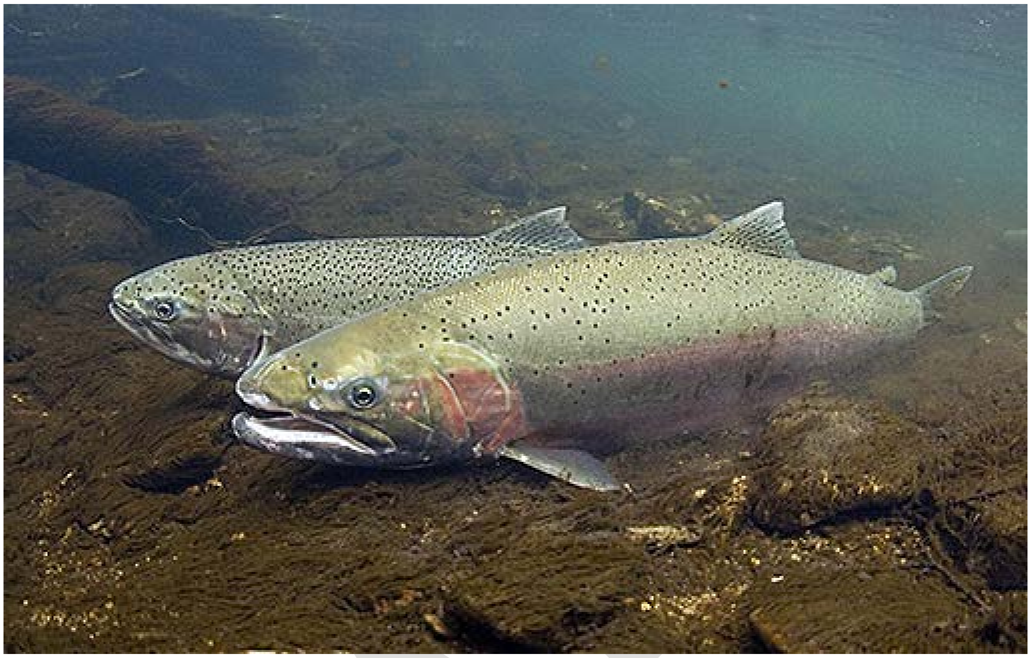

Washington Department of Fish and Wildlife

Coastal Steelhead Proviso Implementation Plan

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Executive Summary

Given the cultural, economic, and ecological significance of steelhead, *Oncorhynchus mykiss*, population declines of the species along Washington's Pacific coast and associated declines in angling opportunities have highlighted the need to design and fund recreational fisheries management strategies that balance angling opportunities with conservation objectives. In pursuit of that goal, and to fulfill the Legislature's 2021-2023 operating budget proviso, Washington Department of Fish and Wildlife's (WDFW) has developed the Coastal Steelhead Proviso Implementation Plan (CSPIP), which lays an adaptive groundwork for steelhead fishery management in the river systems of Grays Harbor, Willapa Bay, and the coastal Olympic Peninsula. WDFW designed the plan to provide sustainable fishing opportunities, protect coastal steelhead, and incorporate stakeholder input and outreach. Although the state engaged tribal co-managers and Olympic National Park (ONP) in the development of these plans, they only apply to state steelhead management on the Washington coast.

The science based CSPIP incorporates ecological knowledge of the target species while considering the history of harvest and management, state and federal mandates, and socio-economic implications that underpin management decisions. The plan lays out an overarching Proviso Implementation Strategy that addresses five key elements of management: monitoring and evaluation, fisheries regulations, hatchery operations, habitat, and human dimensions. Due to the highly interconnected nature of those elements, the strategy includes an Adaptive Management Framework (Table 1) that assigns appropriate management actions based on wild steelhead abundance and the level of monitoring that is available to inform management. WDFW applies the Proviso Implementation Strategy to individual systems on the Washington coast, acknowledging each river's unique characteristics in terms of habitat, fishing activities, monitoring, tribal co-manager relationships, and hatchery programs. The CSPIP also includes public communication guidelines, an implementation timeline with benchmarks, budget projections, critical research needs, and a vision for next steps.

To this point, a major limiting factor in the development of coastal steelhead management has been a lack of available resources necessary to collect crucial data and inform management decisions. Data gaps cause uncertainty around fishery impacts, and in some cases lead to fishery closures when managers lack sufficient information to create angling opportunities with a high degree of confidence that those fisheries will remain within sustainable impact limits. Given sufficient funding, increased monitoring and research would address that problem, not only by increasing the likelihood that sustainable fisheries can remain open through high-precision sport fishery monitoring, but also by collecting the data required to set long-term conservation objectives. Thus, the increased standard of monitoring and evaluation and critical research associated with the CSPIP creates a win-win situation for multiple stakeholder groups and steelhead-related interests. Specific research topics that need to be addressed include summer steelhead, estimates of non-harvest mortality, the application of SONAR technology for steelhead monitoring, marine survival, juvenile monitoring, habitat restoration impacts on steelhead resilience, and human dimensions of steelhead management. Increased monitoring and research would aid in the development of new management tools such as predator control measures, wild stock gene banks, and innovative hatchery programs (e.g. research, conservation, and wild broodstock programs).

Through this plan, the Department aims to increase the two-way flow of information between steelhead stakeholders and resource managers by providing accurate and consistent information about coastal steelhead, strengthening community partnerships, and increasing opportunities for the public to engage in the fisheries management process. Those objectives would be achieved through media engagement, online resources, a public comment form, and public meetings, among other methods. WDFW recognizes the broad community of people invested in steelhead fisheries and conservation and values their feedback as the Department navigates a solution-oriented path forward.

Based on guidance from the Statewide Steelhead Management Plan (SSMP), WDFW plans to develop Regional Management Plans (RPMs) for each of the steelhead Distinct Population Segments (DPSs) on the Washington coast: the Coastal Olympic Peninsula DPS and the Southwest Washington DPS. That process will further develop the management strategies presented in the CSPIP, in part by setting long-term conservation objectives and by including Integrated Population Model (IPM) based Management Strategy Evaluations (MSEs) to assess the effectiveness of multiple harvest control rules (e.g., catch or effort related limits) in supporting healthy steelhead runs and sustainable fisheries in the long-term. WDFW will use these tools to anticipate and publicly communicate recreational steelhead fishery regulations further in advance of the fishery season than previously possible.

Implementing the CSPIP requires an estimated biennial budget of $5.9 million (including indirect costs) above current appropriations, with most of this amount dedicated to freshwater sport fishery monitoring. WDFW intends to implement the CSPIP during the 2023-2025 biennium budget period. Among other implications, failure to fund this plan would: (1) result in continued uncertainty regarding coastal steelhead fishery impacts, which could lead to fishery closures, (2) hinder the development of Regional Management Plans, including long-term coastal steelhead conservation objectives and Management Strategy Evaluations and (3) slow the pace of critical scientific research needed to improve steelhead fishery management. This plan constitutes a major step forward for coastal steelhead fisheries management that supports conservation while providing sustainable recreational fishing opportunities for years to come. Adaptive management, community engagement, and refinement of quantitative tools as new data becomes available will persist in perpetuity, with the understanding that reevaluation and adaptation are inherent elements of this new paradigm.

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Acronyms

AHA	All-H (i.e., Habitat, Harvest, Hatcheries, and Hydropower) Analyzer
CPUE	Catch Per Unit Effort
CRC	Catch Record Card
eCRC	Electronic Catch Record Card
CSPIP	Coastal Steelhead Proviso Implementation Plan
DGM	Demographic Geneflow Model
DIP	Demographically Independent Populations
DNR	Department of Natural Resources
DPS	Distinct Population Segment
ECY	Department of Ecology
ENSO	El Niño—Southern Oscillation
ESA	Endangered Species Act
ESS	Early Summer Steelhead
ETM	Ensemble Timeseries Model
EWS	Early Winter Steelhead
FFA	Future Farmers of America
FMEP	Fisheries Management and Evaluation Plan
FTE	Full-Time Equivalent
GRTS	Generalized Random Tessellation Stratified
HSRG	Hatchery Scientific Review Group
LWS	Late Winter Steelhead
MPG	Major Population Group
MSE	Management Strategy Evaluation
NOAA	National Oceanic and Atmospheric Administration

NPGO	North Pacific Gyre Oscillation
OEY	Ocean Entry Year
PDO	Pacific Decadal Oscillation
pHOS	Proportion of Hatchery Origin Spawners
PIT	Passive Integrated Transponder
PNI	Proportion of Natural Influence
RCO	Recreation and Conservation Office
RMP	Regional Management Plan
SAR	Smolt to Adult Returns
SSMP	Statewide Steelhead Management Plan
USFS	United States Forest Service
VSP	Viable Salmonid Population
WDFW	Washington Department of Fish and Wildlife
WDOT	Washington Department of Transportation
WRIA	Water Resource Index Area
WSGB	Wild Stock Gene Bank
WSMZ	Wild Steelhead Management Zone

1. Purpose Statement

The purpose of this document is to communicate a Coastal Steelhead Proviso Implementation Plan (CSPIP) that supports sustainable recreational fishing opportunities and protects steelhead runs in Willapa Bay, Grays Harbor, and the coastal Olympic Peninsula watersheds, consistent with the Statewide Steelhead Management Plan (SSMP). The CSPIP outlines an overarching Proviso Implementation Strategy (Section 3) that includes guidelines pertaining to recreational fishery regulations, monitoring and evaluation, hatchery operations, habitat, and human dimensions. It also details a Communications strategy (Section 4) to facilitate the two-way exchange of ideas between WDFW and fisheries stakeholders about state recreational fishery regulations and coastal steelhead management more broadly. Additionally, the CSPIP identifies Critical Research (Section 8), Budget Projections (Section 7), and an Implementation Timeline (Section 6) necessary to successfully carryout this work. The Plan constitutes one step in a larger process designed to advance coastal steelhead management. That process will require additional data, time, and funding, with the planned next step of developing comprehensive Regional Management Plans (Section 5) for the Olympic Peninsula and Southwest Washington steelhead Distinct Population Segments with tribal co-managers, as outlined in the SSMP.

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Figure 1: Map depicting watersheds that fall within the geographic scope of the Coastal Steelhead Proviso Implementation Strategy and the boundaries of the Coastal Olympic Peninsula and Southwest Washington Distinct Population Segments Watersheds crosshatched blue contain winter steelhead populations, while watersheds crosshatched red contain summer steelhead populations.

2. Background

Designing effective management of declining anadromous *Oncorhynchus mykiss* populations, commonly known as "steelhead," on the Washington coast has elicited a broad array of passionate, varied, and at times conflicting perspectives of stakeholder groups, including recreational users, management entities, and the scientific community. Given those perspectives, this CSPIP stives to align with the social needs of Washingtonians and the management objectives of state recreational fisheries managers through improved communication and heightened precision around sport fishery management tools. The purpose of this section is to provide context for the management strategies outlined in the sections to follow. Acknowledging multiple perspectives, it will consider both biological and social aspects of the coastal steelhead fishery, with recognition of steelhead biology, treaty rights and associated harvest, evolving conservation concerns, the SSMP, and the recreational steelhead fishery.

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2.1 Wild Steelhead Biology

2.1.1 Life History

Oncorhynchus mykiss exhibit among the greatest diversity life history strategies of the Pacific salmonid species. Some *O. mykiss* complete their entire life cycle in freshwater and are referred to as residents or "rainbow trout," while the anadromous form known as "steelhead" migrate to the marine environment before returning to their natal streams to spawn. In addition, steelhead are iteroparous, like other trout, which means they can undergo multiple spawning migrations. Anadromous and resident *O. mykiss* can live side by side and interbreed, producing offspring that can adopt either strategy based on a combination of genetic and environmental factors (Kendall et al. 2015). In this way, the offspring of rainbow trout can migrate to the ocean as steelhead. Although the two forms are difficult to differentiate before steelhead adapt to survive in the ocean as juveniles, the anadromous form has a distinct appearance upon its return to freshwater from the ocean.

2.1.2 Distribution and Range

O. mykiss reside within the widest latitudinal range of any Pacific salmonid species (Behnke 2002), with resident rainbow trout occupying a broader spatial distribution than their anadromous counterparts (Light et al. 1989) suggesting a decline from historical spatial distribution of steelhead. In North America today, anadromous steelhead occur from approximately southern California to the Gulf of Alaska (Taft 1933, Sutherland 1973, Burger et al. 1983, Gwartney 1983), although their putative historical ranges were wider (Carl et al. 1959). Steelhead also occupy freshwater and marine environments across regions of northeastern Asia. Areas with the greatest historical steelhead abundance include the Columbia River Basin and neighboring rivers to the north and south (Light et al. 1987), the Kamchatka Peninsula

(Savvaitova et al. 1973), and the Sacramento-San Juaquin watershed (NOAA Fisheries, 2022). Commonly hypothesized contributors to shrinking spatial distribution of *O. mykiss* include habitat destruction, overfishing, and shifting oceanographic conditions caused by climate change, especially ocean temperature and food availability (Busby et al. 1996). Some of the highest quality habitat in North America likely exists along the Washington Coast where this current work is focused.

2.1.3 Life Cycle

Juvenile Rearing

Steelhead begin their hatching from nests deposited in gravel depressions, known as "redds," dug by their mothers in freshwater streams. After hatching, the young fish progress through a series of developmental stages, becoming alevin, fry, parr, and eventually smolts that begin their migrations to the ocean. Smolts generally enter the marine environment at 1-7 years old, although most Washington steelhead smolts enter the ocean at age 2 (Scott & Gill 2008). The timing of their maturation and emigration depends on a combination of environmental and density dependent factors. During the freshwater rearing period, juvenile steelhead require a relatively cold, clean, and structurally complex habitat that supports growth and provides cover from predators year-round.

Marine Residency

After entering the marine environment, steelhead spend between 0-5 years at sea, but most remain in the ocean for one or two winters before returning to their natal rivers (Scott & Gill 2008). Unlike other Pacific salmonids that remain in nearshore waters, most steelhead seasonally migrate thousands of kilometers across open ocean to marine feeding grounds in northern parts of the Bering Sea and the west coast of Asia (Sutherland 1973, Okazaki 1985, Burgner et al. 1992, Welch et al. 1998, Atcheson et al. 2012, Myers 2018). Although most steelhead research focuses on freshwater systems (Daly et al. 2014), declining smolt-to-adult return (SAR) rates have motivated research into factors contributing to estuarine and marine survival (Friedland et al. 2014, Moore et al. 2015, Kendall et al. 2017, Thalmann et al. 2020, Losee et al. 2021, Moore et al. 2021). Broad-scale patterns of ocean circulation, described by indices such as the Pacific Decadal Oscillation (PDO), the El Niño—Southern Oscillation (ENSO), and the North Pacific Gyre Oscillation (NPGO), and finer-scale predator prey interactions appear to influence steelhead marine survival (Welch et al. 2000, Kendall et al. 2017, Sobocinski et al. 2020, Moore et al. 2021). However, research on non-stationary relationships between varying ocean indicators and salmon populations (Litzow et al. 2018) indicates that survival-related factors drive ecological relationships at multiple spatiotemporal scales.

Even though steelhead migrate offshore quickly (McMichael et al. 2013, Myers 2018), the availability of prey in coastal near-surface waters, including crustaceans, insects, and small fishes, has a strong influence on overall marine survival (Pearcy et al. 1990, Brodeur et al. 2013, Daly et al. 2014). Climactic phenomena including the PDO, ENSO, and NPGO impact the

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abundance and composition of food sources available to steelhead in coastal waters (Daly et al. 2013, Sydeman et al. 2013, Thalmann et al. 2020). Most recently, U.S. coastal waters reached anomalously high sea surface temperatures between September 2014 and 2016 (Bond et al. 2015, Di Lorenzo and Mantua 2016, McClatchie et al. 2016), coupled with the strongest tropical Pacific El Niño on record in 2016 (Jacox et al. 2016). Researchers referred to the resulting warm water mass as the "Blob" and documented poor body condition, below average stomach fullness, and the consumption of different prey species, including gelatinous salps, compared to cold water years (Thalmann et al. 2020).

Adult Returns and Run Timing

Following the ocean phase of the steelhead lifecycle, individuals return to freshwater as one of two primary run types, summer runs and winter runs. While steelhead of these different run types are a part of the same species, they exhibit important differences in run timing and sexual maturation (Burgner et al. 1992). In a state of sexual immaturity, summer steelhead generally return to rivers between April and October, where they wait in deep, cold pools know ad "cold-water refuges" (Nakamoto 1994) and continue to develop for up to 10 months prior to spawning (Scott & Gill 2008). This holding behavior makes summer steelhead particularly susceptible to harvest, poaching, natural predation, and/or climate change impacts increased river temperatures and low flows Additionally, evidence suggests that summer steelhead, in some cases, spawn earlier and farther upstream than their winter counterparts, utilizing habitats beyond the reach of other anadromous salmonids (Scott & Gill 2008).

Winter steelhead, on the other hand, return to freshwater as mature adults between November and early June and generally reach peak spawning abundances between mid-April and mid-May in western Washington. The majority of Washington's coastal watersheds support sympatric summer and winter steelhead populations. According to the SSMP, hatchery operators and managers must consider the timing of their releases and implement regulations to protect the spatial and temporal distribution as well as the genetic diversity of steelhead populations. The existence of multiple steelhead run timings increases the abundance and resilience of coastal steelhead in the face of changing environmental conditions but creates added complexity for fishery management in western Washington.

As they travel upstream to their spawning grounds, steelhead can exhibit swimming speeds over 26 feet per second (fps) and can leap to about 11 ft maximum vertical height and 22 ft. horizontal distance (Powers & Orsborn 1985, Ruggerone 2008), giving them the ability to scale many natural obstacles and support a broad spawning distribution within a watershed. Despite power and agility, steelhead migration has been impeded by many human-made structures, especially culverts and dams, which have been identified as major hinderances to steelhead population viability (Pess et al. 2008, Pearse et al. 2011, Clark et al. 2020). Dams can create physical barriers to fish passage and generate high flow events that overpower steelhead and wash them downstream, leading to stranding and mortality of adult and juvenile steelhead (Hunter 1992), ultimately limiting production of steelhead for future generations.

Spawning

Steelhead have a protracted spawning period relative to other salmonids (Quinn, 2019) lasting up to 8 months in coastal watersheds (December-July) (McMillan et al. 2007) with individual spawning events concentrated around the crepuscular period (i.e., dawn and dusk) (Dietze et al. 2020). Specifically, spawning females dig oval-shaped gravel depressions with their caudal fin (Orcutt et al. 1968) called "redds." At least one male steelhead and/or resident rainbow trout waits nearby as the female prepares to spawn. Intense competition to engage in spawning occurs when multiple males are present. As females release their eggs in the deepest part of the redd, males simultaneously eject their milt close by. The females then loosen gravel upstream to cover the fertilized eggs. This process repeats every few minutes for over a period of days to weeks for an individual female (Shapovalov & Taft 1954, Orcutt et al. 1968). In some instances, later-spawning pairs superimpose their redds where others had built them previously, excavating fertilized eggs from the gravel. Steelhead prefer to spawn in sediment ranging from medium sized gravel to cobble (Reiser & White 1988) with water temperatures between 4 - 10°C (Bell 1986) at depths of greater than 24 cm and stream flow velocities from 40 to 90 cm/s (Smith 1973).

Iteroparity

Although some steelhead die after spawning, summer and winter steelhead can spawn more than once (and are thus iteroparous), completing multiple cycles of ocean migration and spawning. This feature of the steelhead life cycle bolsters population resilience (Crespi and Teo 2002, Moore et al. 2014, Trammel et al. 2016) by providing plasticity and increased productivity in successive spawning years (Seamons & Quinn 2010, Halttunen 2011, Copeland et al. 2019). In fact, Seamons & Quinn (2010) found that steelhead repeat spawners produced twice as many progeny during their lifetimes as one-time spawners. In Washington, steelhead that reproduce in multiple years are usually females (Withler 1966, Ward and Slaney 1988) who have spent one year at sea. Rates of repeat spawning vary widely (0-79%) across both spatial and temporal scales (Withler 1966, Narum et al. 2008, Nielsen & Turner 2011) and have declined in recent years (Claiborne et al. in prep.). Factors effecting the success of steelhead to successfully "recondition" and migrate to the ocean after spawning include fisheries regulations, climate change, habitat quality, and other human influences (Scott & Gill 2008). Overall, relatively little research has focused on steelhead iteroparity making it difficult for managers to account for when setting management objectives (Halttuten 2011, Copeland et al. 2019).

2.1.4 Ecological Significance

Even after death, anadromous salmonids continue to play an essential role in Washington's coastal ecosystems. Their carcasses provide food and essential marine-derived nutrients for juvenile fish and terrestrial ecosystems, although fewer steelhead die and contribute to nutrient cycling compared to Pacific salmon species. Nevertheless, evidence suggests that young steelhead rely on salmonid carcasses as a food source (Cederholm et al. 2001), especially in the winter when food sources is limited (Bilby et al. 1998). A wide variety of other animals, including black bears, bald eagles, river otters, and insects also eat dead salmonids (Reimchen 1994; Willson and Halupka 1995; Cederholm et al. 1999). These animals distribute marine-derived nutrients and fertilize forests with their waste. One study indicated that spawning Pacific salmonids (*Oncorhynchus* spp.) provided nearly a quarter of the nitrogen that trees alongside spawning grounds needed to grow (Helfield & Naiman 2001). Steelhead production depends on healthy riparian forests, and therefore spawning *Oncorhynchus* spp. support the maintenance of habitat essential for subsequent generations (Helfield & Naiman 2001). Declining Pacific salmonid populations endanger a diversity of wildlife and the sustainability of healthy forest ecosystems (Gresh et al. 2000, Stockner 2003, Hocking et al. 2009).

Overall, steelhead populations on Washington's Pacific coast have been subject to far less research than their Puget Sound and Columbia River counterparts, and factors that might influence the survival of coastal populations are not well understood. This knowledge gap has frequently been identified as a limiting factor to developing effective conservation and fisheries management strategies in recent years.

2.2 Hatchery Rearing

The Department operates two types of artificial production programs for steelhead: integrated and segregated. Integrated programs use natural origin broodstock while segregated programs use eggs derived exclusively from returning hatchery fish. Although hatchery programs can provide ecological and economic benefits, they can also present risks to natural steelhead populations (HSRG 2004, Naish et al. 2007). Those risks include but are not limited to competition of hatchery and wild fish at juvenile and adult stages, change to density-dependent population dynamics, and gene flow from hatchery to wild fish when hatchery fish stray to spawning grounds and interbreed with natural origin populations, thereby reducing their fitness (McMichael et al. 1997, McMichael et al. 1999, Anderson et al. 2020). The SSMP and HSRG designate thresholds for allowable geneflow for segregated populations and Proportion of Hatchery Origin Spawners (pHOS) and Proportion of National Influence (PNI) for integrated programs to control risks associated with impacts of hatchery fish on wild populations.

Statewide, WDFW operates hatchery programs with one of two primary goals: conservation or harvest. Currently, all steelhead hatcheries on Washington's Pacific coast are harvest oriented. Conservation hatcheries are traditionally explored when populations are at immediate risk of being lost. The success of such programs for steelhead has been limited, although they have been attempted outside of the coastal region in Hood Canal, as well as the Elwha, Green, and White rivers. Before establishing those programs, WDFW would need to identify the specific factors that led to population declines so those factors could be addressed in conjunction with conservation hatcheries to allow wild populations to rebound once the program(s) were discontinued. Additionally, the department would need to identify quasi-extinction thresholds as well as critical abundance thresholds for each population.

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2.3 History of Harvest and Management

Pacific Northwest tribes have maintained a relationship with *Oncorhynchus* spp. from time immemorial, depending on them not only as a source of physical sustenance, but as an intrinsic part of their spiritual, cultural, and place-based identity. Although limited data on steelhead populations prior to the late twentieth century exists, retrospective studies along the west coast of the United States indicate that salmon and steelhead abundance fluctuated with changes in ocean conditions centuries prior to modern-day fishing (Mantua et al. 1997; Beamish et al. 1999). However, recent evidence suggests that the greatest declines occurred following European settlement of the Pacific Northwest, especially with the development of commercial fisheries in the 1800s (Cobb 1930, Busby et al. 1996, Gayeski et al. 2011).

On the Washington coast, recreational, commercial and subsistence fishing have taken place throughout the twentieth century to the present day, however, stock assessment activities for steelhead did not begin until the late 1970's (Cooper et al. 1992; Johnson et al. 1997). These monitoring efforts have provided estimates of abundance that suggests runsize has declined significantly over the last 4 decades. However, recent study comparing cannery records on the Queets River from 1923 to mean steelhead abundance between 1980 – 2017 suggests that the decline in steelhead abundance began decades prior and may be more significant than estimates using only recent data (McMillian et al. 2021).

2.3.1 The Development of Tribal Co-Management

In 1854 and 1855, Western Washington tribes signed a series of treaties with the United States government, ceding most of their traditional lands but securing the right to fish, hunt, gather shellfish, and exercise other sovereign rights in customary locations. Despite these treaties, the State of Washington enacted policies that supported the exclusion of tribal members from the steelhead fishery in the early twentieth century (Mentor 1981). On several occasions, the federal government challenged these policies. Most notably, in *United States vs. Washington* (1974), the U.S. District Court for the Western District of Washington ruled that tribes have the right to take up to 50% of allowable harvest based on co-manager agreements within their usual and accustomed fishing grounds (Mentor 1981). This ruling subsequently became known as the Boldt Decision after its author, District Judge George H. Boldt.

Judicial pressure on the State of Washington to uphold treaty rights motivated an increase in fisheries monitoring in the 1970s and 1980s. The Boldt Decision necessitated the development of both resource co-management and increased fisheries monitoring to determine resource allocation. Since the decision, tribal, state, and federal governments collaboratively determine harvest limits. To achieve co-management objectives, biologists from WDFW and coastal Washington treaty tribes work collaboratively to predict the abundance of steelhead returning in future years and set regulations for each party's respective fisheries to ensure that sport and tribal fisheries allow optimum numbers of fish to spawn (WDFW 2021).

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2.3.2 Shifting Management

A lack of data for the coastal region has created challenges in determining the maximum sustainable harvest of steelhead. Determining the number of fish that can be caught while still maintaining a healthy abundance is paramount to managing fisheries and referred to as maximum sustainable yield (MSY). This number can be approximated by using mathematical models, most notably the Ricker and Beverton-Holt models. These models predict maximum sustainable harvest based on the ratio of reproducing “spawners” to adult “recruits” that survive their ocean migration and return to their natal streams to estimate the number of spawners needed to maximize and predict recruits in future years. However, relatively little data on the numbers of spawners and recruits in Western Washington streams existed in the post-Boldt era due to a lack of resources, especially on the coastal areas of the Olympic Peninsula and Southwest Washington. Indeed, to a large degree, those data gaps and limited resources persist to the present day. As a result, WDFW has identified the need to reassess steelhead fisheries management metrics and forecasting methodologies.

Fishery Modeling

A lack of data for the coastal region has created challenges in determining the maximum sustainable harvest of steelhead. Generally, the number of fish that can be caught while still maintaining a healthy abundance can be approximated by using mathematical models, most notably the Ricker and Beverton-Holt models. These models predict maximum sustainable harvest based on the ratio of reproducing “spawners” to adult “recruits” that survive their ocean migration and return to their natal streams. However, relatively little data on the numbers of spawners and recruits in Western Washington streams existed in the post-Boldt era due to a lack of resources, especially on the coastal areas of the Olympic Peninsula and Southwest Washington. Indeed, to a large degree, those data gaps and limited resources persist to the present day.

To work around this data gap, Gibbons et al. (1985) developed a “Potential Parr Production (PPP)” measure by estimating the number of steelhead offspring that could be produced in each river system based on available habitat. That data was then applied to a modified Beverton-Holt model to determine escapement goals. Although the PPP approach was deemed the best available method at the time it was developed, it relies on numerous assumptions that have not been validated. Additionally, the river-specific habitat data that is essential to the model has not been reevaluated since the 1980s despite changes to the habitat over time. As a result, WDFW has identified the need to reassess steelhead fisheries management metrics and forecasting methodologies.

Three Step Plan

Motivated by “the varied status of wild steelhead stocks statewide, in conjunction with the increased expectations for resource managers to balance public interests towards conservation, tribal and non-tribal fisheries, economic stability as well as other social-cultural and environmental values,” (SSMP 2008) WDFW developed a three-step plan to preserve steelhead.

First, the Department completed a comprehensive scientific review of steelhead stocks to "lay the foundation for… improved management plans" (SSMP 2008). That report is titled *"Oncorhynchus mykiss: Assessment of Washington State's Anadromous Populations and Programs"* by Scott & Gill 2008.

Second, the Department created the Statewide Steelhead Management Plan (SSMP) in 2008, a framework of policies, strategies, and actions for steelhead management throughout the state. The goal of the SSMP is to "restore and maintain the abundance, distribution, diversity, and long-term productivity of Washington's wild steelhead and their habitats to assure healthy stocks. In a manner consistent with this goal, the Department will seek to protect and restore steelhead to achieve cultural, economic, and ecosystem benefits for current and future residents of Washington State". The Department sought to attain this goal through policies pertaining to the following subjects: natural production, artificial production, habitat protection and restoration, fishery management, monitoring, evaluation, and adaptive management, regulatory compliance, and outreach and education. The SSMP also indicated that steelhead population status reports should be generated every five years. Implementation of and adherence to SSMP policies, strategies, and actions has been inconsistent across the state and within Region 6 due in part to a lack of resources, among other factors.

The development of RMPs constitutes the third step towards improving steelhead management that WDFW identified in the early 2000s. In some areas of the state where Endangered Species Act (ESA) listed steelhead populations exist, federally required Fisheries Management and Evaluation Plans (FMEPs) have guided steelhead management in the absence of RMPs. However, because the Olympic Peninsula and Southwest Washington DPSs have not been ESA listed (though they have been petitioned for listing), FMEPs have not been written for those areas. Contingent on the availability of funding, the Department intends to create RMPs that contain at a minimum all the information required in federal FMEPs to increase the consistency of steelhead fisheries management, research, and conservation across the state.

Recent Rule Changes
Since the early 1990s, additional strategies to support sustainable fisheries in the presence of declining wild steelhead abundance have been implemented, including harvest restrictions (i.e., bag limits), gear restrictions, reduced season length, and, in 2016, a statewide ban on harvesting wild steelhead. These strategies were designed to support recreational fishing opportunities by limiting mortality on wild populations. Given previous failures to meet escapement goals and some of the lowest wild steelhead returns on record, WDFW expanded use of the "no fishing from a floating device" rule and restricted the use of bait in steelhead fisheries across all coastal watersheds in the winter of 2020-21. Together, these regulations were expected to provide fishing opportunity for a growing number of steelhead anglers in the presence of a declining wild steelhead population by reducing total encounters and associated mortalities.

2.4 Steelhead in Decline

Wild steelhead abundance has declined across most of its range, including on the coastal Olympic Peninsula and southwest Washington. Those declines led to the listing of five out of seven DPSs of wild steelhead in Washington state as "threatened" under ESA and the development of Washington's SSMP in 2008. NOAA designated those DPSs as part of a hierarchical, spatial framework to organize recovery efforts across regions. DPSs are divided into Major Population Groups (MPGs), which are divided further into Demographically Independent Populations (DIPs) (Cram et al. 2018).

The Puget Sound, Lower Columbia River, Middle Columbia River, Upper Columbia River, and Snake River Basin DPSs are listed as ESA threatened. Because the Olympic Peninsula and Southwest Washington segments are not listed, most of those areas have not been further delineated into federally recognized MPGs and DIPs, except for the coast stratum MPG along the Columbia River in southwest Washington. (NOAA Fisheries 2022b). In general, less steelhead management funding has been available for non-ESA listed DPSs compared to listed DPSs. Because MPGs have not been identified for the Coastal Olympic Peninsula DPS and most of the Southwest Washington DPS, the CSPIP assumes that each Water Resource Inventory Area (WRIA) contains at least one MPG. WRIAs were designated by the State of Washington based on natural watershed areas.

Until recently, management agencies considered these coastal populations to be relatively healthy compared to other DPSs across the state; however, improved analyses and record low run sizes over the past several years have altered that predominant narrative. Evidence suggests that human influences have degraded all the Viable Salmonid Population (VSP) measures of steelhead population health. For example, a recent study analysis suggested that most steelhead populations in Washington state had a declining trend in abundance (Cram et al. 2018). Run timing diversity has also decreased, with fish arriving to the river later (up to two months) and within a shorter time range than they did historically (McMillan 2021). This is important because constricted genetic and run-time diversity (Tillotson and Quinn 2018) degrade the resilience of steelhead populations. A 2018 assessment indicated that the number of adults produced by each adult spawner (i.e., adult-to-adult productivity) for Southwest Washington and Olympic Peninsula steelhead populations was consistently less than one, meaning that populations are in decline prior to fisheries occurring (Cram et al. 2018).

A century of splash dams, stream clearance, road building and harvesting trees along the riverbank have degraded steelhead habitat in coastal rivers. Although regulatory changes have improved watershed management over time, the fragmentation of historical habitat continues today due to dams, culvert fish barriers, and disconnected floodplains in the coastal rivers. Further, with increasing number of anglers seeking to catch and release steelhead in the coastal region and improved techniques to do so, encounter rates are thought to be higher than ever before, despite fewer wild steelhead present. Forecasted run sizes for Pacific coast rivers in

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advance of the 2020-21 recreational fishing season reached historic lows, which led managers to close all coastal steelhead fisheries before they began for the first time ever.

2.5 Economic & Cultural Significance

Participation in the recreational fishery constitutes an important part of the culture and traditions of non-tribal coastal communities. Steelhead also make up an intrinsic part of tribal life on the coast, enabling tribes to exercise their traditional lifestyles and livelihoods. Coastal tribes, including the Chehalis, Hoh, Makah, Quileute, and Quinault operate commercial, ceremonial and subsistence fisheries (C & S) in their usual and accustomed fishing area in the coastal region. In adherence to treaty rights and/or Executive Orders, those operations are managed by the governments of each respective tribe. As autonomous nations, those tribes serve as key partners in the development of mutually beneficial fisheries management and conservation objectives, contributing independent data and expertise.

Declining wild populations threaten the world-renowned recreational steelhead fishery, which provides an important economic stimulus for many coastal communities. The fishery attracts more affluent individuals to lower-income coastal communities, where they provide economic input and employment opportunities, especially by hiring fishing guides, staying at hotels, and eating at local restaurants. Anderson and Fonner (2021) surveyed 86 steelhead anglers who had fished in coastal Olympic Peninsula rivers between 2018 and 2020 and demonstrated those individuals were predominantly Caucasian (93%), male (88%), institutionally educated (53% bachelor's or higher), and affluent (58% made $100,000+/year). Out of 78 respondents who fished on Southwest Washington rivers, a mean of 92% were Caucasian, 85% male, 40% held a bachelor's degree or higher, and 35% made over $100,000/year. Steelhead anglers surveyed across the state (*n*=494) spent money on lodging, fishing tackle, gear, or bait, and fuel for their car and/or boat. These results suggest that steelhead fisherman travel to the coast and spend significant amounts of money. According to the US Census, median income per person in Washington's Pacific coast counties (including Clallam, Jefferson, Grays Harbor, and Pacific) from 2015 to 2019 was between $26,109 and $36,598 per year.

2.6 Habitat

Steelhead survival depends on the availability of suitable and connected marine and freshwater habitat. On Washington's Pacific coast, that habitat runs through a variety of land uses, including federally protected land in Olympic National Park (ONP), industrial timberlands, farms, rural residential areas, cities, and under a labyrinth of state, county, and private roads. Those land uses present unique challenges to the maintenance, protection, and restoration of healthy steelhead habitat, requiring collaboration between a variety of public and private stakeholders. In the Revised Code of Washington (RCW) 77.85, which was originally enacted in 1999, the state Legislature lays out an overall vision for the monitoring, protection, and recovery of salmon, including the Statewide Salmon Recovery Strategy. Within RCW 77.85, the term "salmon" refers to "all species of the family Salmonidae which are capable of self-sustaining, natural production," including steelhead. In that legal code, the legislature identified

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habitat restoration as a vital component of salmon recovery efforts that should be carried out according to a watershed-based and locally implemented project framework with the support of the state and federal government.

Under that framework, salmonid habitat related projects are identified by Lead Entities in particular areas. Counties, cities, and tribal governments jointly designated those areas and formed the Lead Entities that are responsible for identifying projects; these Lead Entities are organized by the Washington State Recreation and Conservation Office (RCO). Lead Entities can be a county, city, conservation district, special district, tribal government, regional recovery organization, or other entity as deemed appropriate. Each area-specific Lead Entity established citizen and technical committee that represents the interests of counties, cities, conservation districts, tribes, environmental groups, business interests, landowners, community members, volunteer groups, regional fish enhancement groups, and other habitat interests. Lead Entity functions are supported with state and federal funding through contracts administered by the RCO. Each Lead Entity committee compiles a habitat project list that identifies, prioritizes, and explores potential funding for specific habitat projects. Those lists are then submitted to the Salmon Recovery Funding Board. Local organizations carry out habitat projects after they have been identified and approved.

Although WDFW is just one of many partners in the collaborative salmonid habitat monitoring, protection, and restoration process, the Department plays several key roles. First, WDFW has an important role in habitat protection and restoration through the Hydraulic Project Approval (HPA) permitting process. According to RCW 77.55, construction projects in or near most marine and/or freshwater habitats in Washington require approval from WDFW. This process ensures that construction is done in a manner that protects fish and their aquatic habitats.

Second, WDFW addresses issues pertaining to fish passage along with external partners. Salmonid researchers and managers widely recognize obstructions to the steelhead habitat connectivity as a major factor contributing to their decline. In Region 6, many road crossings obstruct fish passage because they are undersized, blocked, too steep, or have stream flow velocities that are too great to permit passage during high flows, blocking adults from reaching their spawning grounds and preventing juveniles from accessing cool water refuges during the warm summer months and high-water refuge during winter floods. WDFW developed statewide protocols for fish passage assessment statewide and maintains a statewide fish passage database. The Department also hosts the Brian Abbott Fish Barrier Removal Board, secured legislative funding for fish barrier corrections. And third, WDFW has taken on oversight of recent large-scale habitat restoration projects in the Chehalis River Basin as well as the development of the Aquatic Species Restoration Plan within the Chehalis Basin Strategy (ASRPSC 2019). WDFW is well situated to support fish passage correction projects sponsored by tribal governments, local organizations, and nonprofits throughout the Washington coast.

2.7 Background Summary

The ecological complexity, cultural significance, and economic benefit of anadromous *Oncorhynchus mykiss* make the species an integral part of Washington’s Pacific coast. Steelhead

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exhibit a unique capacity for resilience given their broad distribution, multiple life history strategies, varied run timings, and ability to spawn more than once. Steelhead are integral part of the marine and freshwater ecosystem as well as nutrient flow between the rivers, forests, and wildlife. This unique species has been important to human lives and livelihoods for thousands of years and despite declining abundance, distribution, productivity, and diversity, continues to play a role in Washington's culture and economy through co-managed fisheries. The remainder of this document outlines how WDFW can move towards recreational fisheries management strategies that both protect fishing opportunities and promote steelhead conservation through a balanced, practical, and science-based approach.

Additional WDFW Resources

For more detailed context on the biological and ecological status of steelhead and the implication of that status for fisheries management in Washington, refer to *"Oncorhynchus mykiss: Assessment of Washington State's Anadromous Populations and Programs"* by Scott & Gill (2008), which was developed to inform the strategies and policies outlined in the Statewide Steelhead Management Plan (2008), *"Steelhead at Risk: Assessment of Washington's Steelhead Populations"* by Cram et al. (2018), and the "State of Salmon in Watersheds 2020" reports generated through the Governor's Salmon Recovery Office, the United States Fish and Wildlife Service (USFWS) and NOAA Fisheries (https://stateofsalmon.wa.gov/).

