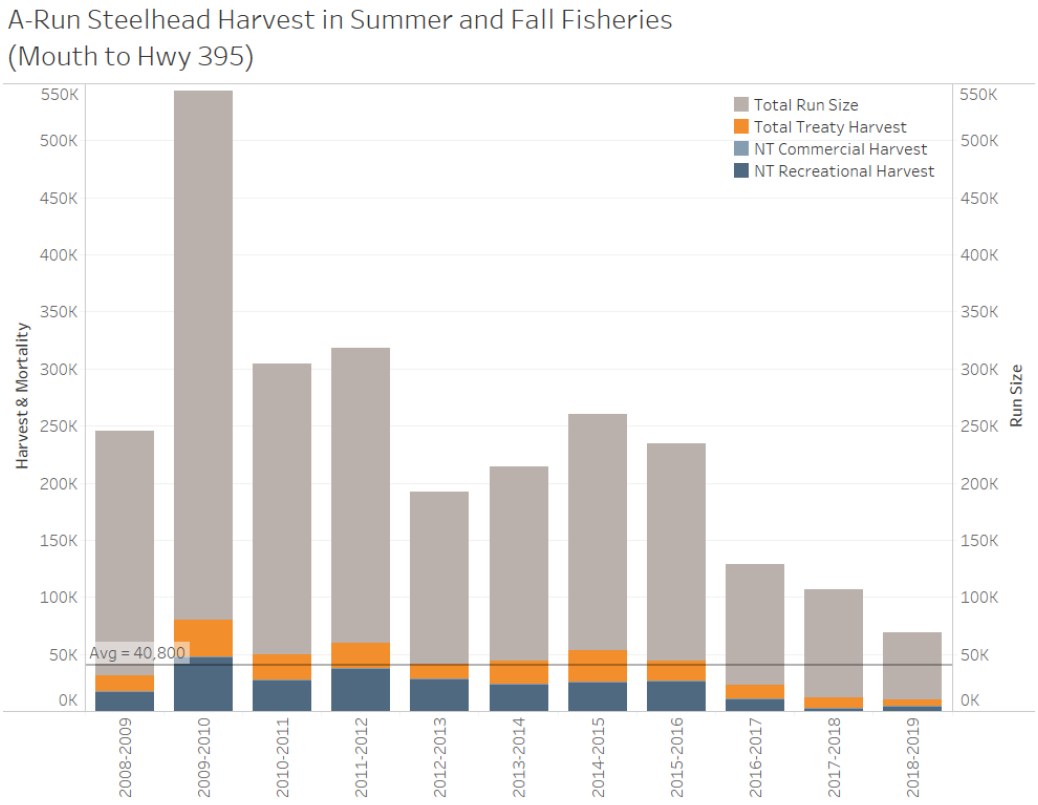


Figure 16. A-Index Summer Steelhead treaty and non-treaty harvest from 2008-2018 by summer and fall fisheries below Highway 395. Total run size is shown for trends (data from WDFW and ODFW 2019 and TAC 2019).

Composite harvest impacts on UC steelhead are not tracked. Composite harvest impacts on unclipped A-index steelhead are tracked and have ranged from 7-16% between 2008-2018 (Figure 14). Average harvest impacts on unclipped fish was approximately 10% during this time period which accounted for an average of 7,500 unclipped A-index steelhead (WDFW and ODFW 2019).

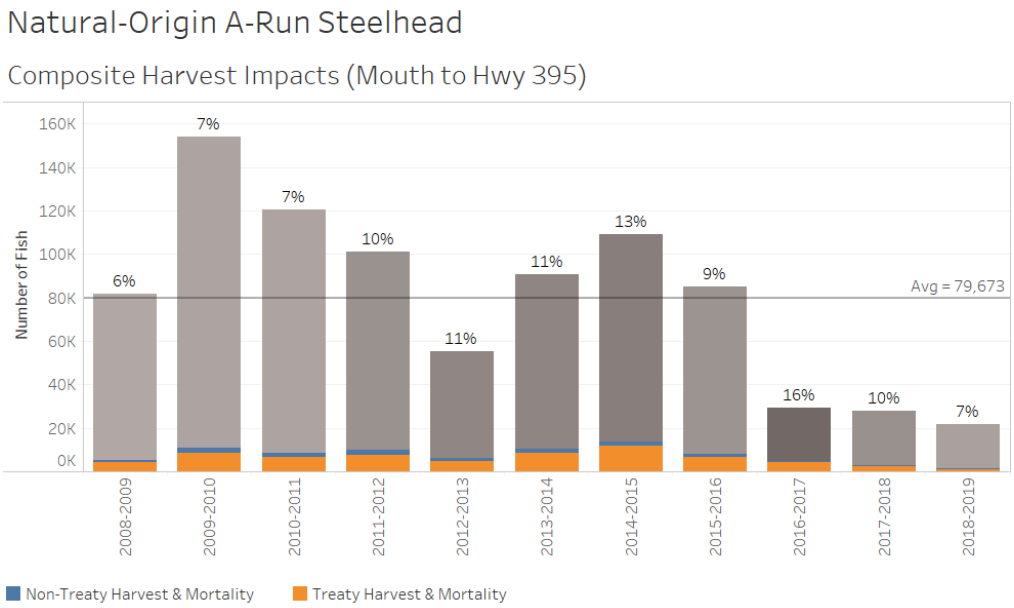


Figure 17. Estimated numbers of natural-origin (unclipped) Upriver A-index steelhead returning to the Columbia River from 2008-2018 and subsequent harvest in treaty and non-treaty fisheries and total harvest rate (%) below Highway 395 (data from TAC 2019; WDFW and ODFW 2019).

There is a 4% ESA take limit on Upper Columbia steelhead for all non-treaty fisheries. There is no specific harvest rate limit proposed for treaty fisheries on A-Index summer steelhead, but they are expected to remain within recent (2008 – 2016) average rates (0.5 – 3.0%). Based on rates of harvest of unclipped A-index steelhead NMFS estimated a total expected take of 5-14.1% for UC steelhead under the current 2018 *U.S. v. Oregon* agreement with 4.1-12.4% from treaty fisheries and 0.9-1.7% from non-treaty fisheries (NMFS 2018; Table 12).

Table 12. Authorized level of incidental take (as a proportion of total run-size) of listed UC steelhead for fisheries included in the 2008-2017 *U.S. v. Oregon* agreement (NMFS 2018).

