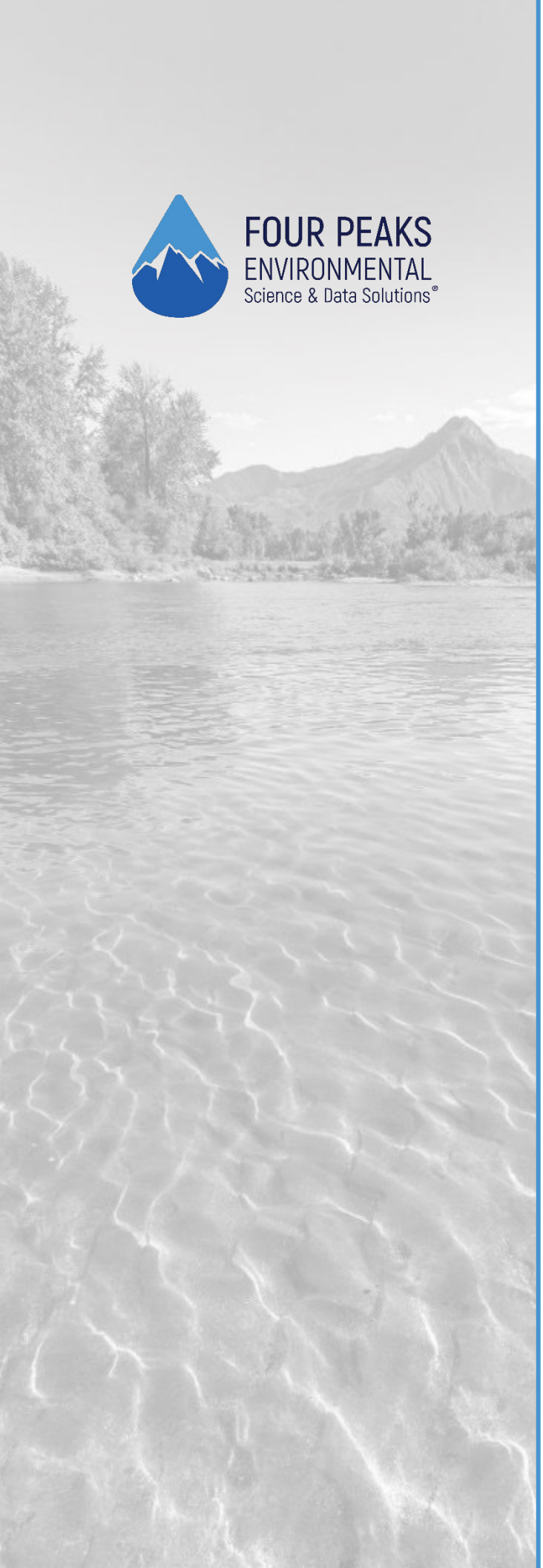

FOUR PEAKS ENVIRONMENTAL
Science & Data Solutions®

OREGON DEPARTMENT OF FISH AND WILDLIFE FUTURE HATCHERY NEEDS ASSESSMENT

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Abbreviations

Abbreviation	Definition
A/P	abundance and productivity
CRBE	Columbia River Basin Endorsement
DPS	Distinct Population Segments
ELS	Electronic Licensing System
ESA	Endangered Species Act
ESU	Evolutionarily Significant Units
MPG	major population group
NOAA	National Oceanic and Atmospheric Administration
ODFW	Oregon Department of Fish and Wildlife
SMU	Species Management Units
SONCC	Southern Oregon and Northern California Coast
VSP	Viable salmonid population

Executive Summary

The Oregon State Legislature directed Oregon Department of Fish and Wildlife (ODFW) to undertake a climate vulnerability assessment of state-owned fish hatcheries, including an assessment of the likely impact of climate change on the future need for hatchery programs. This report addresses these future hatchery needs by assessing the status and trends of the Evolutionary Significant Units (ESUs)/Species Management Units (SMUs)/Distinct Population Segments (DPSs)[1], their climate vulnerability, hatchery production, and recreational angler use to identify future needs based on biological risk and hatchery status. While there are slight differences in ESU/SMU/DPS geographic boundaries, the boundaries and regions are similar enough to produce comparisons that successfully achieve the goal of identifying future hatchery needs.