3. Proviso Implementation Strategy

This overarching Proviso Implementation Strategy lays out coastal steelhead management guidelines pertaining to five subject areas: (1) Monitoring and Evaluation, (2) Fishing Regulations, (3) Hatchery Operations, (4) Habitat, and (5) Socioeconomics (Figure 2). Each subject area contains guidelines that apply to the major river systems[1] on Washington's Pacific coast. Three of the subject areas (Monitoring and Evaluation, Fisheries Regulations, and Hatchery Operations) are linked in an Adaptive Management Framework due to their highly interconnected nature (Table 1). According to that Adaptive Management Framework, fisheries managers shift their actions between one of three regimes (Maintenance, Transitional, and Emergency) according to VSP-based thresholds and/or other management objectives. These thresholds and objectives may evolve over time as new information and/or analyses become available, including IPM based MSEs. The River Specific Supplements (Section 9) describe how each of the five subject areas within the Proviso Implementation Strategy pertain to each major river system, including additional information and/or guidelines, capturing system-specific

[1] "Major river systems" refers to the large-scale drainages associated with Willapa Bay (including the North River, Palix River, Nemah River, and the Naselle River), the large-scale drainages associated with Gray's Harbor (including the Humptulips River, the Wynoochee River, and the Chehalis River), the Queets/Clearwater River complex, the Quinault River, the Hoh River, and the Quillayute River (including its major tributaries: the Sol Duc, Calawah, and Bogachiel). Details pertaining to Independent Streams that flow to the Pacific coast but fall outside these major watersheds are presented in Section 9.8: Independent Streams.

nuances not contained in the overarching Proviso Implementation Strategy. Implementing these actions and associated fisheries will require ongoing financial investment from the state. This holistic and adaptive Strategy provides an interim approach that, by design, may evolve over time and will be included in future RMPs.

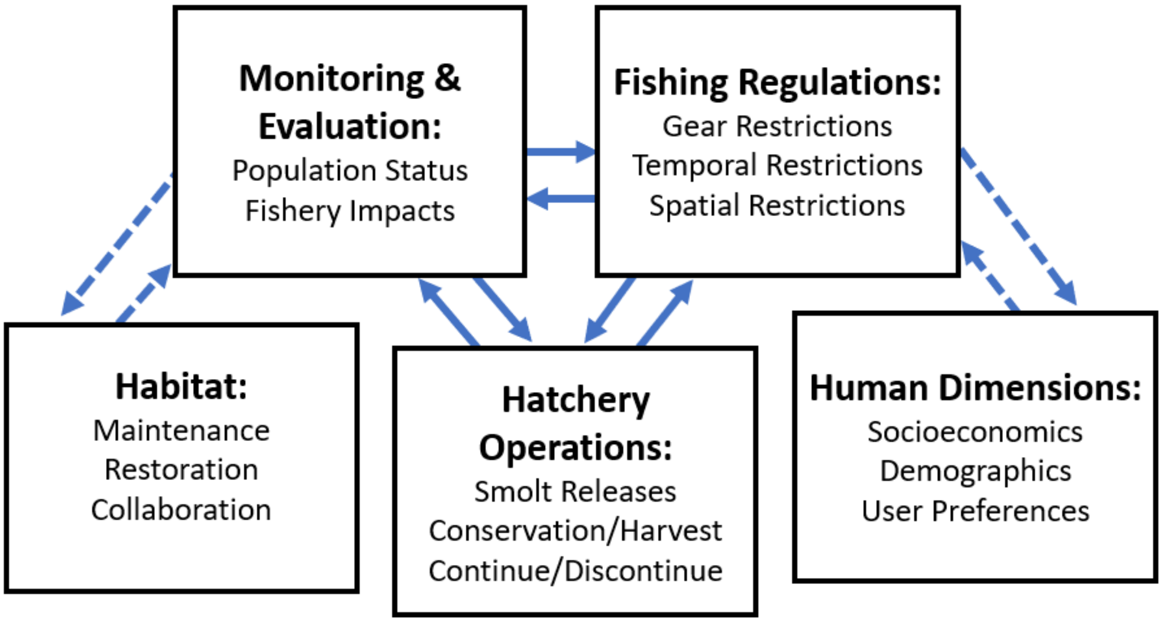

Figure 2: The five primary subject areas addressed in the Proviso Implementation Strategy. The bidirectional arrows linking Fisheries Regulations, Monitoring and Evaluation, and Hatchery Operations are made up of solid lines because they constitute the primary activities currently carried out by WDFW pertaining to coastal steelhead management and are interconnected in the Adaptive Management Framework (Table 1). Habitat and Human Dimensions are linked using dashed arrows because although they influence and are influenced by the other subject areas, integrating habitat and human dimensions activities into fishery management will require more collaborative development between Region 6 Fish Management, other internal WDFW divisions, and external partners.

Current management objectives are escapement-based, as outlined in the Statewide Steelhead Management Plan (SSMP). The SSMP indicates that WDFW should set theoretical goals for the number of wild steelhead that should "escape" fisheries and reach wild spawning grounds (aka escapement). If the forecasted run size exceeds the escapement goal, the number of fish above escapement is considered the allowable mortality. If the forecasted run size is below the forecasted escapement, the allowable mortality is 10% of the forecasted run size. If fisheries managers cannot confidently design a fishery that will limit impacts within the allowable thresholds, they will close the fishery to protect wild steelhead runs. These SSMP-based guidelines informed the creation of the three management regimes included in the Adaptive Management Framework: Maintenance, Transitional, and Emergency. Those regimes are broadly defined as the following:

- **Maintenance:** actions taken to provide fishing opportunity while minimizing risk to wild populations
- **Transitional:** actions taken to provide limited fishing opportunity while promoting a transition to the Maintenance regime
- **Emergency:** actions taken to minimize risk and relieve stressors (fishing, hatcheries etc.) on low-abundance wild runs and promote a transition to Maintenance regime

However, the criteria that assign steelhead populations to a specific regime may shift over time, depending on data availability and/or changing objectives. For instance, steelhead within a river system are assigned to management regimes using abundance metrics as the primary "wild steelhead thresholds", additional VSP parameters are evaluated by managers, including productivity, spatial distribution, and diversity and the intention is that these metrics would formally influence management regime designation in the future. *Table 1* contains an overview of how the three regimes guide management actions pertaining to Monitoring and Evaluation, Fisheries Regulations, and Maintenance. The following text contains more detailed descriptions of how each regime influences management.

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Table 1: An overview of the coastal steelhead fishery Adaptive Management Framework encompassing monitoring and evaluation, fishery regulations, and hatchery operations. This strategy outlines three management regimes (Maintenance, Transitional, and Emergency). These regimes are presently determined based on wild steelhead abundance and allowable impacts on wild steelhead outlined in the Statewide Steelhead Management Plan, however, criteria for regime determination and management objectives may shift over time.

	Maintenance	**Transitional**	**Emergency**
Wild Steelhead Thresholds	**Population forecasted to meet or exceed escapement goal and/or other management thresholds**	**Population forecasted to be lower than escapement goal and/or does not meet other management thresholds but fisheries still feasible within management objectives**	**Population forecasted to be lower than escapement goal and/or does not meet other management thresholds; managers unable to design a fishery that will confidently meet management objectives**
Monitoring and Evaluation	• Ensure standard monitoring and evaluation guidelines are met	• Increase the resolution and/or distribution of sport fishery monitoring and VSP data collection above the standard	• Increase the resolution and/or distribution VSP data collection above the standard
Fisheries Regulations	• Follow 3-Step Regulation Process • Provide diverse angling opportunities within management objectives, designed considering all VSP	• Follow 3-Step Regulation Process • Provide diverse angling opportunities within management objectives After 3 of 5 years in Transitional:	• Recreational fishery closure

	parameters	- Hatchery-Targeted Fisheries preceding fishery limitations or closures	
Hatchery Operations	• Design hatchery operations to provide angling opportunity, remain within genetic thresholds and minimize ecological impacts	• Design hatchery operations to remain within genetic thresholds and minimize ecological impacts • After 3 of 5 years in Transitional: Hatchery Equilibrium Protocol	• Hatchery Equilibrium Protocol • Prioritize conservation hatchery research • Possible program discontinuation

3.1 Monitoring and Evaluation

Monitoring and Evaluation forms the foundation of WDFW Fish Management's ability to both effectively and adaptively manage fisheries and meet conservation objectives for coastal steelhead. Systematically collecting and evaluating data enables the Department to accurately measure fishery impacts and the dynamics of steelhead populations. The following guidelines apply to all river systems on Washington's Pacific coast:

3.1.1 The Adaptive Management Framework influences monitoring and evaluation within each major river system according to the following guidelines:

- **Maintenance:** The Department will ensure that standard monitoring and evaluation protocols are carried out within each major river system of Willapa Bay, Grays Harbor, and the coastal Olympic Peninsula. Monitoring and evaluation techniques implemented will be chosen considering the cost effectiveness and likelihood of meeting objectives. Standard monitoring and evaluation will include but is not limited to the following elements:
  1. **Pre-season forecasting** calculated to set management regimes and fisheries regulations. WDFW will reevaluate forecasting methodology on a regular basis with the goal of reaching effective and, where appropriate, consistent methodologies across Districts within Region 6 using the best available science. Forecasts will be developed and finalized with co-managers.
  2. **Escapement and runsize estimation:** WDFW will estimate wild steelhead escapement and runsize post season and/or in-season based on the best available data. Data sources could include, but are not limited to:
     - **Spawning ground surveys** designed and carried out according to methods that produce the most accurate possible escapement estimates, given environmental conditions and personnel capacity. Methods could include the **Generalized Random Tessellation Stratified (GRTS)** method, Index-supplemental Method, SONAR-based method, or alternatives that support unbiased escapement estimates with measures of uncertainty if possible. Regardless, survey methodologies will be described in a **Region 6 Spawning Ground Survey Guidebook**, which is currently under

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development. All staff who conduct spawning ground surveys will participate in a **Spawning Ground Survey Workshop** plus supplemental training as needed to maintain consistent techniques. Tribal and ONP crews will be invited to attend those workshops. The Department will assess the validity of the March 15th hatchery/wild cutoff date and alter the timing of spawning ground surveys in accordance with system-specific wild steelhead run timing. Additionally, the Department will assess and utilize system-specific spawning adults per redd conversion factors used to estimate escapement.

- **Tribal data** gained through collaborative co-management with coastal tribes. Tribal data could pertain to commercial and C & S fisheries, spawning ground surveys, biological sampling (age, size etc.), and/or juvenile abundance. Tribal fishery data allows managers to compare in season runsize estimates to preseason forecasts.
- **SONAR** used to enumerate and study the behavior of fish passing a SONAR device under the direction of a dedicated SONAR team (Critical Research Section 8.4: Sonar Monitoring) in the absence of trap counts common where dams are in place. This SONAR team will work in conjunction with Science Division, Fish Management, and a statewide SONAR working group. Complimentary tangle netting and/or other techniques may be used to evaluate the species composition of fish passing the device and could with adequate resources support in-season estimates of steelhead runsize.
- **Passive Integrated Transponder (PIT) Tag Arrays** can be applied in a variety of ways including tagging of juveniles to be tracked passively into the freshwater.

3. **Sport Fishery Monitoring** designed to provide high resolution data on fishery effort and impacts. Methods utilized to collect those data could include but are not limited to:
    - **Creel surveys** conducted according to the state-wide protocols, if adequately funded will be used to estimate angler encounter rates with steelhead, catch per unit effort (CPUE), and fishery demographics through angler interviews.
    - **Test fisheries** to provide independent estimates of CPUE and catch for steelhead in recreational fisheries, which will assist with validation of creel estimates. This work will also support collection of genetic and age-structure data from encountered steelhead and estimates of release mortality.
    - **Catch record cards** submitted by anglers either electronically or in paper form. Region 6 Fish Management will transition to electronic catch record cards (eCRC) as the primary mode of collecting harvest data, with paper cards as a secondary option. The Department may also include released fish in eCRC to track encounter rates, which could replace and/or supplement aspects of creel surveys as a more cost-effective sport fishery monitoring tool if eCRCs are submitted on the day of encounter.
4. **Age structure and genetic data** used to improve the accuracy of forecasting models and answer questions pertaining to hatchery genetic influence, population diversity, and other subjects as deemed beneficial to fisheries management and steelhead research.

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5. **Juvenile monitoring** from screw trapping, snorkeling surveys, eDNA, SONAR, and/or other methods (Critical Research Section 8.3: Juvenile Monitoring). Trapping of out-migrating steelhead smolts as they travel from their natal streams to the ocean helps to calculate productivity and rearing capacity of the freshwater environment as well as smolt to adult return (SAR) rates, a metric of survival. The cost effectiveness, feasibility, repeatability, and accuracy of each monitoring strategy with be evaluated prior to utilization of that strategy and/or at least every five years following implementation, with priority placed on carrying out consistent strategies across watershed where possible.

- **Transitional:** In addition to carrying out the standard Monitoring and Evaluation protocols outlined above, the Department will increase the spatial distribution and/or frequency of sport fishery monitoring. Specifically, the precision and accuracy of estimates of catch in sport fisheries is directly related to survey effort (i.e., number of staff) therefore reduced uncertainty around fishery impacts will be necessary to support fisheries in the transitional regime and will be achieved.
- **Emergency:** In addition to carrying out the standard Monitoring and Evaluation protocols outline above the Department will increase the resolution and/or distribution of data collection techniques that provide information on VSP parameters. That monitoring would increase the amount of data available to assess conservation concerns associated with declining population viability and craft strategies to address those concerns. Those techniques may include but are not limited to:
  1. **Increasing the resolution and/or frequency of spawning ground surveys:** Technical staff not utilized for sport fishery monitoring during closed fisheries may be partially reallocated to spawning ground survey crews or other monitoring efforts designed to collect information on steelhead VSP parameters.
  2. **Prioritizing SONAR monitoring** and associated species composition data collection to provide in-season updates of wild steelhead runsize to allow for changes to fisheries where possible.

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3.1.2 Data collection and management procedures will be continually updated in accordance with the following vision:

WDFW currently manages coastal steelhead data at an individual project level in a variety of spreadsheets and databases. This strategy has adequately served individual project needs but creates coordination challenges at broader spatial and temporal scales. Therefore, the Department is currently in the process of:

- **Modernizing databases into a cloud-based infrastructure.** Coastal steelhead data will be stored in central repositories. Data managers are actively meeting with district staff to ensure new solutions address the needs and issues facing local projects. Integrating mobile electronic devices for field data collection has begun and will continue to expand. Staff will migrate from paper-based to electronic data entry to improve data flow efficiency and accuracy.

- **Developing web-based interfaces** for staff to view existing data and perform quality assurance checks. These systems will have data export tools ranging from generic outputs of raw data to specialized summaries required for specific objectives as well as automated data transfers to co-managers and regional repositories. These data export tools may be internal and/or accessible to the public through the WDFW website.
- **Overcoming barriers to progress** including lack of staff time to develop software and provide adequate technical support, as well as costs to acquire the necessary technology.

3.1.3 Quantitative forecasting methodologies will be continually developed and improved in collaboration with Science Division. The performance of these tools will be compared against existing methodologies. Decisions about the utilization of forecasting tools in pre-season planning will be made with co-managers.

This plan addresses two quantitative analysis techniques that are currently under development within WDFW: an ensemble timeseries model and an integrated population model (IPM). The timeseries model will be used as a supplemental tool for single-year population abundance forecasting, while the IPM will be assessed for its effectiveness in estimating population parameters, evaluating long-term population status, and as a step towards comprehensive Management Strategy Evaluations (MSEs) (discussed further in Section 5: Regional Management Plans). Examples of the ensemble timeseries model are included in the River Specific Supplements (Section 9). All utilized forecasting methodologies will be reevaluated on a regular basis to assess the relative accuracy and precision of each model. A full description of the methods and results of these modeling techniques is included in the Appendices; however, summarized descriptions are provided below:

The Ensemble Timeseries Model was created by Department staff in 2022 using several types of commonly used forecasting models fit to historical estimates of runsize (catch + escapement). Data used to fit the models are split into a training and a validation dataset to evaluate the ability of each model to make one-year-ahead forecasts. We evaluate forecasts for the last ten years of the available time series and compare models based on their forecasting accuracy/performance. Using these individual models, we then develop ensembles of multiple models by evaluating optimal model weights to construct the best possible ensemble, which is then used to generate the final one-year-ahead forecast of future run size. The relative performance of the Ensemble Timeseries Model has not been evaluated against more traditional approaches; however, it offers some potential advantages. Advantages of the Ensemble Timeseries Model approach include:

- Some of the models within the ensemble are fit with regression covariates such as stream flow, sea surface temperature (SST), and the North Pacific Gyre Oscillation (NPGO) index.

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- The approach is code-based and could be linked to centralized steelhead databases to automatically produce forecasts.
- Could increase the transparency and consistency of forecasting techniques coast wide.

The Integrated Population Model (IPM) builds on previously developed Bayesian IPMs (Buhle et al. 2018; Scheuerell et al. 2021). It explicitly accounts for iteroparity by accommodating a more complex age structure that includes repeat spawners and by estimating kelt survival rate. This model also incorporates different sources of fishing-related retention and non-retention mortality, and accounts for variation in population parameters over time. IPMs are increasingly used to inform conservation science and fishery management, including recent applications to salmonid populations in Washington (Buhle et al. 2018; Scheuerell et al. 2021). Please refer to the Appendix 12.1.2 for complete methods associated with the model development and implementation. The steelhead IPM is currently being developed to:

- **Estimate population parameters**, such as productivity and capacity, and to calculate biological reference points
- **Evaluate long-term population status** relative to conservation metrics
- **Serve as the foundation for comprehensive management strategy evaluations (MSEs)** for Washington's coastal steelhead systems

The advantages of IPMs over traditional spawner-recruit models include their ability to:

- **Account for uncertainty** within the data sources, which is especially important when studying coastal steelhead because relatively little data exists on those populations. IPMs consist of a process model, which describes the unobserved true population dynamics, and an observation model that describes the noisy observations of the true state of the population. They capture the full uncertainty in the observations and can deal with missing data (Schaub and Kéry 2022).
- **Include environmental covariates**, which is beneficial because coastal steelhead populations are likely influenced by changing environmental conditions such as sea surface temperature and streamflow rates.

3.1.4 WDFW will address data gaps that create uncertainty within steelhead management and pertain to all coastal systems through a combination of critical research and monitoring. That uncertainty can lead to under- or over-estimation of wild steelhead escapement and hatchery genetic impacts, among other implications, and limits WDFW's ability to manage with precision and accuracy. Those data gaps include:

- **Uncertainty around the March 15th cutoff data for hatchery vs. wild redds.** What is the temporal run timing and spawning overlap between hatchery and wild fish? This information should be used to replace the current March 15th hatchery/wild cutoff

date used in escapement estimation. Acoustic or radio telemetry could be used to assess rates, timing, and distribution of hatchery straying to natural spawning grounds.
- **Unknown error from spawning ground survey expansions**
- **Validity of redds per female expansion values in estimates escapement**
- **Impacts of unharvested hatchery fish during fisheries closures**
- **Distribution, abundance, and contribution to steelhead populations of rainbow trout (resident *O. mykiss*)**

3.2 Fishery Regulations

The primary purpose of the CSPIP is to design recreational fishery tools that support sustainable steelhead runs while providing fishing opportunities where possible. This section describes the process that managers use to determine specific fishery regulations (the 3-Step Regulation Process: Figure 3) and how those regulations are influenced by the Adaptive Management Framework (Table 1). The following guidelines apply to all river systems on Washington's Pacific coast:

3.2.1 The Adaptive Management Framework influences steelhead fishery regulations according to the following guidelines:

- **Maintenance:** The full spectrum of possible recreational fisheries that are expected to meet management objectives will be explored. Fisheries will be designed to avoid disproportionately impacting wild runs spatially or temporally.
- **Transitional:** If a river has been in the Transitional regime for less than 3 of 5 years (4 years of empirical plus 1 year of forecasted), the full spectrum of possible recreational fisheries will be explored. If a system has been in the Transitional regime for greater than or equal to 3 out of 5 years (4 years empirical plus 1 year of forecasted), then the following guidelines apply:
    1. **Hatchery-Targeted Fisheries:** Managers will design Hatchery-Targeted Fisheries to prioritize removal of hatchery fish, although catch and release opportunity on wild fish may also be available within management objectives. Hatchery-Targeted Fisheries will continue for the minimum number required to remove hatchery returns from a given river (up to 3 years), coinciding with the Hatchery Equilibrium Protocol (Section 3.3.1).
    2. **Fishery Limitations or Closures:** If wild steelhead abundance and availability of monitoring indicates that a river should remain in the Transitional regime after the hatchery fish have been removed from that river through Hatchery-Targeted Fisheries, recreational fisheries may continue, primarily to allow for fisheries targeting salmon species.
- **Emergency:** Fisheries in the Emergency regime will be closed to recreational steelhead fishing.

3.2.2 Managers will set steelhead fishery regulations according to the Three-Step Regulation Process (Figure 3). That process includes:

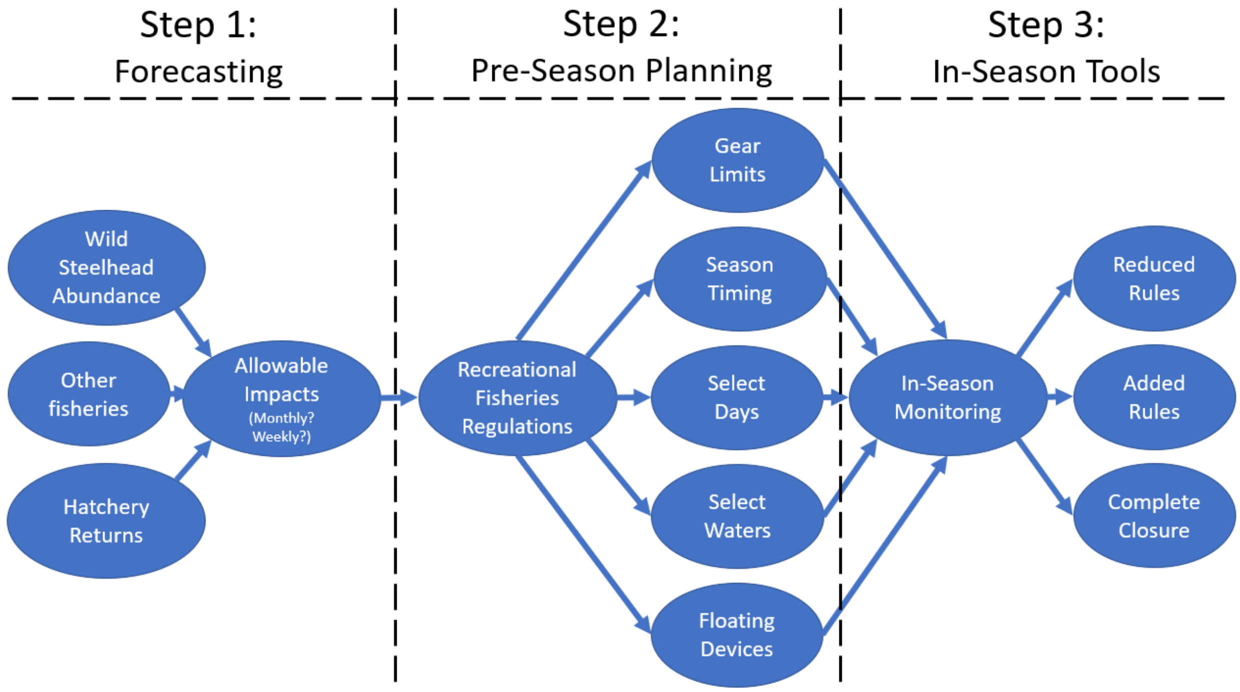

Figure 3: A graphic representation of the Three-Step Regulation Process, including forecasting, pre-season planning, and in-season update tools.

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<u>Step 1: Forecasting</u>

- Forecasting of wild and hatchery-origin steelhead run sizes is a co-manager process that relies on recent year averages of reconstructed runsizes (harvest + escapement) from scale analysis, past environmental conditions, and spawner-recruit models such as Ricker and Beverton-Holt. The Department is currently developing an Ensemble Timeseries Model and an Integrated Population Model (IPM) using advanced quantitative techniques as supplemental forecasting tools (Section 3.1.3).
- Forecasting of hatchery-origin steelhead runs depends on smolt release numbers and trends in smolt to adult returns (SAR).
- Forecasts allow fisheries managers to plan fishing seasons and maximize the number of hatchery origin steelhead harvested while limiting impacts on wild steelhead. These allowable impacts can be generated on seasonal, monthly, or weekly scales depending on data availability, monitoring intensity, and river-specific management objectives.

<u>Step 2: Pre-Season Planning</u>

Pre-season planning is the process by which the Department determines which recreational fisheries regulations are most likely to meet shared management objectives of the state[2] and tribal co-managers. Determining which fisheries regulations are most likely to meet management objectives and the preferences of the angling public requires a multistep quantitative and public engagement process. Examples of specific regulations considered may include, but are not limited to gear restrictions (e.g., barbless hooks, no bait etc.), daily harvest limits, floating device restrictions and restrictions on the duration or timing of fisheries and others. **<u>Step 3: In-Season Update Tools</u>**

In conjunction with tribal comanagers, the Department may update the forecasted runsize based on in-season information. As resources become available that support improved technologies (SONAR, creel etc.) to estimate steelhead abundance in season, uncertainty will be reduced and flexibility to adjust fisheries in-season is likely to improve. In-season, fisheries managers from the state, tribal governmental, and Olympic National Park will explore the following options to increase the likelihood of meeting management objectives:

- **Increased Opportunity:** If in-season monitoring indicates that wild steelhead are more abundant than pre-season forecasts, emergency restrictions may be lifted to increase fishing opportunity while remaining within management objectives.
- **Additional Restrictions:** If in-season monitoring indicates that wild steelhead are less abundant than forecasted within a given season, additional restrictions may be added increase the likelihood of meeting management objectives.
- **Fishery Closure:** If in-season monitoring indicates that steelhead are less abundant than forecasted within a given season and additional restrictions are unlikely to reduce impacts within management objectives, systems may be closed to all fishing for the remainder of the season.

3.2.3 The Department will pursue the following additional actions when designing and/or updating fishery regulations:

4 **Include steelhead impacts from other fisheries in estimates of total wild steelhead impacts.** Recreational fisheries targeting species other than *O. mykiss*, including spring Chinook and fall Coho, have the potential to encounter coastal steelhead. Therefore, WDFW will include impacts of those "other fisheries" in fisheries management calculations to provide the greatest certainty that fisheries do not exceed allowable impact thresholds on wild steelhead.

5 **Evaluate permanent fisheries regulations** pertaining to anadromous and resident trout populations against angling and conservation objectives. The Department may alter permanent regulations or implement emergency regulations based on that evaluation.

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[2] In the short term, those management objectives include wild steelhead escapement goals and limiting mortality of wild steelhead in systems with forecasted run sizes that are less that escapement goals to 10%, as outlined in the Statewide Steelhead Management Plan (SSMP). Those management objectives may change over time.

6 **Tailor "warmwater" fishery regulations to reduce predation on steelhead by invasive species such as Smallmouth Bass.** Given sufficient funding and staff capacity, Region 6 staff will collect age and size structure data for Smallmouth Bass to quantify the consumption rates by size class and assess variability in predation timing. This proposed work will be crucial for continuing to identify ways to reduce predation by growing populations of non-native gamefish in the coastal region.

3.3 Hatchery Operations

Region 6 Fish Management will design hatchery operations that consider multiple factors including the ecological impacts of hatchery production, the ability to provide angling opportunities within management guidelines, and mitigation agreements. The following guidelines apply to all river systems on Washington's Pacific coast:

3.3.1 The Adaptive Management Framework influences hatchery operations according to the following guidelines: (Exceptions to the Adaptive Management Framework may be considered for conservation research programs and/or in rivers with established mitigation programs or other pre-existing agreements.)

- **Maintenance:** In the Maintenance regime, hatchery operations will be designed to remain within SSMP genetic thresholds[3], given relatively diverse recreational fisheries taking place. Additional ecological interactions between hatchery steelhead, wild *O. mykiss*, and other species will also be considered and minimized to the extent possible in hatchery operations. Operational changes may include scaling of hatchery smolt releases improving attraction to facilities and increasing the proportion of wild fish used in broodstock management for integrated hatcheries.
- **Transitional:** If a river system has been in the Transitional regime for less than 3 out of 5 years (4 years of empirical and 1 year of forecasted) then hatchery operations will be designed to remain within SSMP genetic thresholds. Additional ecological interactions between hatchery steelhead, wild *O. mykiss*, and other species will also be considered and minimized in hatchery operations. Operational changes may include scaling of hatchery smolt releases. However, if a river system has been in the Transitional regime for greater than or equal to 3 out of 5 years (4 years of empirical and 1 year of forecasted) actions will be taken to transition the wild steelhead population to maintenance regimes. These actions include:
    1. **Hatchery Equilibrium Protocol:** the Hatchery Equilibrium Protocol provides tools to minimize hatchery influence while the effected hatchery programs for the future. These tools consists of options for integrated and segregated programs to reduce genetic impacts of hatchery-origin steelhead during fishery reductions or closures,[4] including

[3] Currently, genetic impact thresholds for coastal steelhead are included in the SSMP, however, these thresholds may change over time as policy evolves.

[4] WDFW may adjust the options associated with the Hatchery Equilibrium Protocol over time based on evolving management objectives.

pilot programs to test options for reinitiating hatcheries while providing adequate protection for hatchery and natural populations.[5] Options being considered at the time of publication include for segregated hatchery programs, (1) reduce smolt releases to the minimum number required to produce broodstock while maintaining sufficient genetic diversity to reinitiate harvest-oriented programs or (2) eliminate smolt releases with a clear plan in place for how to reinitiate programs with Chambers or another source broodstock with sufficient genetic diversity. For integrated programs, managers will eliminate smolt releases with a clear plan in place for how to reinitiate harvest-oriented programs with natural origin broodstock if re-initiation is deemed appropriate and feasible.[6]

- **Emergency:** Hatchery releases in any system that enters the Emergency regime will be subject to the following guidelines:
  1. **Hatchery Equilibrium Protocol:** *See description above in Transitional regime.*
  2. **Prioritize Conservation Hatchery Research:** Some evidence suggests that integrated hatchery smolt production may help bolster overall adult steelhead recruitment in critically depressed steelhead populations (Courter et al. 2022) with very low abundance. However, hatchery programs pose risks to wild populations in terms of genetic domestication, reduced fitness, density dependence, attraction of predators and other ecological impacts (Nickelson et al. 2003; Araki et al. 2007; Buhle et al. 2009; Christie et al. 2014); therefore, the potential risks and benefits of such programs should be carefully weighed before they are implemented. WDFW will explore and may implement a variety of conservation-oriented hatchery approaches in systems that are in the Emergency regime for multiple years.
  3. **Possible Program Discontinuation:** Steelhead hatchery programs may be discontinued if the rivers in which they operate are frequently subject to recreational fishery closures due to low wild steelhead abundance or if those programs consistently fail to meet their goals. Discontinued programs may be replaced with alternate hatchery programs with different operational approaches and objectives, such as conservation-oriented research programs.

3.3.2 WDFW will pursue the following additional actions when designing and/or updating hatchery operations:

[5] WDFW may adjust the options associated with the Hatchery Equilibrium Protocol over time based on evolving management objectives.

[6] Conventionally, hatchery releases are laid out in co-manager determined Future Brood Documents, which are drafted approximately one year before the open fishery season and finalized during the fall before the season. Alterations to smolt release numbers may be submitted through Amended Future Brood Documents when the Protocol is initiated.

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- **Develop and communicate clear adult production goals for each hatchery program**, including targets for SAR, catch in fisheries, and needs for broodstock.
- **Minimize ecological impacts of hatchery-origin steelhead on wild populations.** These actions may include, but are not limited to:
    - Employing rearing and release techniques to reduce the prevalence of residual juvenile hatchery steelhead in receiving streams/rivers (e.g., Tatara & Berejikian 2012).
- **Relocate surplus adult returns or smolts:** Recaptured adult hatchery-origin steelhead will be relocated to non-anadromous water bodies where genetic risks are low and the potential for fishing opportunities and catch rates are high, consistent with disease policy. Surplus hatchery fish may also be donated to local foodbanks. Excess smolts resulting from downscaling releases may be released in non-anadromous water bodies or be used to support shortfalls in other watersheds if such actions are supported by existing state and federal policies.
- **Optimize trapping efficiency and hatchery attraction:** Trapping efficiency will be periodically evaluated for all state-operated coastal steelhead hatchery programs at least every 3 years. Recapture tools could include leaving hatchery racks open during the entire hatchery steelhead run, increasing flow, and or netting fish below racks if attraction is limited to reduce genetic risks.
- **Reduce spatial and/or temporal overlap between hatchery-origin and wild steelhead** while balancing VSP parameters through strategic release locations**.**
- **Prioritize hatchery research** including but not limited to:
    - Comparison of the performance of integrated and segregated programs against reference streams to determine short-term and long-term impacts on wild steelhead populations, return to the creel and fish condition and quality (e.g. length, girth, age, flesh quality, survival etc.). This research will help weigh the costs and benefits of various hatchery programs.
    - Validation of DGM and AHA models used for hatchery release scaling through studies designed to gather empirical, program specific information on stray rates and gene flow.

3.3.3 WDFW will model how many hatchery smolts could theoretically be released while remaining within genetic thresholds (geneflow, pHOS, & PNI) set by the SSMP, given a variety of fishery and hatchery operations scenarios.

The SSMP set a long-term goal of <2% gene flow from segregated harvest-oriented hatchery steelhead programs into natural origin populations. For integrated hatchery programs, the SSMP states that pHOS in streams should not exceed 30% and PNI should be 70% or higher (SSMP 2008). Scaling recommendations aimed to meet management objectives will be generated using a sliding scale of potential hatchery smolt release numbers based on varying levels of wild steelhead population abundance, trapping efficiency, and other operational parameters. This sliding scale approach was constructed using the Hoffman Demographic Geneflow Model (DGM) (Hoffmann 2017) for segregated programs and the All-H-Analyzer (AHA) model for integrated programs (Appendices 12.1.3-12.1.4). These methodologies will be continually reevaluated and improved as techniques advance and more data on model inputs becomes available.

The *Hoffman Demographic Geneflow Model* (DGM) was developed in 2014 by Annette Hoffman to evaluate geneflow between segregated hatchery steelhead and natural origin steelhead in Puget Sound. The DGM uses a geneflow equation that is described in the SSMP and was updated in 2014 (Busack 2014). This equation utilizes the relative abundance of both hatchery- and natural origin fish on the spawning grounds, as well as their spatial and temporal overlap and the relative reproduction success of potential mating between possible combinations of hatchery and natural origin steelhead (Appendix 12.1.3).

The All-H-Analyzer (AHA) Model is a Microsoft Excel®-based model that HSRG developed to support the review of over 300 hatchery programs across the Pacific Northwest. AHA models the impacts of management decisions and hatchery effectiveness by projecting the average outcome of hatchery operations over 100 generations. This model uses hatchery and natural population data to provide estimates of pHOS, PNI, and predicted returns. Productivity data used by the model includes the SAR, recruits per spawner and adult and smolt capacity (Appendix 12.1.4).

3.3.4 The Department will explore potential designation of Wild Stock Gene Banks (WSGB) for coastal steelhead (which reside in Wild Steelhead Management Zones (WSMZs)) in preparation for a collaborative WSGB designation process.

The SSMP indicates that one WSGB be designated for each Major Population Group (MPG) within each Distinct Population Segment (DPS) for natural origin steelhead, however, MPGs have not been established in Washington's Pacific coast systems. Therefore, WDFW will use Water Resource Index Areas (WRIAs) as a proxy for MPGs when exploring placement of WSBGs, assuming there is at least one MPG per WRIA. The SSMP provides minimum criteria and guidance for WSGBs. In this CSPIP, those criteria, along with more specific and/or additional considerations provided by the HEAT unit, were applied to steelhead in coastal rivers and streams to evaluate their suitability as potential WSGBs. The SSMP WSGB criteria and additional considerations are provided below. WDFW will work with tribal co-managers and fisheries stakeholders to ensure that the selection of WSGBs align with fishery and conservation goals.

SSMP Criteria:

- Each stock selected for inclusion in the gene bank must be sufficiently abundant and productive to be self-sustaining in the future
- No releases of hatchery-origin steelhead will occur in streams where spawning of the stock occurs, or in streams used exclusively by that stock for rearing

- Fisheries can be conducted on WSGB stocks if wild steelhead management objectives are met as well as any necessary federal ESA determinations

CSPIP Expanded Criteria and Considerations:

- Populations must have relatively stable population trends and a six-year average of greater than 300 spawners
- Populations may not occupy rivers or streams where on-station hatchery production or releases occur; however, they may occupy areas that currently support off-station releases. Off-station releases would be discontinued if steelhead populations in the area where those off-station releases occur were designated as WSGBs
- The usefulness of given populations as control groups for research
- The designation of other salmonid populations as WSGBs in overlapping habitat

In some cases, establishing WSGBs around robust natural populations may necessitate discontinuing on station hatchery production. Those decisions should be based on the status of natural populations and the success of hatchery programs in meeting their goals.

3.4 Habitat

The Washington state Legislature identified habitat restoration as a vital component of steelhead recovery efforts (RCW 77.85) and accordingly outlined the Statewide Salmon Recovery Policy, which was first published in 1999 and updated in 2022. That legal code indicates that salmonid habitat projects should be carried out according to a watershed-based and locally implemented project framework, under the direction of Lead Entities, with the support of state, federal, and tribal government.

WDFW currently supports that overall strategy in Region 6 through the following actions:

- Facilitating the HPA permitting process
- Serving on the Technical Advisory Groups of the Lead Entities
- Addressing fish passage through a statewide protocol for fish passage assessment and by prioritizing fish passage projects for funding through the Brian Abbott Fish Barrier Removal Board
- Providing oversight of large-scale habitat restoration projects in the Chehalis River basin and the development of the Aquatic Species Restoration Plan within the Chehalis Basin Strategy

In addition to these existing actions, Region 6 staff will carry out the following additional actions to support steelhead habitat monitoring, maintenance, and/or restoration:

- Following each steelhead fishery season, Region 6 Fish Management will prepare a concise report summarizing the pre-season forecasts for both wild and hatchery steelhead, estimated sport harvest of hatchery steelhead, estimated mortality of wild steelhead, observed run timing for wild and hatchery steelhead, and estimated run size

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for wild and hatchery steelhead. On an annual basis, this report will be provided to the Lead Entities that cover coastal Washington WRIAs for their consideration in prioritizing new habitat related projects. Report sharing with will facilitated through collaboration with the Coast Salmon Partnership and/or other relevant organizations.

- WDFW will establish and/or improve information sharing pathways between Fish and Habitat Divisions in Region 6, which could include but is not limited to creating better connectivity between Habitat and Fish Geographic Information Systems (GIS) data layer, including those pertaining to HPAs, fish passage, and spawning ground survey reaches
- In collaboration with the WDFW Science Division, Region 6 Fish Management will pursue research relating steelhead habitat metrics to fisheries management with the goal of identifying the scale and nature of habitat restoration needed to help both wild and hatchery origin steelhead populations meet conservation and fishery objectives (Section 8.5).

3.5 Human Dimensions

WDFW's stated mission is to preserve, protect and perpetuate fish, wildlife and ecosystems while providing sustainable fish and wildlife recreational and commercial opportunities. Coastal steelhead managers recognize the enormous impacts that changes to those recreational and commercial opportunities have on Pacific coast communities and individuals who rely on fisheries for their livelihoods. As a result, Region 6 Fish Management will develop strategies to better understand the human dimensions of Washington's coastal steelhead fishery.