	Take Limits from *U.S. v. Oregon* 2008-2017	Range of take observed	Average Annual Take
UC steelhead (non-treaty)	4.0%[3]	1.1-3.3%	1.9%

[3]*Applies to non-Tribal fisheries only; 2% in winter/spring/summer seasons and 2% in fall seasons for total of 4%*

Keefer et al. (2015) also calculated reach conversion rates for radio tagged steelhead in the Lower Columbia River from 2013-2014 which can be used to understand harvest impacts (Figure 15). The study indicated that 45-46% of early steelhead, and 72-73% of late steelhead survived to McNary Dam. Upper Columbia steelhead are generally classified in the "early" run. After excluding fish that were caught or migrated to tributaries between the dams, early-run steelhead survival from Bonneville to McNary was 75%. In reaches with less fishing pressure survival was calculated to be above 95%. The study had limited sample sizes of upper Columbia stocks (assigned using genetic testing) but found that Bonneville-McNary conversion estimates for genetically- assigned UC steelhead were 82% indicating that UC steelhead may actually survive much better through the lower river than what is reflected in the

aggregate conversion. A critical remaining uncertainty noted in the study was the fates of upstream migrants that were unaccounted for. The authors presumed that many of these fish were harvested but not reported. Others were presumably pre-spawn mortalities and smaller numbers may have entered tributaries undetected or spawned at mainstem sites.

WDFW has estimated survival rates for the four Upper Columbia steelhead populations from Bonneville Dam to Upper Columbia dams based on PIT tag data from 2000-2013 (Cram and Kendall et al. 2018). It should be noted that PIT tag estimates of harvest cannot be directly compared to harvest rates used in fishery management. Total mortality (or impact) rate (including reported harvest, any unreported harvest, non-harvest mortality, and potentially straying) was similar for all four populations and ranged from 9.7%-10.8%. The Methow steelhead population had the highest average harvest rate and the Entiat had the lowest. When unaccounted-for losses are included (some of which could be harvest-related), losses increase considerably. Harvest and unaccounted-for losses accounted for 24.2%-32.3% of undetected steelhead adults between 2001-2013. The Wenatchee steelhead population had the highest rate of unaccounted-for losses (22.2%) (Table 13).

Table 13. Population-specific harvest and conversion rates for UC steelhead based on PIT-tag data from 2001-2013 (Cram and Kendall et al. 2018).

DPS/Population	Average harvest rate %	Conversion rate (BONN to upriver detection site below)	Average harvest rate + unaccounted for loss %	Years
Upper Columbia	10.3		26.8	
Upper Columbia Wenatchee	9.9	Rocky Reach	32.3	2001-2013
Upper Columbia Entiat	9.7	Rocky Reach	26.6	2001-2013
Upper Columbia Methow	10.8	Wells Dam	24.2	2001-2013
Upper Columbia Okanogan	10.7	Wells Dam	24.2	2001-2013

Bull Trout

As stated in the UC Recovery Plan, fishing was likely an important factor leading to the decline of bull trout in the Upper Columbia Basin. Certain areas within the basin had bull trout fisheries, and large numbers of bull trout were harvested (WDFW 1992). There was even a commercial fishery for bull trout in Lake Chelan (Brown 1984). Today bull trout harvest is prohibited, with the exception of a bull trout fishery on the Lost River. Although bull trout harvest is prohibited, they are still vulnerable to take due to misidentification, hooking mortality, and poaching. Schmetterling and Long (1999) found that only 44% of anglers correctly identified bull trout, and anglers frequently confused related species (i.e., bull trout and brook trout). Due to timing and location, bull trout are caught incidentally during conservation fisheries for steelhead, coho fisheries, in the sockeye salmon fishery in Lake Wenatchee, and sometimes during open seasons for mountain whitefish, and during spring Chinook conservation fisheries and summer Chinook fisheries (Travis Maitland, WDFW, *pers. comm*; U.S.FWS 2002). The effects of poaching could be significant but have not been evaluated (e.g. Taylor and White 1992; Schmetterling and Long 1999).

Bull trout appear to be more vulnerable to fishing than other species of salmonids (Paul et al. 2003). The bull trout spawning migration timing coincides with the timing of spring Chinook salmon fisheries. Post-

spawning adult migration and sub-adult emigration, coincide with steelhead fisheries. Similarly, sockeye fisheries in Lake Wenatchee occur during a time of the year when large numbers of bull trout aggregate in Lake Wenatchee and feed actively in preparation for continuing their spawning migration into the Chiwawa, White, and Little Wenatchee rivers. The correspondence between bull trout migration timing and fisheries targeted at hatchery returns of other salmonids, combined with fishing for natural origin sockeye in Lake Wenatchee when bull trout abundance in the Lake is highest, raises the potential for adult bull trout to be caught on their upstream spawning migration through the lower Wenatchee River, while feeding in Lake Wenatchee, and again when migrating back downstream to feed and overwinter in the lower Wenatchee River or the Columbia River (U.S.FWS 2017). Estimates of hooking injury and mortality of non-anadromous salmonids vary widely. Hooking mortality estimates range from <1 to 40 percent (Post et al. 2003, pg. 26; Gutowsky et al. 2011). WDFW uses a 10% hooking morality rate for fisheries (WDFW 2015a; 2015b).

The Lost River bull trout fishery in the Methow was established under a 4(d) Rule for sport fishing regulations (63 FR 31647). The fishery was based on a 1993 population estimate which indicated that there were adequate numbers of catchable bull trout in the Lost River between Drake Creek and Diamond Creek to establish a fishery. A follow-up population assessment in 2012 showed a similar population size and the fishery remains open. The fishery requires selective gear, has a two-fish limit, and a 14-inch minimum size. However access to the fishing area has been affected by fire and deteriorated trail maintenance and WDFW believes angling effort has dramatically declined since the early 1990's (Ryan Fortier, WDFW*, pers. comm*).

Factors Affecting Harvest Impacts

Survival of adult salmonids in their interaction with fisheries is influenced by many factors including origin and marking (hatchery or natural-origin), river conditions, hooking, migrating timing, and travel time. The effect of these factors on mortality are briefly described below.

Origin and Marking

Many fisheries in the Columbia River are mark-selective, meaning they target ad-clipped hatchery-origin fish. For this reason, ad-clipped hatchery-origin fish are more likely to be harvested if they are exposed to mark-selective fisheries. Spring Chinook and steelhead that migrate during periods when non-mark-selective fisheries are in place have the same or similar rates of mortality. Natural-origin Upper Columbia spring Chinook and steelhead are unclipped, however hatchery-origin UC spring Chinook and steelhead can be either clipped or unclipped depending on the hatchery program from which they were released (see UCSRB Hatchery Summary Maier (2017)). Using PIT tag-based survival estimates, unmarked hatchery-origin fish have a higher probability of survival than marked hatchery-origin fish although the difference appears to be small and inconsistent. Rub et al. (2019) found a difference in the survival rate of ad-clipped Upriver spring Chinook traveling from the mouth to Bonneville Dam. This difference ranged from 3% to 25% with some years showing a higher survival for clipped fish (three out of eight years between 2010-2018) and some years showing a higher survival for unclipped fish. Most years showed >9% survival advantage for unclipped fish in the reaches below Bonneville Dam (M.Rubb, *pers. com.,* Feb. 2020). Crozier et al. (2016) also found that hatchery fish survived at a higher rate than

natural-origin fish (84% vs. 81%) between Bonneville and McNary, although the trend was not true in every year and the difference was minimal. Given that both natural and hatchery-origin fish are exposed to the same environmental conditions in this reach it can be assumed that the majority of this difference is due to selective fishing in the reach.

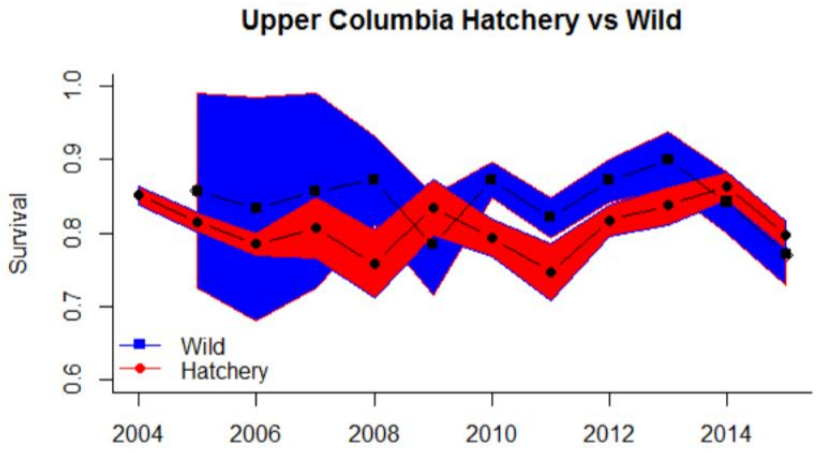


Figure 18. Snake and upper Columbia River survival from PIT tag-based estimates between Bonneville (BON) to McNary (MCN) dams by rear type (hatchery and wild). Shaded area represents ±1 SE (Figure from Crozier et al. 2016).

Run Timing

For adults, the timing of when fish enter the river and start their upstream migration plays a major role in their subsequent susceptibility to harvest and can play a role in mortality of released fish due to in-river environmental conditions. Fish arriving in the Columbia River during times of high fishing pressure are more likely to be caught and kept if they are the target species or caught and released if they are non-target species. UC spring Chinook are some of the earliest arriving populations in the Columbia Basin. The Methow, Entiat, and Wenatchee all peak before May 15th in their arrival at Bonneville Dam (Crozier et al. 2016). Hatchery fish from the UC spring-run Chinook Salmon ESU have earlier timing than natural-origin fish (Crozier 2016). Earliest arriving spring Chinook can be caught at a higher rate than later arriving fish due to how effort is spread out over the fishing season. This at least partially contributes to low survival rates of earlier arriving fish (Figure 19). Lower survival of early arriving fish can also be attributed to increased susceptibility to pinniped predation (Rub et al. 2019).

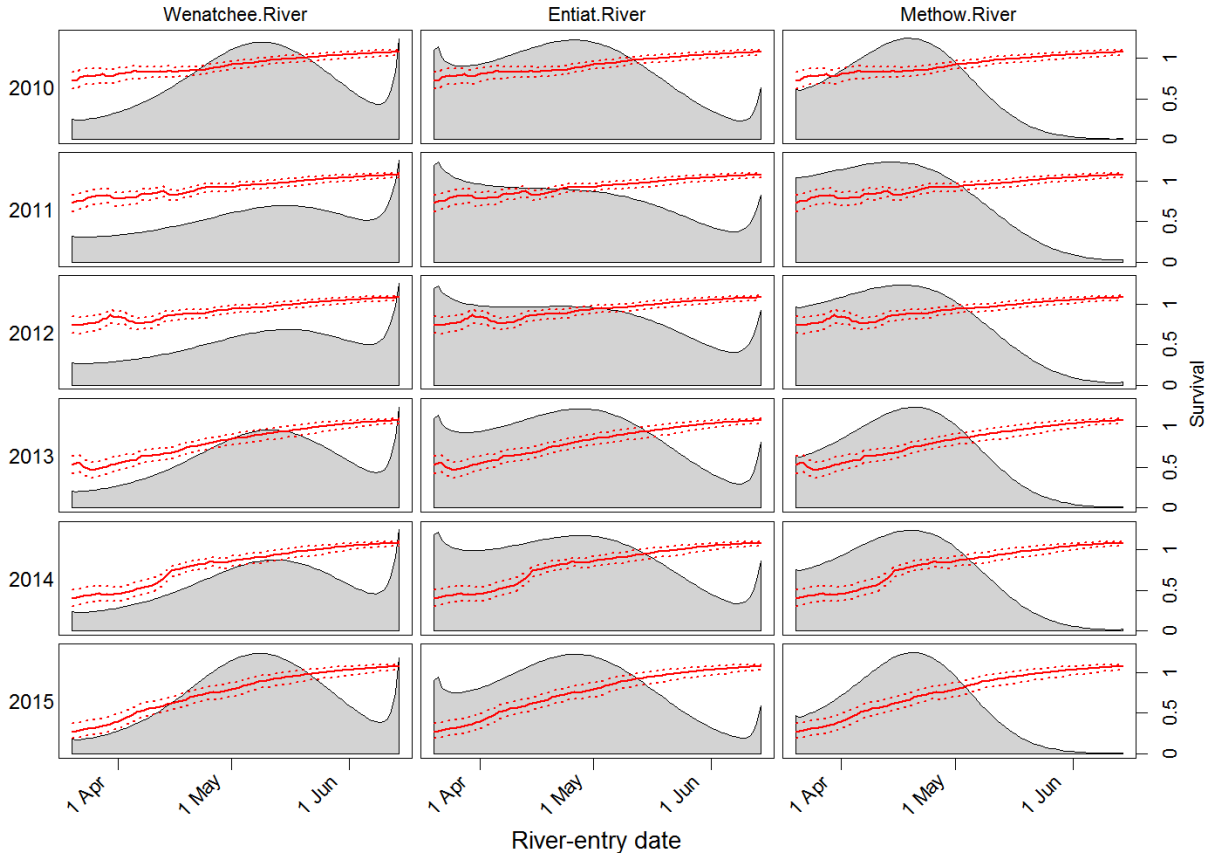


Figure 19. Survival of UC populations of spring Chinook based on river entry date. (Figure provided by M.Sorel, NMFS 2019).