These strategies may include, but are not limited to, surveys sent to recreational fishery license holders or the general public, additional questions added to steelhead fishery creel surveys, and/or novel analysis of existing guide logbook and creel data. The strategies may be carried out through collaboration between WDFW Conservation Social Scientists, District and Area Biologists, Science Division, Fish Management, Communication and Public Engagement, and external entities such as NOAA and research universities. Research topics of interest include:

- Shifts in recreational angling effort given fishery closures and/or restrictions such as no fishing from a floating device and gear restrictions
- Recreational angler preferences about fishery regulations when multiple options are likely to meet management objectives
- Recreational angler and professional guide attitudes and preferences pertaining to the no fishing from a floating device rule
- Fishery demographics including county, state, and/or county of residence
- Local economic impacts of shifts in fishery regulations

4. Communications

Overall Strategy

This plan aims to increase the two-way flow of information regarding coastal steelhead angling, science, and management on the path toward developing balanced policies that integrate conservation objectives, stakeholder needs, and angling opportunities. As a part of that process, WDFW remains committed to expanding awareness of the science around coastal steelhead to instill a commitment toward supporting steelhead recovery. The primary objectives are to provide accurate and consistent information about coastal steelhead, expand partnerships and build legitimacy around coastal steelhead science and conservation and increase opportunities for stakeholders to engage in and contribute to the fisheries management process. These objectives will be pursued through **(1) media engagement, (2) online resources, and (3) public and targeted stakeholder meetings**.

4.1 Media Engagement

The Department will work with broadcast, print, and radio news outlets to increase public awareness about the scientific, communications, and co-management efforts that guide steelhead fisheries management. To increase transparency of the agency's scientific process, staff will invite media to observe and/or participate in fisheries monitoring protocols such as spawning ground surveys, tour scientific laboratories, and watch fieldwork associated with novel research. During these interactions, Department staff will describe how science is used to inform management policies. WDFW will create communications products, which can include news releases, blog posts, web content, or social media ahead of public engagement opportunities and to announce the availability of new coastal steelhead data on the agency's website. Additionally, the Department will explore opportunities to produce op-ed pieces and for staff to appear as guests on fishing-related podcasts. These media engagement actions will be crafted in collaboration with tribal co-managers and/or partner organizations where appropriate.

4.2 Online Resources

WDFW will maintain, create, and/or adapt online platforms to disperse and receive information about steelhead populations and the recreational fisheries that target them. Online information will be dispersed through social media, a fisheries landings website, and the Department's blog. The Department will also take public comments online. The public will also be invited to reach out directly to regional fisheries managers, whose contact information will be readily available online, to ask questions and provide feedback.

- **Social Media:** Staff will strategically use organic and targeted social media to increase the visibility of steelhead research and management. Other social media content could include posts highlighting current steelhead research, conservation efforts, monitoring, and angling. Additionally, Facebook "Event" pages will be created for public meetings. Where appropriate, social media content will be shared with partners, including prominent coastal steelhead-oriented groups, to amplify messaging.

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- **Landings Website:** The Department will launch and maintain a web page to provide the public with in-season recreational steelhead landings. This information will be updated weekly by district-level fisheries biologists based on catch record cards and creel surveys, where available. Additionally, staff will explore incorporating and interactive Tableau or ArcGIS dashboard to display data. Staff will include feature links to coastal steelhead information prominently on the Department's website during and prior to important public engagement milestones such as townhall meetings.
- **WDFW's Medium Blog:** Communications staff will provide the public with up-to-date information on pre-season planning before the recreational steelhead fishery using the Department's blog. To stimulate collaboration and ease of access to relevant information, the Department will consider facilitating guest blog posts written by partner organizations containing links to their websites and/or newsletters.
- **Public Comment Form:** Department staff will maintain an online form inviting members of the public to comment on and inquire about steelhead research and management. Links to the form will be available on social media, the landings webpage, and the Department's blog.

4.3 Stakeholder and Public Meetings

The Department will consider holding meetings with the public and stakeholders in advance of, during, and/or following the recreational steelhead fishery season. The timing and scope of these meetings will depend on evolving management strategies, the conservation status of target populations, and stakeholder requests. These meetings will include, but not be limited to, the following categories:

- **Public Townhalls:** Based on the precedent established prior to and during the 2020-2021 recreational steelhead fishery and positive feedback received in Region 6, the regional Fisheries Management team will consider holding a series of public meetings, virtual and/or in person, per year pertaining to the recreational steelhead fishery.
- **Partner and Co-manager Data-Sharing:** On an ongoing basis, Department staff will identify and follow through with opportunities to share data from sources including but not limited to recreational catch record cards, juvenile monitoring, redd surveys, creel surveys, and novel research with partner organizations. The objectives of this data-sharing include increasing the transparency of WDFW fisheries management processes, broadening awareness regarding the conservation status of coastal steelhead, and supporting steelhead research.
- **Briefings for Public Officials**: Staff will consider briefing the Washington Fish and Wildlife Commission, regional legislators, as well as local elected officials on the status of coastal steelhead fisheries and conservation efforts upon request or during one of several pre-planned meetings.

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4.4 Coastal Steelhead Advisory Group

As of August 2021, WDFW sought applicants for an ad-hoc advisory group to provide public perspectives and feedback the present plan. Developing this advisory group was one component of extensive outreach WDFW conducted to help guide the current and future management of steelhead stocks on Washington's coastal river systems. Advisors were selected based on their knowledge of steelhead fisheries and life history, willingness to engage in the management process, and their ability to communicate with fishery managers, affiliated groups, and other advisors. Twelve members were selected to join the group in the fall of 2021, and monthly or bi-monthly meetings began in February 2022. According to the 2021-2023 budget, the ad-hoc advisory group meetings culminated in December 2022, when the present plan was submitted to the legislature. The public can access more information about this advisory group, read meeting agendas and summaries, and watch recordings of all the group's meetings at https://wdfw.wa.gov/about/advisory/csag. The meeting summaries capture the diverse perspectives and ideas that were considered during the CSPIP development process.

5. Regional Management Plans

The SSMP states that a Regional Management Plan (RMP) should be written for each DPS of wild steelhead. Although this CSPIP makes progress towards the development of RMPs, comprehensively evaluating coastal steelhead management requires longer-term and more in-depth processes, including further quantitative analysis, negotiating co-manager agreements, and developing recovery plans for at-risk and/or declining wild steelhead populations.

WDFW seeks to increase the consistency of information contained within steelhead management plans statewide, however, the Southwest Washington and Coastal Olympic Peninsula wild steelhead DPS' are the only DPS' in the State of Washington that are not ESA listed. Under the ESA 4(d) rule, management entities are required to submit Fisheries Management and Evaluation Plans (FMEPs) to NOAA. Therefore, for the sake of consistency and comprehensiveness, WDFW intends to include all the information required for ESA mandated FMEPs in the RMPs for the southwest Washington and the coastal Olympic Peninsula. A list of required features associated with the ESA 4(d) rules for FMEPs can be found in *A Citizen's Guide to the 4(d) Rule for Threatened Salmon and Steelhead on the West Coast* (NOAA 2000). These coastal RMPs will build on the progress and guidelines established in this CSPIP. The thorough analysis and policy setting process required to develop RMPs will increase the likelihood that steelhead populations on the Washington coast will both meet conservation objectives and provide reasonable angling opportunities.

WDFW intends to include the following features in coastal steelhead Regional Management Plans:

- **Long-term coastal steelhead conservation objectives.** Conservation objectives may include extinction risk metrics but should go beyond this baseline to establish goals for supporting healthy and sustainable wild steelhead populations, not simply populations with a low likelihood of extinction. These conservation objectives should include goals and performance indicators for all VSP parameters, which may be used to define an "Ideal" in the Adaptive Management Framework (Table 2). WDFW should also work collaboratively with habitat Lead Entities, tribal co-managers, and stakeholder groups to establish habitat quality and quantity objectives, with the eventual goal of linking habitat metrics to fishery management through quantitative analysis.

Table 2: Theoretical framework for the inclusion of long-term conservation objectives and associated management actions pertaining to monitoring and evaluation, fisheries regulations, and hatchery operations in the Adaptive Management Framework within future Regional Management Plans for the Olympic Peninsula and Southwest Washington steelhead DPSs.

	Ideal	**Maintenance**	**Transitional**	**Emergency**
Regime Thresholds (Multiple VSP Parameters)				
Monitoring and Evaluation				
Fisheries Regulations				
Hatchery Operations				

- **Evaluation of harvest control rules through formal MSEs**. The SSMP did not evaluate how well existing escapement goals, nor the 10% allowable wild steelhead impact rate perform relative to management objectives. MSE can be used to overcome that shortcoming and identify which management strategy among a set of candidate strategies performs best in satisfying multiple biological and socio-economic objectives such as providing recreational and commercial harvest opportunities while ensuring the long-term population persistence or recovery of a population (Punt et al. 2016). MSE uses forward projections of population dynamics based on estimated parameters from a population dynamics model, such as an Integrated Population Model (IPM), to simulate the effects of different harvest strategies using Harvest Control Rules (HCRs). HCRs determine the total allowable fishing mortality based on stock status, for example from a pre-season run size forecast. Escapement goals are one type of HCR that are widely used to manage steelhead in Washington state, including coastal populations. Yet, the consequences of current management practices, or any alternative strategies, for fishing opportunities and conservation have rarely been evaluated, and escapement goals for coastal steelhead have not been reassessed since they were established in the 1980s.

To fill this critical knowledge gap, WDFW has embarked on a process of developing a Management Strategy Evaluation approach that can be applied to coastal steelhead and other populations. This will provide managers and policy makers with the information needed to set and implement harvest strategies that best achieve our mission to preserve, protect and perpetuate fish populations while providing sustainable recreational and commercial opportunities. As part of this process, a variety of HCRs can be designed and tested, including historical or MSY-based escapement goals, fixed harvest rate policies, abundance-based harvest rate tiers tied to estimated biological reference points, and many more, as determined by a policy process that involves co-managers and stakeholders. Information gained by the MSE can then be used to develop RMPs as outlined in the Statewide Steelhead Management Plan.

- **Expanded geographic scope**. This expansion would extend comprehensive evaluation of monitoring and evaluation, fisheries regulations, hatchery operations, habitat, and human dimensions of recreational steelhead fisheries outside the CSPIP's geographic scope but within the Coastal Olympic Peninsula and Southwest Washington DPS', including the rivers in the northwest portion of the Olympic Peninsula along the Strait of Juan de Fuca and those in the southern portion of southwest Washington along the Columbia River. Further cross-jurisdiction communications between WDFW Regions will be needed to determine how the Southwest Washington DPS' RMP may or may not fit in with the existing Lower Columbia Recovery Plan and Columbia River management strategies and FMEPs.

- **A description of the listed species and habitat that will be affected by the action**. This information should include fish distribution and abundance in the affected area and a description of the type, quantity, and quality of habitat in the affected area. Although coastal steelhead populations are not ESA listed, they have been petitioned for listing. Additionally, other listed species, such as bull trout and Ozette Lake sockeye, may be impacted by steelhead management. Population and habitat data should be collected for such species.

- **A comprehensive description of the environmental baseline**. This information should describe existing habitat conditions in terms of water quality, access, riparian areas, stream channels, flow, and watershed health indicators such as total impervious area and any existing high quality habitat areas. This CSPIP provides a high-level overview of habitat characteristics of coastal Washington streams, but more comprehensive environmental baseline should be collected and consolidated in future RMPs, in consultation between WDFW, Lead Entities, and habitat-oriented organizations.

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- **Anticipated short term and long-term impacts the action is expected to have on *O. mykiss* (including all life-cycle stages) and its habitat**. This description should include both positive and negative impacts and describe how any adverse impacts will be avoided, mitigated, or minimized. The anticipated short-term impact of management strategies in the CSPIP on wild adult steelhead is that they are more likely to meet escapement goals and thresholds for hatchery genetic impacts as designated in the SSMP. However, anticipated short-term impacts of those strategies on other steelhead life history phases and non-abundance VSP parameters (including spatial distribution, productivity, and diversity) have not been systematically evaluated, nor have long-term impacts. Therefore, a systematic evaluation of short-term and long-term impacts of management strategies on all life history phases of both hatchery and wild-origin steelhead should be a part of the RMP development process, along with guidelines for negative impact avoidance, mitigation, or minimization where appropriate. Carrying out MSEs would help to quantify these short- and long-term impacts, especially in terms of adult abundance relative to quasi-extinction thresholds at assigned levels of risk and/or other population conservation metrics.

- **A discussion of the likelihood that the RMPs will be implemented as described**. Some questions that would need to be answered are: What commitment has been made to carry out the action or program? Are the legal authorities needed to carry out the program in place? Is implementation funding available and adequate? Is staffing available and adequate? What is the schedule for implementation? If the program is currently being implemented, what is its record of implementation and effectiveness to date? WDFW has developed the CSPIP in response to a legislative budget proviso, but the Department's ability to follow-through with the plan depends on securing necessary funding from the state Legislature, ideally during the 2023-2025 budget biennium. This CSPIP includes budget projections for the 2023-2025 biennium, but the amount of funding required to maintain the management strategies presented in the CSPIP and future RMPs will fluctuate over time.

- **A program for monitoring both the RMP's implementation and effectiveness, including a schedule for conducting monitoring and submitting reports**. A preliminary timeline for reevaluation is included in the Implementation Timeline (Section 6), however, this process may be subject to change during the RMP development process, as determined through co-manager and stakeholder communications.

- **A method for using monitoring information to change actions when needed for adaptive management**. The Adaptive Management Framework within the CSPIP was designed to allow fisheries managers to change actions based on data gained through monitoring and evaluation. WDFW intends to carry this framework over from the CSPIP to RMPs, although the specific data inputs and changes in actions may be updated over time to account for possible changes in harvest control rules, conservation objectives, and data availability, among other factors.

6. Implementation Timeline

The implementation timeline outlined below depends on securing the necessary funding prior to the 2023-2025 fiscal biennium. Alternative or delayed funding would alter the implementation timeline. Ideally, coastal steelhead management actions would occur according to the following timeline:

- WDFW will initiate the Proviso Implementation Strategy no later than the 2023/2024 steelhead season according to the following actions:
    1. Classify each river system according to a specific management regime, as outlined in the Adaptive Management Framework
    2. Follow the Three-Step Regulation Process for determining recreational steelhead fishery regulations
    3. Communicate information pertaining to coastal steelhead fisheries management according to the guidelines presented in Section 4: Communications.
    4. Ensure that personnel and goods and services are available to support standard and adaptive monitoring and evaluation in all systems
    5. Re-scale hatchery releases based on HEAT Unit modeling and regime classification. Planning for this process should begin in the fall and winter of 2022 and continue through the fall of 2023.
- The following actions associated with the CSPIP require multi-year implementation processes. Each action is paired with a goal completion window:
    1. Develop post-season and in-season SONAR-based escapement estimation tools. Priority for SONAR monitoring will be given to rivers and streams with the greatest conservation need, as determined by a collaborative Region 6 SONAR working group. Initial site selection and initial deployment should be carried out no later than the 2023-2025 biennium, with the goal of developing the quantitative methods necessary for an efficient in-season tool during the 2025-2027 biennium.
    2. Develop and implement a collaborative human dimensions survey project to better understand fishery demographics, stakeholder perspectives/preferences, and economic impacts of regulation change to be carried out with a goal timeline of no later than the 2024/2025 steelhead fishery season.
    3. Develop Regional Management Plans through a co-manager process, including IPM-based MSEs and long-term conservation goals by the end of the 2025-2027 biennium. This process should be supported by extensive research into changes

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in CPUE, steelhead mortality, and sub-lethal steelhead impacts associated with steelhead fishery regulatory options.

4. Generate a pilot study, with associated quantitative analyses, linking habitat metrics to coastal steelhead fishery management during the 2025-2027 biennium, with the goal of implementing a usable tool during the 2027-2029 biennium.

- Systematic evaluations of the success of the CSPIP (and/or future RMPs) in supporting healthy steelhead populations and providing angling opportunity should be carried out every 5 years.
- Reevaluation of hatchery genetic impacts and smolt release scaling should be carried out at least every 5 years.

7. Budget Projections

The CSPIP is associated with a budget proposal intended for inclusion in the state's 2023-2025 biennium budget. The following information provides a summary of that budget proposal.

Problem Statement: Given their cultural, economic, and ecological significance, declines in coastal steelhead population abundance have highlighted the need to gather additional information and strategically manage fisheries to balance the availability of angling opportunities with conservation objectives. Carrying out that vision requires funding and resources beyond Region 6 Fish Management's current capacity.

Solution: The budget associated with this proposal will fund enhanced management and monitoring of coastal steelhead to establish estimates of total catch in all sport fisheries, in-season updates of population abundance, enhanced forecasting techniques, adaptive hatchery operations and improved public communication. Together this work will support sustainable fisheries on wild and hatchery steelhead on the Washington Coast consistent with the CSPIP (2022).

Budget Request: This budget proposal includes funds for personnel and good and services. The personnel salaries and benefits total $2.24 million annually for 21.3 full-time equivalents (FTEs), including indirect costs. Over 95% of the FTEs would be directly allocated towards increasing monitoring and evaluation capacity. The estimated need for goods and services, including vehicle costs, field equipment and maintenance, lab analysis to process genetic and age data totals $801,196 in the first year and $647,396 annually thereafter. In total, the biennium budget request is $5.9 million.

Failure to fund this plan would: (1) result in continued uncertainty regarding coastal steelhead fishery impacts and therefore potential fishery closures, (2) hinder the development of Regional Management Plans, including long-term coastal steelhead conservation objectives and Management Strategy Evaluations and (3) slow the pace of critical scientific research needed to support steelhead fishery management.

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Strategic Plan Strategy: Funding this proposal will improve the ability of Region 6 to address all four strategies of the WDFW 25-Year Strategic Plan (2020) including:

- Proactively address conservation challenges,
- Engage communities through recreation and stewardship,
- Deliver science that informs Washington's most pressing fish and wildlife questions, and
- Model operational and environmental excellence.

8. Critical Research

Data and knowledge gaps create challenges for developing fisheries management practices that support sustainable steelhead populations and angling opportunities. This section identifies some of the most critical research needs that, if funded and carried out, will directly inform and improve coastal steelhead management. The following are research topics explored in this section; however, the included topics should not be considered an exhaustive list of critical research needs:

- Sport Fishery Monitoring
- Marine Survival
- Juvenile Monitoring
- SONAR Monitoring
- Connecting Habitat Restoration to Steelhead Population Metrics
- Summer Steelhead

Additional critical research needs not detailed in this section include, but are not limited to:

- Resident and Anadromous O. mykiss Interactions
- Impact of Fisheries Regulations on CPUE
- Coastal Steelhead Fishery Human Dimensions
- Redds per Spawner Estimates in Redd-Based Escapement Calculations
- Evaluation of the March 15th Cutoff Date for Identifying Hatchery vs. Wild Redds
- Effectiveness of Conservation Hatchery Programs

8.1 Sport Fishery Monitoring

Fisheries managers need accurate and high-precision estimates steelhead mortalities during steelhead fisheries to meet management objectives, especially given wild steelhead population declines. To quantify those impacts, coastal managers have traditionally used paper catch record cards (CRCs) to estimate the harvest of hatchery fish and creel, literature, and/or CRC-based encounter rates to measure non-harvest mortality of wild fish in catch and release fisheries. Creel surveys have only been conducted in a few coastal watersheds, most notably in the Hoh River. However, these methods only produce post-season impact estimates and do not provide information on how well the fishery aligns with management objectives in-season. In fact, CRCs can take up to two years to process and produce useable data. As a result, coastal managers largely rely on tribal gillnet data to determine if steelhead runs are coming in higher or lower than expected. If runs appear to be lower than expected, managers will sometimes limit or close fisheries in-season out of conservation concerns. This reactive strategy is relatively imprecise and can cause managers to close fisheries due to the high degree of uncertainty around impacts. Therefore, Region 6 Fish Management has prioritized the development in-season fishery update tools that produce accurate, high-precision impact estimates and allow limited fisheries to stay open even when allowable mortality targets are narrow.

Multiple sport fishery monitoring techniques could allow managers to quantify fishery impacts in season, including electronic catch record cards, creel surveys, and associated creel validation techniques such as test fisheries, drone-based effort counts, game cameras etc. Perhaps the easiest and most cost-effective method would be to transition paper CRCs to an electronic system and add a question about released fish. Currently, the paper CRC only asked about harvested fish, not those that were encountered and released. An electronic system that accounts for harvested and released fish would allow for real-time accounting of fishery impacts, especially if compliance estimates were calculated and used as correction factors. CRC data could be validated through limited creel surveys or test fisheries. In the absence of electronic CRCs recording released fish, creel surveys could be more broadly applied to monitor fisheries. Over the past few years, WDFW developed a standardized study design approach for conducting on-site creel surveys that are rooted in established methods (Pollock 1994) and an array of supporting products, including a creel schedule generator, cloud-based electronic data collection, a statewide creel database, and script-based analyses. The Department seeks to further streamline its creel analysis procedures by using a Bayesian state space model to generate daily and/or weekly impact estimates that would be summarized online for the public to view. This work will continue through collaboration between Fish and Science Divisions across multiple Regions.

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8.2 Marine Survival

Scientists and managers are concerned that poor marine survival of Pacific Northwest steelhead may contribute to their declining abundance and lack of recovery (Ward 2000, Moore et al. 2015, Kendall et al. 2017). Steelhead stocks are often monitored less than their neighboring salmon stocks, including for marine survival estimates. Kendall et al. (2017) documented patterns of adult abundance and marine survival (as the number of smolts that survived to return as adults, so called “smolt survival”) in BC, Washington (including coastal stocks), and Oregon. Marine survival is an important driver of adult steelhead population abundance and thus better understanding marine survival trends over time and among populations, in addition to biotic and abiotic environmental variables related to marine survival, can help with steelhead population abundance forecasting and population projection methodologies.

8.2.1 Estimation of steelhead smolt survival rates

WDFW estimated smolt survival rates for 13 hatchery stocks and 2 wild populations of coastal Washington steelhead (Table 3). Staff gathered data from WDFW's hatchery databases and other sources including the estimated number of hatchery or natural-origin smolts emigrating to the ocean (*S*), the estimated number of hatchery- or natural-origin adults returning to spawn (*N*), the estimated number of hatchery- or natural-origin adult fish caught (*C*), and the estimated age composition of the adults. Using the adult age data, WDFW assigned the adults to a given ocean entry year (OEY) cohort (*i*). The Department compared the number of total adults in each cohort ($N_i + C_i$) to the number of smolts from that OEY cohort (S_i) to estimate the smolt survival for that cohort:

Eq. 1 $$Smolt\ survival_i = \frac{N_i + C_i}{S_i}.$$

Table 3: Coastal steelhead stocks and populations, including run timing, for which smolt survival rates have been estimated, the number of ocean entry years (OEY) for which data are available, the first and last OEY with data, and the minimum and maximum values seen. 1. For hatchery-origin adults, estimates of the number of fish spawning in the wild are not available, and therefore N only included returns to the hatchery. This can lead to an unknown amount of negative bias in smolt survival rates for hatchery-origin stocks.

Stock/population	Origin	OEY range	Smolt survival rate range	Number of years with data
Bingham Creek winter	Hatchery	1993-2017	0.11-3.52%	25
Humptulips River summer	Hatchery	1994-2017	0.34-4.52%	20
Humptulips River winter	Hatchery	1977-2018	0.18-4.40%	42
Naselle R. early winter	Hatchery	1985-2018	0.08-4.61%	34
Newaukum River winter	Hatchery	2003-2017	0.00-9.02%	14
North River and Smith Creek winter	Hatchery	1993-2018	0.06-3.06%	18
Quillayute River summer	Hatchery	1994-2017	0.52-10.60%	24
Quillayute River winter	Hatchery	1982-2017	1.48-18.26%	36
Skookumchuck River winter	Hatchery	2001-2018	0.97-6.83%	18
Upper Chehalis River winter	Hatchery	2002-2018	0.06-1.70%	13
Willapa River winter	Hatchery	1985-2018	0.24-3.53%	34
Wynoochee River summer	Hatchery	1994-2017	0.59-6.38%	24
Wynoochee River winter	Hatchery	1993-2017	0.49-3.67%	25
Bingham Creek winter	Natural	1997-2018	2.75-17.89%	22
Queets River winter	Natural	1981-2013	3.96-20.66%	31

8.2.2 Smolt survival trends

Coastal steelhead smolt survival time series have varied greatly over time (Figure 4) and among stocks/populations (Figure 5). Annual smolt survival values ranged from less than 0.1% to 21%,

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with an average of 3.6% among stocks/populations. Smolt survival rates from natural-origin fish were consistently higher than from hatchery-origin fish. For both groups, average smolt survival rates were higher in the 1980s than in later time periods. For hatchery-origin stocks, recent average marine survival values have declined from higher rates seen in the early 2000s.

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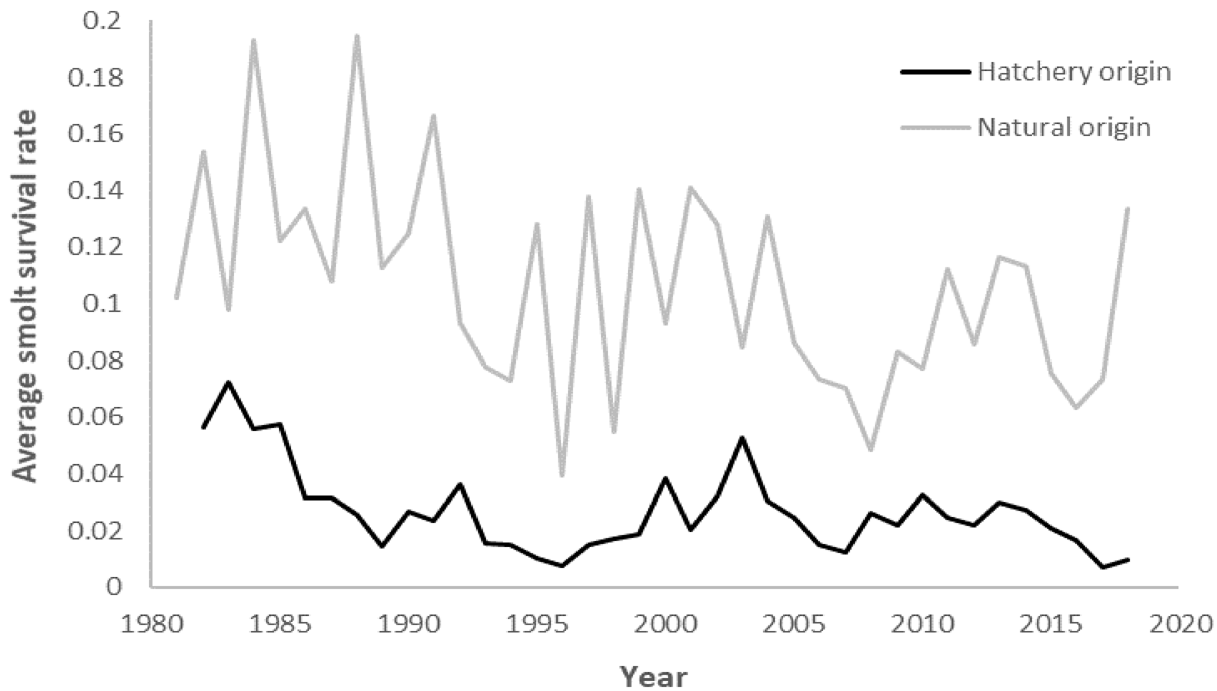

Figure 4: Average coastal Washington steelhead smolt survival rate for the 13 hatchery-origin stocks and 2 natural-origin populations between the early 1980s and 2018.

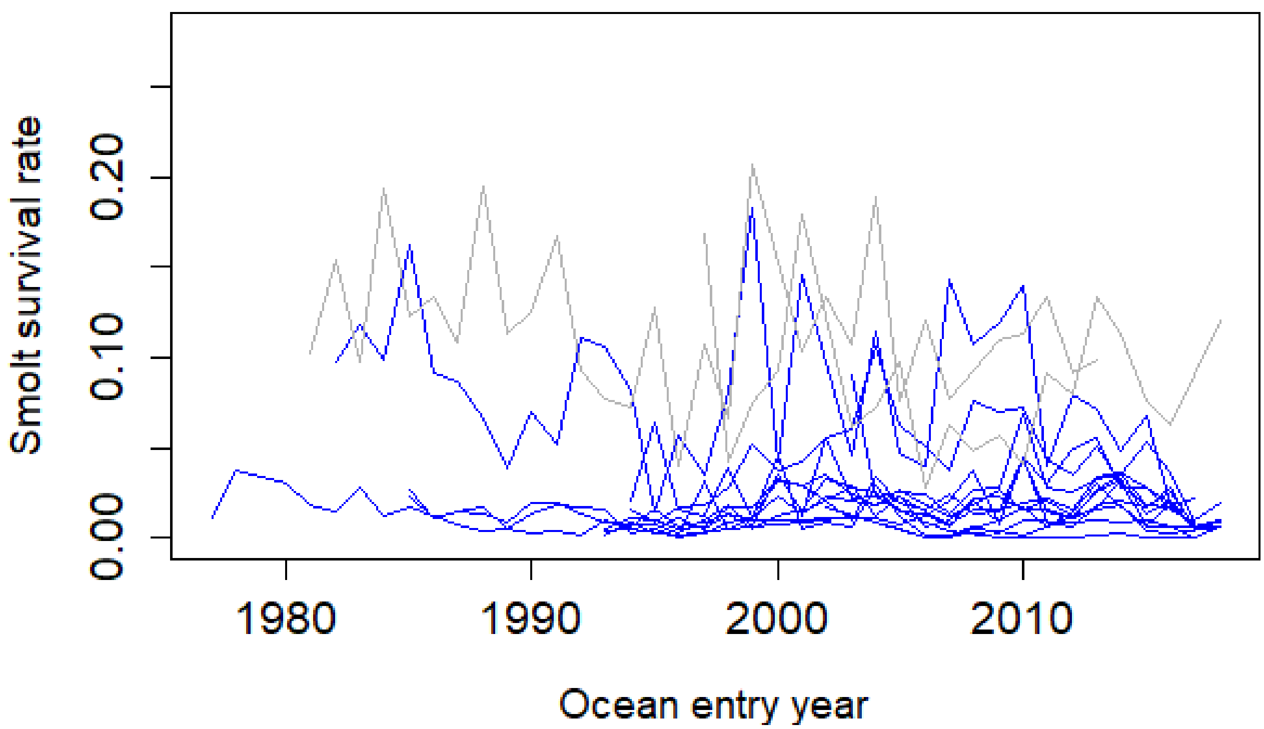

Figure 5: Time series of steelhead smolt survival rates for individual hatchery-origin populations (blue lines) and natural-origin populations (grey lines) between the early 1980s and 2018.

Smolt survival data on coastal Washington natural-origin steelhead populations are lacking. Collecting data from additional populations would help scientists and managers to better understand variation among populations and future trends. Variation in steelhead marine survival impacts the number of adult fish present within commercial and recreational fisheries and therefore the development of fisheries regulations that limit impacts to wild fish and provide opportunity within management objectives. Currently, WDFW manages coastal steelhead fisheries relative to watershed-specific escapement goals. Escapement goals indicate the number of adult spawners that should "escape" the fishery and reach the spawning grounds to theoretically ensure sustainable steelhead productivity within those river systems.

Lower rate of marine survival for wild steelhead since the 1980s, and potentially decreasing trends since the early 2000s suggested by hatchery-origin smolt survival rates, suggest that more adult spawners must reach the spawning grounds to increase the likelihood of population sustainability over time. Lower marine survival also indicates that escapement goals are less likely to be met, even in the absence of fisheries impacts. Scientists and fisheries managers will continue to track marine survival rates and evaluate the need to adjust allowable impacts of fisheries on wild steelhead populations according to shifts in marine survival.

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8.3 Juvenile Monitoring

Juvenile monitoring of coastal steelhead is a critical research need because annual abundance estimates are required for life cycle modeling and for understanding factors that limit population abundance. For example, quantifying variability in juvenile abundance contributes to better understanding of population growth rate during both freshwater and marine phases (e.g., smolt-per-adult production and smolt-to-adult returns) which is important for determining conservation status. Juvenile abundance estimates can also be used to forecast age-specific adult returns and set management objectives, particularly during years of low and high abundance. Juvenile monitoring can also help characterize a system's carrying capacity and identify potential bottlenecks during critical life stages to help target areas for restoration. Information gathered from juvenile monitoring also provides details on life history diversity (age, size, run timing, and origin) and helps identify successful life history strategies in a changing climate. Currently, juvenile monitoring of coastal steelhead only occurs in Grays Harbor. Data gaps remain in the following coastal systems: Willapa Bay, Humptulips, Quinault, Queets, Hoh, and Quillayute.

Statewide, rotary screw traps (Figure 6) are used to estimate annual juvenile abundance, including in the Grays Harbor system (West et al. 2021). Rotary screw traps capture juvenile steelhead as they emigrate from natal freshwater habitat and make their way to the Pacific Ocean. The traps consist of three main components: a rotating cone, a submerged livebox, and floating pontoons. As downstream migrating fish enter the mouth of the rotating cone, they are guided into the livebox where they are held prior to being sampled and released. The pontoons provide flotation for the cone and livebox assembly. Juvenile steelhead captured by the rotary screw trap are counted, weighed, measured for length, and often have scales and fin tissue sampled for age and genetic analyses. Additionally, Passive Integrated Transponder, or PIT tags, are implanted in some of the fish and population abundance estimated from mark recapture studies (Volkhardt et al. 2007; Bonner and Schwarz 2011). Annual abundance estimates allow biologists to track how populations are performing and to evaluate the efficacy of management and restoration actions on population viability.

Figure 6: Rotary screw trap used to estimate juvenile steelhead abundance originating upstream of river mile 52 on the Chehalis River of Grays Harbor showing cone, livebox (covered), and floating pontoons. (Photo: D. Olson)

A specialized crew consisting of a project lead biologist and two to three seasonal technicians are required to conduct juvenile monitoring work on an ongoing basis and generate annual estimates of abundance at a particular location. The work requires an initial investment in a trap but can be supported as part of annual monitoring and evaluation. Rotary screw traps only sample a portion of the river; therefore, the trap's efficiency must be regularly estimated to extrapolate from the collection totals to the estimated size of the population. Additionally, several assumptions must be tested during operation to ensure accurate data collection. For example, traps must sample throughout the duration of the outmigration period, which can be challenging during the springtime when flows are high. Unbiased estimates also require that marks are not lost, marking does not affect behavior, initial capture probabilities are homogenous, recaptured fish are completely mixed with unmarked fish, and mark status is reported correctly. Trapping crews conduct several trials throughout the season to reduce the probability of any assumption violations and try to reduce the probability that fish handlingaffects behavior or survival.

Estimates of juvenile steelhead abundance and life history diversity recorded in databases and presented as annual reports will be incorporated into the existing management framework and be used to forecast adult returns and assess population viability. The work addresses key scientific and management data gaps related to the steelhead life cycle. Combined with robust estimates of adult abundance as part of a fish-in and fish-out package, juvenile monitoring helps identify factors limiting the long-term survival and productivity of coastal steelhead populations consistent with WDFW's mission to preserve, protect and perpetuate fish, wildlife and ecosystems while providing sustainable fish and wildlife recreational and commercial opportunities.

8.4 SONAR Monitoring

High frequency multibeam sound navigation and ranging (sonar) technology has the potential to provide Region 6 Fish Management with a non-invasive method to estimate adult steelhead escapement in Washington's coastal rivers. Sonar offers several advantages over traditional escapement estimation methodologies such as spawning ground surveys and weir counts. First, sonar allows researchers to continuously record sonographic images of migrating fish 24 hours a day, regardless of turbidity, darkness, or other low visibility conditions (Wei et al. 2022). Second, researchers can use those images to enumerate migrating fish and record their movement direction, speed, length, and behavior without the need for handling, walking through spawning grounds, or other physical interference. However, translating sonar-generated fish counts into species specific escapement or runsize values requires data on species composition that is often collected through tangle netting. Tangle netting does interfere with natural fish behavior and require handling. Nonetheless, sonar itself offers a non-invasive approach, and other non-invasive approaches to determine species composition are available, including observation of tail beat frequency and size class distribution. Additionally, researchers have found counting salmonids using sonar to be as accurate as visual counts using an enumeration fence (Holmes et al. 2006) and less biased than traditional methods such as weir counts and spawning ground surveys (Baumgartner et al. 2006).

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In coastal rivers where fisheries are closed due to low steelhead abundance, the non-invasive nature of sonar could be especially beneficial to steelhead populations as either an alternative to spawning ground surveys or as a supplemental tool to validate escapement values. In rivers with active fisheries, sonar could act both as a supplemental post-season escapement estimation tool and potentially as an in-season update tool. However, technological advancements in sonar data processing within WDFW would be required to use sonar as an in-season tool. Although sonar technologies, especially dual frequency identification sonar (DIDSON) and adaptive resolution imaging sonar (ARIS), have previously been used to assess salmonid abundance and other population metrics across western North America and beyond (e.g. Woodey 1984, Banneheka et al. 1995, Xie et al. 2002, Moursund et al. 2003, Pipal et al. 2010, Coyle and Reed 2012, Metheny and Duffy 2014, Peters et al. 2022), WDFW-directed efforts to carryout similar work in Region 6 have thus far been unable to generate in-season nor post-season escapement steelhead escapement estimates.

Two such efforts include the utilization of ARIS units on the Hoh and Dungeness rivers. Although those projects provided agency staff invaluable experience with how to install, operate, and manage sonar devices, they were not able to reach their full potential due largely to limited staff resources and technical support. Both projects were supplemental to the full-time workloads of existing agency personnel. That lack of available bandwidth led to difficultly in managing the many challenges associated with running a sonar device and generating useable escapement values from the resulting data. Some of the challenges that arose included selecting sites where the units would be secure and effective under variable environmental conditions, accessing consistent power supply, dealing with potential equipment theft and vandalism, making frequent adjustments to the unit's position as water levels changed, and securing staff time to review sonographic imagery and conduct data analysis. The time required to manually review imagery was perhaps the greatest limiting factor to generating escapement estimates. Given advancements in automated data processing, as demonstrated by Ghobrial 2019, Kulits et al. 2020, Helminen and Linnansaari 2021, Connolly et al. 2022, and Wei et al. 2022, among others, technically trained agency staff would be able to review sonar imagery in a fraction of the time that was previously required.

Moving forward, WDFW intends to create a dedicated Region 6 sonar working group whose primary responsibilities would be to generate post-season and potentially in-season adult salmonid escapement estimates as well as develop automated data processing techniques. This work would be caried out through a collaboration between Region 6 Fish Management, WDFW Science Division, tribal co-managers, and Olympic National Park. Specifically, the working group would be made up of a new team of WDFW biologists and technicians, supported by multiple stakeholders and the technical expertise of existing agency staff. The budget associated with the CSPIP would fund the group's steelhead focused activities, especially during wild summer and winter steelhead spawning season. Additional funding would come from associated projects focused on other species as part of a holistic vision of science-based fisheries management. Decisions about where and when to place individual units would be made through a collaborative decision-making process within the working group, with an emphasis on monitoring areas with the highest conservation and management concerns. For steelhead, these areas would align with the areas that are in either the Emergency or Transitional management regimes, as determined through the Adaptive Management Framework within the CSPIP (Table 1). This work would become an integral part of long-term adult salmonid monitoring on Washington's Pacific coast.

8.5 Connecting Habitat Restoration to Steelhead Population Metrics

Freshwater habitat protection and restoration constitute essential tools for increasing the likelihood of sustainable wild steelhead populations and angling opportunities. Restoring habitat quality and quantity through activities such as gravel augmentation, riparian planting, adding woody debris to streams, road improvements to reduce sediment runoff, and migration barrier removal, among other actions, have the potential to increase the productivity of steelhead populations (Roni et al. 2002, 2008, 2021; Bernhardt et al. 2005; Beechie et al. 2015, 2021). Evidence suggests that combinations of these actions could increase wild steelhead early life history rearing capacity by 107% (Beechie et al. 2015) to 125% (Roni et al. 2010). However, within WDFW Region 6 and more broadly across the state, habitat restoration has not been explicitly linked to fisheries management, including hatchery production. This disconnect is due in part to the internal structure of the Department, whereby Fish Management is generally responsible for fisheries management and hatchery operations, Science Division works on limited habitat restoration projects, and Habitat Division facilitates barrier removals and habitat-related construction permitting.[7] However, emerging quantitative methods provide the potential to systematically evaluate the type and magnitude of habitat restoration actions necessary to meet fisheries management and conservation goals by estimating the number of additional fish that could be produced through specific actions at the watershed level.