Late arriving UC spring Chinook can also be more prone to harvest because they are exposed to summer fisheries after June 15th that have different harvest management guidelines. Crozier (2016) found that although most natural-origin Methow spring Chinook arrive at Bonneville Dam before June 15th most years, an average of 6% of natural origin Entiat spring Chinook and 10% of Wenatchee spring Chinook arrived after June 15th. Conditions in the Columbia River and the ocean can play a large role in migration timing in any given year. There is considerable year-to-year variation in run timing, affecting the proportion of fish that pass after June 15th in any given year. For instance, in many years all adult UC spring Chinook had passed before June 15th but in 2011 24% of the Wenatchee population passed after June 15th and in 2013 42% of the Entiat population passed after June 15th (Crozier et al. 2016). It is unknown how many natural-origin UC spring Chinook are caught in summer fisheries due to their late arrival date in the river.

Steelhead from the Upper Columbia DPS typically arrive early in the Columbia steelhead run, with an arrival at Bonneville Dam between July 6 and September 11 (Hess et al. 2016; Crozier et al. in press). Wenatchee steelhead arrive slightly later than the other UC populations. By 10 September, 75% of the Upper Columbia MPG has passed McNary Dam. Crozier et al. (in press) found that the key factors that determined arrival day at Bonneville Dam (in order or importance) were July temperature, a discharge variable (flow or spill), hatchery origin, ocean years, and month at tagging. The majority of UC steelhead passed Bonneville Dam between early July and September (DART 2019). Early arriving steelhead are

exposed to the summer fisheries in the Columbia River. Later arriving fish are exposed to the fall fisheries. Given the amount of fishing pressure in the Columbia mainstem during these two time periods, later arriving fish are more likely to be caught and released and may experience higher mortality rates due to increased handling in warmer water.

Travel Time

Travel time can increase susceptibility to fisheries because the longer a fish spends in an area with an active fishery, the more likely it is to be caught. Typically, spring Chinook migrate quickly upstream through the mainstem Columbia River. Mean cumulative passage from Bonneville Dam to Rock Island Dam is approximately 16 d. Delays in migration are known to increase the likelihood of mortality in the river (Crozier et al. 2016). Median travel time between Bonneville and McNary was fastest for Methow (6.05 d for hatchery, 6.2 d for wild fish), and longest for Wenatchee River fish (6.8 d for hatchery and 7.5 d for wild fish). For Wenatchee River fish, the additional travel time for the wild cohort indicated an even greater difference in harvest exposure than indicated by their later arrival timing at Bonneville (Crozier et al. 2016). River conditions and year-specific circumstances affect travel time for late arriving spring Chinook in particular. In 2008 and 2011, late timed fish were delayed and travel time from Bonneville to McNary Dam was extended to 8.0 days, again emphasizing that year-specific differences matter (Crozier et al. 2016).

The majority of UC steelhead passed Bonneville Dam between early July and September (DART 2019). UC steelhead tend to move quickly through the lower four dams and up into the upper Columbia Region shortly after passing Bonneville. Fish that are predicted to be slow have been found to be significantly less likely to be detected at McNary than fish that were predicted to be fast due to both environmental conditions (high temperatures) and exposure to fisheries (Crozier et al. in press). Although they migrate quickly through the lower river, UC steelhead do spend a considerable amount of time in the mainstem Columbia above Priest Rapids Dam, holding and migrating. Depending on when and where they migrate in this area they can be exposed to Upper Columbia recreational fisheries between July and October in the mainstem Columbia River.

Handling and Encounter

Handling and encounter in fisheries can affect later survival. In selective fisheries, non-target fish (e.g. species, size, or mark) are released after landing and depending on the extent of injuries and stress those fish can later die as a result of capture, mostly in the first 24 hours after release (Muoneke and Childress 1994). In addition, there can also be a suite of sub-lethal physiological, behavioral, and fitness impairments that can arise from handling (Cooke et al. 2002). The main factors found to reduce survival are fishing method, hooking location, physical damage (e.g. scale loss, abrasion, loss of mucus coasting, etc.), handling out of the water, and high water temperatures (see Cowx et al. 2017). Handling can also affect predation risk which could be important to consider in areas like the lower Columbia River where there can be intense predator risk from pinnipeds (see Raby et al. 2013; Maier 2014).

Temperature is an important factor to consider in evaluating the susceptibility to hooking mortality. The majority of the UC spring Chinook run typically passes through the lower river before critical temperatures are reached, but the last portion of the run (approximately 3-10% of the run) encounters

high temperatures above 20° C (Maier 2019; DART 2018). When water temperatures approach 20° C, adult salmon have difficulty migrating upstream, and at 22° C, migration stops altogether (Keefer 2018). UC steelhead encounter high temperatures in the lower river reaches with the majority of the run (85% on average) exposed to temperatures exceeding 20° C (UCSRB 2019; DART 2018). Crozier et al. (in press) found that survival of UC steelhead decreases dramatically when temperatures at Bonneville Dam exceed 20° C.

An ODFW/WDFW summary found that approximately 21% of spring Chinook and 42% of steelhead are caught and then released in the mainstem Columbia River recreational fisheries downstream of Bonneville Dam, illustrating that a significant portion of UC spring Chinook and steelhead may be subject to the lethal and sub-lethal effects of handling as they encounter various fisheries within the mainstem and tributaries (ODFW/WDFW 2019). Specific hooking morality rates have been studied based on gear, season, and species. Hooking mortality rates are a key component required for calculating impacts to non-retained salmonids in Columbia River fisheries. TAC conducted extensive literature reviews and concluded that a post-release mortality rate of 10% should be applied to mainstem recreational fisheries for salmon and steelhead during the spring management timeframe (WDFW and ODFW 2019). A table showing the rates of incidental mortality by fishery is presented in Table 5.

Predators

Studies have found that fish that encounter fisheries in areas with predators can be more susceptible to predation, either during the encounter (while avoiding gear or while hooked or netted) or after the encounter when they are stressed or injured. With exception of depredation (predation on fish during the fishing process, before fish are landed), which can be directly observed during some forms of fishing, most of the fishery-related mortality associated with predators is difficult to evaluate. It is very difficult to elicit mortality that is directly caused by predators as a result of an encounter with a fishery (e.g., the number of released fish that otherwise would eventually recover and survive but that succumb to predators while temporarily incapacitated after release). As such, there is a lack of quantitative information summarized in the available literature to estimate the likely impact of predators on fishery-related mortality. There is some evidence that areas with high abundances of predators, like the lower Columbia, could be leading to higher rates of overall fishery-related mortality. Rub et al. 2019 noted that there may be a small component of predation that is related to harvest through depredation from fishing gear. The authors cited anecdotal reports from fishermen of this phenomenon that have increased in the Columbia River along with increasing pinniped abundance; however, there is currently no data regarding the actual frequency of depredation events.