That quantitative tool could be developed by combining several pre-existing models: an integrated population model (IPM) based management strategy evaluation (MSE) currently under development within WDFW Science Division and the Habitat Assessment and Restoration Planning (HARP) model developed by Beechie et al. 2021 and Jorgensen et al. 2021 (NOAA Fisheries website). The IPM-based MSE allows managers to evaluate the impact of a suite of harvest control rules on wild steelhead populations against management objectives, which could include conservation and/or allowable extinction risk goals, as determined through the co-management process. The IPM uses a lifecycle-based stock-recruit model that assesses steelhead productivity. The HARP model allows managers to estimate the impact of specific types of habitat change (linked to potential restoration activities) at multiple spatial scales on steelhead productivity and population abundance. The HARP model consists of three steps: GIS-based historical habitat reference analysis, contemporary habitat reference through habitat

[7] This paragraph describes WDFW's habitat related activities, but WDFW is just one of multiple actors that plan and carry-out habitat related activities. Overall, salmonid habitat restoration projects are selected and carried out by local Lead Entities, as outlined in the legislative Statewide Salmon Recovery Strategy (RCW 77.85).

surveys, and life-cycle modelling. Theoretically, resultant habitat-change based productivity values could be used as input parameters in the MSE to determine which harvest control options might allow for the attainment of management objectives under different restoration scenarios.

Developing and maintaining a quantitative tool linking restoration activities to fisheries management options would require significant funding (an initial estimate of $250,000 per watershed initially) and collaboration between Science Division, Fish Management, tribal co-managers, NOAA, and habitat Lead Entities, among other partners and stakeholders. After habitat restoration projects were completed, ongoing fish in-fish out (FIFO) monitoring would be necessary to empirically evaluate the success of those activities in increasing steelhead productivity and/or population abundance. This monitoring would need to be completed before fisheries management activities (such as recreational fisheries regulations and hatchery operations) were altered, as theoretical models need to be tested.

A lower-cost option to prioritizing habitat restoration activities would be to utilize pre-existing Intrinsic Potential (IP) models (From Habitat Intrinsic Potential Modeling of Selected Streams of the Outer Washington coast for Anadromous Salmonid Fish 2021). These models evaluate persistent geomorphic features using GIS relative to fish-habitat relationships to determine relative salmonid habitat suitability. This allows entities planning restoration activities to focus their efforts on areas with the highest relative habitat suitability. This method is similar to the relatively coarse Potential Parr Production method (Gibbons et al. 1985) that was used to develop wild steelhead escapement goals on Pacific coast streams in the 1980s. Opting for an IP approach would not provide a direct pathway for integrating potential habitat restoration into fisheries management decisions. Additionally, IP models are unable to estimate the increased productivity and population abundance that would result from restoration activities and how those would affect future abundances and alternative harvest strategies. These limitations could contribute to the persistence of insular habitat activities both within and outside WDFW.

8.6 Summer Steelhead

Life history diversity among steelhead, including variations in run timing, increases their adaptability and overall population viability. Therefore, effective steelhead management must consider and account for both summer and winter runs to increase the likelihood of protecting and perpetuating runs. Unfortunately, very little scientific literature nor data exists on the nine wild populations of summer steelhead on Washington's Pacific coast: the Calawah, Clearwater, Hoh, Queets, Quillayute/Bogachiel, Quinault, Sol Duc, Chehalis, and Humptulips populations. In fact, genetic data availability, which provides useful insights into summer steelhead populations, was the lowest for the Olympic Peninsula and Southwest Washington steelhead DPSs as of 2018, at 16.1% and 21.1% respectively (Cram et al. 2018). This data gap makes it difficult to manage fish stocks in a manner consistent with maintaining the full expression of steelhead life history strategies. WDFW currently lacks sufficient data to evaluate short- and long-term population trends, extinction risk, or fishery impacts for coastal summer steelhead populations (Cram et al. 2018).

Given this critical research, Region 6 Fish Management will pursue a multifaceted summer steelhead monitoring and evaluation strategy designed to gather data on all VSP parameters (abundance, distribution, diversity, and productivity) using multiple techniques: snorkel surveys, acoustic telemetry, electrofishing, and genetics. Genetic data will be attained through fishery sampling, especially from tribal gill nets and creel surveys, to understand relative freshwater entry run timing of summer and winter steelhead. More fine-scale information on run timing, spawn timing, and spatial distribution will be acquired using acoustic telemetry. Snorkel surveys will be used to enumerate adult steelhead in freshwater pools prior to spawning, while electrofishing of steelhead fry coupled with genetic sampling will be used to understand spawn timing, juvenile run timing, and distribution. Multi-year data sets on adult and juvenile abundance will be used to estimate system-specific productivity. In terms of the timeline for implementation for various aspects of this project, priority will be given to analyses that can be conducted using existing data, samples, and/or equipment, especially genetic testing of fin clips from tribal gill net fisheries and utilization of agency-owned acoustic telemetry tags and receivers.

Although information of Washington's coastal steelhead is sparse, researchers have studied summer steelhead in other west coast areas. That research has found that summer steelhead enter freshwater in a sexually immature state and hold for 6-12 months prior to spawning (Behnke 2002), whereas winter steelhead migrate into freshwater when they are more sexually mature and spawn soon after freshwater entry. The benefits of early freshwater entry may include increased access to spawning habitat and relatively low energetic demands of dormancy in river habitats (Robards & Quinn 2002). Summer steelhead tend to enter river systems during relatively low flows and hold in lower watersheds until flows increase in the fall, winter, and early spring when they move farther upstream (Briggs 1953). In coastal areas, summer steelhead often scale waterfalls and other barriers that are impassable to salmon and winter steelhead during their upstream migration (Cram et al. 2018). As a result, summer steelhead tend to spawn farther upstream than winter steelhead, limiting interbreeding through spatial separation. Evidence suggests that even in instances when summer and winter steelhead spawning overlaps spatially and temporally, the two phenotypes avoid interbreeding (Smith & Northcote 1969; Arciniega et al. 2016). Steelhead run timing is likely associated with genetics; several studies have documented a strong association between GREB1L gene region and migration timing in a coastal subspecies of steelhead (*O. mykiss iridues*) (Hess et al. 2016, Prince et al. 2017, Ford et al. 2020). WDFW will explore the methodologies previously employed to study summer steelhead and modify them as necessary to meet the immediate data needs for coastal populations.

8.7 Coastal Steelhead Human Dimensions

Social science research explicitly focused on the human dimensions of coastal steelhead is limited, with perhaps the exception of economic analyses (Anderson and Fonner 2021). This limitation demonstrates critical social science research gaps and needs that can be remedied by future research. Known previous research has looked at anthropologic activities and their impacts on coastal (winter) steelhead (among other coastal salmonids) along the West Coast of the U.S. (Mrakovcich 2006). According to Mrakovcich (2006), urbanization, agriculture, and dams all pose series threats to winter steelhead stocks. Conversely, the presence of tribal lands and watershed groups had positive impacts on winter steelhead, while more research was determined to be needed to understand the impacts of hatcheries (Mrakovcich 2006) more thoroughly. Overall, Mrakovcich (2006) noted that the more anthropogenic or human activities within a watershed, the worse the status of salmon stocks, including winter steelhead. The negative impacts of human-built coastal infrastructure have been a noted concern for coastal steelhead elsewhere (Crozier et al. 2021; Moore and Berejikian 2022). Moore and Berejikian (2022) highlighted the negative impacts of other coastal infrastructure (Hood Canal Bridge in Puget Sound) on steelhead smolt behaviors and predation patterns. Similarly, Crozier et al. (2021) illustrated the negative impacts of climate change and anthropogenic factors, like infrastructure (e.g., dams) on coastal steelhead. According to Crozier et al. (2021), climate change impacts, like stream temperature, sea surface temperature, and ocean acidification threaten coastal steelhead, as do anthropogenic factors, such as migration barriers, habitat degradation, and hatchery influence.

While the aforementioned literature may be limited, some notable human dimensions have already been documented, including negative and positive anthropogenic activities that impact coastal steelhead, like those associated with human-built infrastructure. Understanding these impacts is integral to conservation and fisheries management; however, more social science research is needed to better understand people-steelhead interactions and inform coastal steelhead management. For example, more research is needed in order to better understand: (1) anglers' management or regulatory preferences, including potential willingness to pay or loss aversion associated with steelhead conservation policies or actions; (2) coastal communities' dependence on steelhead for cultural, social, economic, subsistence, health/wellbeing, and spiritual purposes; (3) anglers' recreational activities and economic behaviors associated with steelhead; (4) steelhead conservation and environmental justice; and (5) communities' environmental or stewardship attitudes and behaviors associated with improving steelhead stocks. Such research is aligned with conservation social sciences and natural resource economics more broadly, including those associated with fisheries management and conservation more broadly (Ommer et al. 2009; Piennar et al. 2017; Lovie et al. 2018; Bennett et al. 2018; McDonald et al. 2020). The lack of clarity and data associated with those topics limits agency knowledge associated with steelhead fisheries management. For example, the lack of data and information on steelhead conservation and environmental justice can negatively impact management, decision-making, and local communities, particularly those

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communities most dependent on steelhead for their wellbeing or even livelihoods. Additionally, further understanding of anglers' management or regulatory preferences can assist WDFW and other key decision-makers with best gauging anglers' (or others') responses to regulatory or management change.

Depending on prioritization, funding, capacity, time, feasibility, and resources, multiple or combined social science studies could be designed to address the above-mentioned human dimensions' research topics (among others that may arise). For example, community-based (e.g., place-, partner- or stakeholder-based) focus groups, surveys, and/or interviews could be conducted, including by adding additional questions or even a QR code (to another survey) to already conducted WA creel surveys. Such methods have been used prior to help address similar or complementary fisheries and other conservation topics. Potential challenges include community contention, relevant partner support and interest, timing and capacity, and funding limitations. Future funding for such research could be identified both internally and externally; however, large-scale external funding for fisheries social science research may be limited. One mechanism to address potential challenges or limitations is through collaborative pilot studies that leverage time, capacity, funding, and overall support for short periods of time that could also produce outputs that can be used to help justify or legitimize future projects or funding applications. Due to current known limitations and gaps, it is difficult to concretely specify and prioritize which research projects will take precedence; however, additional dialogue and collaboration with pertinent community and fisheries partners, along with WDFW staff, can assist with those integral next steps.

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9. River Specific Supplements

WDFW recreational steelhead fisheries management activities in the major river systems of Willapa Bay, Grays Harbor, and the coastal Olympic Peninsula will be carried out in accordance with the guidelines detailed in the Proviso Implementation Strategy (Section 3). The following River Specific Supplements provide additional information and guidelines pertaining to Monitoring and Evaluation, Fisheries Regulations, and Hatchery Operations for each major river system.

9.1 Willapa Bay

As the second largest estuary on the west coast of the United States, Willapa Bay supports both biodiverse ecosystems and economic activities, including shellfish aquaculture and commercial fishing, in addition to populations of wild and hatchery origin steelhead. Numerous rivers flow in to Willapa Bay, including the Willapa, Naselle, Nemah, North, Niawiakum, Palix, Cedar, and Bear rivers. The Willapa Bay drainage falls within Water Resource Index Area (WRIA) 24. Industries that impact salmon and steelhead habitat that area include commercial forestry, agriculture, and livestock grazing. The local lead entity in the Willapa basin is called the Willapa

Bay Lead Entity, which is coordinated by the Pacific Conservation District. Traditionally, WDFW manages the recreational steelhead fisheries in these rivers in combination, with a single escapement goal for all wild steelhead that enter Willapa Bay. However, the Department is currently evaluating the potential effectiveness of using river-specific escapement goals within the Willapa Bay area to allow for more nuanced fisheries management, both in terms of identifying steelhead population segments with the greatest conservation needs and providing fisheries opportunity where possible.

The most recent WDFW escapement goal for Willapa Bay wild steelhead is 4,206 fish (down from 10,000 prior to 2013), and the population has only met that goal once in the past 10 years (2012/13-2021/22). During that period, the average estimated escapement and run size of wild fish has been 3,136 and 3,243, respectively (Figure 8). Monitoring indicates that Willapa Bay rivers currently do not support populations of summer-run wild steelhead. Willapa Bay wild steelhead population trends are more difficult to discern than other systems due to the relatively short timeseries of runsize and escapement data (1995/96-2021/22) compared to other coastal systems for which WDFW has data going back to the 1970s. For more detailed information about tributary-specific wild steelhead population trends and extinction risk assessment as of 2018, see Cram et al. (2018). WDFW intends to conduct in-depth analyses of the status of coastal steelhead populations and generate long-term conservation objectives during the development of RMPs (Section 5), pending the availability of sufficient funding.

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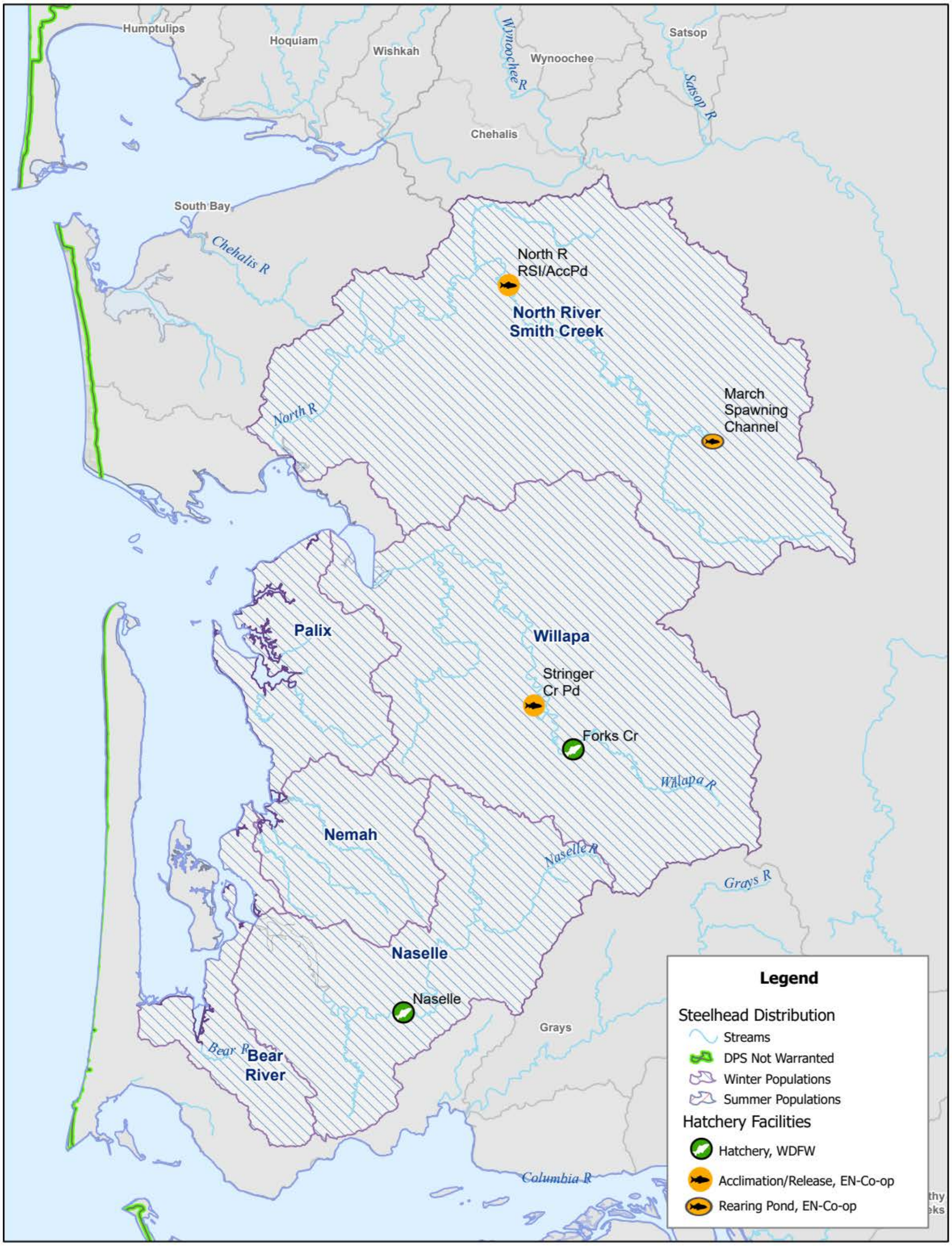


Figure 7: Map of the Willapa Basin

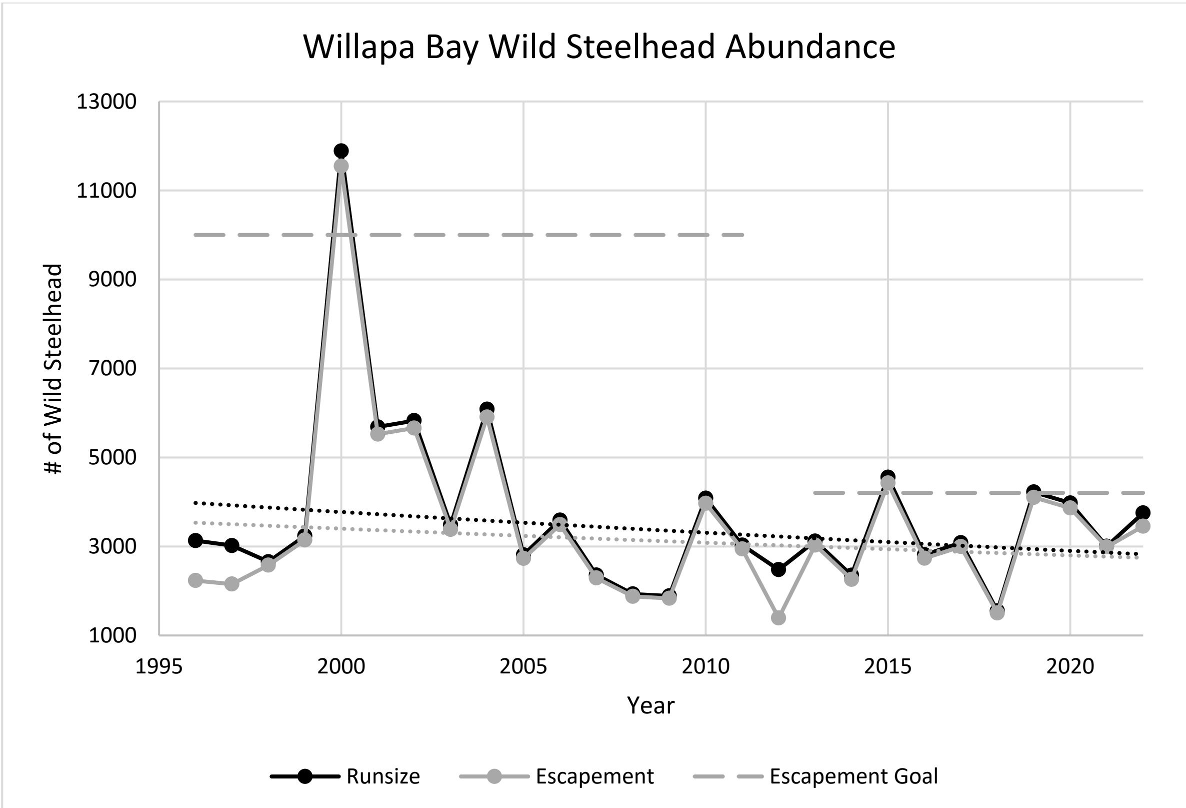


Figure 8: Willapa Bay wild steelhead runsize and escapement between the 1995/96 and 2021/22 recreational steelhead fishery seasons. The dashed line indicates the escapement goal, which was reevaluated in 2013 and changed from 10,000 to 4,200 fish. The dotted lines show fitted exponential trendlines for runsize and escapement.

9.1.1 Monitoring and Evaluation

Like many of Washington's coastal systems that support wild and hatchery origin steelhead, monitoring and evaluation activities in the rivers that flow into Willapa Bay have been limited, especially given the lack of resources and tribal co-managers. Limited monitoring and evaluation have resulted in data gaps, especially related to population genetics, wild steelhead age structure, wild smolt to adult returns (SAR), and recreational fishery impacts. The Proviso Implementation Strategy outlines a pathway to make significant steps towards filling these data gaps, both by increasing the baseline of monitoring and evaluation across the board, and by allowing for creel-based sport fish monitoring and increased spawning ground survey and/or SONAR coverage as determined by the Adaptive Management Framework (Table 1).

Forecast Methods

WDFW is currently in the process of applying new quantitative analysis techniques to forecast future adult wild steelhead spawner abundance both one year ahead and in the long-term using ensemble timeseries modeling and IPMs, respectively. As an example, the ensemble timeseries model was applied to combined Willapa Bay data to produce a forecast for the 2021/22 season after the season. This product allows managers to assess ensemble timeseries model performance compared to other methodologies. The best performing model for Willapa Bay was stack weighted and produced a forecast of 3,690 fish (95% CI 2,124-6,434) for the 2021/22 fishing season. The performance of the model against calculated post-season runsize estimates was evaluated over ten years prior to the 2021/22 season (Figure 9).

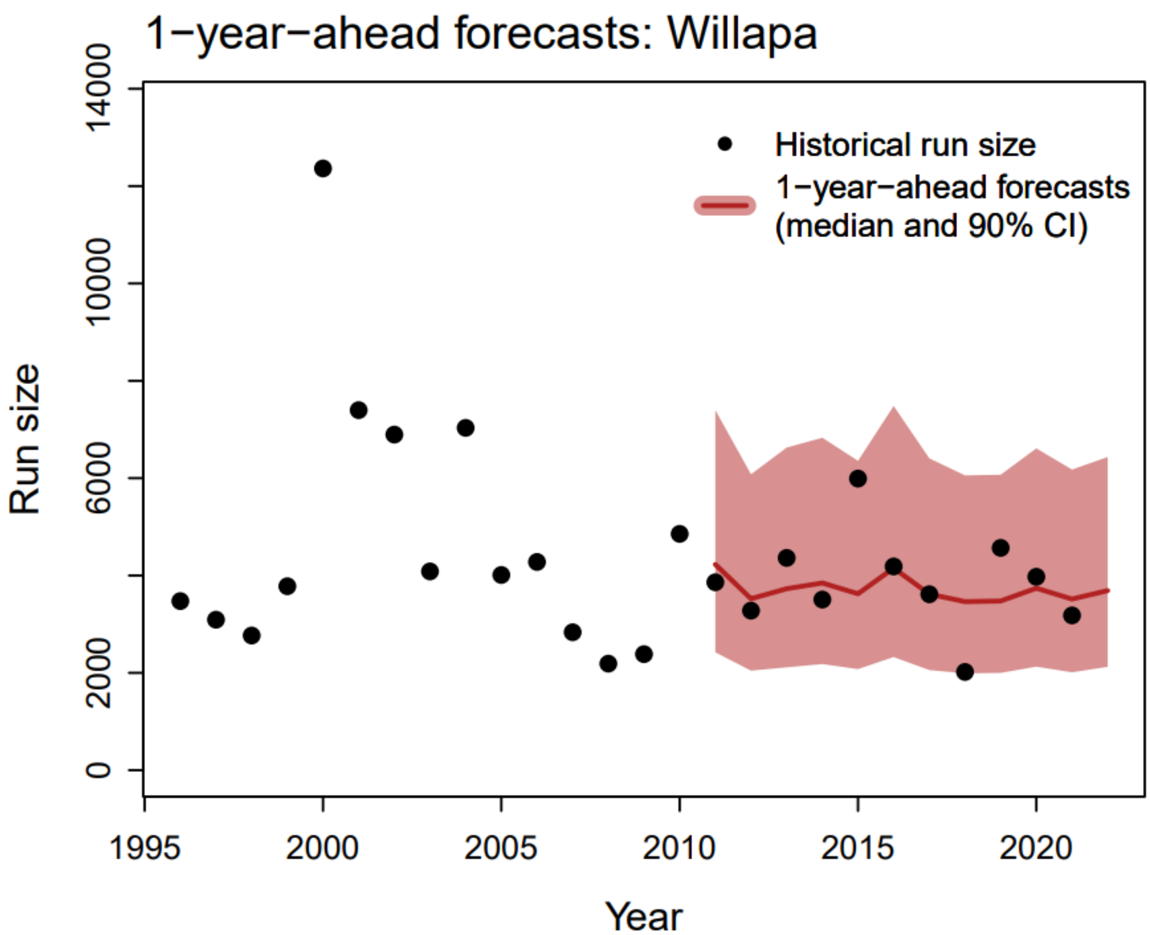


Figure 9: One year ahead forecasts of wild steelhead runsize generated by the ensemble timeseries model and bounded by a 90% confidence interval.

Beyond generating long-term population projections, the Department's additional goals in developing IPMs are to estimate steelhead population parameters and to lay the foundation for Management Strategy Evaluations (MSEs). Although the creation of a steelhead specific IPM is still a work in progress, WDFW has prioritized the application of that model to

Willapa Bay data once it is complete. This type of quantitative analysis is especially needed in the Willapa Bay area for several reasons. First, Willapa Bay has not been the subject of exhaustive escapement goal reevaluation in recent years, whereas other systems on the coast were modeled using a Bayesian life cycle approach by Ohlberger et al. (2018). Second, Willapa Bay has been the subject of less intensive steelhead monitoring and evaluation than other areas of the coast more generally, leading to uncertainty in management that could be alleviated through IPM based MSEs. And third, the Department plans to evaluate the relative effectiveness in meeting management objectives of splitting Willapa Bay area management up by river (exact partitioning TBD) rather than considering the whole area under a single escapement goal. IPMs will be developed at the population scale (as opposed to MPG scale) within the Willapa Bay area. All these techniques will be continually reassessed and improved in collaboration between Region 6 Fish Management and Science Division.

9.1.2 Fisheries Regulations

Fishing in Willapa Bay rivers consists primarily of bank angling, with limited, primitive boat access on the Willapa and Naselle rivers. According to creel data from the 2021-22 steelhead season, and approximately 30-50 recreational anglers and 2-4 professional fishing guides fish in Willapa Bay rivers on any given day during the open season. The current permanent fishing regulations for Willapa Bay rivers are listed below (Table 4). Emergency regulations beyond the permanent regulations will be determined using the 3-Step Regulation Process (Section 3.2.2).

Table 4: Permanent steelhead and trout regulations in the Willapa Bay basin.

Willapa Bay:	River	Closure Day	Regulations	Trout
	Bear	Mar. 31	SPB, SGR Dec. 1	Cutthroat trout and wild RB: min size 14". Saturday before Memorial Day – Mar. 31
	Nemah	Mar. 31	SPB, SGR	Cutthroat trout and wild RB: min size 14". Saturday before Memorial Day – Mar. 31
	Naselle	Apr. 15	SPB Aug. 1 – Nov. 30, SGR Feb. 1	Cutthroat trout and wild RB: min size 14". Saturday before Memorial Day – Mar. 31
	North/Smith	Feb. 28	SPB, SGR Dec. 1	Cutthroat trout and wild RB: min size 14". Saturday before Memorial Day – Mar. 31

	Palix	31-Mar	SPB, SGR Dec. 1	Cutthroat trout and wild RB: min size 14". Saturday before Memorial Day – Mar. 31
	Willapa River	31-Mar	SPB, statewide Dec. 1	Cutthroat trout and wild RB: min size 14". Saturday before Memorial Day – Mar. 31
	Willapa South Fork	28-Feb	SPB, statewide Dec. 1	Cutthroat trout and wild RB: min size 14". Saturday before Memorial Day – Mar. 31

KEY: SPB = single-point barbless hooks, SGR = selective gear rules, RB = rainbow trout

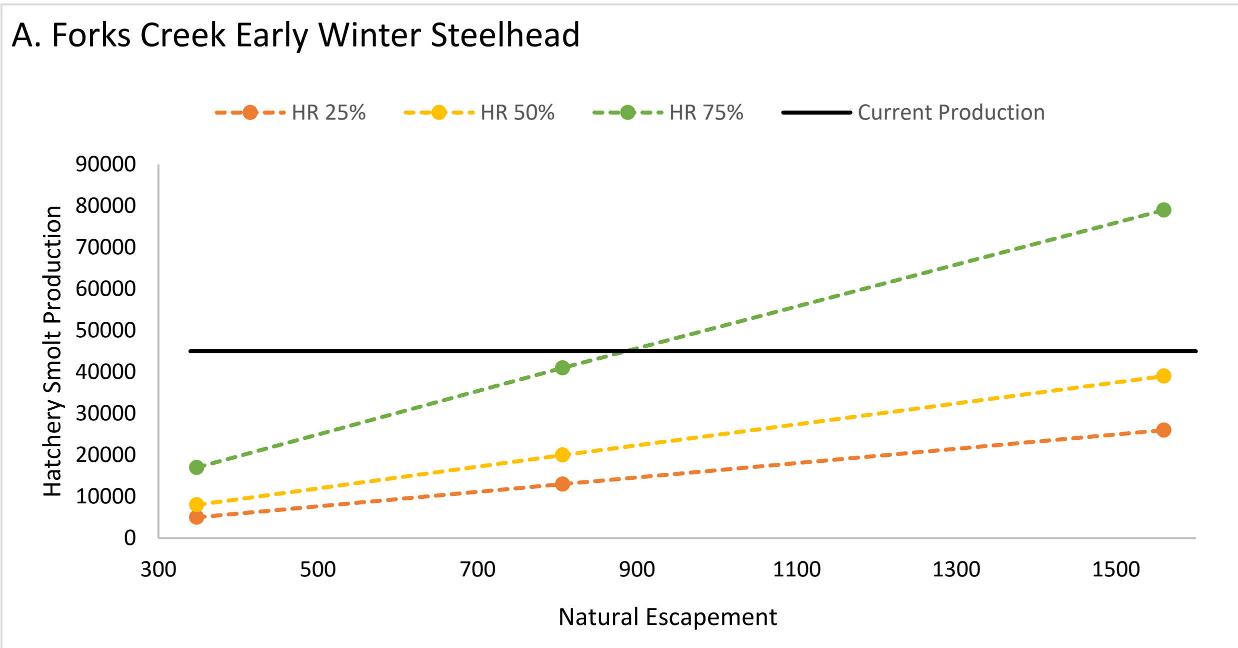
The Proviso Implementation Strategy will increase the likelihood that fishery regulations will allow runs to meet management objectives by increasing the standard amount of data available to inform the regulation-setting process, and by clearly outlining that process (Section 4: Communications). Increased creel data will be especially useful for understanding sport fishery impacts within Willapa Bay rivers because only limited creel has been conducted in the past.

The strategy also allows fishery regulations to adapt given different levels of wild steelhead abundance, with priority given to providing angling opportunity on hatchery origin fish in the Transitional management regime. The exact timing, duration, and location of hatchery targeted fisheries will be determined annually in the pre-season regulation setting process. However, historically, hatchery-oriented fisheries have occurred in the following locations:

- In Willapa River below the mouth of Forks Creek, from approximately river mile (RM) 30.5 to RM 16. Fishing pressure tends to be the greatest within 4 miles of Forks Creek Hatchery, where hatchery returns peak in December and January.
- In Naselle River approximately between RM 24 and RM 14 without a rack in place at Naselle Hatchery, where hatchery returns peak in December and January.

9.1.3 Hatchery Operations

Within the Willapa Bay area, WDFW currently operates segregated early winter steelhead hatchery programs at the Forks Creek and Naselle Hatcheries with an additional outplant site on the North River. In recent years, these programs have released 45,000, 75,000, and 10,000 smolts per year, respectively. To increase the likelihood that genetic impacts of hatchery fish on wild populations remain within pHOS, PNI, and geneflow thresholds set in the SSMP and to minimize additional ecological impacts, WDFW will evaluate and adjust hatchery operations at least every three years. Using the DGM or AHA models, WDFW will estimate the number of hatchery-origin smolts that can be released by each hatchery program given varying levels of trapping efficiency, SAR, fishing effort, and other pertinent variables (Appendices 12.1.3-12.1.4). Potential smolt release estimates for the Forks Creek and Naselle hatchery programs are shown below (Figure 10). The North River outplant has been recommended for discontinuation, and therefore is not modeled below.



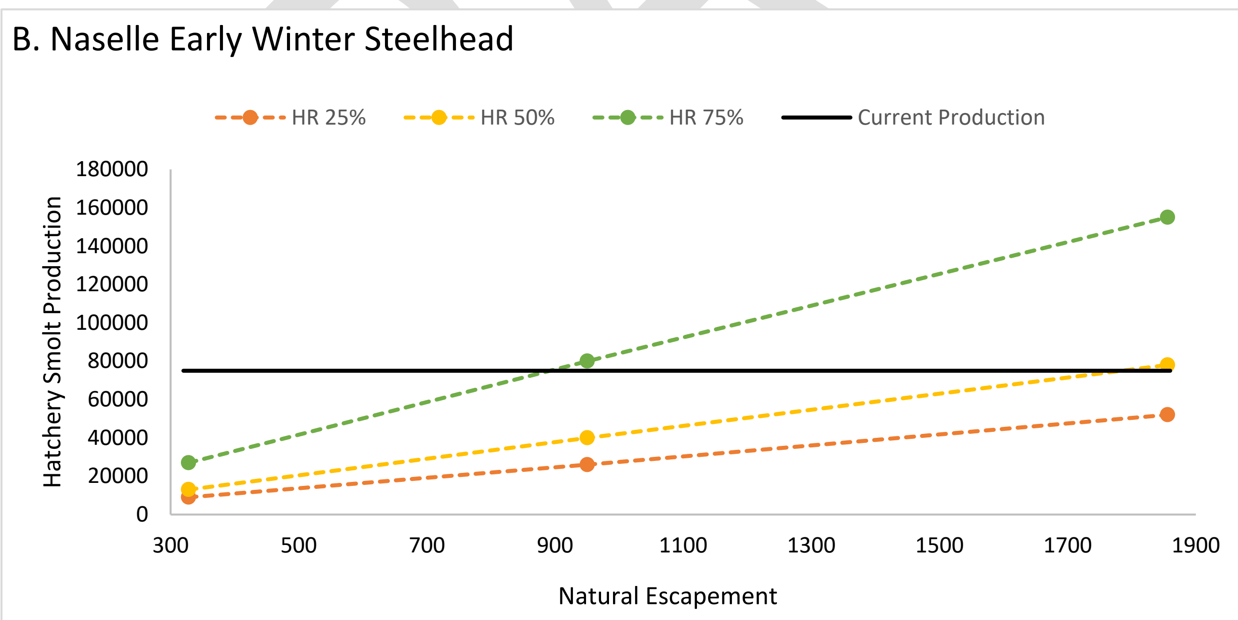


Figure 10: Potential smolt release estimates for the Forks Creek Early Winter (A) and Naselle Early Winter (B) steelhead hatchery programs at varying levels of natural escapement and homing rate (HR) based on the DGM model. In this instance HR is defined as the percent of returning hatchery fish that are removed from the river, either by returning to the hatchery or through trapping. The dashed lines showing potential smolt releases do not represent a linear function, rather, releases were modeled at three points: the minimum natural origin steelhead escapement on record, the maximum natural origin steelhead escapement on record, and the average natural origin steelhead abundance in the Willapa basin between 1996 and 2022. The dashed lines connecting these three points show an approximation of smolt releases likely to meet genetic impact thresholds at various levels of natural origin steelhead escapement between those 3 points. Potential smolt releases likely to meet genetic impact thresholds will be reevaluated at least every 3 years using recent year average abundance (currently 5-year average).

Wild Stock Gene Banks

WDFW will pursue a stakeholder process to designate WSGBs for coastal steelhead. In pursuit of this objective, steelhead in Willapa Bay streams were evaluated for suitability as WSGBs according to the criteria listed in Section 3.3.4 (Table 5).

Table 5: Evaluation of wild steelhead in Willapa Bay rivers as potential WSGBs.

Population	Criteria met?	Pertinent Information
North River/Smith Creek Winter Steelhead	Yes	• Six-year average of 571 spawners • Relatively stable population has been increasing since 2003, despite long-term declines • Currently designated as a wild Chinook management zone and is a candidate for Coho and Chum • High level of hatchery influence from out planting from Forks Creek Hatchery. Out-planting would need to be discontinued
Willapa River Winter Steehead	No	• Six-year average of 884 spawners • Increasing population trend since 2005, despite long-term declines • Current on station EWS releases from Forks Creek Hatchery
Palix River Winter Steelhead	No	• Six-year average of 148 spawners • Long-term increasing trend • No hatchery release
Nemah River Winter Steelhead	Yes	• Six-year average 495 of spawners • Slightly increasing population trend since 2005, despite long-term declines • Historic hatchery plants until 2009 and one plant in 2015 • Would serve as an excellent control stream for future hatchery research

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Population	Criteria met?	Pertinent Information
Naselle River Winter Steelhead	No	• Six-year average of 942 spawners • Long-term population decline • Current on station release from Naselle Hatchery • Naselle EWS program has the lowest survival of the Pacific Coast segregated programs if the survival cannot be improved, WDFW should consider discontinuing it and designating the Naselle River as a WSMZ
Bear River Winter Steelhead	No	• Six-year average of 202 spawners • Long-term decreasing population trend • No hatchery releases

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9.2 Chehalis System

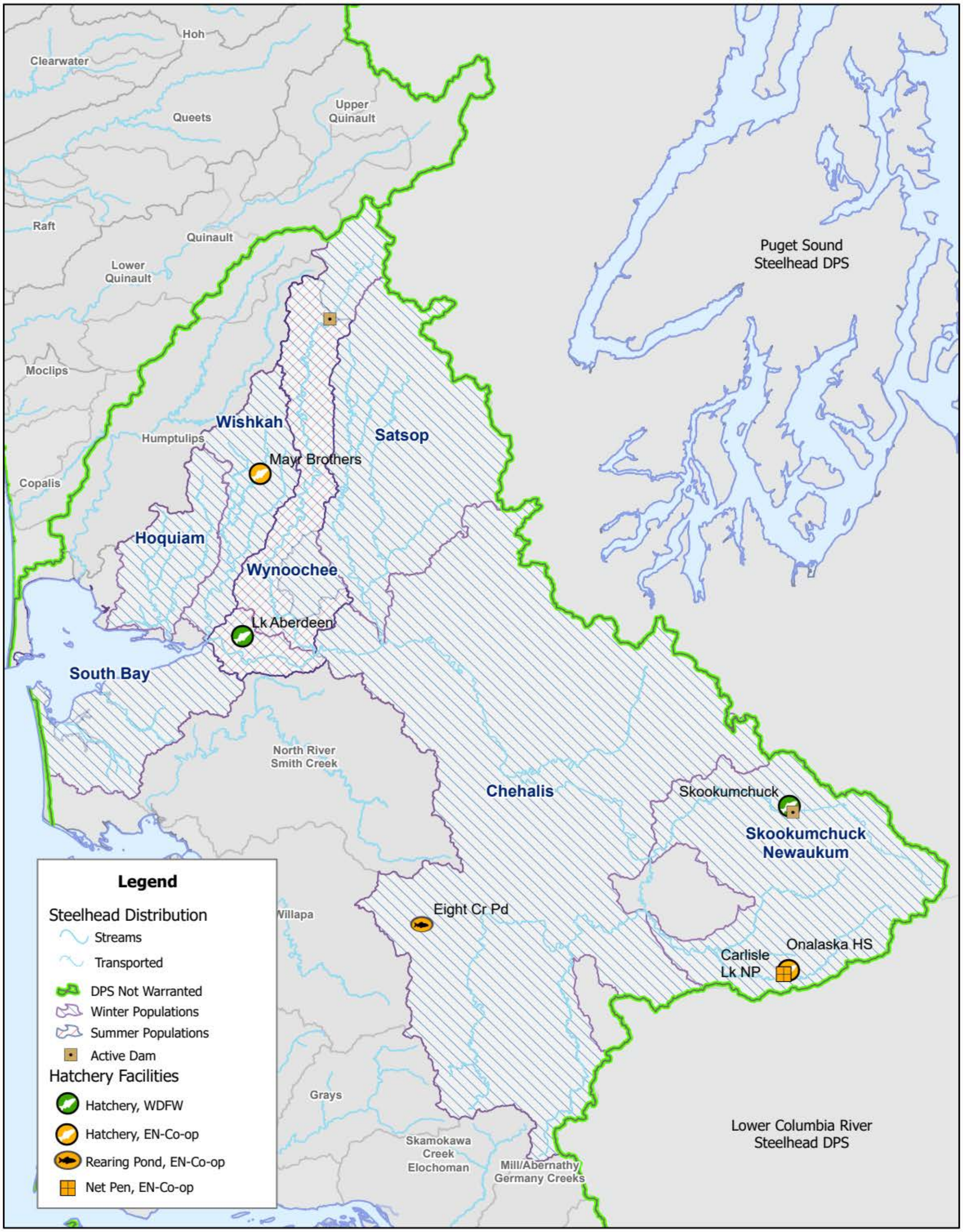

Figure 11: Map of the Grays Harbor Basin excluding the Humptulips River, which is managed separately (Section 9.3)

The rivers that flow into the Grays Harbor estuary provide drainage for a land area collectively known as the Chehalis Basin, which covers approximately 2,700 square miles, making it the second largest drainage basin in Washington state (WAECY 2022). The Chehalis River and its numerous tributaries including the South Fork, Newaukum, Skookumchuck, Black, Cloquallum, Porter, Satsop, Wynoochee, and Wishkah rivers, drain most of that land area. The Elk, Hoquiam, and Humptulips rivers also flow into Grays Harbor independently of the Chehalis River but are part of the Chehalis Basin. In terms of steelhead management, steelhead populations in the Chehalis River and its tributaries along with the Hoquiam have traditionally been considered separately from the Humptulips River, which is considered separately in Section 9.3. Steelhead in the Elk River are not surveyed. The Grays Harbor estuary itself is smaller than the neighboring Willapa Bay estuary, but nonetheless contains a diversity of marine, estuarine, intertidal, and terrestrial organisms and is home to the Grays Harbor National Wildlife Refuge. The Chehalis Basin falls within WRIAs 22 and 23 and is associated with the Chehalis Lead Entity.