Harvest- Areas of Uncertainty

There are a number of uncertainties in harvest and harvest management that limit our ability to quantify the effects of harvest on Upper Columbia spring Chinook and steelhead populations. These uncertainties can be attributed to either a lack of data or a lack of existing information (analysis and reporting of data). Although in many ways harvest impacts are some of the most straightforward and well reported of all the “H’s” there is very little information that is reported in a way that aligns with salmon recovery domains and recovery criteria. Below we describe some of the most important uncertainties as they

have been described in reports and evaluations of harvest (e.g. NNMFS 2016; Cram and Kendall et al. 2018; ISAB 2018) or as we found them to be in this summary exercise. The identification of these knowledge gaps provides information for both describing the limitations of the existing evidence base and directing the efforts of future research

Harvest Evaluation and Reporting

- Reporting of harvest at the ESU or DPS level is not done across all fisheries in which they are caught is not done.
- The effect of aggregate fisheries management (across all venues) on natural-origin escapement or other VSP parameters has not been evaluated.
- The precise level of DPS harvest relative to harvest groups of steelhead is not known or reported.
- Information on rates and differences in harvest between UC populations, including measures of precision and bias, are not available.
- The impact of fisheries on marked and unmarked (ad-clipped and unclipped) ESA-listed UC spring Chinook and steelhead and the impact of fisheries on natural-origin UC spring Chinook and steelhead (only unclipped) has not been evaluated or reported.
- The effect of mark-selective fisheries on natural-origin escapement or other VSP parameters has not been evaluated or reported.
- Estimates of various sources of uncertainty in harvest management are not reported on.
- Harvest impacts of steelhead DPS across management seasons is not tracked or reported.
- Harvest impacts at a finer temporal resolution than season (month or week) are not reported.
- Estimated uncertainty (variance) in harvest estimates (versus current point estimates) are not available.
- Effects of fisheries above Highway 395 on UC steelhead and spring Chinook are not regularly reporting on in coordination with other harvest reporting for the Columbia Basin.
- Impacts of run timing on susceptibility to harvest (e.g. Impacts of summer fisheries on late returning spring Chinook which would be reported as summer Chinook).

Harvest Decisions

- Adult sampling at Bonneville Dam is used to set steelhead harvest and those estimates are constrained by operation of the adult fish facility (AFF) at Bonneville Dam. The AFF subsamples the run as it passes by Bonneville for biological data and depending on the run size & time of the year, it might only subsample at a rate of 1%, creating a potential bias in depicting the run as a whole for the year.
- Fall back and re-ascension effects to dam counts have not been evaluated in the context of their effect on fisheries management decisions.
- Run sizes of steelhead at the mouth of the Columbia River are not generated but are useful to estimate impacts by catch area.
- It is unclear how best to incorporate the complexities of steelhead life histories into the context of harvest management and how well the current management incorporates these differences among populations and DPS of steelhead.

- Estimates of the rates of under-reporting and the extent to which current estimates of harvest are negatively biased.

Incidental Mortality

- Rates and fates of net drop-outs and non-landed hooking, effect of fishery-related injuries and the effect on success to spawning grounds are not available.
- Little to nothing is known about the frequency and consequence of multiple fishery interactions for an individual fish.
- Water temperature is a major modifier of mortality through a variety of physiological and disease-related mechanisms, yet much remains unknown about its ability to mediate the fish response to fishery encounters now and under climate change conditions.
- Very little evidence currently exists to fully understand the impact of predation across different fisheries and species, especially as related to pinnipeds in the Lower Columbia below Bonneville Dam.
- A major knowledge gap is the extent to which fishery-related mortality represents an incremental level of mortality/risk over background natural mortality.

Harvest and Recovery Criteria

The Recovery Plan focuses on the viable salmonid population (VSP) criteria as the core measure used to gauge progress toward recovery. These include abundance, productivity, spatial structure, and diversity. Harvest affects some of these parameters and can have both negative and positive impacts on the viability of Upper Columbia populations, although there is still uncertainty about the extent of these effects. Although fisheries remove adult fish that are destined for the Upper Columbia, they are primarily focused on hatchery-origin adults. As discussed in the UCSRB Hatchery Background Summary (Maier 2017) removal of hatchery fish in some circumstances can have a positive impact on viability, such as in years of high returns of both hatchery and natural-origin adults when the goal is to maximize natural-origin escapement and minimize hatchery-origin spawning.

From the standpoint of understanding harvest and its impact on progress toward recovery, NMFS has developed and applied integrated population models to the Upper Columbia River spring Chinook ESU and used the estimated parameters and states to simulate the impact of fishery exploitation rate on future abundance and quasi-extinction risk. As expected, predicted abundance declined and quasi-extinction risk increased across a range of fixed harvest rates from 0–30%. The models showed that large-scale environmental fluctuations (e.g., ocean conditions and hydrosystem operations) were at least as important as harvest in determining long-term population viability. If future environmental conditions are relatively poor, and especially if they are assumed to have undergone a persistent state shift at some point in the last 60 years, then quasi-extinction risks were shown to be dramatically elevated even in the absence of harvest (Buhle et al. 2018).

Abundance and Productivity

Current Abundance Risk: UC Spring Chinook – High & Steelhead - all populations high risk except Wenatchee steelhead which is low risk (NMFS 2016)

Harvest leads to a reduction in abundance when ESA-listed adults are retained in fisheries and through incidental mortality that occurs during fisheries.. These impacts can be offset to some extent through mitigation hatchery programs. Population growth rate (productivity) provides information about how well a population is performing, how well it can respond to low survival periods, and determines its future abundance. Productivity is influenced by both freshwater tributary egg-to-emigrant survival, out-of-basin smolt-to-adult return (SAR), and adult pre-spawn mortality. Harvest affects both SARs and pre-spawn mortality through the direct and indirect impacts to adults as well as the potential effect on population characteristics of size and age at maturity. Harvest can also reduce productivity, and therefore future abundance, if it selectively removes larger or older fish that are more fecund or more effective spawners.

Spatial Structure and Diversity

Current Spatial Structure Risk: UC Spring Chinook & Steelhead - High (NMFS 2016)

A population's spatial structure is made up of both the geographic distribution of individuals in the population and the processes that generate that distribution. Most fisheries occur before fish reach their spawning areas, and therefore there is little effect to spatial structure. Because the overall harvest rate on listed fish is low, it is unlikely that harvest is limiting any upper Columbia populations from meeting their spatial structure goals. For Wenatchee River spring Chinook, the development of the Leavenworth National Fish Hatchery and the associated terminal fishery in Icicle Creek for unlisted spring Chinook led to the exclusion of this area from the ESU listing. Therefore, a combination of hatchery and harvest objectives in Icicle Creek have excluded one minor spawning area from the Wenatchee population. However, occupation of this minor spawning area is not a spatial structure requirement for the Wenatchee River population to meet its spatial structure recovery criteria (MAIER 2007).

There is little data to evaluate the effect that harvest has had on diversity of Upper Columbia listed populations of steelhead and spring Chinook. Diversity in a population or ESU is especially important because it is difficult to replace once it is lost. Much of the diversity within a population comes from local adaptation to a particular environment over many generations. The loss of fish that exhibit diverse life history strategies or phenotypic characteristics leads to the overall loss of life history diversity in the population. Harvest has the potential to inadvertently influence diversity and therefore erode the adaptive fit between an ESU or population and its environment, thereby increasing its risk of extinction. This influence could occur through several potential mechanisms including effects on migration timing and a reduction in size of returning spawners.

Some proportion of the population exhibits migration behaviors outside the typical migration periods. These life histories may experience a higher risk of mortality associated with harvest because the fisheries may not be managed to protect ESA-listed fish outside core migratory periods (e.g. late

migrating spring Chinook and early migrating summer steelhead that encounter summer fisheries). Adults that migrate earliest in the fishing season are also disproportionately caught in fisheries. Over time this selection pressure on the population can shorten or shift the migration period of the entire population (Adkison and Cunnigham 2015; Quinn et al. 2007). Harvest pressure can also change the size and age composition of adults that return to the spawning grounds, and therefore also change the diversity and range of these characteristics within the population. This phenomenon has been shown to occur in salmon populations across the Northwest (Ricker 1980; Ohlberger et al. 2018), although the exact link to harvest practices has not been made. Older size classes of hatchery and natural-origin Chinook (four and five years old) have decreased both in numbers and in size by as much as 10 percent in length, and substantially more in weight. New or modified life histories may benefit or harm the population depending on how well they survive and are able to reproduce. Generally, life history diversity (a range of characteristics) buffers the population from stochasticity (Schindler et al. 2010).

Literature Cited

Barnas, K., T. Cooney, L. Crozier, M. Diaz, M. Ford, J. Hard, …M. Williams. 2015. *Status Review Update for Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Pacific Northwest*. [online] URL: https://archive.fisheries.noaa.gov/wcr/publications/status_reviews/salmon_steelhead/2016/2016_nwfsc.pdf

Beacham, T.D., and C.B. Murray. 1987. *Adaptive Variation in Body Size, Age, Morphology, Egg Size, and Developmental Biology of Chum Salmon (Oncorhynchus keta) in British Columbia*. Canadian Journal of Fisheries and Aquatic Sciences 44:244-261.

Bilby, R., P. Bisson, C. Coutant, D. Goodman, S. Hanna, N. Huntly N, …B. Riddell. 2005. *Report on Harvest Management of Columbia Basin Salmon Steelhead*. [online] URL: https://www.nwcouncil.org/sites/default/files/isab2005_4.pdf

BPA (Bonneville Power Administration). 2010. *Columbia River hatcheries: an evolving role*. September 2010.

Brown, L. G. 1984. Lake Chelan fishery investigations. Washington Department of Fish and Wildlife, Wenatchee, Washington.

Buhle, E. R., M. D. Scheuerell, T. D. Cooney, M. J. Ford, R. W. Zabel, and J. T. Thorson. *Using Integrated Population Models to Evaluate Fishery and Environmental Impacts on Pacific Salmon Viability*. NMFS Technical Memorandum NMFS-NWFSC0 140. April 2018. [online] URL: https://www.nwfsc.noaa.gov/assets/25/9397_05222018_110900_TechMemo140.pdf

Byrne, A., J. Hymer, S. Ellis, R. Dick, K. Keller, C. A. Steele, M. Begay, T. Miller. 2018. A Genetic Analysis of the Summer Steelhead Stock Composition in the Columbia River and the Snake River Tribal and Sport Fisheries - June 16, 2015 to March 31, 2016. [online] URL: https://collaboration.idfg.idaho.gov/FisheriesTechnicalReports/Res18-106%20Genetic%20Stock%20Steelhead%20Composition%202015.pdf

Campbell, S. K., and V. L. Butler. 2010. *Archaeological evidence for resilience of Pacific Northwest salmon populations and the socioecological system over the last ~7,500 years. Ecology and Society.* **15**(1): 17. [online] URL: http://www.ecologyandsociety.org/vol15/iss1/art17/

Columbia Basin Partnership. 2020. Phase II Columbia Basin Partnership report (unpublished draft report by the CBP). February 2020.

Columbia River Inter-Tribal Fish Commission (CRITFC), Celilo Falls (n.d.). Retrieved November 19, 2019, from https://www.critfc.org/salmon-culture/tribal-salmon-culture/fishing-techniques/

Columbia River Inter-Tribal Fish Commission (CRITFC), Columbia River Zone 6 (n.d.). Retrieved December 2019, from https://www.critfc.org/about-us/columbia-river-zone-6/

Columbia river Inter-Tribal Fish Commission, Celilo Falls (n.d.). Retrieved November 19, 2019, from https://www.critfc.org/salmon-culture/tribal-salmon-culture/celilo-falls/

Columbia river Inter-Tribal Fish Commission, Celilo Falls (n.d.). Retrieved November 19, 2019, from https://www.critfc.org/salmon-culture/tribal-salmon-culture/fishing-techniques/

Collins, J., R. Rhew, M. Robertson. U.S. Fish and Wildlife Service Biological Opinion addressing Implementation of the *U.S. v. Oregon* Management Agreement for Non-Treaty and Treaty Indian Fisheries in the Columbia River Basin from 2018 to 2027 – Biological Opinion In Reply Refer to: 01FLSR00-2018-F-0001. 23 February 2018. Letter

Cram, J., N. Kendall, A. Marshall, T. Buehrens, T. Seamons, B. Leland, K. Ryding, and E. Neatherlin. 2018. Steelhead at Risk Report: Assessment of Washington's Steelhead Populations. Washington Department of Fish and Wildlife. October 2018. Available online at: https://wdfw.wa.gov/sites/default/files/publications/02070/fpt_19-03%20steelhead%20at%20risk_oct%202018_final.pdf.

Crozier, L., E. Dorfmeier, T. March, B. Sandford, and D. Widener. 2016. Refining our understanding of early and late migration of adult Upper Columbia spring and Snake River spring/summer Chinook salmon: passage timing, travel time, fallback and survival. Fish Ecology Division, Northwest Fisheries Science Center National Marine, Fisheries Service, Seattle, WA.

Dornbusch, P. and A. Sihler. 2013. ESA Recovery Plan for Lower Columbia River Coho Salmon, Lower Columbia River Chinook Salmon, Columbia River Chum Salmon, and Lower Columbia River Steelhead. National Marine Fisheries Service, Northwest Region. [online] URL: https://archive.fisheries.noaa.gov/wcr/publications/recovery_planning/salmon_steelhead/domains/willamette_lowercol/lower_columbia/final_plan_documents/final_lcr_plan_june_2013_-corrected.pdf

DPUD (Douglas County Public Utility Company). 2017. Unpublished data summarized for ISAB review of UC spring Chinook in ISAB 2017.