The Chehalis Basin encompasses a variety of land uses, including agriculture, public forests, and timber harvest as well as commercial and residential development, especially along the I-5 corridor (Beechie et al. 2021). The Chehalis Basin contains the greatest amount of urban and suburban development of all Washington's Pacific coast watersheds. The combination of development in the basin's floodplains and climate change has caused several major flooding events that caused millions of dollars of property damage and shut down public interstate, highway, and rail infrastructure around the cities of Chehalis and Centralia (WAECY 2022). In response to these natural disasters, the state Legislature created the Office of the Chehalis Basin to implement a collaborative Chehalis Basin Strategy. The primary objectives of that strategy are to reduce flood damage and restore and improve aquatic species habitat, which directly impacts wild and hatchery steelhead populations. Flood reduction measures include the proposed construction of a dam in the upper watershed of the Chehalis River, which would impact spawning and rearing habitat of approximately one third of the Chehalis Basin wild winter steelhead.

WDFW and the Quinault Indian Nation co-manage wild and hatchery steelhead in the Chehalis Basin. Steelhead management decisions also impact the Chehalis Tribe, but as a non-treaty tribe their allocations are shared with non-tribal members of the public. The co-manager agreed-to wild steelhead escapement goal for the Chehalis Basin (excluding the Humptulips, Hoquiam, and Elk rivers) is 8,600 fish, and the population has met that goal three times in the last 10 years (2012/13-2021/22; Figure 12). During that period, the average escapement and run size of wild fish have been 8,066 and 7,079 fish, respectively. There is a population of wild summer steelhead in the Wynoochee River, although very little data exists on that population. For more detailed information about tributary-specific wild steelhead population trends and extinction risk assessment as of 2018, see Cram et al. (2018). WDFW intends to conduct in-depth analyses of the status of coastal steelhead populations and generate long-term conservation objectives during the development of RMPs (Section 5), pending the availability of sufficient funding.

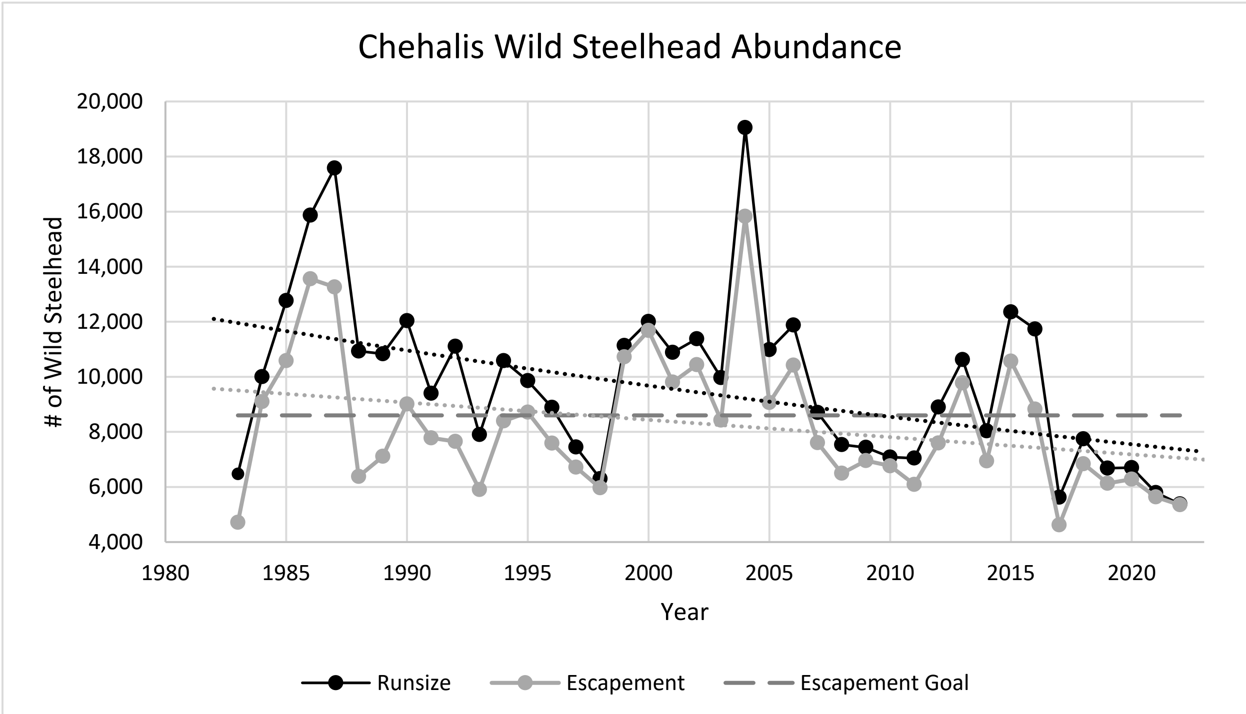

Figure 12: Chehalis Basin wild steelhead runsize and escapement between the 1982/83 and 2021/22 recreational steelhead fishery seasons. The dotted curves show fitted exponential trends.

9.2.1 Monitoring and Evaluation

As the largest coastal watershed, one of the primary challenges associated with monitoring and evaluation in the Chehalis Basin is having enough personnel to cover the extensive area. Getting enough boots on the ground will be even more important moving forward given the addition of creel surveys to standard monitoring and evaluation. Although the Chehalis Basin has fewer staff per linear river mile than other systems in coastal Washington, it is the only coastal watershed in which WDFW collects targeted juvenile steelhead abundance data. These data are collected at the WDFW operated mainstem Chehalis River, Newaukum River, and Bingham Creek smolt traps as well as one smolt trap operated by the Chehalis Tribe on the upper Chehalis River near the confluence with Independence Creek. WDFW has not previously conducted creel surveys in the Chehalis Basin, and preliminary estimates indicate that a crew of ten fishery technicians are needed to survey the area and provide information about how many fish anglers are encountering in the mark-selective fishery, with two technicians in the lower mainstem, two in the upper mainstem, two in the Satsop, two in the Wynoochee, one in the Skookumchuck, and one in the Wishkah.

Steelhead spawning ground surveys in the Chehalis are conducted beginning March 1st and cover approximately 40% of the watershed through index and supplemental surveys expanded to the total watershed. These survey areas target high population density regions, so shifts in habitat utilization from year to year could lead to increased uncertainty around escapement estimates. As a result, WDFW intends to study population density distribution over time to improve expansion equations (*see* Walther et al. 2022). The Department will also assess the statistical power of escapement estimates based on spawning ground survey coverage and the utility of implementing a GRTS sampling methodology. Based on these assessments, WDFW may need to increase the number of spawning ground personnel to improve the accuracy of escapement estimates. SONAR data would also be useful in the Chehalis Basin as an additional or alternative escapement estimation tool, especially in rivers like the Skookumchuck with poor visibility that prevents surveyors from counting redds.

Data Gaps: In addition to the monitoring and evaluation activities laid out in the Proviso Implementation Strategy (Section 3), WDFW has identified and prioritized additional work that will be done to fill the following data gaps:

- Summer steelhead abundance and distribution
- Genetics of wild steelhead broodstock used in integrated programs: is over mining of broodstock occurring?
- Role of bass predation in steelhead population dynamics

Forecast Methods

WDFW is currently applying new quantitative analysis techniques to forecast future adult wild steelhead spawner abundance both one year ahead and in the long-term using ensemble timeseries modeling and IPMs, respectively. As an example, the ensemble timeseries model was applied to combined Chehalis Basin (excluding the Humptulips River) data to produce a forecast for the 2021/22 season. This product allows managers to assess ensemble timeseries model performance compared to other methodologies. The best performing model for the Chehalis Basin was the stack weighted approach and produced a forecast of 7,728 fish (95% CI 4,562-13,768) for the 2021/22 fishing season. The performance of the model against calculated post-season runsize estimates was evaluated over ten years prior to the 2021/22 season (Figure 13). Beyond generating long-term population projections, the Department's additional goals in developing IPMs are to estimate steelhead population parameters and to lay the foundation for Management Strategy Evaluations (MSEs). The creation of the steelhead specific IPM that will be applied to Chehalis Basin data is currently a work in progress.

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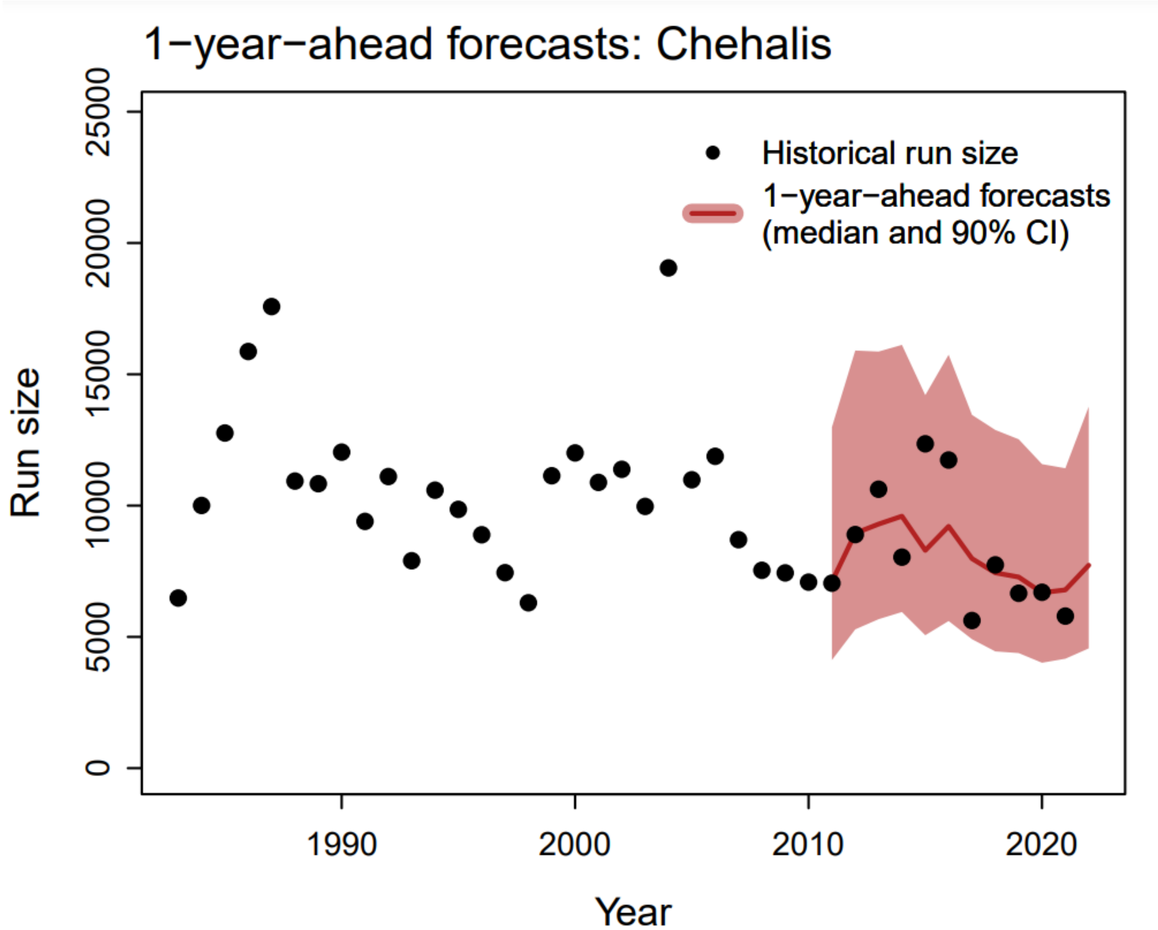

Figure 13: One year ahead forecasts of wild steelhead runsize generated by the ensemble timeseries model and bounded by a 90% confidence interval.

9.2.2 Fisheries Regulations

Given its size and diversity, the Chehalis basin has the potential to provide a variety of steelhead fishing opportunities. For instance, the Satsop and Wynoochee rivers contain multiple boat launches and flows that are conducive to boat angling,, while the Skookumchuck is more conducive to bank angling. The Newaukum River is also physically conducive to bank angling, although access is relatively limited because of private property. The Wishkah has both good bank angling and limited boat access. Based on WDFW CRC data and knowledge from local fisheries managers, an average of approximately 110-150 recreational anglers and 16-26 professional fishing guides fish in Chehalis Basin rivers on any given day during the open season (excluding the Humptulips and Elk rivers). The current permanent fishing regulations for Chehalis Basin rivers (excluding the Humptulips and Elk rivers) are listed below (Table 6). Emergency regulations beyond the permanent regulations will be determined using the 3-Step Regulation Process (Section 3.2.2). To protect wild spawning steelhead, the Department will consider moving the trout season opener from the

Saturday before Memorial Day back to the first Saturday of June when most late-spawning winter steelhead are done spawning.

Table 6: Permanent steelhead and rainbow trout regulations in the Chehalis Basin.

Chehalis Basin:	River	Closure Day	Regulations	Trout
	Chehalis	15-Apr	SPB Aug 1-Nov. 30	cutthroat and wild RB min size 14".
	Hoquiam	28-Feb	SPB, statewide Dec. 1	cutthroat and wild RB min size 14".
	Wishkah	28-Feb	SPB, statewide Dec. 1	cutthroat and wild RB min size 14".
	Van Winkle Creek	31-Jan	SPB, statewide Dec. 1	cutthroat and wild RB min size 14".
	Wynoochee	31-Mar	SPB, statewide Dec. 1	cutthroat and wild RB min size 14".
	Satsop	31-Mar	SPB, statewide Dec. 1	cutthroat and wild RB min size 14".
	Cloquallum Creek	28-Feb	statewide rules	cutthroat and wild RB min size 14".
	Skookumchuck	30-Apr	SPB, statewide Dec. 1	cutthroat and wild RB min size 14".
	Newakuam	30-Apr	SPB, statewide Dec. 1	cutthroat and wild RB min size 14".
	SF Chehalis	15-Apr	statewide rules	cutthroat and wild RB min size 14".
	Elk Creek	31-Mar	statewide rules	cutthroat and wild RB min size 14".
	Elk River	28-Feb	SPB, statewide Dec. 1	cutthroat and wild RB min size 14".
	Johns River	28-Feb	SPB, statewide Dec. 1	cutthroat and wild RB min size 14".

KEY: SPB = single-point barbless hooks, SGR = selected gear rules, RB = rainbow trout

The Proviso Implementation Strategy will increase the likelihood that fishery regulations will allow runs to meet management objectives by increasing the baseline amount of data available to inform the regulation-setting process, and by clearly outlining that process (See Section 4: Communications). Increased creel data will be especially useful for understanding sport fishery impacts within Chehalis Basin rivers because it has not been applied there in the past. WDFW plans to develop more robust in-season update tools based on creel and/or SONAR data to change fisheries regulations in-season as needed.

Hatchery Targeted Fisheries

The strategy also allows fishery regulations to adapt given different levels of wild steelhead abundance, with priority given to providing angling opportunity on hatchery origin fish in the Transitional management regime. The timing, duration, and location of hatchery targeted fisheries will be determined annually in the pre-season regulation setting process. Determining when and where to implement hatchery targeted fisheries in the Chehalis Basin will be more challenging than in other areas because there are integrated hatchery steelhead runs on the Wynoochee, Satsop, Skookumchuck, and Upper Chehalis rivers. Therefore, WDFW will work to assess the relative impacts and success of providing angling opportunity of integrated vs. segregated programs in those rivers when designing sustainable fisheries.

9.2.3 Hatcheries

Within the Chehalis Basin (excluding the Humptulips River), WDFW currently operates hatchery steelhead programs at the Mayr Brothers (Wishkah River), Lake Aberdeen (Wynoochee River), Bingham Creek, and Skookumchuck hatcheries as well as the Eight Creek Acclimation Ponds on the Upper Chehalis River. Additionally, the Department partners with the Onalaska Future Farmers of America (FFA) educational hatchery program on Carlisle Lake; fish from that program are released into Gheer Creek, which flows into the South Fork of the Newaukum River. The following list details the program type and recent year releases for each of those programs:

- **Mayr Brothers Hatchery** (Wishkah River) segregated early winter steelhead program: 15,000 smolts per year
- **Lake Aberdeen Hatchery** (Wynoochee River) integrated late winter steelhead program*****: 170,000 smolts per year
- **Lake Aberdeen Hatchery** (Wynoochee River) segregated early summer steelhead program*****: 60,000 smolts per year
- **Bingham Creek Hatchery** integrated late winter steelhead program: 55,000 smolts per year
- **Skookumchuck Hatchery** integrated late winter steelhead program: 75,000 smolts per year
- **Onalaska FFA Hatchery** (Newaukum River) integrated late winter steelhead program: 30,000 smolts per year
- **Eight Creek Acclimation Ponds** (Upper Chehalis) integrated late winter steelhead program: 32,000 smolts
  *****Mitigation programs: exception to the Proviso Implementation Strategy may apply

To increase the likelihood that genetic impacts of hatchery fish on wild populations remain within pHOS, PNI, and geneflow thresholds set in the SSMP and to minimize additional ecological impacts, WDFW will evaluate and adjust hatchery operations at least every three years. Using the DGM or AHA models, WDFW will estimate the number of hatchery-origin

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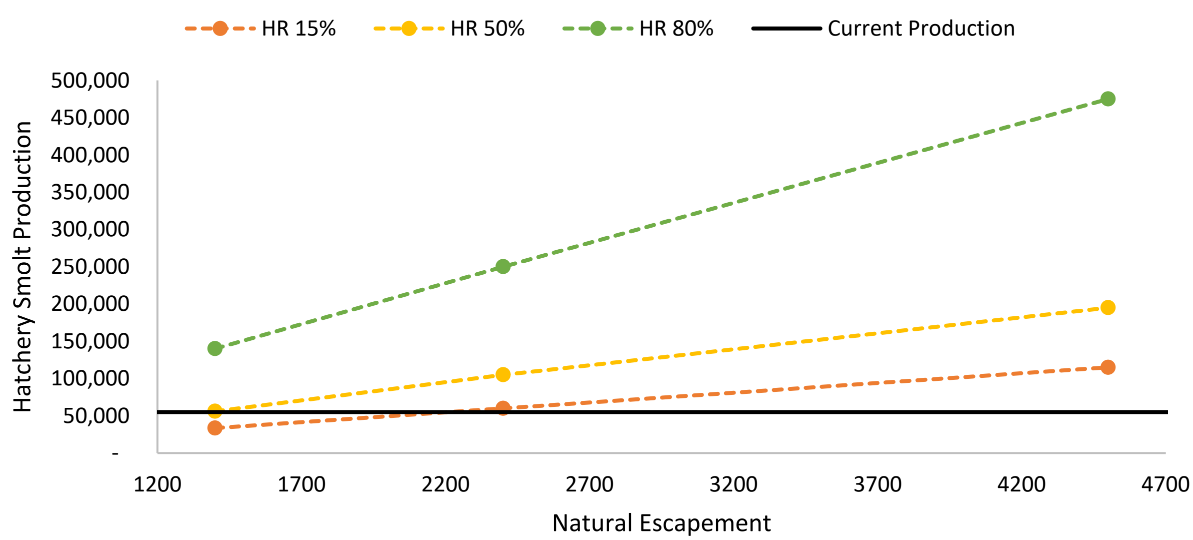
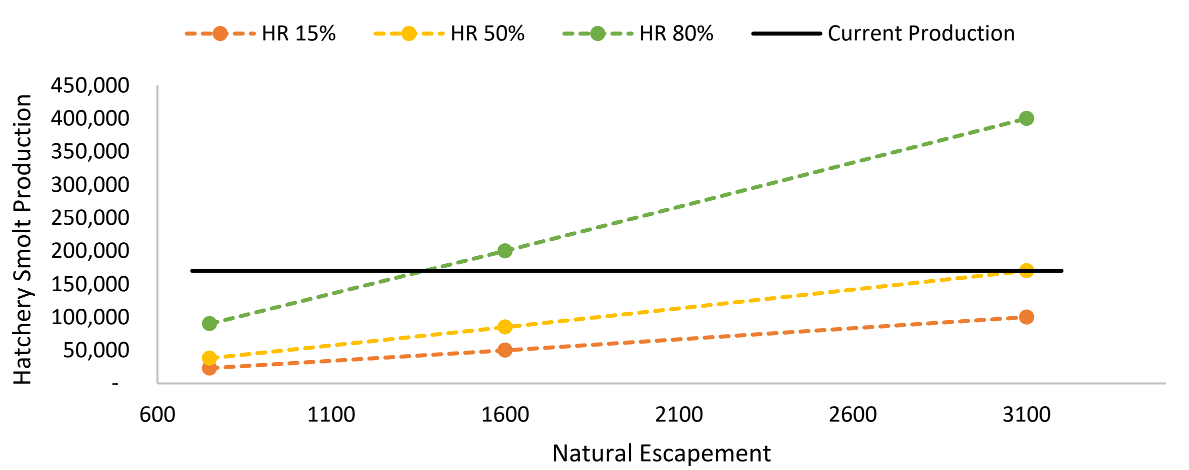
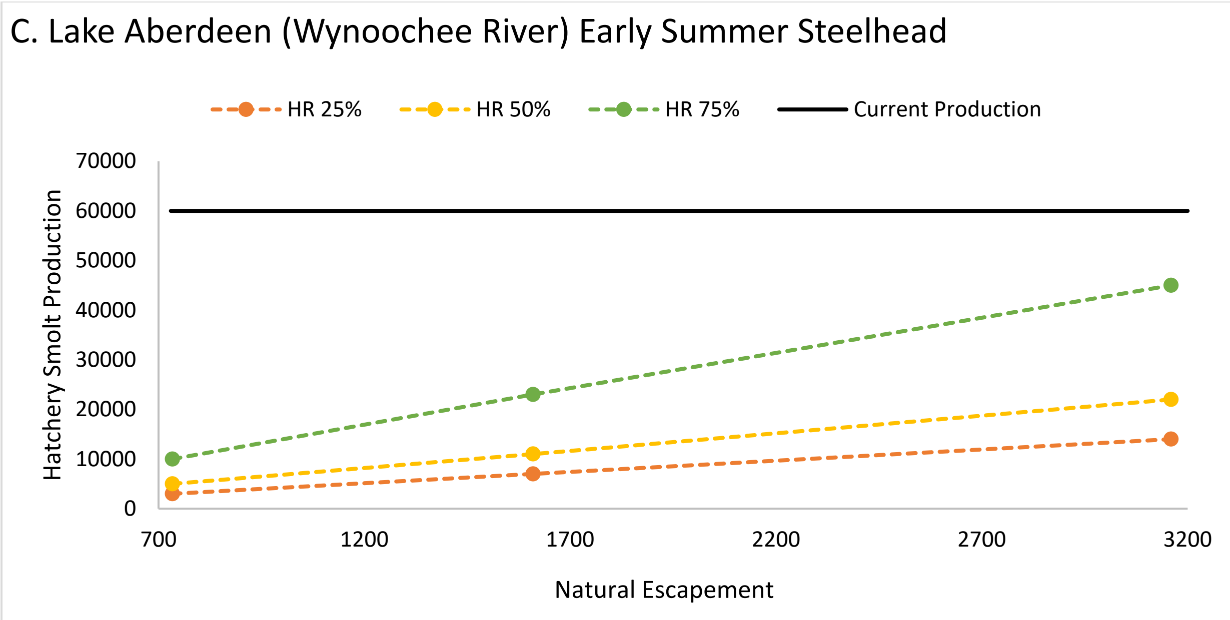
smolts that can be released by each hatchery program given varying levels of trapping efficiency, SAR, fishing effort, and other pertinent variables (Appendices 12.1.3-12.1.4). Potential smolt release estimates for the Bingham Creek, Lake Aberdeen, Skookumchuck, Onalaska FFA, Mayr Brothers, and Eight Creek programs are shown below (Figure 14). Exceptions to meeting the SSMP guidelines for genetic impacts to wild fish may be applicable to rivers with existing dam associated mitigation agreements.

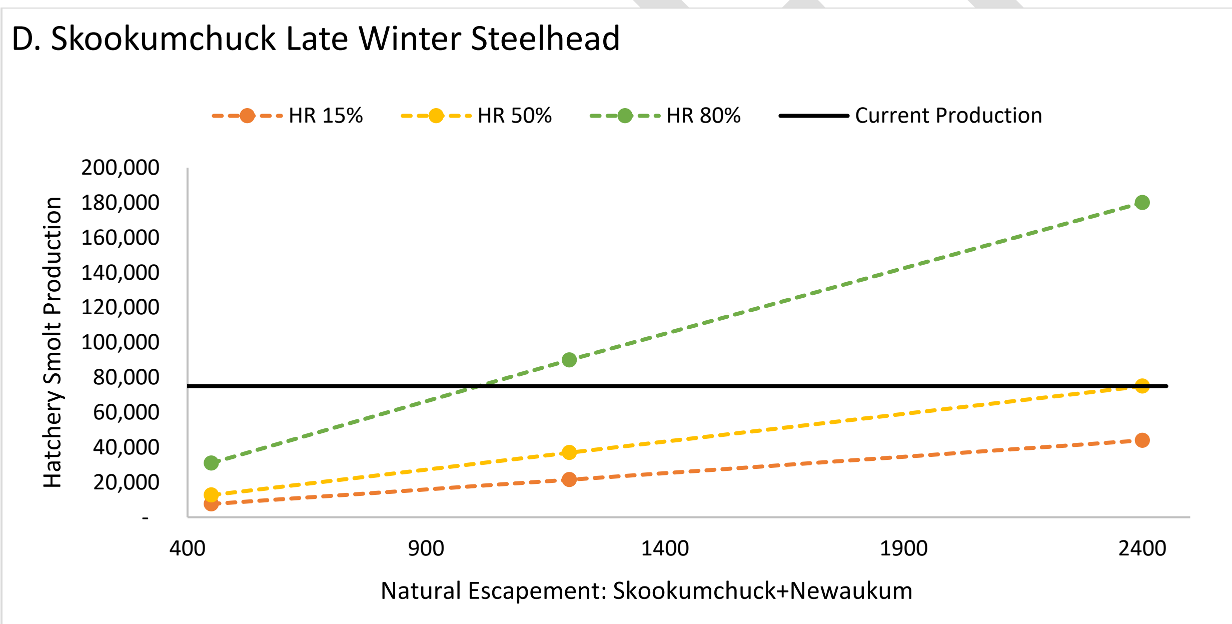
A. Bingham Creek Late Winter Steelhead

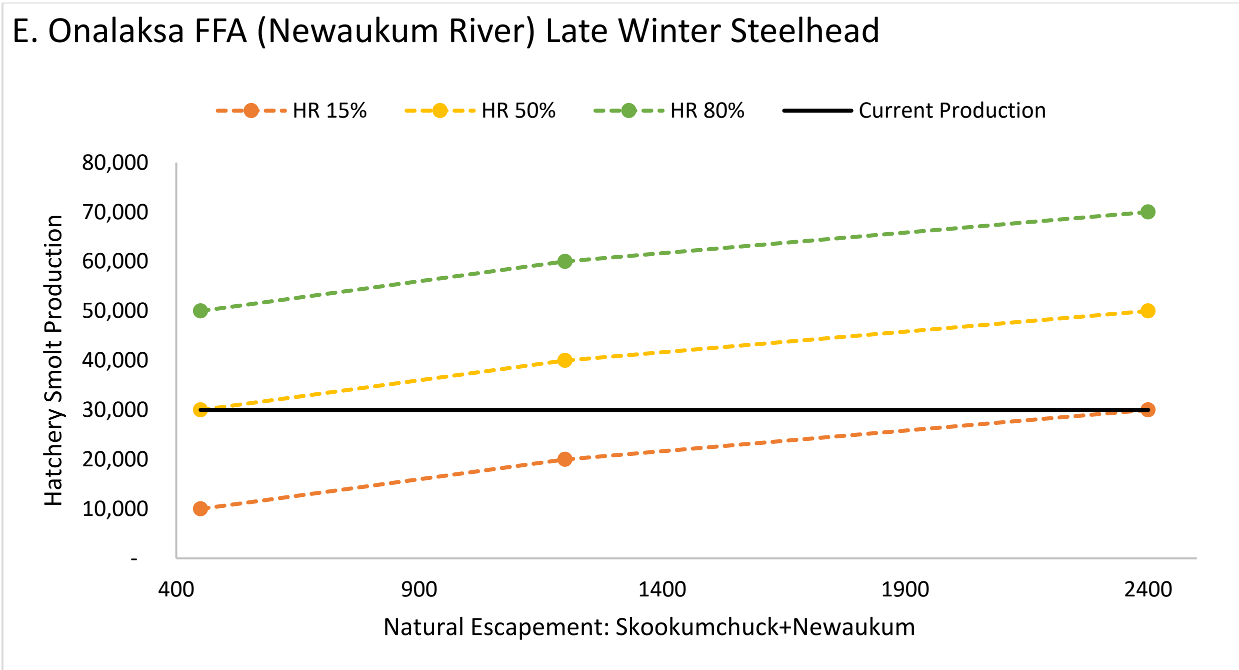


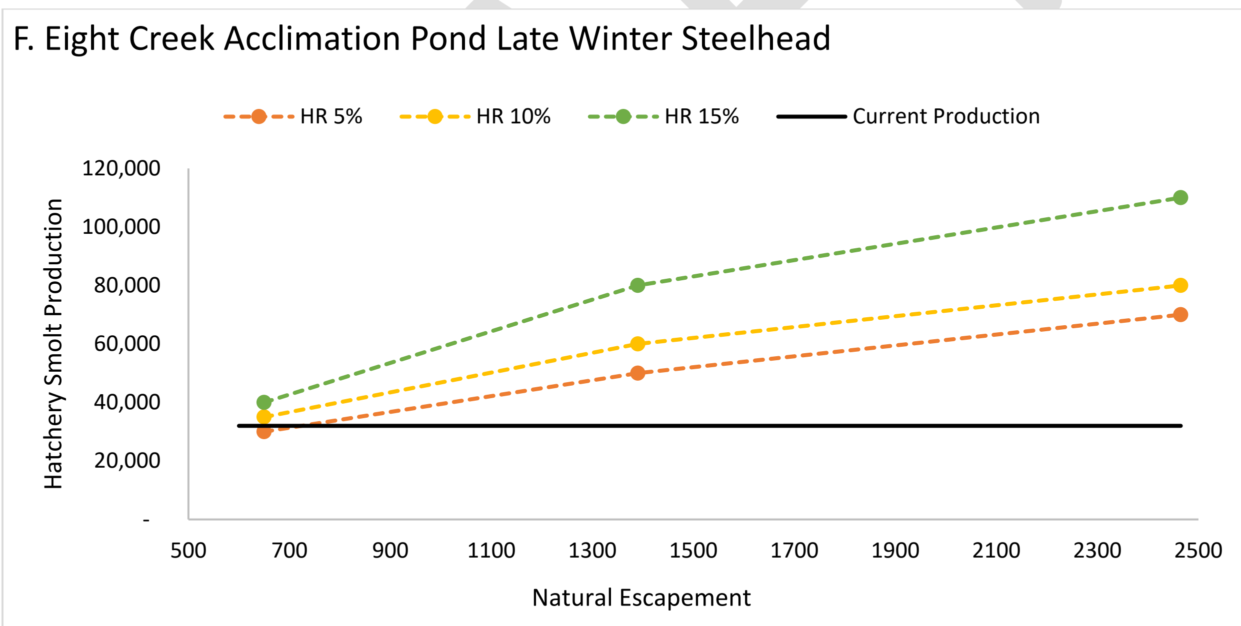
B. Lake Aberdeen (Wynoochee River) Late Winter Steelhead




C. Lake Aberdeen (Wynoochee River) Early Summer Steelhead
HR 25%
HR 50%
HR 75%
Current Production
Hatchery Smolt Production
70000
60000
50000
40000
30000
20000
10000
0
700
1200
1700
2200
2700
3200
Natural Escapement


D. Skookumchuck Late Winter Steelhead
HR 15%
HR 50%
HR 80%
Current Production
Hatchery Smolt Production
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
-
400
900
1400
1900
2400
Natural Escapement: Skookumchuck+Newaukum


E. Onalaksa FFA (Newaukum River) Late Winter Steelhead
HR 15%
HR 50%
HR 80%
Current Production
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
Hatchery Smolt Production
400
900
1400
1900
2400
Natural Escapement: Skookumchuck+Newaukum


F. Eight Creek Acclimation Pond Late Winter Steelhead
HR 5%
HR 10%
HR 15%
Current Production
120,000
100,000
80,000
60,000
40,000
20,000
-
Hatchery Smolt Production
500
700
900
1100
1300
1500
1700
1900
2100
2300
2500
Natural Escapement

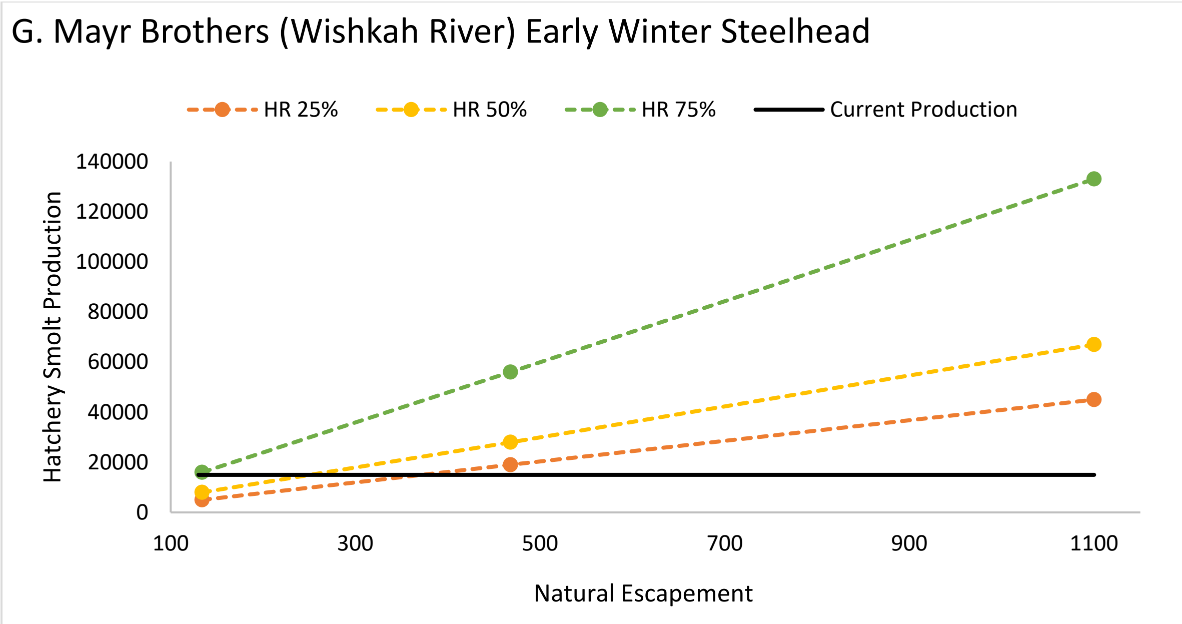


Figure 14: Potential smolt release estimates for the Bingham Creek Late Winter (A) Lake Aberdeen (Wynoochee River) Late Winter (B) Lake Aberdeen (Wynoochee River) Early Summer (C) Skookumchuck Late Winter (D) Onalaska FFA (Newaukum River) Late Winter (E) Eight Creek Acclimation Pond (Upper Chehalis River) Late Winter (F) and Mayr Brothers (Wishkah River) Early Winter Steelhead hatchery programs at varying levels of natural escapement and homing rate (HR) based on the DGM or AHA modeling. AHA was used to model integrated programs, while the DGM was used to model segregated programs. In this instance, HR is defined as the percent of returning hatchery fish that are removed from the river, either by returning to the hatchery or through trapping. The dashed lines showing potential smolt releases do not represent a linear function, rather, releases were modeled at three points: the minimum natural origin steelhead escapement on record, the maximum natural origin steelhead escapement on record, and the average natural origin steelhead abundance over the recorded period. The dashed lines connecting these three points show an approximation of smolt releases likely to meet genetic impact thresholds at various levels of natural origin steelhead escapement between those 3 points. Potential smolt releases likely to meet genetic impact thresholds will be reevaluated at least every 3 years using recent year average abundance (currently 5-year average). Cumulative genetic impacts are considered for hatchery programs occurring in the same river.

Wild Stock Gene Banks

WDFW will pursue a stakeholder process to designate WSGBs for coastal steelhead. In pursuit of this objective, steelhead in the Chehalis Basin were evaluated for suitability as WSGBs according to the criteria listed in Section 3.3.4 (Table 7).

Table 7: Evaluation of wild steelhead in Chehalis Basin rivers as potential WSGBs.