Humling, M. 2016. Memorandum on Winthrop NFH Spring Chinook and Steelhead Performance Metrics for the UCSRB. U.S. Fish and Wildlife Service, May 2, 2016.

ISAB (NWPCC Independent Scientific Advisory Board). 2017. Review of NMFS' Interior Columbia Basin Life-Cycle Modeling. Council Document Number 2017-1. Published February 9, 2018. Portland, Oregon. Available online at: https://www.nwcouncil.org/fish-and-wildlife/fw-independent-advisory-committees/independent-scientific-advisory-board/review-of-noaa-fisheries-interior-columbia-basin-life-cycle-modeling-draft-report

ISAB (NWPCC Independent Scientific Advisory Board). 2018. Review of Spring Chinook Salmon in the Upper Columbia River. Council Document Number 2018-1. Published February 9, 2018. Portland, Oregon. Available online at: https://www.nwcouncil.org/fish-and-wildlife/fw-independent-advisory-committees/independent-scientific-advisory-board/review-of-spring-chinook-salmon-in-the-upper-columbia-river

Garrison, R. C., and M. M. Rosentreter. 1981. *Stock Assessment and Genetic Studies of Anadromous Salmonids*. Federal Aid Progress Rpts Fisheries, 1980. Oregon Dept. Fish and Wildlife, Fish Div, Portland.

Gorge Connection, (n.d.). Retrieved November 20, 2019, from http://www.gorgeconnection.com/fishing/history.php

Gutowsky, F. G., P. H. Harrison, S. J. Landsman, M. Power, and S. J. Cooke. 2011. Injury and Immediate Mortality Associated with Recreational Troll Capture of Bull Trout (Salvelinus Confluentus) in a Reservoir in the Kootenay-Rocky Mountain Region of British Columbia. Fisheries Research. **109**(2-3): 379-383.

History Link, (n.d.). Retrieved November 19, 2019, from https://www.historylink.org/File/8036

Lumley, P. (2019). ATNI Tribal Leaders Summit on Climate Change: [Slide Player slides]. Retrieved from https://slideplayer.com/slide/4198617/

Maier, G. 208. Upper Columbia Hydropower Background Summary. Upper Columbia Salmon Recovery Board, https://www.ucsrb.org/mdocuments-library/reports/

Maier, G. 2017. Upper Columbia Hatchery Background Summary. Upper Columbia Salmon Recovery Board. https://www.ucsrb.org/mdocuments-library/reports/

Muir, H., M. Maxey, C. Thomas, T. Becker and M. Cooper. 2019. Monitoring and Evaluation of the Leavenworth National Fish Hatchery Spring Chinook Salmon Program, 2018. U.S. Fish and Wildlife Service, Leavenworth WA.

NWFSC (Northwest Fisheries Science Center). 2015. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. Available online at: https://www.nwfsc.noaa.gov/assets/11/8623_03072016_124156_Ford-NWSalmonBioStatusReviewUpdate-Dec%2021-2015%20v2.pdf

NMFS (National Oceanic and Atmospheric Administration The National Marine Fisheries Service). 2003. Biological Opinion and Magnuson-Stevens Fishery Conservation Management Act on Issuance of Permit 1395 jointly to WDFW, Chelan PUD, and Douglas PUD, Issuance of Permit 1396 to the U.S.FWS, and Issuance of Permit 1412 to the Confederated Tribes of the Colville Reservation. October 2, 2003. NMFS Consultation No.: NWR-2002-000981. 92p.

NMFS (National Oceanic and Atmospheric Administration The National Marine Fisheries Service). 2017. Final Environmental Impact Statement to Analyze Impacts of NOAA's National Marine Fisheries Service joining as a signatory to a new *U.S. v. Oregon* Management Agreement for the Years 2018-2027. National Marine Fisheries Service, Seattle, WA. Available online at http://www.westcoat.fisheries.noaa.gov/fisheries/salmon_steelhead/united_state_v_oregon.html.

NWPCC. 2020. Northwest Power and Conservation Council, Columbia River History. Retrieved, November 6, 2019, from https://www.nwcouncil.org/reports/columbia-river-history/commercialfishing

NWPCC (Northwest Power and Conservation Council). 2020. Columbia River History. Retrieved May 21, 2020 from https://www.nwcouncil.org/reports/columbia-river-history/indianfishing

NWPCC (Northwest Power and Conservation Council). 2020. Kettle Falls (n.d.). Retrieved November 6, 2019 from https://www.nwcouncil.org/reports/columbia-river-history/KettleFalls

Ohlberger, J., E. J. Ward, D. E. Schindler, B. Lewis. (2018). *Demographic changes in Chinook salmon across the Northeast Pacific Ocean*. Fish and Fisheries, **19**(3), 533– 546. [online] URL: https://doi.org/10.1111/faf.12272

ODFW and WDFW (Oregon Department of Wildlife and Washington Department of Wildlife). Columbia River Salmon and Steelhead Fishery Management – An Overview. [PowerPoint slides]. Retrieved from https://wdfw.wa.gov/sites/default/files/2019-08/Review%20of%20Recent%20Columbia%20River%20Fishery%20Policy%20History%20presenatation.pdf

ODFW and WDFW (Oregon Department of Wildlife and Washington Department of Wildlife). 2019. Joint-State Columbia River Fishery Policy Review Committee. Retrieved from https://wdfw.wa.gov/sites/default/files/2019-09/Alternatives%20Results%20Spring%20Chinook%2008-29-19.pdf

Patterson, D.A., Robinson, K.A., Raby, G.D., Bass, A.L., Houtman, R., Hinch, S.G., and Cooke, S.J. 2017. Guidance to Derive and Update Fishing-Related Incidental Mortality Rates for Pacific Salmon. DFO Can. Sci. Advis. Sec. Res. Doc. 2017/011. vii + 56 p.

Patterson, D.A., Robinson, K.A., Lennox, R.J., Nettles, T.L., Donaldson, L.A., Eliason, E.J., Raby, G.D., Chapman, J.M., Cook, K.V., Donaldson, M.R., Bass, A.L., Drenner, S.M., Reid, A.J., Cooke, S.J., and Hinch, S.G. 2017. Review and Evaluation of Fishing-Related Incidental Mortality for Pacific Salmon. DFO Can. Sci. Advis. Sec. Res. Doc. 2017/010. ix + 155 p.