Population	Criteria met?	Pertinent Information
Hoquiam River Winter Steelhead	Yes	• Six-year average of 309 spawners • Long-term population decline, relatively stable since 1997 • Historical outplants of EWS in the drainage,

Population	Criteria met?	Pertinent Information
		but no hatchery plants since 2006
Wishkah River Winter Steelhead	Yes	• Six-year average of 360 spawners • Long-term population decline, with slower decline since 1994 • No hatchery plants between 1995 and 2019 • Currently has off-station EWS releases at Mayr Brothers Ponds from Humptulips Hatchery
South Bay Winter Steelhead	No	• No population data • John River received EWS outplants until 2007 and the Elk River received EWS outplants until 2006.
Wynoochee River Winter Steelhead	No	• Six-year average of 1,393 spawners • Long-term population decline • Dam on the upper watershed with unknown effects on survival of downstream migrants • Current off station releases from Lake Aberdeen Hatchery
Satsop River Winter Steelhead	No	• Six-year average of 2,108 spawners. Long-term decline • Current on-station hatchery program at Bingham Creek (East Fork Satsop) • West Fork Satsop should be considered as a candidate to serve as a control stream for research with the Bingham Creek late winter steelhead program. • WF Satsop & EF Satsop populations are not separate, so the Satsop is not suitable as a WRIA 22 WSMZ
Skookumchuck/ Newaukum River Winter Steelhead	No	• Six-year average of 1,125 spawners • Stable population trend • Current on-station hatchery program at Skookumchuck Hatchery and off station release at Carlisle Lake on the Newaukum River
Chehalis River Winter / Summer Steelhead	Yes	• Six-year average of 2,190 of spawners • Population experiencing slight long-term decline but relatively stable recently • Some hatchery influence from off-station release of Eight Creek integrated late winter steelhead program

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9.3 Humptulips River

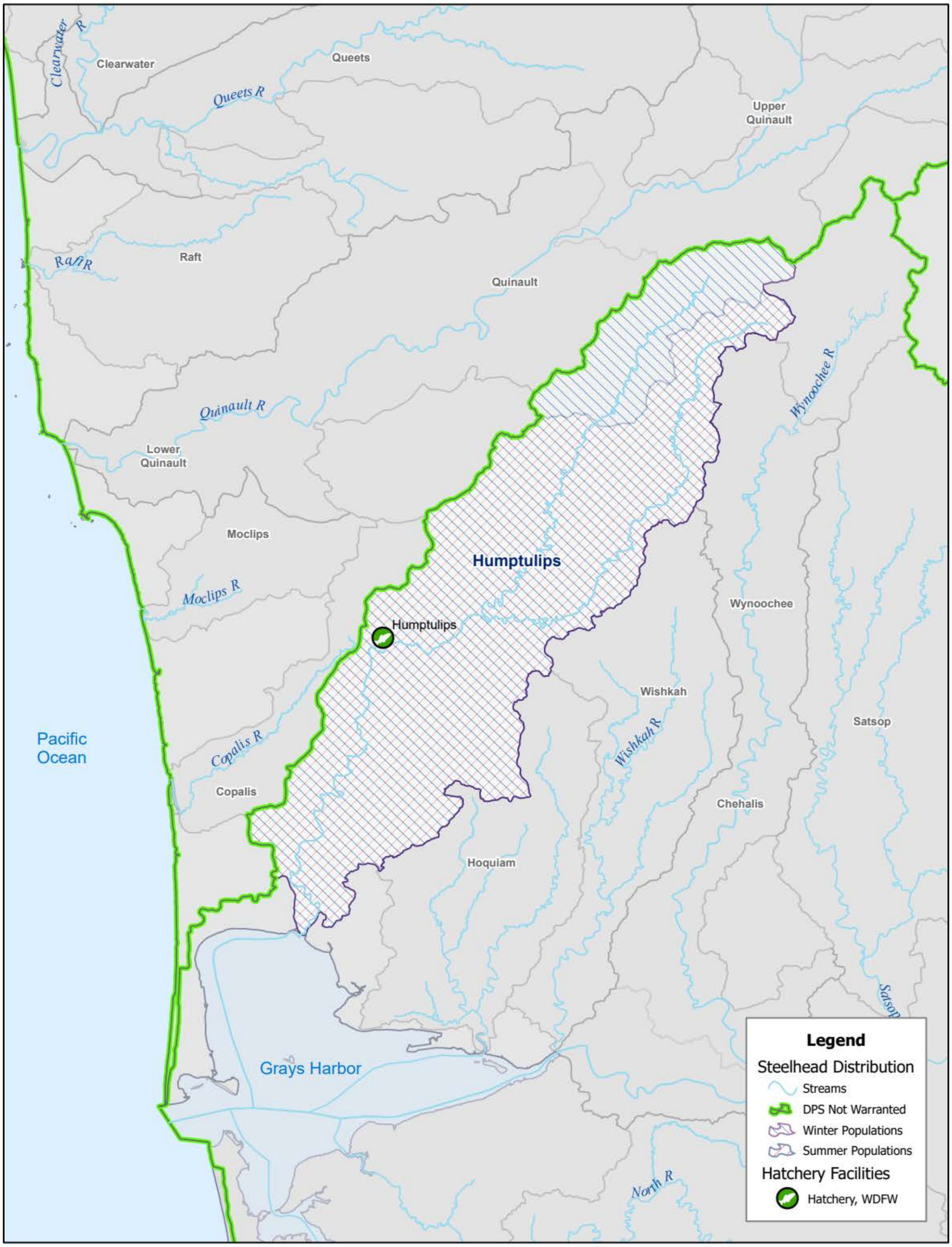

Figure 15: Map of the Humptulips River basin

The Humptulips River (mainstem 19.9 mi) originates in the Olympic Mountains and flows into the northern portion of Grays Harbor near the communities of Copalis and Humptulips. The river's total watershed area is around 274 mi^2, and its main tributaries include the East Fork Humptulips River (19.9 mi) and the West Fork Humptulips River (29.8 mi). Although the Humptulips river drainage is considered part of the Chehalis Basin, its steelhead populations have traditionally been managed separately from the rest of the Chehalis Basin. ONP and the U. S. Forest Service manage the river's headwaters, however, most of its fishery resources are co-managed by WDFW and the Quinault Indian Nation. The entirety of the Humptulips River watershed falls within the usual and accustomed fishing areas of the Quinault Indian Nation. Although upstream habitat in ONP is relatively pristine, a variety of land uses, including timber harvest, agriculture, and limited public infrastructure impact portions of the river's steelhead habitat. The Humptulips River falls within WRIA 22 and is associated with the Chehalis Lead Entity.

The Humptulips River supports wild spawning populations of winter-run steelhead as well as early summer and early winter hatchery steelhead runs. The current co-manager agreed-to escapement goal for all wild steelhead in the Humptulips River is 1,600 fish, but the population has only met that goal in four out of the past ten years (2012/13-2021/22). During that time, the average escapement and runsize of wild steelhead have been 1,592 and 1,942 fish, respectively. Overall, Humptulips wild steelhead population abundance shows a declining trend (Figure 16). For more detailed information about tributary-specific wild steelhead population

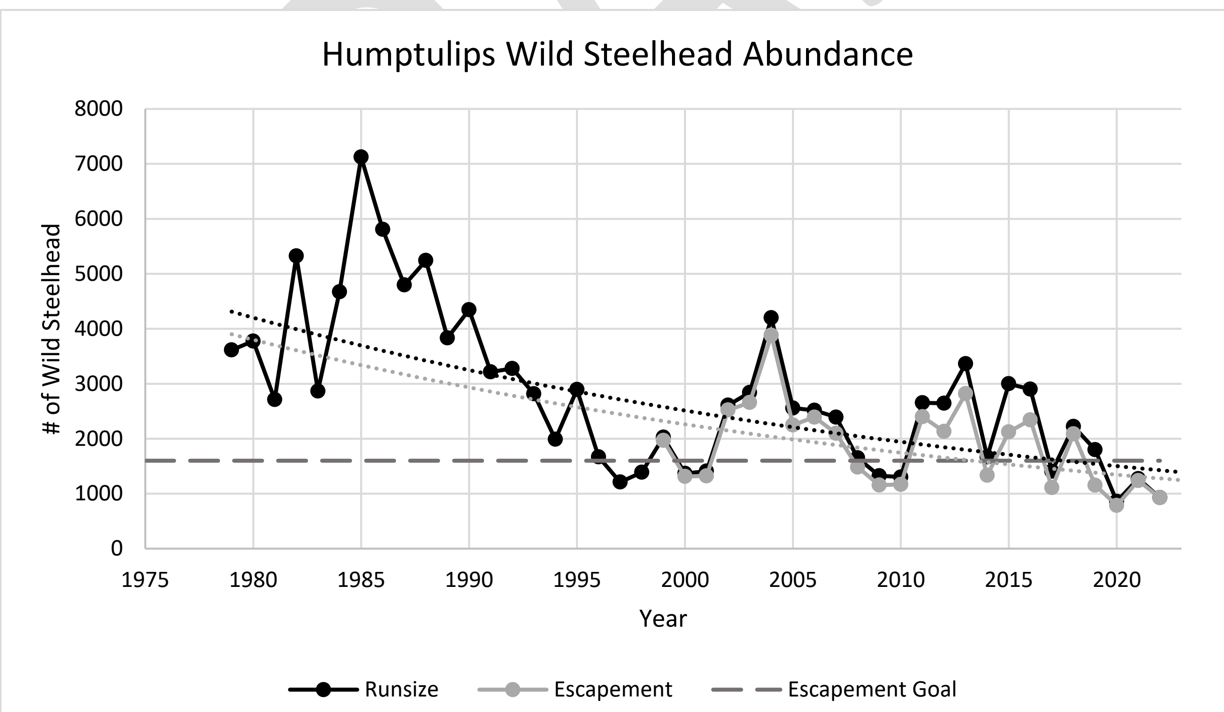

Figure 16: Humptulips River wild steelhead runsize and escapement between the 1978/79 and 2021/22 recreational steelhead fishery seasons. The dotted curves show fitted exponential trends.

trends and extinction risk assessment as of 2018, see Cram et al. (2018). WDFW intends to conduct in-depth analyses of the status of coastal steelhead populations and generate long-term conservation objectives during the development of RMPs (Section 5), pending the availability of sufficient funding.

9.3.1 Monitoring and Evaluation

Monitoring and evaluation of wild steelhead in the Humptulips River currently consists of spawning ground surveys conducted by the Quinault Indian Nation. The Proviso Implementation Strategy outlines a pathway for WDFW to contribute informative data to the co-management of Humptulips steelhead through an increased standard in monitoring and evaluation, especially regarding sport fishery monitoring.

Forecast Methods

WDFW is currently in the process of applying new quantitative analysis techniques to forecast future adult wild steelhead spawner abundance both one year ahead and in the long-term using ensemble timeseries modeling and IPMs, respectively. The Department's additional goals in developing IPMs are to estimate steelhead population parameters and lay to foundation for Management Strategy Evaluations (MSEs). As an example, the ensemble timeseries model was applied to Humptulips River data to produce a forecast for the 2021/22 season. This product allows managers to assess ensemble timeseries model performance compared to other methodologies. The best performing model for the Humptulips River was stack weighted and produced a forecast of 1295 fish (95% CI 579-2817) for the 2021/22 fishing season. The performance of the model against calculated post-season runsize estimates was evaluated over ten years prior to the 2021/22 season (Figure 17).

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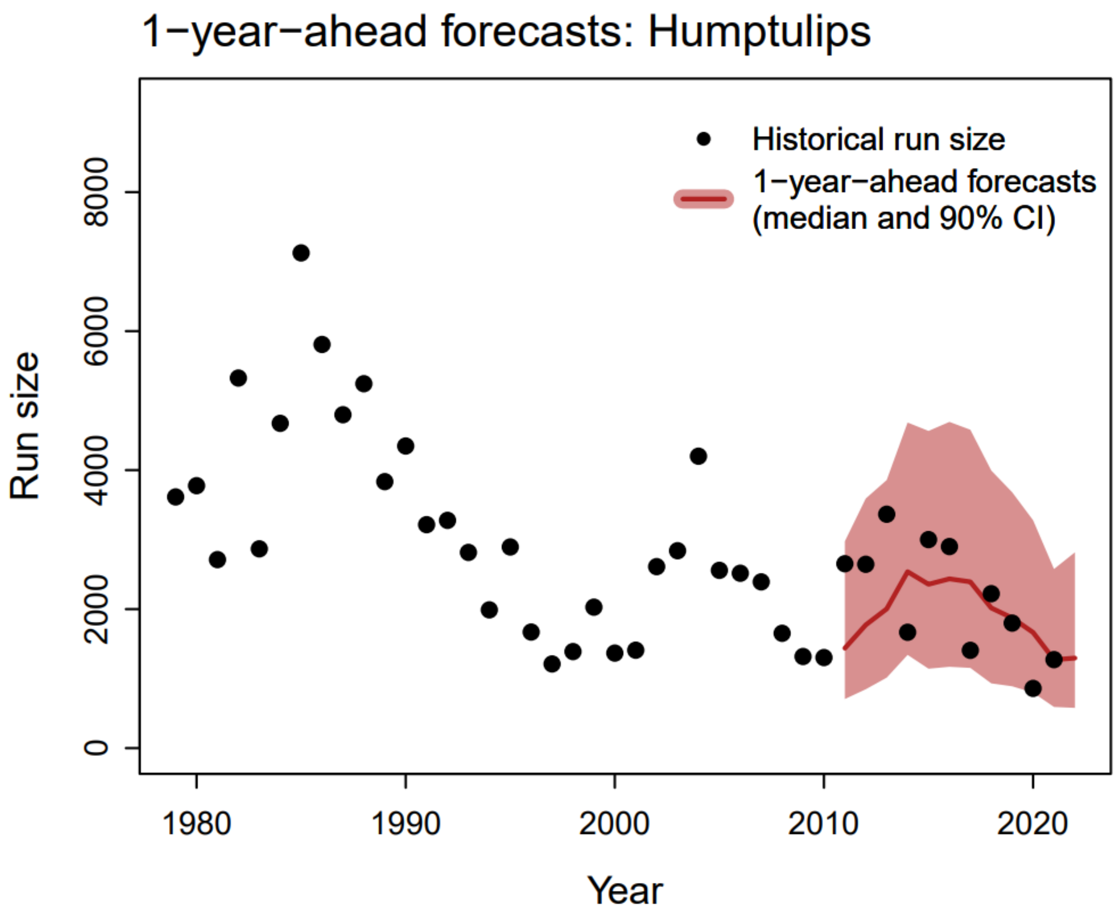

Figure 17: One year ahead forecasts of wild steelhead runsize generated by the ensemble timeseries model and bounded by a 90% confidence interval.

9.3.2 Fisheries Regulations

The availability of boat access and the flows on the Humptulips River make it accessible for both boat and bank angling, and typically recreational fishery effort targeting segregated, early timed hatchery fish peaks before February. Based on WDFW CRC data and knowledge from regional fisheries managers, approximately 20-50 recreational anglers and 2-14 professional fishing guides fish on the Humptulips River and its tributaries on any given day during the open season. Between 1995/95-2018/19, anglers in the state-operated fishery caught an average of 48% of early winter hatchery steelhead and 75% of early summer hatchery steelhead. The current permanent fishing regulations for the Humptulips River are listed below (Table 8). Emergency regulations beyond the permanent regulations will be determined using the 3-Step Regulation Process (Section 3.2.2). To protect wild spawning steelhead, the Department will consider moving the trout season opener from the Saturday before Memorial Day back to the first Saturday of June when most late-spawning winter steelhead are done spawning.

Table 8: Permanent steelhead and rainbow trout regulations in the Humptulips River.

Humptulips River:	River	Closure Day	Regulations	Trout
	Humptulips	31-Mar	SPB, statewide Dec. 1	cutthroat and wild RB min size 14".
	Humptulips upstream Hwy 101 bridge.	31-Mar	SPB Aug 16-Nov 30, SGR, Mar 1	cutthroat and wild RB min size 14".

KEY: SPB = single-point barbless hooks, SGR = selected gear rules, RB = rainbow trout

The Proviso Implementation Strategy will increase the likelihood that fishery regulations will allow runs to meet management objectives by increasing the standard amount of data available to inform the regulation-setting process, and by clearly outlining that process (See Section 4: Communications). Increased creel data will be especially useful for understanding sport fishery impacts in the Humptulips River because it has not been applied there since the 1980s. WDFW plans to develop more robust in-season update tools based on creel and/or SONAR data to change fisheries regulations in-season as needed. The strategy also allows fishery regulations to adapt given different levels of wild steelhead abundance, with priority given to providing angling opportunity on hatchery origin fish in the Transitional management regime. The exact timing, duration, and location of hatchery targeted fisheries will be determined annually in the pre-season regulation setting process.

9.3.3 Hatchery Operations

WDFW currently operates segregated early winter steelhead and early summer steelhead programs at the Humptulips Hatchery, which in recent years have released 125,000 and 30,000 smolts per year, respectively. To increase the likelihood that genetic impacts of hatchery fish on wild populations remain within pHOS, PNI, and geneflow thresholds set in the SSMP and to minimize additional ecological impacts, WDFW will evaluate and adjust hatchery operations at least every three years. Using the DGM or AHA models, WDFW will estimate the number of hatchery-origin smolts that can be released by each hatchery program given varying levels of trapping efficiency, SAR, fishing effort, and other pertinent variables (Appendices 12.1.3-12.1.4). Potential smolt release estimates for the Humptulips Hatchery steelhead programs are shown below (Figure 18).

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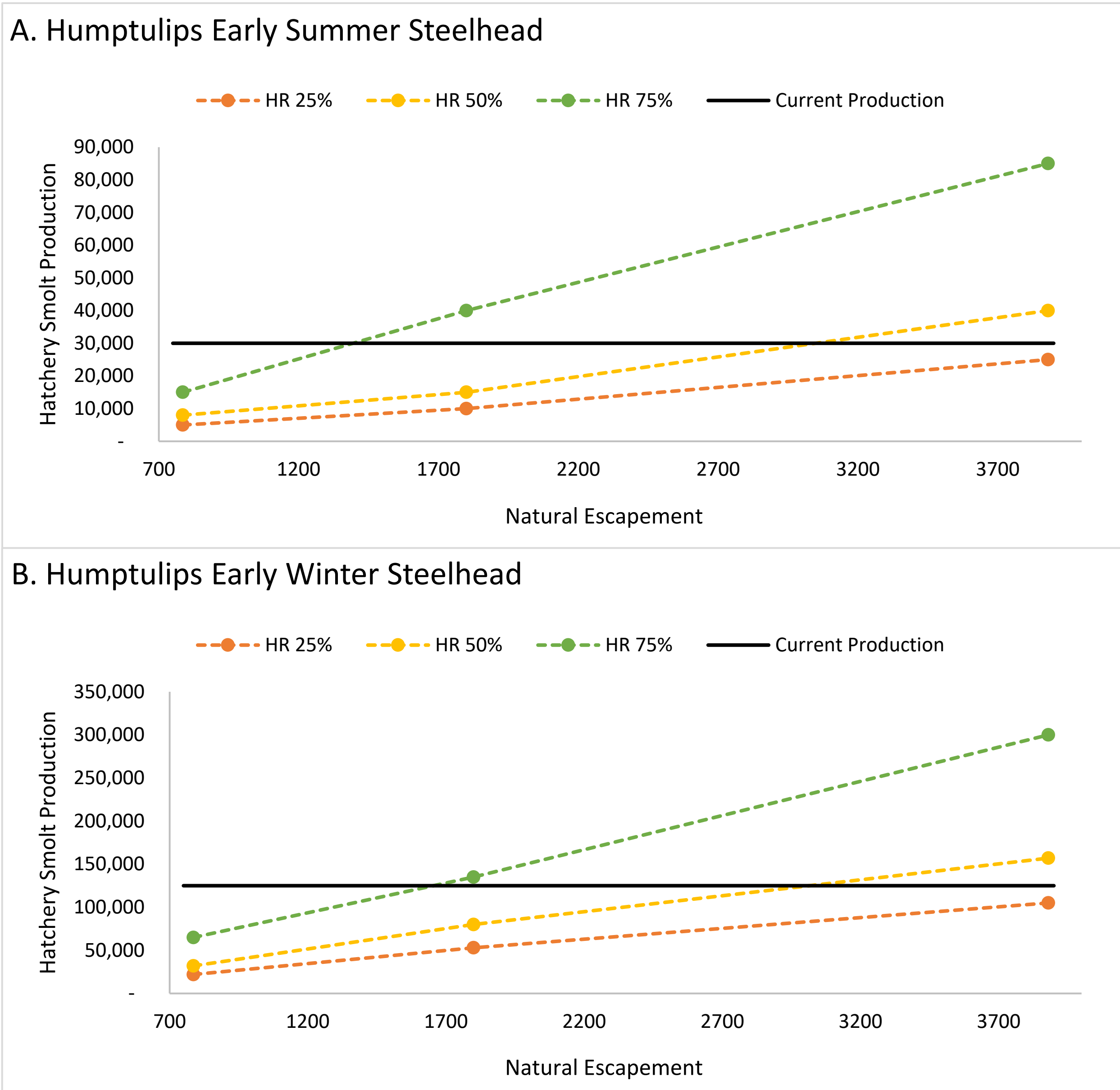

Figure 18: Potential smolt release estimates for the Humptulips Early Summer (A) and Humptulips Early Winter (B) Steelhead hatchery programs at varying levels of natural escapement and homing rate (HR) based on the DGM model. In this instance HR is defined as the percent of returning hatchery fish that are removed from the river, either by returning to the hatchery or through trapping. The dashed lines showing potential smolt releases do not represent a linear function, rather, releases were modeled at three points: the minimum natural origin steelhead escapement on record, the maximum natural origin steelhead escapement on record, and average wild steelhead abundance between 1979 and 2022. The dashed lines connecting these three points show an approximation of smolt releases likely to meet genetic impact thresholds at various levels of natural origin steelhead escapement between those 3 points. Potential smolt releases likely to meet genetic impact thresholds will be reevaluated at least every 3 years using recent year average abundance (currently 5-year average). Cumulative genetic impacts are considered for hatchery programs in the same river.

Wild Stock Gene Banks

WDFW will pursue a stakeholder process to designate WSGBs for coastal steelhead. In pursuit of this objective, steelhead in the Humptulips River were evaluated for suitability as WSGBs according to the criteria listed in Section 3.3.4 (Table 9).

Table 9: Evaluation of wild steelhead in the Humptulips River as a potential WSGB.

Population	Status	Criteria
Humptulips River Winter/ Summer Steelhead	Criteria not met	• Six-year average of 1,709 spawners • Significant long-term decline • Current on-station releases from Humptulips Hatchery

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9.4 Quinault River

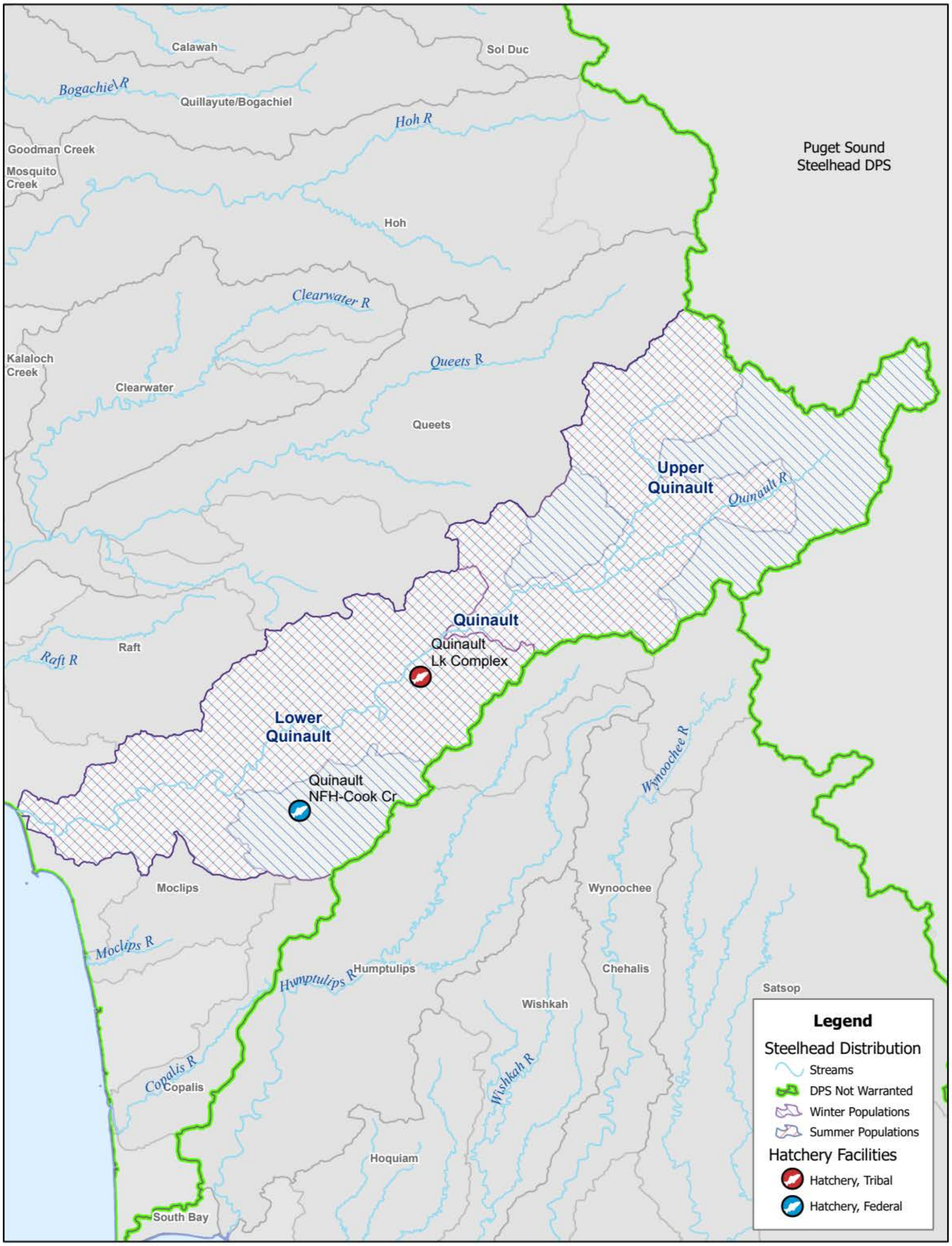

Figure 19: Map of the Quinault River, including summer and winter steelhead populations, DPS boundaries, and hatchery facility locations.

The Quinault River originates in the Olympic Mountains and flows 70 mi to the Pacific Ocean near the community of Taholah within the Quinault Indian Reservation. The Quinault River's total watershed area is 188 mi^2 and its major tributaries include the North Fork Quinault River, Graves Creek, Fox Creek, and Cook Creek. Steelhead populations in the Quinault River are managed by ONP within the park boundaries, and co-managed by WDFW and the Quinault Indian Nation outside the park. Lake Quinault is situated from river mile 33.5 to river mile 36.5; WDFW manages recreational fisheries above the lake and below the ONP boundary, referred to as the "upper Quinault," while the Quinault Indian Nation manages a tribal gill net fishery and a recreational fishery below the lake, referred to as the "lower Quinault." The entirety of the Quinault River watershed falls within the usual and accustomed fishing areas of the Quinault Indian Nation. Numerous habitat-related factors influence steelhead populations in marine, estuarine, and freshwater environments that must be considered when determining how to protect and perpetuate steelhead and the fisheries they support. Although portions of the Quinault River flow through relatively pristine forest habitat within Olympic National Park, both present day and historical logging operations and glacial recession, among other factors, have influenced the river's habitat quality and availability (WRIA 21 Recovery Plan). The Quinault River falls within WRIA 21 and is associated with the Quinault Indian Nation Lead Entity.

The Quinault River supports wild populations of both summer and winter-run steelhead as well as tribally produced hatchery populations. The current co-manager agreed-to escapement goal for all wild steelhead in the Upper Quinault River is 1,600 fish, and the steelhead populations have met that goal in five of the past ten seasons (2012/13-2021/22). During that time, the average escapement and runsize of Upper Quinault wild steelhead have been 1,496 and 2,566 fish, respectively. The average run size for all Quinault River wild steelhead between 2012/13 and 2021/2022 was 4,067 fish. The relative abundance and spatial distribution of Quinault summer-run wild steelhead is unknown. In combination, Quinault wild steelhead populations show a declining trend (Figure 20). For more detailed information about tributary-specific wild steelhead population trends and extinction risk assessment as of 2018, see Cram et al. (2018). WDFW intends to conduct in-depth analyses of the status of coastal steelhead populations and generate long-term conservation objectives during the development of RMPs (Section 5), pending the availability of sufficient funding.

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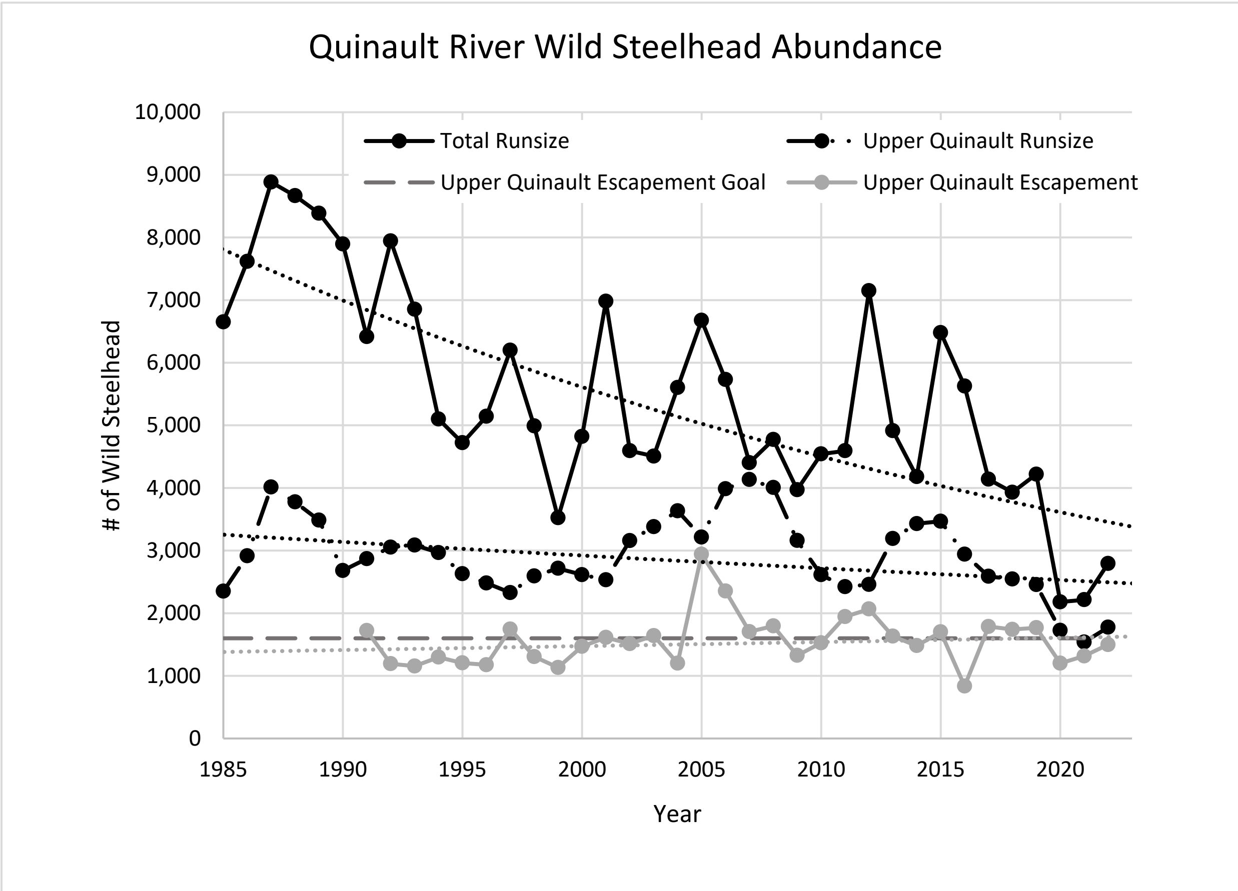

Figure 20: Total runsize, Upper Quinault runsize, and Upper Quinault escapement between the 1984/85 and 2021/22 recreational steelhead fishery seasons. The Upper and Lower Quinault River areas are separated because the State of Washington manages a recreational steelhead fishery in the upper river, while the Quinault Tribe manages steelhead in the lower river. The dotted curves show fitted exponential trends.

9.4.1 Monitoring and Evaluation

Monitoring and evaluation of wild steelhead in the Quinault River currently consists of spawning ground surveys conducted by the Quinault Indian Nation and ONP. The Proviso Implementation Strategy outlines a pathway for WDFW to contribute informative data to the co-management of Quinault River steelhead through an increased standard in monitoring and evaluation, especially regarding sport fishery monitoring.

Data Gaps: In addition to the monitoring and evaluation activities laid out in the Proviso Implementation Strategy (Section 3), WDFW has identified and prioritized additional work that will be done to fill the following data gaps for the Quinault River:

- Summer-run steelhead abundance and distribution (Section 8.6)

- Validity of the credit card rule (described below) to differentiate hatchery from natural-origin steelhead when the adipose fins of hatchery fish are not clipped
- Bull trout and steelhead interactions

Forecast Methods

WDFW is currently in the process of applying new quantitative analysis techniques to forecast future adult wild steelhead spawner abundance both one year ahead and in the long-term using ensemble timeseries modeling and IPMs, respectively. The Department's additional goals in developing IPMs are to estimate steelhead population parameters and lay to foundation for Management Strategy Evaluations (MSEs). As an example, the ensemble timeseries model was applied to Quinault River data to produce a forecast for the 2021/22 season. This product allows managers to assess ensemble timeseries model performance compared to other methodologies. The best performing model for the Quinault River was the stack weighted approach and produced a forecast of 3,484 fish (95% CI 1,973-6,246) for the 2021/22 fishing season. The performance of the model against calculated post-season runsize estimates was evaluated over ten years prior to the 2021/22 season (Figure 21).

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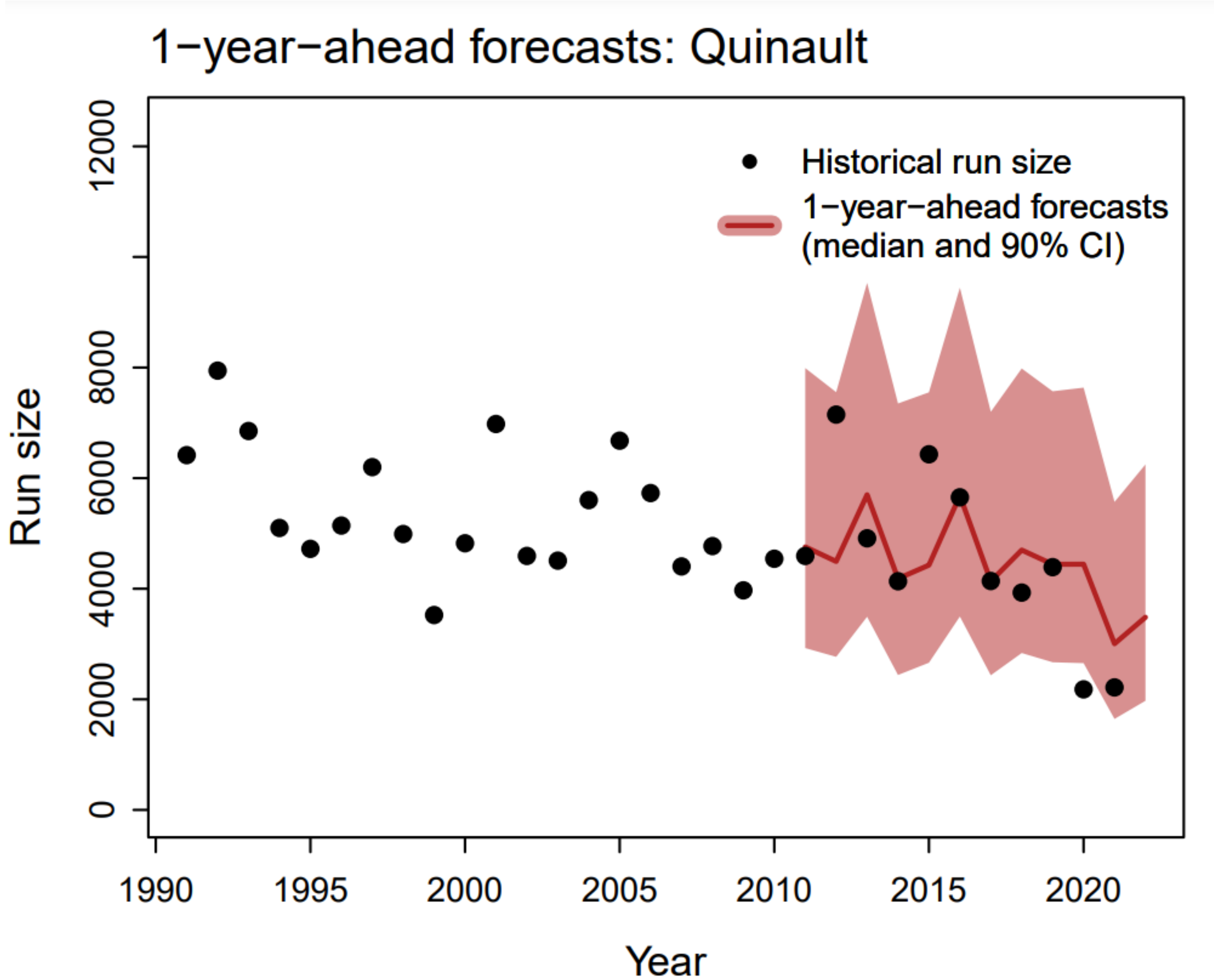

Figure 21: One year ahead forecasts of wild steelhead runsize generated by the ensemble timeseries model and bounded by a 90% confidence interval.

9.4.2 Fisheries Regulations

Boat and bank access are available in the lower river with a tribal guide only, while limited boat access and boat access are available in the state managed fishery above Lake Quinault. Based on WDFW CRC data and knowledge from regional fishery managers, approximately 10-15 recreational anglers and 2-5 professional fishing guides fish in the upper Quinault River on any given day during the open season. The current permanent fishing regulations for the upper Quinault River are listed below (Table 10). Motorized boats are currently prohibited on Lake Quinault and the upper river. Emergency regulations beyond the permanent regulations will be determined using the 3-Step Regulation Process (Section 3.2.2). The steelhead fishery in the lower Quinault River is operated by the Quinault Indian Nation.

Table 10: Permanent steelhead and rainbow trout regulations in the state-managed portion of the Quinault River.

Upper Quinault:	River	Closure Day	Regulations	Trout
	U. Quinault	15-Apr	SPB, NO BAIT Feb 16	cutthroat and wild RB min size 14".

KEY: SPB = single-point barbless hooks, SGR = selected gear rules, RB = rainbow trout

The Proviso Implementation Strategy will increase the likelihood that fishery regulations will allow runs to meet management objectives by increasing the standard amount of data available to inform the regulation-setting process, and by clearly outlining that process (See Section 4: Communications). Increased creel data will be especially useful for understanding sport fishery impacts in the upper Quinault River because it has not been applied there in the past. WDFW plans to develop more robust in-season update tools based on creel and/or SONAR data to change fisheries regulations in-season as needed.

Credit Card Rule and Hatchery Targeted Fisheries

Implementing and managing hatchery targeted fisheries in the Quinault River could be more challenging than in other systems because most hatchery fish released in the area are not adipose fin clipped, making it difficult to differentiate between hatchery and natural origin steelhead. Current regulations allow for the retention of steelhead with a dorsal fin height of less than 2 1/8 inches, colloquially known as the “credit card rule” because the height of a credit card is approximately 2 1/8 inches. The assumption behind this rule is that hatchery steelhead tend to have stunted dorsal fins because they are raised in close quarters with other fish. However, larger hatchery fish can grow dorsal fins that are longer than 2 1/8 inches even if they are somewhat stunted. Therefore, WDFW intends to evaluate the validity of the credit card rule and/or advocate for the adipose fin clipping of all hatchery fish.

9.4.3 Hatcheries

There are currently no WDFW managed hatcheries in the Quinault River basin. However, there are two tribal programs: the segregated Quinault National Fish Hatchery at Cook Creek, the integrated Lake Quinault Net Pens.

Wild Stock Gene Banks

WDFW will pursue a stakeholder process to designate WSGBs for coastal steelhead. In pursuit of this objective, steelhead in the Quinault River were evaluated for suitability as WSGBs according to the criteria listed in Section 3.3.4 (Table 11).

Table 11: Evaluation of wild steelhead in the Quinault River as potential WSGBs.