Paul, A. J., Post, J. R. and Stelfox, J. D. 2003. Can anglers influence the abundance of native and nonnative salmonids in a stream from the Canadian Rocky Mountains?. *North American Journal of Fisheries Management*, 23: 109–119. [Taylor & Francis Online]

Post, J.R., Mushens, C., Paul, A. and Sullivan, M. (2003), Assessment of Alternative Harvest Regulations for Sustaining Recreational Fisheries: Model Development and Application to Bull Trout. North American Journal of Fisheries Management, 23: 22-34. doi:10.1577/1548-8675(2003)023<0022:AOAHRF>2.0.CO;2

PSC (Pacific Salmon Commission). 2004. Estimation And Application Of Incidental Fishing Mortality In Chinook Salmon Management Under The 1999 Agreement To The Pacific Salmon Treaty. Pacific Salmon Commission Joint Chinook Technical Committee Report (Tcchinook (04)-1), April 2004.

Quinn, T.P., Hodgson, S., Flynn, L., Hilborn, R. & Rogers, D.E. (2007) Directional selection by fisheries and the timing of sockeye salmon (Oncorhynchus nerka) migrations. Ecological Applications, 17, 731– 739.

Raby, G.D., Packer, J.R., Danylchuk, A.J. and Cooke, S.J. (2014), The understudied and underappreciated role of predation in the mortality of fish released from fishing gears. Fish, 15: 489-505. doi:10.1111/faf.12033

Ricker, W. E. 1981. Changes in the Average Size and Average Age of Pacific Salmon. Canadian Journal of Fisheries and Aquatic Sciences, **38**(12), 1636-1656. [online] URL: https://www.nrcresearchpress.com/doi/pdf/10.1139/f81-213

Sandercock, F. K. 1991. *Life History of Coho Salmon (Oncorhynchus kisutch)*. Pacific Salmon Life Histories. C. Groot and L. Margolis. University of British Columbia Press, Vancouver. 395-446.

Schill, D. J. 1996. *Hooking mortality of bait-caught rainbow trout in an Idaho 1 stream and a hatchery: 2 implications for special-regulation management*. North American Journal of Fisheries Management 3 16:348-356.

Schill, D. J. and R. L. Scarpella. 1997. *Barded hook restrictions in catch-and-release trout fisheries: a 5 social issue*. North American Journal of Fisheries Management 17:873-881.

Schindler, D., Hilborn, R., Chasco, B. et al. 2010. Population diversity and the portfolio effect in an exploited species. Nature 465:609–612.

Schmetterling, D.A. and Long, M.H. (1999), Montana Anglers' Inability to Identify Bull Trout and other Salmonids. Fisheries, 24: 24-27. doi:10.1577/1548-8446(1999)024<0024:MAITIB>2.0.CO;2

Smithsonian Nation Museum of American History Behring Center, (n.d.). Retrieved November 19, 2019, from https://americanhistory.si.edu/onthewater/exhibition/3_6.html

Sorel MH, MW Rub, and RW Zabel. 2017. Population-specific migration timing affects en-route survival of Chinook salmon through the Lower Columbia River. Chapter 6a *in* Life-cycle models of salmonid populations in the interior Columbia River basin. Report to the Independent Scientific Advisory Board. pg. 385-416

TAC (*U.S. v Oregon* Technical Advisory Committee). 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020. TAC Annual Reports
Abundance, Stock Status and ESA Impacts. Prepared by the *U.S. v Oregon* Technical Advisory Committee.

Taylor, M. J. and K. R. White. 1992. *A meta-analysis of hooking mortality of non-anadromous trout*. North

37 American Journal of Fisheries Management 12:760-767.

Thom, B. A. (2017). *Final Environmental Impact Statement to Analyze Impacts of NOAA's National Marine Fisheries Service joining as a signatory to a new U.S. v. Oregon Management Agreement for the Years 20481-2027*. [online] URL: https://www.westcoast.fisheries.noaa.gov/publications/nepa/salmon_steelhead/final_environmental_impact_statement_and_record_of_decision_for_us_v._oregon.pdf

UCSRB (Upper Columbia Salmon Recovery Board). 2007. Upper Columbia Spring Chinook and Steelhead Recovery Plan. August 2007.

U.S. v. Oregon. 2018. 2018-2027 United States v. Oregon Management Agreement. Case 3:68-cv-00513-MO. Document 2607-1. Filed February 26, 2018. U.S. Ninth Circuit. Available online at: https://caselaw.findlaw.com/us-9th-circuit/1016808.html

U.S.FWS (U.S. Fish & Wildlife Service). (2018, February 26). *2018-2027 United States v. Oregon Management Agreement*. [online] URL: https://www.fws.gov/lsnakecomplan/Reports/U.S.vOregon/FINAL.2018-%202027%20U.S.vOregon%20Management%20Agreement%20with%20Signature%20Feb%202018%20.pdf

U.S.FWS. 2017. Biological Opinion for the Wenatchee River Spring Chinook Salmon, Summer Chinook Salmon, and Steelhead Hatchery Programs. U.S. Fish and Wildlife Service, Central Washington Field Office, Wenatchee, Washington. November 2017.

Wipfli, M.S., J.P. Hudson, D.T. Chaloner, and J.P. Caouette. 1999. *Influence of Salmon Spawner Densities on Stream Productivity in Southeast Alaska*. Canadian Journal of Fisheries and Aquatic Sciences 56:1600-1611.

WDFW (Washington Department of Fish and Wildlife). 1992. Draft Bull Trout/Dolly Varden Management and Recovery Plan. Washington Department of Wildlife, Fisheries Management Division, Olympia, WA. 125 p.

WDFW (Washington Department of Fish and Wildlife). 2001-2015. UC Steelhead Fishery Annual Summaries. Prepared for NOAA Fisheries, Portland Oregon. June 2015.

WDFW (Washington Department of Fish and Wildlife). 2015a. 2014 Wenatchee River spring Chinook Fishery Report. Prepared for NOAA Fisheries, Portland Oregon. June 2015.

WDFW (Washington Department of Fish and Wildlife). 2015b. 2015 Wenatchee River spring Chinook Fishery Report. Prepared for NOAA Fisheries, Portland Oregon. November 2015.

WDFW & ODFW (Washington Department of Fish and Wildlife and Oregon Department of Fish and Wildlife). 2019. 2019 Joint Staff Report: Stock Status and Fisheries for Fall Chinook Salmon, Coho Salmon, Chum Salmon, Summer Steelhead, and White Sturgeon. https://wdfw.wa.gov/sites/default/files/publications/02085/wdfw02085.pdf

WDFW (Washington Department of Fish and Wildlife). 2020. Unpublished data on spring Chinook and steelhead caught in recreational fisheries above Highway 395. Retrieved from Region 2 Fish Program Manager, WDFW.

WDFW (Washington Dept. of Fish and Wildlife). 2020. Columbia River Alternative Gear Advisory Board. Online information at https://wdfw.wa.gov/about/advisory/cragab.

White, Richard. 1996. *The Organic Machine.* Hill and Wang Critical Issues