Population	WDFW criteria met?	Criteria
Quinault River Summer	NA	• No population data

Steelhead		
Lower Quinault Winter Steelhead	Criteria not met	• Six-year average of 1,258 spawners • Significant long-term decline • Hatchery programs at Quinault National Fish Hatchery and Lake Quinault Net Pens
Upper Quinault River Winter Steelhead	Criteria met	• Six-year average of 1,473 spawners • Slight long-term increasing population trend • No current hatchery releases but straying from Lake Quinault net pens may be a concern

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9.5 Queets/Clearwater Basin

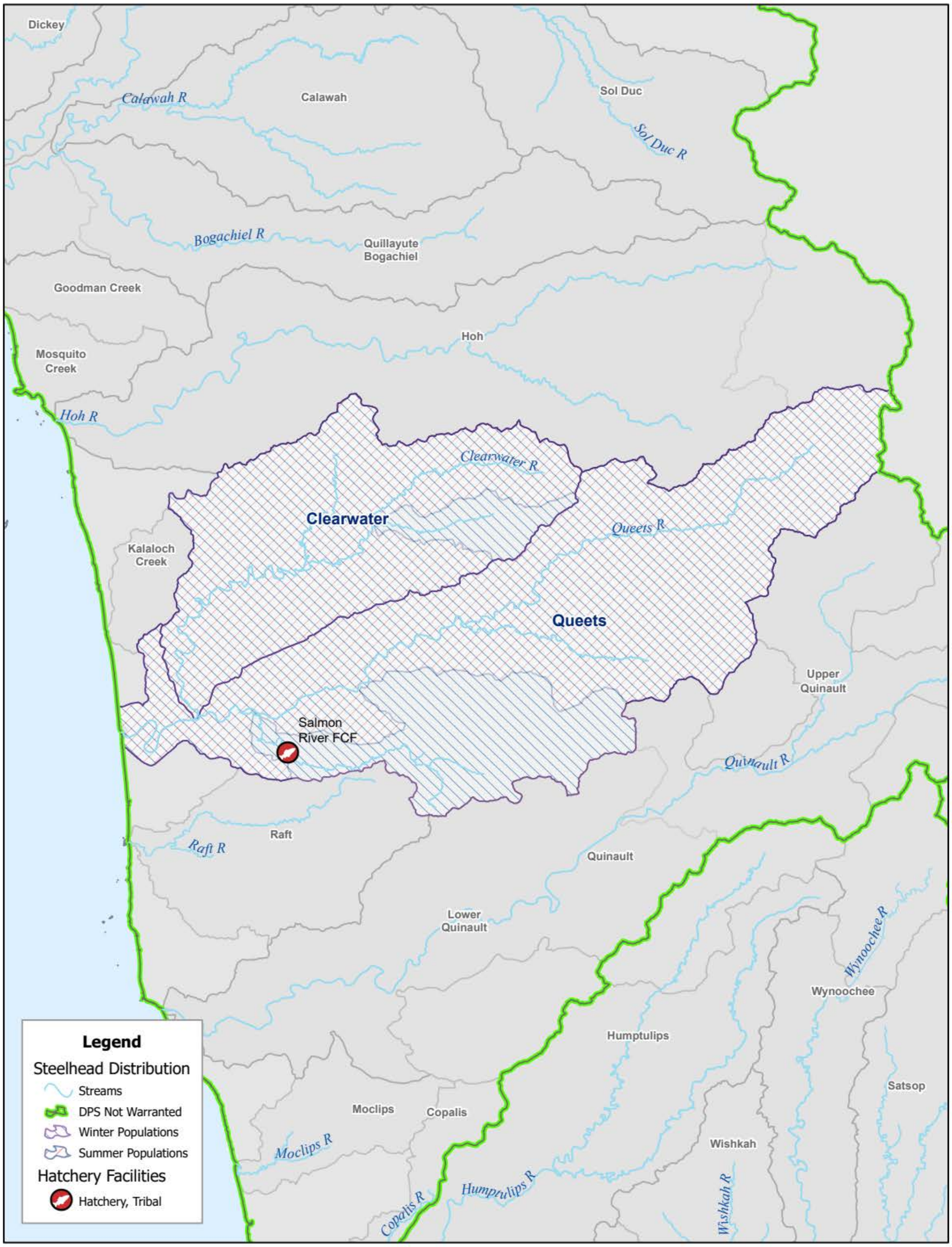

Figure 22: Map of the Queets/Clearwater basin, including summer and winter steelhead populations, DPS boundaries, and hatchery facility locations.

The Queets River runs 52.8 mi from the Base of Humes Glacier to the Pacific Ocean near the community of Queets, WA. The drainage basin that feeds the Queets River encompasses 204.6 mi^2 and its tributaries include the Clearwater River, Salmon River, Sams River, Matheny Creek, and Tshetshy Creek. Almost the entire length of the river runs through ONP, except for the last 4.0 mi, which flows through the Quinault Indian Reservation. Steelhead populations are managed by ONP within the park boundaries and co-managed by WDFW and the Quinault Indian Nation outside the park. The entirety of the Queets system falls within the usual and accustomed fishing areas of the Quinault Indian Nation. Historical and current logging operations and glacial recession, among other factors, have influenced the river's habitat quality and availability, in part by altering patterns of river flow, water temperature, sediment transport, and woody debris transport and availability within the Queets/Clearwater system (WRIA 21 recovery plan). The Queets/Clearwater system falls within WRIA 21 and is associated with the Quinault Indian Nation Lead Entity.

The Queets/Clearwater system supports wild spawning populations of summer and winter-run steelhead as well as hatchery runs. The current WDFW escapement goal for wild steelhead in the Queets/Clearwater system is 4,200 fish, and the wild populations have met that goal 2 out of the past 10 seasons (2012/13-2021/22). During that time, the average escapement and runsizes have been 3,308 and 4,709 fish, respectively. In combination, Queets/Clearwater wild steelhead populations show a declining abundance trend (Figure 23). Available data on the relative abundance and spatial distribution of Queets/Clearwater summer-run wild steelhead is limited. For more detailed information about river-specific wild steelhead population trends and extinction risk assessment as of 2018, see Cram et al. (2018). WDFW intends to conduct in-depth analyses of the status of coastal steelhead populations and generate long-term conservation objectives during the development of RMPs (Section 5), pending the availability of sufficient funding.

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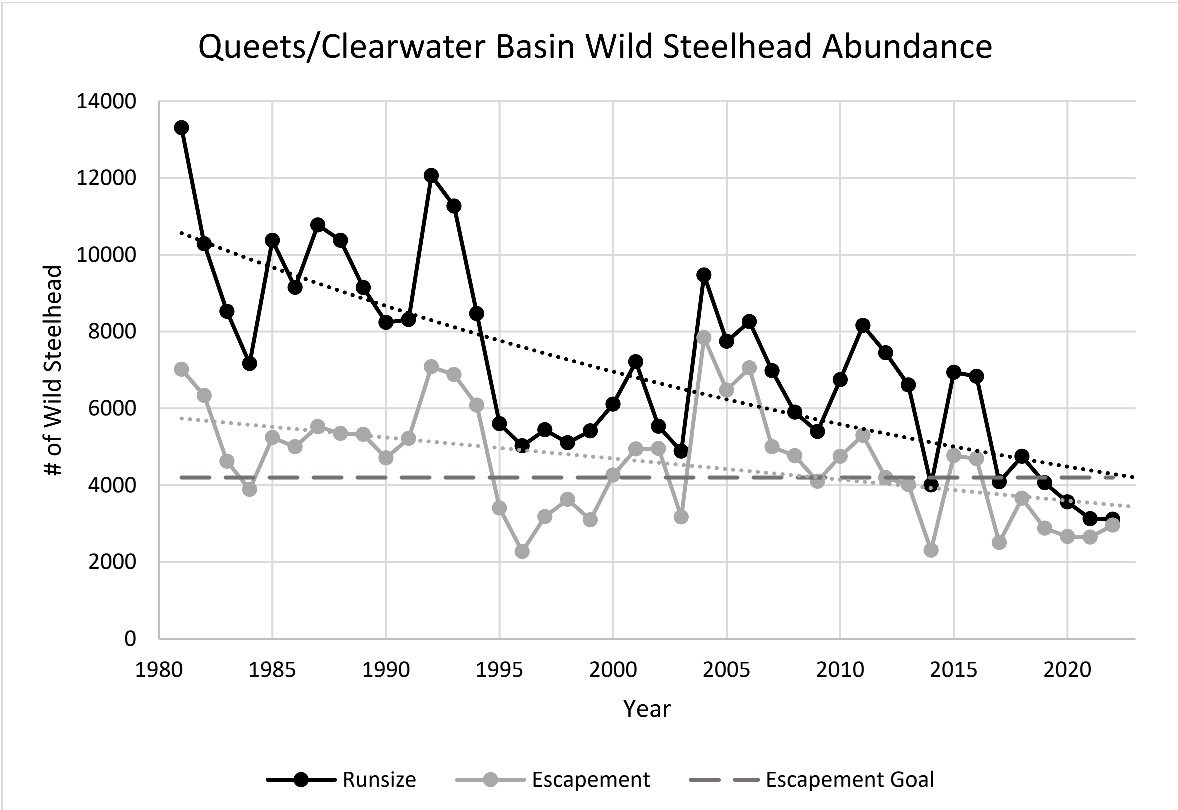

Figure 23: Queets/Clearwater basin wild steelhead runsize and escapement between the 1980/81 and 2021/22 recreational steelhead fishery seasons. The dotted curves show fitted exponential trends.

9.5.1 Monitoring and Evaluation

Steelhead monitoring and evaluation in the Queets/Clearwater Basin primarily consists of spawning ground surveys. The Quinault Indian Nation surveys approximately 90% of the basin while WDFW covers the remaining 10%. The Proviso Implementation Strategy outlines a pathway for WDFW to contribute more data to the co-management of Queets/Clearwater steelhead through an increased standard of monitoring and evaluation, especially regarding sport fishery monitoring.

Data Gaps: In addition to the monitoring and evaluation activities laid out in the Proviso Implementation Strategy (Section 3), WDFW has identified and prioritized additional work that will be done to fill the following data gaps for the Queets/Clearwater Basin:

- Summer-run steelhead abundance and distribution (Section 8.6)
- Validity of the "credit card rule" to differentiate hatchery from natural origin steelhead when the adipose fins of hatchery fish are not clipped
- Bull trout and steelhead interactions

Forecast Methods

WDFW is currently in the process of applying new quantitative analysis techniques to forecast future adult wild steelhead spawner abundance both one year ahead and in the long-term using ensemble timeseries modeling and IPMs, respectively. The Department's additional goals in developing IPMs are to estimate steelhead population parameters and lay to foundation for Management Strategy Evaluations (MSEs). As an example, the ensemble timeseries model was applied to Queets/Clearwater data to produce a forecast for the 2021/22 season after the season. This product allows managers to assess ensemble timeseries model performance compared to other methodologies. The best performing model for the Queets/Clearwater was an ARIMA approach with covariates and produced a forecast of 3,542 fish (95% CI 2,289-5,480) for the 2021/22 fishing season. The performance of the model against calculated post-season runsize estimates was evaluated over ten years prior to the 2021/22 season (See Figure 4). The steelhead specific IPM that will be applied to Queets/Clearwater data is under development.

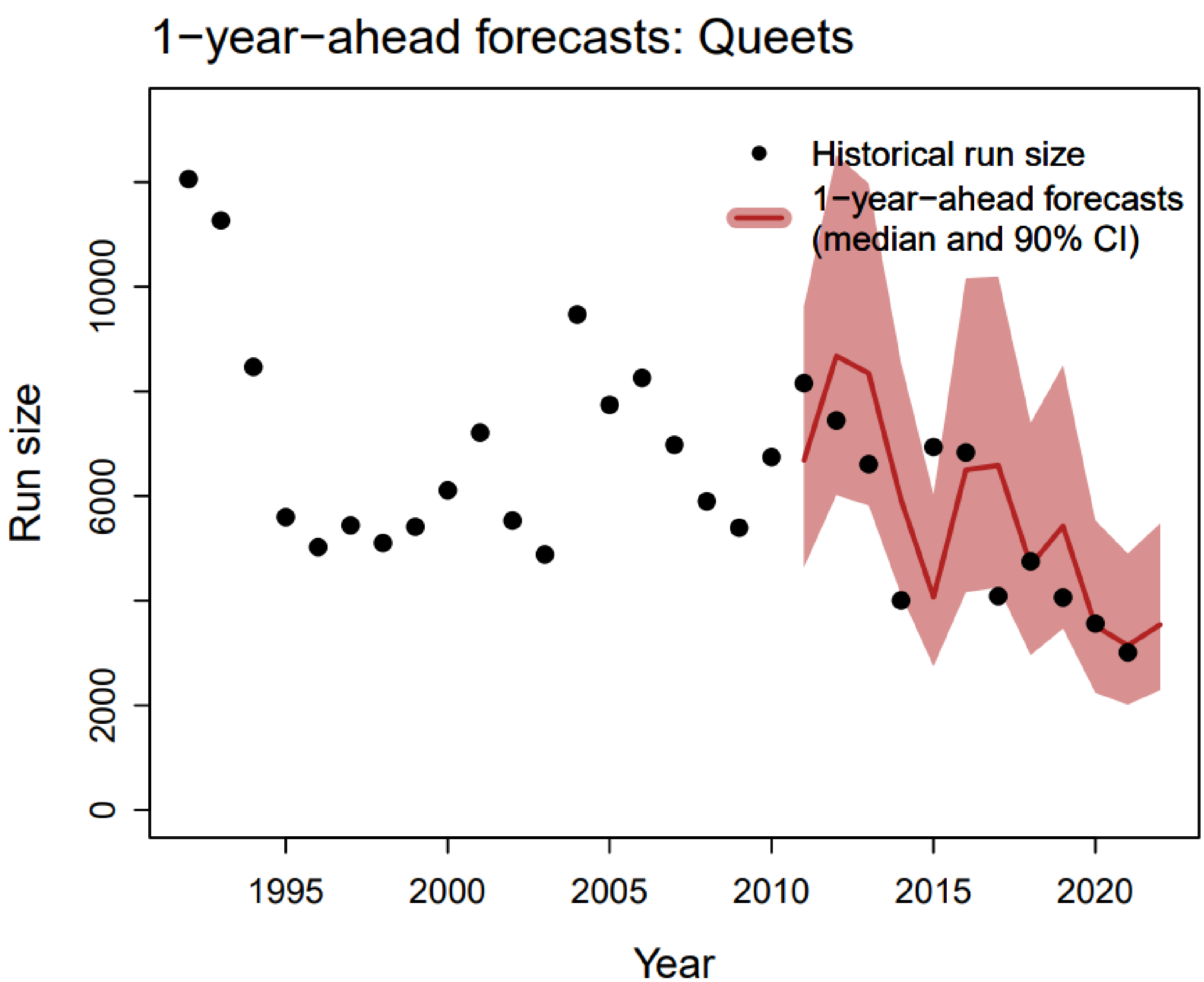

Figure 24: One year ahead forecasts of wild steelhead runsize generated by the ensemble timeseries model and bounded by a 90% confidence interval.

9.5.2 Fisheries Regulations

The recreational fishery in the Queets River consists primarily of boat angling, facilitated by several boat launches. Fishing on the Salmon River, on the other hand, is limited to bank angling. The Salmon River runs through state-managed land, Quinault Indian Nation land, and ONP. Portions of the river are only accessible to recreational anglers with a tribal guide. Based on WDFW CRC data and knowledge from regional fishery managers, approximately 55-65 recreational anglers and 13-18 professional fishing guides fish for steelhead in the Queets/Clearwater system on any given day during the open season.

Table 12: Permanent steelhead and rainbow trout regulations in the Queets/Clearwater basin.

Queets/Clearwater:	River	Closure Day	Regulations	Trout
	Queets R.	15-Apr	ONP, SPB, bait allowed below Hartzell, Dec 1-Feb 28.	cutthroat and wild RB min size 14".
	Clearwater	15-Apr	SPB; Bait prohibited Feb. 16 to Aug. 31st	cutthroat and wild RB min size 14".

KEY: SPB = single-point barbless hooks, SGR = selected gear rules, RB = rainbow trout, ONP = Olympic National Park

The Proviso Implementation Strategy will increase the likelihood that fishery regulations will allow runs to meet management objectives by increasing the standard amount of data available to inform the regulation-setting process, and by clearly outlining that process (Section 4: Communications). Increased creel data will be especially useful for understanding sport fishery impacts in the Queets/Clearwater Basin because it has not been applied there in the past. WDFW plans to develop more robust in-season update tools based on creel and/or SONAR data to change fisheries regulations in-season as needed.

Credit Card Rule and Hatchery Targeted Fisheries

Implementing and managing hatchery targeted fisheries in the Queets/Clearwater Basin could be more challenging than in other systems because most hatchery fish released in the area are not adipose fin clipped, making it difficult to differentiate between hatchery and natural origin steelhead. Current regulations allow for the retention of steelhead with a dorsal fin height of less than 2 1/8 inches, colloquially known as the “credit card rule” because the height of a credit card is approximately 2 1/8 inches. The assumption behind this rule is that hatchery steelhead tend to have stunted dorsal fins because they are raised in close quarters with other fish. However, larger hatchery fish can grow dorsal fins that are longer than 2 1/8 inches even if they are somewhat stunted. Therefore, WDFW intends to evaluate the validity of the credit card rule and/or advocate for the adipose fin clipping of all hatchery fish.

9.5.3 Hatchery Operations

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There are currently no WDFW managed hatcheries in the Queets nor Clearwater basins. However, there is one federal program: the integrated Salmon River Fish Culture Facility.

Wild Stock Gene Banks

WDFW will pursue a stakeholder process to designate WSGBs for coastal steelhead. In pursuit of this objective, steelhead in the Queets/Clearwater basin were evaluated for suitability as WSGBs according to the criteria listed in Section 3.3.4 (Table 13).

Table 13: Evaluation of wild steelhead in the Queets/Clearwater basin as potential WSGBs.

Population	Status	Criteria
Queets River Winter/ Summer Steelhead	Criteria not met	• Six-year average of 2,030 spawners • No data on summer population • Long-term population decline • Current Quinault Tribe on-station EWS releases from Salmon River Hatchery
Clearwater River Winter/ Summer Steelhead	Candidate for WRIA 21	• Six-year average of 1,408 spawners • Long-term declining population trend, but relatively stable trend since 1994 • No data on summer population • Very limited hatchery influence with <1,000 smolts released in 1981 and 1983

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9.6 Quillayute Basin

Figure 25: Map of the Quillayute Basin

The Quillayute River system is composed of the Quillayute mainstem (5.6 mi mouth to the confluence of the Sol Duc and Bogachiel) and four major tributaries: the Bogachiel, Calawah, Sol Duc, and Dickey rivers. This large watershed encompasses 305.0 mi^2 of land between the west side of the Olympic Mountains and the Pacific Ocean near the village of La Push. A significant portion of the watershed falls within the boundaries of ONP, and fisheries resources in that area are managed by the National Park Service. Sections of the Quillayute system that lie outside the park are co-managed by WDFW and the Quileute Tribe. The entire basin falls within the usual and accustomed fishing areas of the Quileute Indian Nation and a portion of the basin falls within the usual and accustomed fishing areas of the Hoh Tribe. Although river habitat within ONP is relatively pristine, logging operations, among other factors, have influenced the river's habitat quality and availability. The Quillayute River system falls within WRIA 20 and is associated with the North Pacific Coast Lead Entity.

The Quillayute River system supports wild spawning populations of summer and winter-run steelhead as well as hatchery runs. The current co-manager agreed-to wild steelhead escapement goal for the Quillayute system is 5,900 fish; in sum, population abundance in the system has met or exceeded that goal in 9 out of 10 years between the 2012/13 and 2021/22 seasons. During that time, the average escapement and runsizes have been 7,192 and 8,950 fish, respectively. Available data on the relative abundance and spatial distribution of Quillayute summer-run wild steelhead is limited. Combined wild populations in the Quillayute system show declining abundance since the mid-1990s, although population abundance in recent years is like that of the late 1970s and early 1980s (Figure 26). Data was not systematically collected for escapement nor runsize by WDFW, the Quileute Tribe, nor ONP prior to the 1970s, however, historical data sources suggest that population abundance has declined relative to early 20th century (McMillan et al. 2021). For more detailed information about tributary-specific wild steelhead population trends and extinction risk assessment as of 2018, see Cram et al. (2018). WDFW intends to conduct in-depth analyses of the status of coastal steelhead populations and generate long-term conservation objectives during the development of RMPs (Section 5), pending the availability of sufficient funding.

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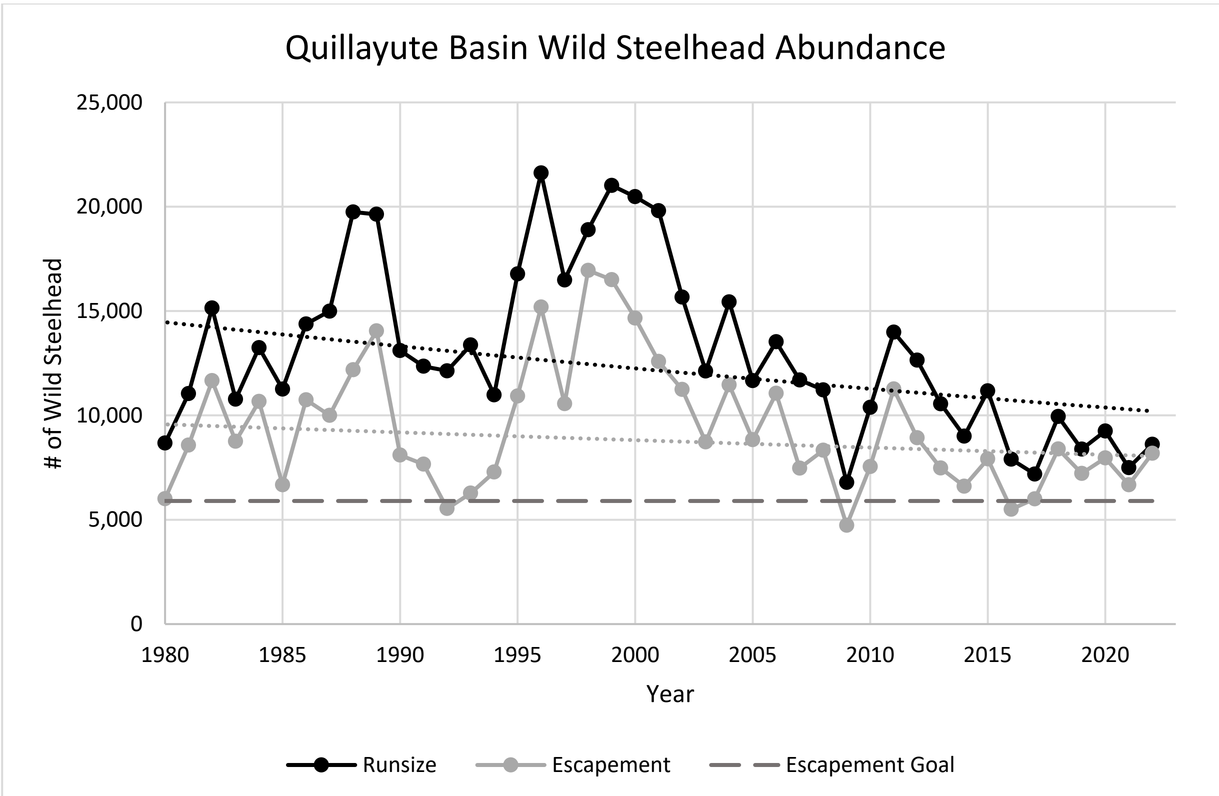

Figure 26: Total Quillayute Basin wild steelhead runsize and escapement between the 1977/78 and 2021/22 recreational steelhead fishery seasons, including the Dickey, Calawah, Bogachiel, and Sol Duc rivers. The dotted curves show fitted exponential trends.

9.6.1 Monitoring and Evaluation

The Proviso Implementation Strategy will increase standard monitoring and evaluation in the Quillayute Basin, especially by enhancing sport fishery monitoring and increasing spawning ground survey and/or SONAR coverage as determined by the Adaptive Management Framework (Table 1) and co-manager discussion. Currently, spawning ground surveys are carried out through collaboration between WDFW, the Quileute Tribe, and ONP. Tribal fisheries technicians conduct ground-based surveys approximately every 10-14 days in index areas and once or twice per season in supplemental areas. WDFW conducts aerial surveys approximately 6 times per season, covering the mainstem Quillayute River and the major tributaries. ONP surveys the upper Sol Duc River. Ground to air corrections factors are calculated using the two survey methods. Data from surveyed areas is expanded to un-surveyed areas to determine total steelhead escapement. In recent years, landslides in the Bogachiel River have limited the Department’s ability to detect redds during high turbidity events; the utilization of SONAR technology could allow WDFW to estimate escapement even in low visibility conditions. Limited creel surveys have been carried out in the Quillayute River since the Boldt decision, but comprehensive creel surveying has largely been absent from the system in recent years.

In the Quillayute Basin, steelhead management benefits from the close working relationship between WDFW and the Quileute Tribe. During the tribal gillnet fishery, the Quileute Tribe collects scales that provide information about the run timing and age class distribution of both hatchery and wild fish. The run timing information allows the tribe to predict how many hatchery and wild fish to expect during statistical weeks of the open season. The tribe also generates preseason forecasts and calculates a “catchability coefficient” to predict harvest and set gillnet seasons and management plans.

Data Gaps: In addition to the monitoring and evaluation activities laid out in the Proviso Implementation Strategy (Section 3), WDFW has identified and prioritized additional work that will be done to fill the following data gaps for the Quillayute:

- Summer-run steelhead abundance and distribution (Section 8.6)
- Research comparing population parameters of wild steelhead in the Sol Duc to the Bogachiel and Calawah to understand the value of WSMZs
- Wild steelhead spawning distribution in areas not regularly surveyed, such as the upper North Fork of the Sol Duc River

Forecast Methods

WDFW is currently in the process of applying new quantitative analysis techniques to forecast future adult wild steelhead spawner abundance, both one year ahead and in the long-term using ensemble timeseries modeling and IPMs, respectively. The Department’s additional goals in developing IPMs are to estimate steelhead population parameters and lay to foundation for Management Strategy Evaluations (MSEs). As an example, the ensemble timeseries model was applied to combined Quillayute Basin data to produce a forecast for the 2021/22 season after the season. This product allows managers to assess ensemble timeseries model performance compared to other methodologies. The best performing model for the Quillayute Basin was the stack weighted approach and produced a forecast of 8,008 fish (95% CI 5,526-11,607) for the 2021/22 fishing season. The performance of the model against calculated post-season runsize estimates was evaluated over ten years prior to the 2021/22 season (Figure 27).

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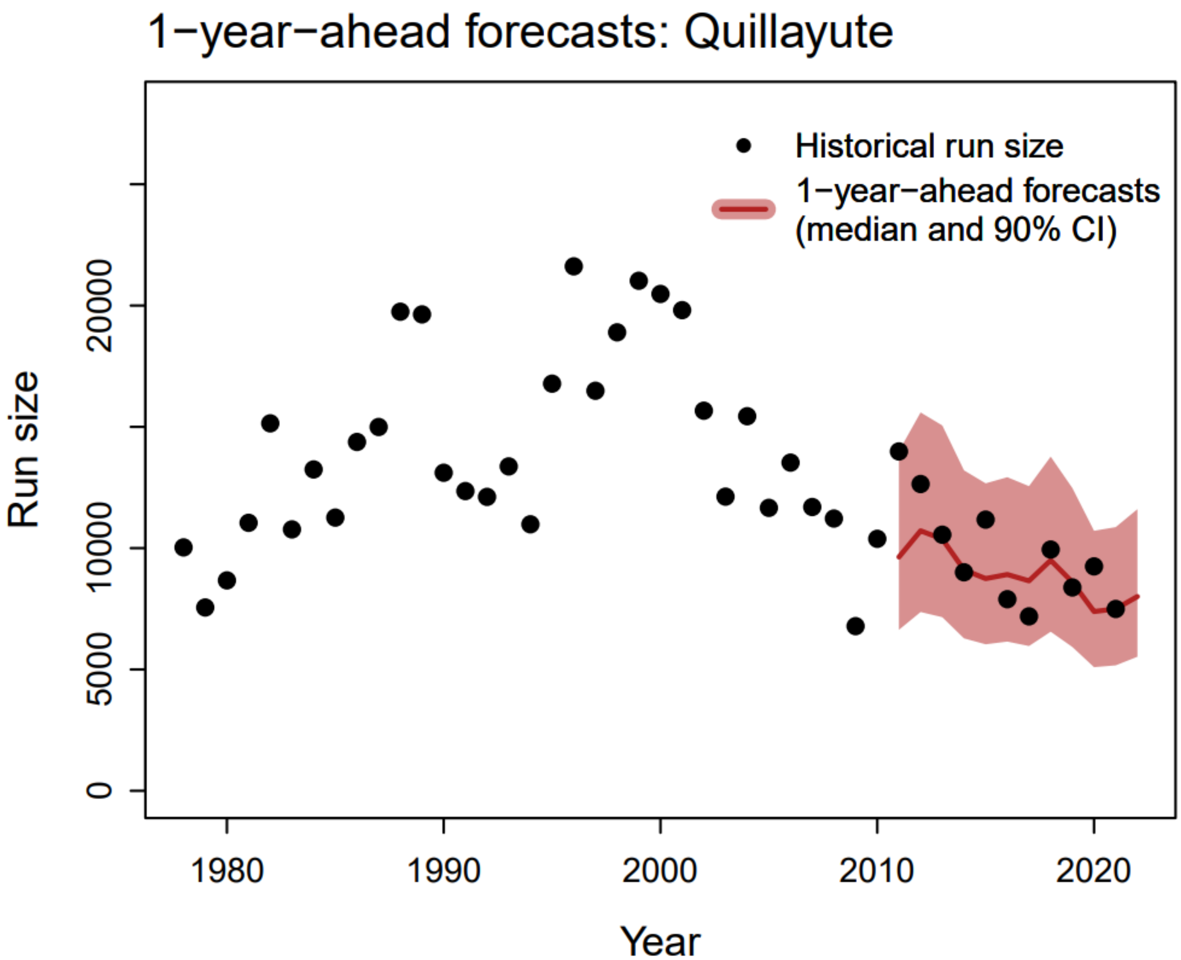

Figure 27: One year ahead forecasts of wild steelhead runsize generated by the ensemble timeseries model and bounded by a 90% confidence interval.

9.6.2 Fisheries Regulations

Numerous boat launches provide access for boat anglers on the Sol Duc, Bogachiel, Calawah and Quillayute rivers when steelhead populations support those activities. Bank anglers can access locations on the mainstem Quillayute and its tributaries, however due to the high gradient and boulder substrate in the Sol Duc and Calawah rivers wading long distances is challenging. Based on WDFW data and knowledge from regional fish managers, on any given day during the open steelhead fishery season, about 20-25 recreational steelhead anglers and 8-10 guides fish the Bogachiel, 30-35 recreational steelhead anglers and 10-15 guides fish the Sol Duc, 20-25 recreational anglers and 5-10 guides fish the Calawah, 15-20 recreational anglers and 0-2 guides fish the Dickey, and 6-8 recreational anglers and 2-4 guides fish the mainstem Quillayute. The current permanent fishing regulations for the Quillayute Basin are listed below (Table 14). Emergency regulations beyond the permanent regulations will be determined using the 3-Step Regulation Process (Section 3.2.2).

Table 14: Permanent steelhead and rainbow trout regulations in the Quillayute basin.

Quillayute:	River	Closure Day	Regulations	Trout
	Quillayute	year round	SPB; Nov 1-limit 3 hatchery, Mar. 1	release wild RB
	Bogachiel (below Hwy 101)	30-Apr	SPB, NO BAIT Feb 16., 3 hatchery steelhead	release wild RB
	Bogachiel (above Hwy 101)	30-Apr	SPB, NO BAIT Feb 16., 3 hatchery steelhead	release wild RB
	Calawah (below Hwy 101)	30-Apr	SPB, NO BAIT Feb 16., 3 hatchery steelhead	release wild RB
	Calawah (above Hwy 101)	30-Apr	SPB, NO BAIT	release wild RB
	S. Fork Calwah	29-Feb	SPB, NO BAIT	release wild RB
	Dickey	30-Apr	SPB, NO BAIT, Feb 16	release wild RB
	Thunder Creek (tributary to Dickey R.)	30-Apr	SPB; NO BAIT;	release wild RB
	Sol Duc, below hatchery	Year round	SPB, NO BAIT, Feb 16	release wild RB
	Sol Duc, above hatchery	30-Apr	SPB; NO BAIT;	release wild RB

KEY: SPB = single-point barbless hooks, SGR = selected gear rules, 1BH = one barbless hook
RB = rainbow trout

The Proviso Implementation Strategy will increase the likelihood that fishery regulations will allow runs to meet management objectives by increasing the standard amount of data available to inform the regulation-setting process, and by clearly outlining that process (See Section 4: Communications). Increased creel data will be especially useful for understanding sport fishery impacts in the Quillayute River because it has been limited there in the past. WDFW plans to develop more robust in-season update tools based on creel and/or SONAR data to change fisheries regulations in-season as needed. The strategy also allows fishery regulations to adapt given different levels of wild steelhead abundance, with priority given to providing angling opportunity on hatchery origin fish in the Transitional management regime. The exact timing, duration, and location of hatchery targeted fisheries will be determined annually in the pre-season regulation setting process.

9.6.3 Hatchery Operations

Within the Quillayute Basin, WDFW currently operates a segregated EWS program and a segregated ESS program at the Bogachiel Hatchery and Calawah Ponds. In recent years, the EWS program has released 150,000 smolts per year, while the ESS program has released 30,000 smolts per year. To increase the likelihood that genetic impacts of hatchery fish on wild populations remain within pHOS, PNI, and geneflow thresholds set in the SSMP and to minimize additional ecological impacts, WDFW will evaluate and adjust hatchery operations

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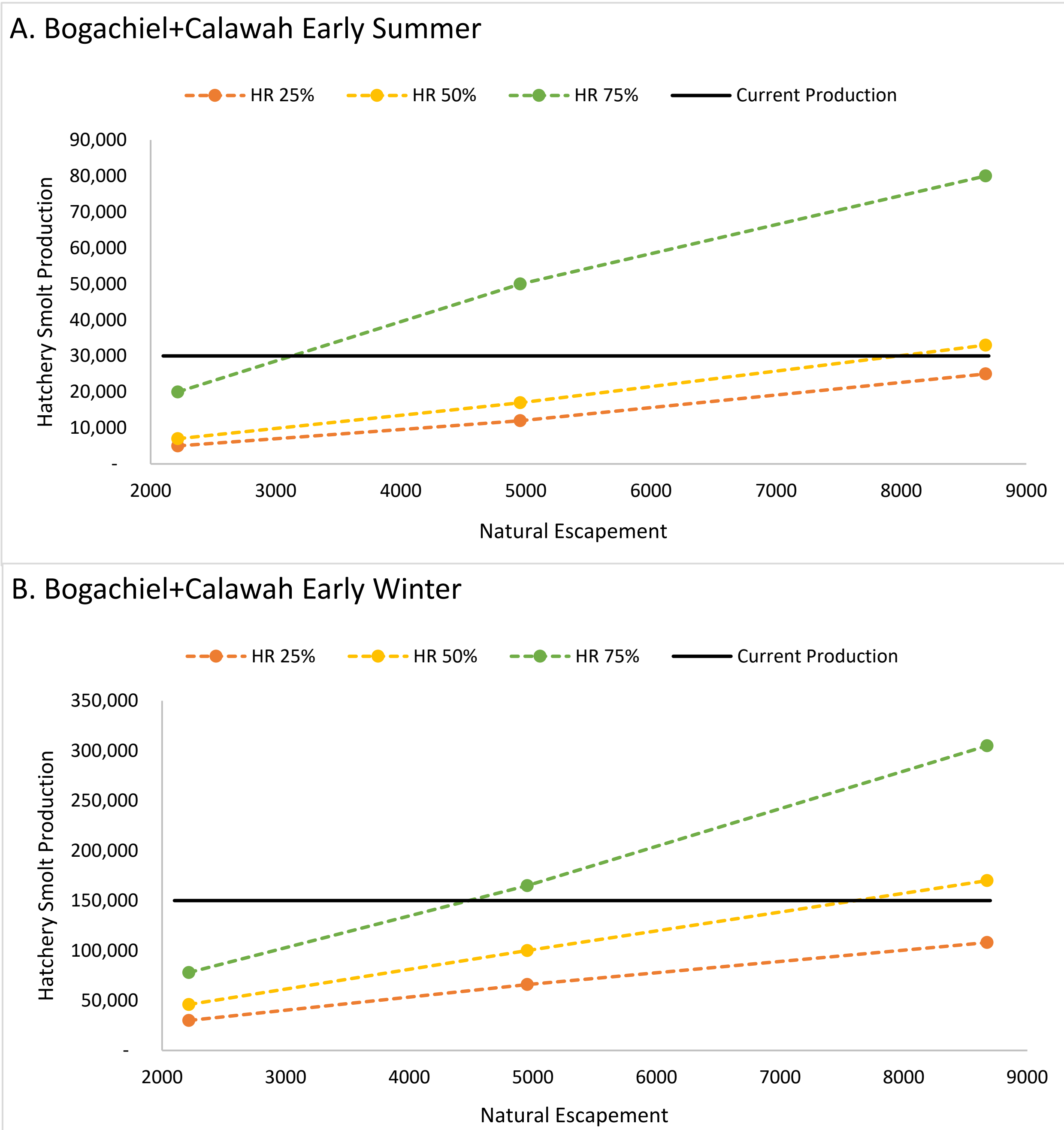

Figure 28: Potential smolt release estimates for the Forks Creek Early Winter (A) and Naselle Early Winter (B) steelhead hatchery programs at varying levels of natural escapement and homing rate (HR) based on the DGM model. In this instance HR is defined as the percent of returning hatchery fish that are removed from the river, either by returning to the hatchery or through trapping. The dashed lines showing potential smolt releases do not represent a linear function, rather, releases were modeled at three points: the minimum natural origin steelhead escapement on record, the maximum natural origin steelhead escapement on record, and the recent 5-year average natural origin steelhead abundance (what years?). The dashed lines connecting these three points show an approximation of smolt releases likely to meet genetic impact thresholds at various levels of natural origin steelhead escapement between those 3 points. Potential smolt releases likely to meet genetic impact thresholds will be reevaluated at least every 3 years using recent year average abundance (currently 5-year average).

at least every three years. Using the DGM or AHA models, WDFW will estimate the number of hatchery smolts that can be released by each hatchery program given varying levels of trapping efficiency, SAR, fishing effort, and other pertinent variables (Appendices 12.1.3-12.1.4). Potential smolt release estimates for the Bogachiel and Calawah hatchery programs are shown in Figure 28.

Wild Stock Gene Banks

WDFW will pursue a stakeholder process to designate WSGBs for coastal steelhead. In pursuit of this objective, steelhead in the Quillayute basin were evaluated for suitability as WSGBs according to the criteria listed in Section 3.3.4 (Table 15).

Table 15: Evaluation of wild steelhead in the Quillayute basin as potential WSGBs.

Population	Status	Criteria
Dickey River Winter Steelhead	Candidate for WRIA 20	• Six-year average of 374 spawners • Relatively stable but slightly decreasing population trend • Limited hatchery influence, with the only plants occurring in 1973 in West Fork Dickey and 1998 in Dickey Lake
Sol Duc River Winter/ Summer Steelhead	Current WSMZ for WRIA 20	NA
Calawah River Winter/ Summer Steelhead	Criteria not met	• Six-year average of 2,626 spawners • No data on summer population • Slightly increasing population trend • Current on-station hatchery releases from Calawah Ponds
Bogachiel River Winter/ Summer Steelhead	Criteria not met	• Six-year average of 1,156 spawners • No data on summer population • Long-term population decline • Current on-station releases from Bogachiel Hatchery

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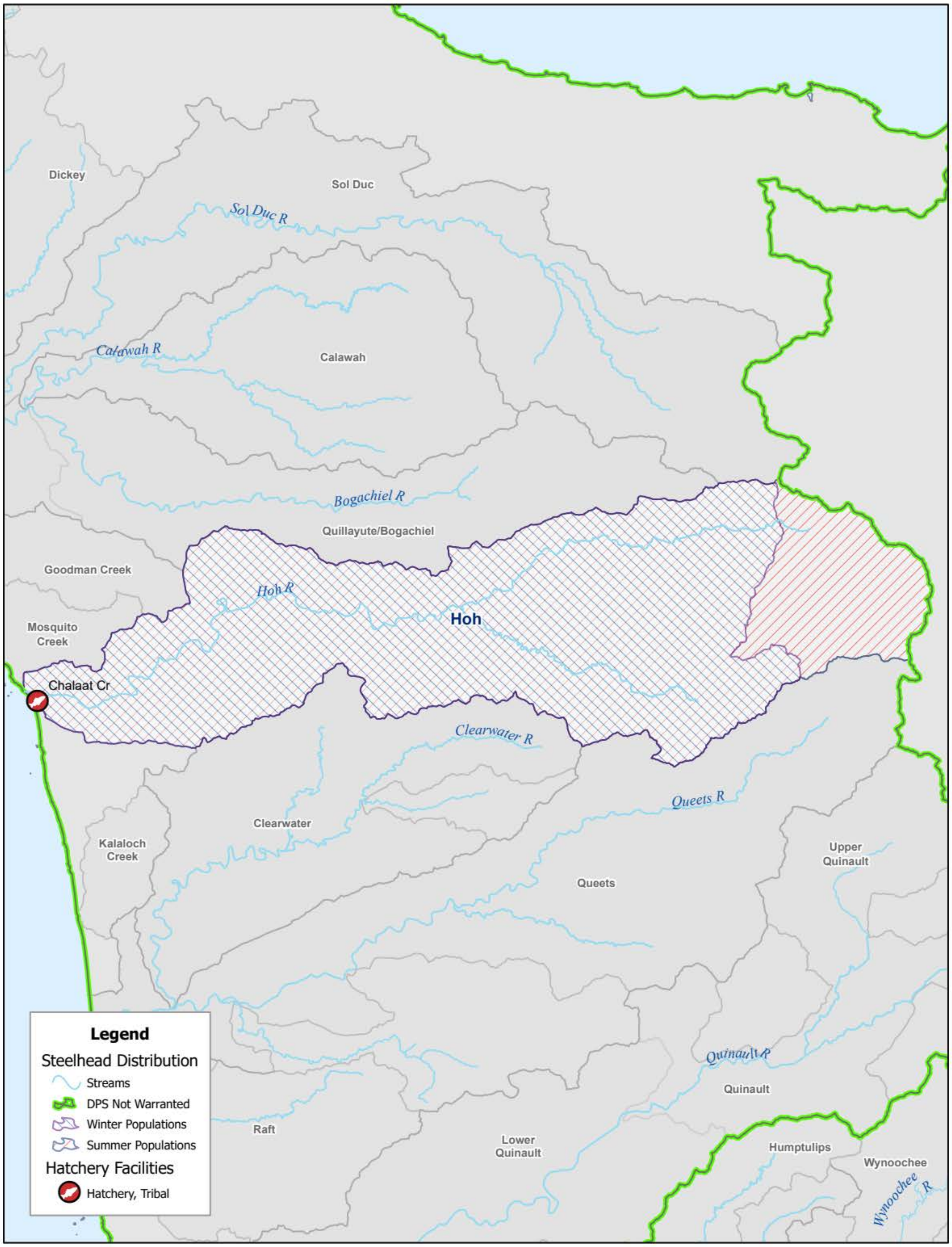
9.7 Hoh River



Dickey
Sol Duc
Sol Duc R
Calawah R
Calawah
Bogachiel R
Quillayute/Bogachiel
Goodman Creek
Hoh R
Hoh
Mosquito Creek
Chalaat Cr
Clearwater R
Queets R
Clearwater
Kalaloch Creek
Upper Quinault
Queets
Quinault R
Quinault
Raft
Lower Quinault
Humptulips
Wynoochee
Wynoochee R
Legend
Steelhead Distribution
Streams
DPS Not Warranted
Winter Populations
Summer Populations
Hatchery Facilities
Hatchery, Tribal

Figure 29: Map of the Hoh River drainage, including summer and winter steelhead populations, DPS boundaries, and hatchery facility locations.

The Hoh River originates from glaciers in the Olympic Mountains and flows 56.5 mi to the Pacific Ocean near the town of Oil City. This watershed contains 44 named tributaries, including the South Fork Hoh. Together, the Hoh River receives an annual mean precipitation of 358 cm and an annual mean daily flow of 71 cm^3/s (England 2003, Brenkman et al. 2007). Fifty eight percent of the Hoh River watershed is under the management authority of ONP, however WDFW is responsible for comanaging natural resources downstream of river kilometer 47.48 with the Hoh Tribe. The entirely of the Hoh River falls within the usual and accustomed fishing grounds of the Hoh Tribe. Although most of the Hoh watershed is relatively pristine due to ONP protection, historical logging operations and glacial recession, among other factors, have influenced the river's habitat quality and availability. The Hoh River falls within WRIA 20 and is associated with the North Pacific Coast Lead Entity.

The Hoh River supports wild spawning populations of summer and winter-run steelhead as well as a hatchery run. The current co-manager agreed-to wild steelhead escapement goal on the Hoh River is 2,400 fish, and the populations met that goal 6 out of 10 seasons between the 2012/13 and 2021/22 seasons. During that time, the average escapement and runsizes have been 2,551 and 3,250 fish, respectively. In combination, Hoh River populations show a declining abundance trend (Figure 30). Available data on the relative abundance and spatial distribution of Hoh summer-run wild steelhead is limited. For more detailed information about river specific wild steelhead population trends and extinction risk assessment as of 2018, see Cram et al. (2018). WDFW intends to conduct in-depth analyses of the status of coastal steelhead populations and generate long-term conservation objectives during the development of RMPs (Section 5), pending the availability of sufficient funding.

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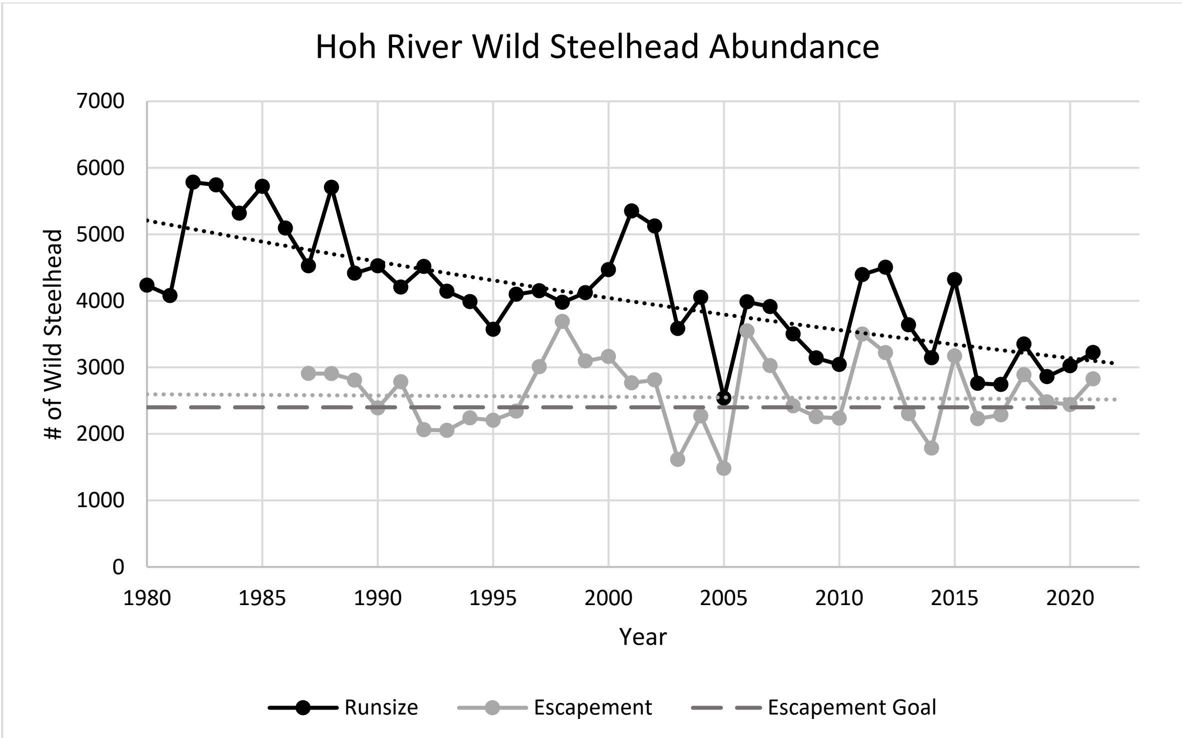

Figure 30: Hoh River wild steelhead runsize and escapement between the 1979/80 and 2021/22 recreational steelhead fishery seasons. The dotted curves show fitted exponential trends.

9.7.1 Monitoring and Evaluation

The Proviso Implementation Strategy will increase standard monitoring and evaluation in the Hoh River, especially by increasing spawning ground survey and/or SONAR coverage as determined by the Adaptive Management Framework (Table 1). Currently, spawning ground surveys are carried out through collaboration between WDFW, the Hoh Tribe, and ONP. The Hoh Tribe and WDFW split survey indexes in the mainstem and tributaries, while ONP covers one mainstem index. Most years 100% of known steelhead spawning areas are surveyed in regular or supplemental indexes. In years when complete survey coverage is not possible, data from surveyed areas is expanded to un-surveyed areas to estimate total steelhead escapement.

The Hoh River is the only river on Washington's Pacific coast that has been the subject of consistent creel surveying to monitor the steelhead sport fishery in recent years. The Proviso Implementation Strategy supports the continuation of that work as a part of standard monitoring and evaluation; however, the Department will continually improve its creel methodologies. WDFW staff will work to improve in-season recreational fishery update tools, develop an R package for in-season analysis of creel data, and program agency iPads to compile creel data more efficiently. Technical advancements made to processing creel data in the Hoh River will be shared with other management districts across Region 6, with the goal of increasing regional consistency in monitoring and evaluation techniques.

Data Gaps: In addition to the monitoring and evaluation activities laid out in the Proviso Implementation Strategy (Section 3), WDFW has identified and prioritized additional work that will be done to fill the following data gaps for the Hoh Basin:

- Summer-run steelhead abundance and distribution
- Interactions between bull trout and steelhead trout

Forecast Methods

WDFW is currently in the process of applying new quantitative analysis techniques to forecast future adult wild steelhead spawner abundance both one year ahead and in the long-term using ensemble timeseries modeling and IPMs, respectively. The Department's additional goals in developing IPMs are to estimate steelhead population parameters and lay to foundation for Management Strategy Evaluations (MSEs). As an example, the ensemble timeseries model was applied to Hoh River data to produce a forecast for the 2021/22 season after the season. This product allows managers to assess ensemble timeseries model performance compared to other methodologies. The best performing model for the Hoh River was a stack weighted approach and produced a forecast of 3,550 fish (95% CI 2,378-5,369) for the 2021/22 fishing season. The performance of the model against calculated post-season runsize estimates was evaluated over ten years prior to the 2021/22 season (Figure 31). The steelhead specific IPM that will be applied to Hoh River data is currently under development through collaboration between WDFW Fish Management and Science Division.

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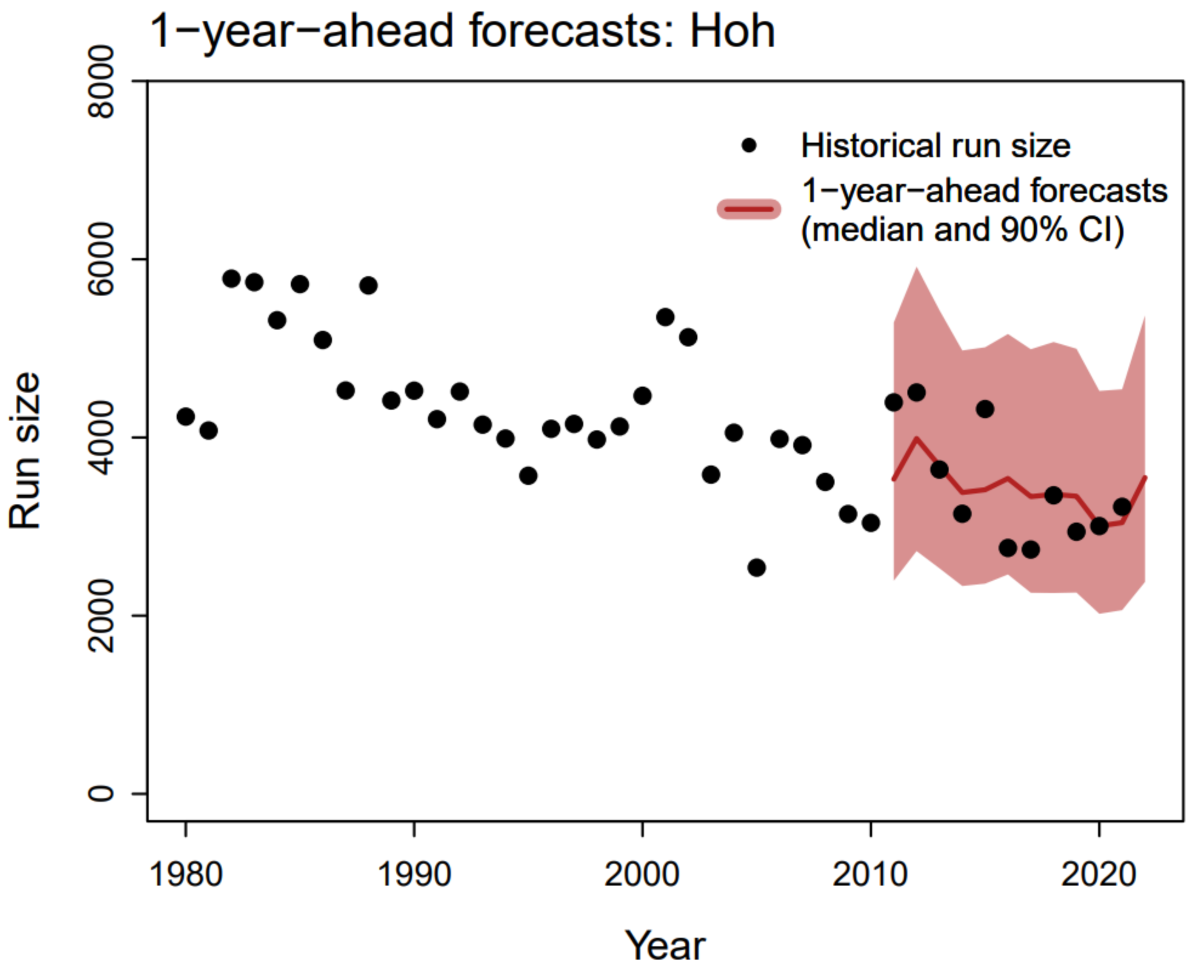

Figure 31: One year ahead forecasts of wild steelhead runsize generated by the ensemble timeseries model and bounded by a 90% confidence interval.

9.7.2 Fisheries Regulations

The Hoh River provides easy access to both bank and boat anglers, with good road access, numerous boat launches, and a walkable bank. However, in recent years, emergency regulations have closed the Hoh River to fishing from a floating device due to low wild steelhead returns. This floating device restriction initially applied above Morgan's crossing and was subsequently extended to the entire river. According to WDFW creel data, about 60-65 recreational anglers (outside ONP, excluding the South Fork Hoh) and 25-30 professional guides fish for steelhead in the Hoh River on any given day during the open season. The current permanent fishing regulations for the Hoh River are listed below (Table 16). Emergency regulations beyond the permanent regulations will be determined using the Three-Step Regulation Process (Section 3.2.2).

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Table 16: Permanent steelhead and rainbow trout state recreational fishery regulations in the Hoh River.

Hoh:	River	Closure Day	Regulations	Trout
	Hoh R. (below Oxbow/Hwy 101)	15-Apr	SPB, Feb 16, bait prohibited	release wild RB
	Hoh R. (above Oxbow/Hwy 101)	15-Apr	SPB, NO BAIT Dec 1	release wild RB
	SF Hoh	15-Apr	SPB, no bait,	release wild RB

KEY: SPB = single-point barbless hooks, SGR = selected gear rules, RB = rainbow trout

The Proviso Implementation Strategy will increase the likelihood that fishery regulations will allow runs to meet management objectives by increasing the standard amount of data available to inform the regulation-setting process, and by clearly outlining that process (See Section 4: Communications). WDFW plans to develop more robust in-season update tools based on creel and/or SONAR data to change fisheries regulations in-season as needed. The strategy also allows fishery regulations to adapt given different levels of wild steelhead abundance, with priority given to providing angling opportunity on hatchery origin fish in the Transitional management regime. The exact timing, duration, and location of hatchery targeted fisheries will be determined annually in the pre-season regulation setting process.

9.7.3 Hatchery Operations

There are currently no WDFW operated hatcheries on the Hoh River, however, there is one tribal program: the Chalaat Creek Hatchery, which has used broodstock from the Bogachiel Hatchery or natural Hoh recruits since 2019. Prior to 2019, the program used broodstock from the Quinault National Fish Hatchery on Cook Creek.

Wild Stock Gene Banks

WDFW will pursue a stakeholder process to designate WSGBs for coastal steelhead. In pursuit of this objective, steelhead in the Hoh River were evaluated for suitability as WSGBs according to the criteria listed in Section 3.3.4 (Table 17).

Table 17: Evaluation of wild steelhead in the Hoh River as a potential WSGB.

Population	Status	Criteria
Hoh River Winter/ Summer Steelhead	Criteria not met	• Six-year average of 2,582 spawners • No data on summer population • Long-term population decline • Current Hoh Tribe on-station EWS releases from Chalaat Creek Hatchery

9.8 Independent Streams

Figure 32: Map of coastal independent rivers and streams

In this context, “independent streams” refers to relatively small streams that flow directly to the Pacific Ocean and are therefore independent from the other major basins or rivers systems covered is this CSPIP. There are over 100 miles of independent streams on Washington’s Pacific coast, which have been historically planted with hatchery fish and open to recreational fishing. For the most part, WDFW has been unable to prioritize monitoring in those streams at current staffing levels given relatively low population abundance and limited fishing opportunities. However, steelhead populations in those areas are likely important to maintaining the overall population diversity and spatial distribution of coastal steelhead. Therefore, WDFW will design steelhead management moving forward that is more inclusive of small yet important streams than it has been previously.

9.8.1 Monitoring and Evaluation

The Proviso Implementation Strategy will increase standard monitoring and evaluation in independent streams, especially by enhancing sport fishery monitoring and escapement estimation as determined by the Adaptive Management Framework (Table 1). In recent years the only independent stream that has been monitored regularly is Goodman Creek, where WDFW crews have conducted spawning ground surveys. WDFW and tribal co-managers have also conducted sporadic spawning ground surveys in other independent streams, including but not exclusive to Mosquito Creek, Kalaloch Creek, Cedar Creek, the Raft River and the Moclips River.

Given the availability of personnel and resources moving forward, WDFW will initially conduct supplemental-style spawning ground surveys in independent streams using crews that cover adjacent major river systems. Staff will also explore other escapement estimation methodologies and may implement alternative strategies to ground-based spawning ground surveys in the future. In terms of sport fish monitoring, the Department will assess the relative utility of creel surveys, volunteer trip reports, game cameras, or other methods to estimate effort given relative levels of usage in each stream based on catch record card data.

Forecast Methods

Due to the lack of data available for independent streams, ensemble timeseries models and IPMs have not been applied in those watersheds.

4.8.2 Fisheries Regulations

The current permanent fishing regulations for the coastal independent streams are listed below (Table 18). Emergency regulations beyond the permanent regulations will be determined using the 3-Step Regulation Process (Section 3.2.2).

Table 18: Permanent steelhead and rainbow trout state recreational fishery regulations in coastal independent streams.

Independent Streams:	River	Closure Day	Regulations	Trout
Mid Coast	Copalis	28-Feb	statewide rules	cutthroat and wild RB min size 14".
	Joe Creek	31-Dec	SPB, statewide Dec. 1	cutthroat and wild RB min size 14".
	Moclips	28-Feb	statewide rules	cutthroat and wild RB min size 14".
North Coast	Kalaloch Creek	28-Feb	SGR	cutthroat and wild RB min size 14".
	Cedar Creek	28-Feb	SGR	cutthroat and wild RB min size 14".
	Goodman Creek	28-Feb	SGR	cutthroat and wild RB min size 14".
	Mosquito Creek	28-Feb	SGR	cutthroat and wild RB min size 14".
	Big River-Clallam Co. outside ONP CRC (386)	28-Feb	SGR	cutthroat and wild RB min size 14".
	Sooes (Tsoo-Yess) outside Makah reservation	28-Feb	statewide rules	cutthroat and wild RB min size 14".
	Ozette Lake tributaries			

9.8.3 Hatchery Operations

There are currently no WDFW operated hatcheries in independent streams on the Pacific coast. However, there are three tribal hatcheries (Educket Creek Hatchery, Stony Creek Hatchery, and Umbrella Creek Hatchery) and one federal hatchery (Makah NFH) located on the northern Olympic Peninsula.

Wild Stock Gene Banks

WDFW will pursue a stakeholder process to designate WSGBs for coastal steelhead. In pursuit of this objective, steelhead in coastal independent rivers and streams were evaluated for suitability as WSGBs according to the criteria listed in Section 3.3.4 (Table 19).

Table 19: Evaluation of wild steelhead in coastal independent streams as potential WSGBs.

Population	Status	Criteria

Raft River Winter Steelhead	Criteria not met	• No population data • Received outplants of hatchery steelhead until 2008
Moclips River Winter Steelhead	Criteria not met	• No population data since 2000; 1995-2000 average spawner abundance was 311 • Received outplants of hatchery steelhead until 2007
Copalis River Winter Steelhead	Criteria not met	• No population data • Single hatchery release in 1985
Tsoo-Yess/Waatch Winter Steelhead	Criteria not met	• No population data • Current on-station releases at Makah National Fish Hatchery
Ozette River Winter Steelhead	Criteria not met	• No population data
Goodman Creek Winter Steelhead	Criteria not met	• Six-year average of 99 spawners • Long-term decline • Historic EWS outplants until 2008
Mosquito Creek Winter Steelhead	Criteria not met	• No population data • One outplant of EWS in 1996

10. Conclusion

In this CSPIP, Region 6 Fish Management seeks to design coastal steelhead fisheries management strategies that align with WDFW's mission "to preserve, protect, and perpetuate fish, wildlife and ecosystems while providing sustainable fish and wildlife recreational and commercial opportunities" and fulfill the state Legislature's budget proviso to the 2021-2023 biennium budget pertaining to coastal steelhead. The CSPIP provides pertinent background information on coastal steelhead, lays out an overarching adaptive steelhead management framework and supplemental river-specific information, describes two-way communication strategies between WDFW and the public, identifies critical research needed to support steelhead management, and proposes a budget required to complete this work. In doing so, the Department recognizes the interconnectedness of monitoring and evaluation, fisheries regulations, hatchery operations, habitat protection and restoration, and human dimensions of coastal steelhead fisheries, and seeks to manage holistically and adaptively. This work constitutes one step towards advancing coastal steelhead management and lays the groundwork for a long-term vision supporting sustainable fisheries and healthy steelhead populations on Washington's Pacific coast.

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12. Appendices

12.1 Modeling Methodologies

12.1.1 Ensemble Timeseries Model

Ensemble models used to produce run size forecasts consisted of one or more timeseries models fit to historical estimates of run-size (catch plus escapement). We fit six different types of timeseries models that are commonly used for forecasting: (1) Autoregressive Integrated

Moving Average (ARIMA) models, (2) log-normal Generalized Additive Models (GAM), (3) Prophet and Prophet boost models, which are additive regression models with seasonal terms, (4) elastic net models using Lasso and Ridge regression penalties, (5) error-trend-season models with exponential smoothing, and (6) random forest algorithms.

ARIMA models were fit with or without covariates that were hypothesized to affect steelhead survival. Specifically, we included the minimum, mean, and maximum stream flow during freshwater residence (first and second year after spawning), seasonally averaged sea surface temperature metrics (SST), and the North Pacific Gyre Oscillation (NPGO) index (assuming most fish spend one or two summers at sea). In addition, we tested ARIMA models with up to three autoregressive orders, first-order differencing, and up to two moving average orders. The simplest of these models would be the white noise model ARIMA (0,0,0), first order autoregressive model ARIMA (1,0,0), random walk model ARIMA (0,1,0), and first order moving average model ARIMA (0,0,1).

Data used to fit the models were split into a training and a validation dataset to evaluate the ability of each model to make one-year-ahead forecasts of run size. We evaluated forecasts for the last ten years of the available time series and compared models based on their forecasting accuracy/performance. Performance metrics included were the mean absolute percent error (MAPE), root mean squared error (RMSE), and median symmetric accuracy (MSA). Based on these individual forecasting models, we then developed ensembles of multiple models by evaluating optimal model weights to construct the best possible ensemble. This was done by running an algorithm was iteratively searched for the best combination of model weights for all candidate models. The final ensemble model was then used to generate the final one-year-ahead forecast of future run size.

12.1.2 Integrated Population Model

Integrated Population Models (IPMs) are statistical population dynamics models that integrate multiple sources of information, including time series data on abundances and demographic parameters. By constructing a joint likelihood from the individual data likelihoods, IPMs capture the full uncertainty in the data (Maunder and Punt 2013; Schaub and Kéry 2022). They consist of a process model, which describes the unobserved true population dynamics, and an observation model that describes the noisy observations of the true state of the population. When fit in a Bayesian framework, IPMs can further incorporate independent prior information obtained from other populations, meta-analyses, or expert knowledge. Finally, IPMs can be constructed as hierarchical models of multiple populations such that information is shared across datasets and information available for data-rich populations can inform parameter estimates for data-poor populations (Punt et al. 2011; Buhle et al. 2018).

The IPM used for coastal steelhead builds on previously developed population models (Buhle et al. 2018; Scheuerell et al. 2021). The novelty of the model is that it accounts for iteroparity by accommodating a more complex age structure that includes repeat spawners and by estimating the survival rate of kelts. Accounting for iteroparity is particularly important when calculating biological reference points based on model-estimated parameters. The model also incorporates different sources of fishing-related retention and non-retention mortality, and accounts for variation in population parameters over time by modeling recruitment residuals and kelt survival rate as time-varying processes. Due to the lack of data on smolt abundances and life-histories, the steelhead IPM is an adult-to-adult model that relies on estimates of total catch, non-retention mortality, escapement, and age structure information collected for adult fish returning to spawn.

12.1.3 Hoffman Demographic Geneflow Model (DGM)

The *Hoffman Demographic Geneflow Model* (DGM) was developed in 2014 by Annette Hoffman to evaluate geneflow between segregated hatchery steelhead and natural origin steelhead in the Puget Sound. The DGM uses a geneflow equation that is described in the SSMP and was updated in 2014 (Busack 2014). This equation utilizes the relative abundance of both hatchery- and natural origin fish on the spawning grounds, as well as their spatial and temporal overlap and the relative reproduction success of potential matings between hatchery-by-hatchery (HxH), hatchery-by-natural (HxN) and natural-by-natural (NxN) fish (Hoffmann 2017). To calculate gene flow, the DGM uses five basin input parameters. O_N, O_H, k_1, k_2 and q.

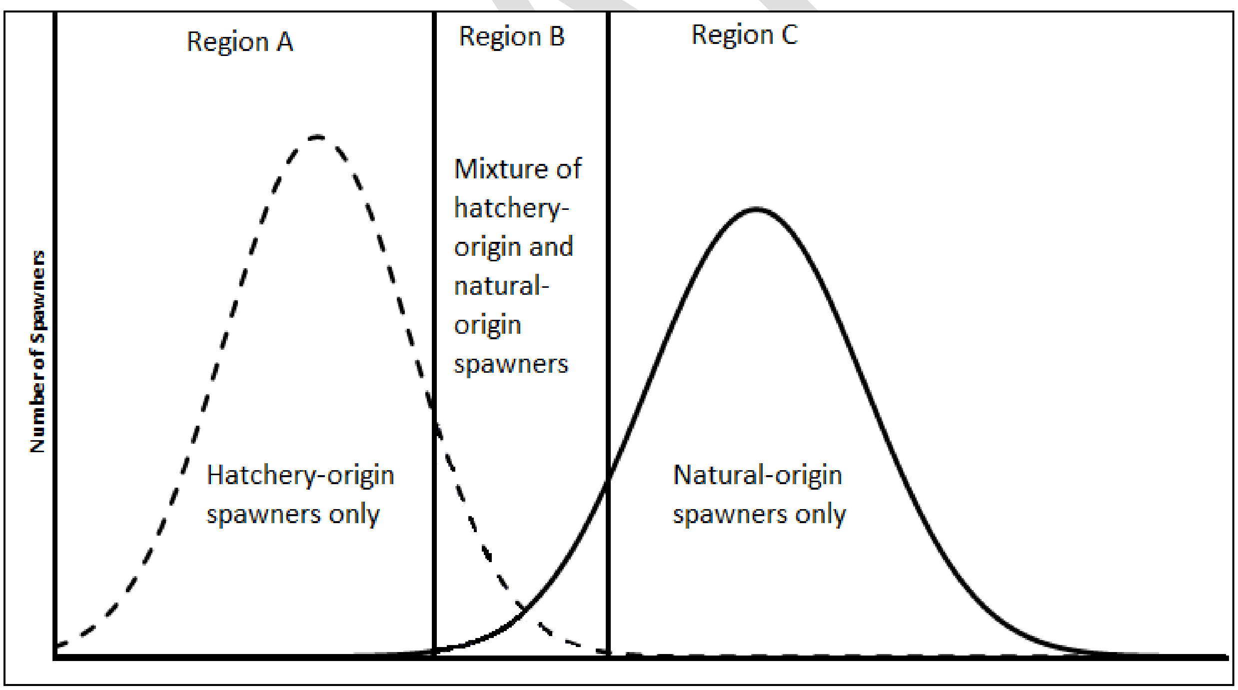

Figure 33: Schematic of temporal spawning overlap between segregated hatchery origin steelhead and natural origin winter steelhead. The shape, sizes, and placement of curves does not represent any real situation (reproduced from the SSMP).

The proportion of natural origin steelhead spawning in Region B or the overlap period (**Figure 33**) is defined as O_N in the model, whereas the proportion of hatchery origin steelhead spawning in region B is defined as O_H. This model relies heavily on a spawning cutoff date of

March 15 and uses redd timing standard deviation from this date to the last redd date to assume the proportion of natural origin redds prior to March 15. The mean hatchery spawn date is based on hatchery spawning events and dates of hatchery fish trapped. In the model k_1 is the relative fitness of HxH crosses and these values were drawn from empirical studies, with values of 0.02 to 0.13 for EWS and 0.09 to 0.18 for ESS (Hoffman 2017). In the model k_2 is the relative fitness of HxN crosses and these values assumed that HxN crosses would be twice as fit as HxH crosses relative to NxN crosses, with values of 0.54 for EWS HxN and 0.57 for ESS HxN (Hoffman 2017). The parameter q in the model is the proportion of total natural spawners of hatchery origin and is estimated based on run reconstructions for each population of natural steelhead.

Hatchery origin spawners in the natural environment (HOS) were estimated from the return of hatchery origin fish to the hatchery expanded based on the assumed trapping efficiency at each hatchery. As actual trapping efficiency data is often lacking for steelhead, the HSRG typically used trapping efficiencies of 80% to 90% for programs with on-station release sites with adult collection facilities (HSRG 2004). Since the trapping efficiency has a large impact on the model results, 70% to 80% was used as a conservative estimate. However, evidence indicated that lower trapping efficiencies should be used for the Lake Aberdeen, North River and Naselle hatchery programs due to either outplanting or poor attraction flow. The model uses a six-year average for hatchery releases, and hatchery and natural origin escapement. This model does not typically include age structure data and instead assumes returns are age-3 at return to determine q. It also does not use catch data, but functions off the hatchery return rate and, as such, changes in the harvest rate downstream of the hatcheries would be expected to alter model outcomes. The geneflow output from the model is an average of four scenarios utilizing the two k_1 values at the two trapping efficiency levels. For more a more thorough description of the DGM and its parameters see Hoffman 2017.

Model Assumptions and Limitations

- Model uses the standard deviation after March 15 as the threshold date for natural spawners. This assumption is made due to an unknown number of hatchery origin redds in the spawning ground data. Alternate scenarios which account for the standard deviation across the entire observed spawning season were conducted for the Willapa Bay programs to show a “worst case” scenario for hatchery impacts.
- Model uses the average of two sets of assumed hatchery trap rate efficiencies, which were adjusted to represent the conditions at each hatchery. However, there is a significant amount of uncertainty around the trapping efficiency values at each facility.
- Natural origin steelhead may include both summer and winter steelhead, and the two run types cannot be assessed separately as escapement data is not available for natural origin summer run populations along Washington’s Pacific coast.
- The model does not incorporate strays from or to other watersheds, but relies on hatchery returns, which may incorporate an unknown level of strays.

- Mean hatchery spawn timing is based on fish spawned in the hatchery as well as trapped fish not used in the broodstock and mortalities, with the assumption that mortalities and trapped fish not used in the broodstock would be ready to spawn immediately for winter steelhead and immediately after the first spawn date for summer steelhead.
- Model does not account for kelts and assumes all fish are first time spawners.
- The model assumes that the fitness of HxH EWS spawners in the wild is between 2% and 13% and that HxH ESS spawners in the wild is between 9% and 18%.
- The model assumes that EWS HxN spawners is 54% and ESS HxN spawners is 57% of the fitness of NxN spawners.
- The model does not include a spatial component and assumes that there is complete spatial overlap between hatchery origin and natural origin spawners on the spawning grounds.
- The model does not account for annual fluctuations in harvest rates when projecting geneflow.

12.1.4 All-H-Analyzer (AHA) Model

The All-H-Analyzer (AHA) Model is a Microsoft Excel®-based model that was developed by the HSRG to support the review of over 300 hatchery programs across the Pacific Northwest (HSRG 2004). AHA models the impacts of management decisions and hatchery effectiveness by projecting the average outcome of hatchery operations over 100 generations. This model uses hatchery and natural population data to provide estimates of pHOS, PNI, and predicted returns. Productivity data used by the model includes the SAR% (smolt to adult survival rate), recruits per spawner and adult and smolt capacity. However, reliable data for natural origin productivity and survival is lacking for most coastal populations, adding a higher degree of uncertainty into in AHA model results compared to those from the DGM. While we have a lower level of confidence in the individual natural origin productivity, capacity and survival data used, the values used resulted in natural origin abundance that was comparable to the six-year average abundance based on empirical data providing at least a moderate degree of confidence in the model outputs. We had a higher level of confidence in the harvest rates and hatchery data used in the model as these parameters were based on empirical data.

Data primarily came from the Hatchery Evaluation and Assessment Team (HEAT) Hatchery Performance Tables, utilizing catch record card (CRC) data for recreational harvest, tribal net data, and hatchery escapement and spawning data. These data were used to verify model inputs for hatchery fish, including SAR%, harvest rate, and trapping efficiencies. The AHA model uses the Ford equation (Ford 2002) to estimate relative fitness. For the coastal steelhead modeling, we utilized the 2020 version of AHA to assess current hatchery program sizes and evaluated scenarios that would fall within the guidelines in the SSMP. These outputs provide initial guidance for scaling hatchery releases and assessing the potential impacts of the programs on natural origin populations. For more details on the AHA Model see HSRG 2020.

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Model Assumptions and Limitations

- Natural origin watershed-specific productivity and capacity was not available. Instead, the model used values within the known range for steelhead that produced a natural origin return similar to the observed six-year average.
- The natural origin SAR% is currently unknown, as watershed-specific natural origin smolt outmigration data is lacking from coastal watershed. For the model we assumed that natural origin SAR% would be higher than the hatchery SAR% and used a set value of 4%.
- Model incorporates the Pacific Decadal Oscillation (PDO) as variability in the smolt to adult return rate (SAR).
- Model does not incorporate strays from other watersheds.
- Model does not account for kelts, and assumes all fish are first time spawners.
- Model does not incorporate extensive habitat parameters beyond adult capacity, smolt capacity and smolts per adult produced, and assumes complete spatial and temporal overlap between hatchery- and natural origin fish.
- Escapement data used for the model relies on the March 15 spawner cutoff date as a means to determine whether spawners are hatchery- or natural origin. However, because fish from integrated programs spawn at a similar time as natural origin fish, the March 15 cutoff cannot be expected to separate hatchery origin and natural origin spawners. It is therefore unlikely that spawners before March 15 are primarily of hatchery origin. Due to this overlap, escapement numbers used in modeling integrated programs likely include significant numbers of hatchery origin spawners and can be expected to be biased high.
- The model was set so that no more than 30% of the natural origin returns will be used as broodstock.
- The relative reproductive success of hatchery origin spawners was assumed to be 80%.
- Six-year average harvest rates were estimated from run reconstruction data on recreational and tribal harvest, hatchery escapement and SAR%.
- Fecundity was based on a six-year average of fish used in broodstock. Where available, NOB and HOB fecundity were calculated separately. Where NOR specific data was not available, we used the fecundity for the overall integrated broodstock as a surrogate.
- The percent of both natural- and hatchery origin females was assumed to be 50%.

In hatchery survival data for both broodstock and juveniles were based on a six-year average of data collected at WDFW hatcheries.

12.2 Escapement-Based Pre-Season Planning

The current escapement-based pre-season planning process proceeds according to the following steps:

1. Basin-specific wild steelhead escapement goals are compared to forecasted wild steelhead run sizes to determine allowable wild steelhead mortality. When the forecasted run size is larger than the escapement goal, the escapement goal is subtracted from the forecasted run size to determine the total allowable wild steelhead mortality.

$$If\ Forecast > Escapement$$
$$Total\ allowable\ mortality = Forecast - Escapement$$

   When the forecasted run size is less than the escapement goal, the total allowable mortality is 10% of the forecasted run size.

$$If\ Forecast < Escapement$$
$$Total\ allowable\ mortality = Forecast * 0.1$$

2. The portion of total allowable mortality for wild steelhead allotted to the recreational fishery is then determined by subtracting indirect impacts (i.e., poaching, and other fisheries, including fall coho and spring Chinook) from the total allowable mortality.

$$Allowable\ fishery\ mortality = Total\ allowable\ mortality - Indirect\ mortality$$

3. A sport angler encounter rate is calculated. Coastal steelhead managers currently use an approximated encounter rate of (1.14) of the wild steelhead run size based on Bentley et al. (2017), which evaluated creel data from the Hoh River. As more encounter data becomes available, values representing encounter rates may be updated, reflecting the nuanced fishery dynamics within each river system, fishery type, and trends in encounters over time.
4. The encounter rate is multiplied by the forecasted run size to predict the number of encounters.
5. A value representing wild steelhead mortality associated with catch and release fisheries is determined. Currently, WDFW uses 10% as a statewide estimate of catch and release mortality in steelhead sport fisheries.
6. The number of encounters is multiplied by the catch and release mortality (in this case 10%) to estimate the number of wild steelhead mortalities associated with a particular fishery.
7. The predicted wild steelhead mortality in an open fishery is compared to the allowable fishery mortality. If the predicted wild steelhead mortality is greater than the allowable fishery mortality limit, one or more emergency fisheries regulations are considered to reduce encounters and/or catch and release mortality so that management objectives are more likely to be met.

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8. If emergency fisheries regulations fail to limit predicted encounters and/or mortality confidently within management objectives during the pre-season planning process, the fishery switches to the Emergency regime.[8]
9. If multiple emergency actions enable fisheries impacts to remain within allowable limits, those options are presented to the public at Coastal Steelhead Townhall Meetings to gauge public preference.

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[8] Confidence in the effectiveness of emergency regulations depends on the resources available to the Department to monitor fisheries through creel surveys, catch record cards, and enforcement. Increased monitoring capacity translates to the acceptability of greater risk.

12.3 Jurisdictional Boundary Map