This report groups status and trend data by region in tables broken down into ESU/SMU/DPS and population/major population group (MPG), as appropriate. Viable salmonid population (VSP) status and overall ESU/SMU/DPS risk are taken or adapted from the most recent management and/or assessment documents available for each ESU/SMU/DPS. In certain cases, data were not available for some or all VSP parameters or data had to be converted into VSP parameters. ESU/SMU/DPS overall risk is Moderate or higher for the majority of the ESU/SMU/DPSs examined. Comparatively fewer ESU/SMU/DPSs are ranked as Moderate or lower ESU/SMU/DPS overall risk. Three ESU/SMU/DPSs lack sufficient information to be ranked.

Climate change vulnerability of each ESU/SMU/DPS is identified based on an Exposure and Sensitivity Ranking (vulnerability) and the ESU/SMU/DPSs adaptive capacity (Crozier et al. 2019). Sufficient data were not available to determine adaptive capacity for all ESU/SMU/DPSs. The majority of the ESU/SMU/DPSs have an Exposure and Sensitivity Ranking of High or Very High. This indicates that the majority of ESU/SMU/DPSs are at substantial risk due to climate change. Adaptive capacity for all ESU/SMU/DPSs is above Moderate except the Southern Oregon and Northern California Coast Coho Salmon ESU, which was low. Overall, despite being at substantial risk due to climate change, most ESU/SMU/DPSs have some capacity to adapt to changes, thereby partially mitigating climate risk.

Hatchery programs are designated as either harvest or conservation programs. Within the harvest hatchery programs, there are two different program types: mitigation and harvest augmentation. Within conservation hatchery programs, there are seven program types, though only supplementation and recovery/restoration are discussed in this report. A hatchery may serve two or more program types and some hatchery programs will have harvest and conservation functions. The overwhelming majority of

[1] Evolutionary Significant Units (ESUs) and Distinct Population Segments (DPSs) are federal designations given by the National Oceanic and Atmospheric Administration. An ESU is a population or group of populations that is substantially reproductively isolated from conspecific population groups and is an important component of the evolutionary legacy of the species. A DPS is a population or group of populations of vertebrates that is distinct from other populations of the species and significant in relation to the whole species. It is the smallest taxonomic unit that can be protected under the Endangered Species Act. Species Management Unit (SMU) is a State designation given by Oregon Department of Fish and Wildlife. An SMU is a collection of populations from a common geographic region that share similar genetic and ecological characteristics.

hatchery programs examined here were solely harvest programs. Only four programs were solely conservation programs, with two supplementation programs and two recovery/restoration programs.

This report uses the volume of licenses, tags, and endorsements as a proxy to gauge the popularity of Oregon fisheries in general, to determine the approximate number of recreational fishery resource users and to examine trends in fisheries use over time. Most angling licenses have shown a significant decreasing trend over the last ~30 years driven primarily by declines in the 1990s. Most tags and endorsements have steadily declined across approximately the same period. This decline is most pronounced for license sales and there appears to be a gap opening between angling license sales and salmon and steelhead (*Oncorhynchus* species) tags and endorsements. This suggests that anglers may be shifting from salmon and steelhead to other types of fisheries. This indicates decreased demand for angling opportunity in general and salmon and steelhead angling opportunity in particular that seems likely to continue.

Harvest can be used as a measure of the importance of hatchery-origin fish to the maintenance of fisheries for specific ESU/SMU/DPSs. The larger a proportion of the fishery is made up of hatchery fish, the more important hatchery production may be to that fishery. Mark-selective fisheries can impact the proportion of hatchery fish in the harvest and, in a mark-selective fishery, overall harvest may be the best proxy. However, this is the best currently available quantitative metric to assess the importance of hatchery programs that is reasonably assignable down to the species, run-type, and ESU/SMU/DPS level. Harvest numbers also cannot capture the importance or impact of catch-and-release fisheries and the Electronic Licensing System (ELS) data reported here does not include paper harvest cards still available and in-use by most Oregon anglers. Therefore, the total numbers of fish reported here should be considered a minimum estimate of harvest.

A large majority of total reported harvest for most fisheries is made up of hatchery-origin fish. Hatchery-origin fish make up the largest proportion of the steelhead *O. mykiss* reported harvest, a large majority of Coho Salmon *O. kisutch* harvest, and a simple majority of total reported harvest for Chinook Salmon *O. tshawytscha* across both run-types. However, most spring Chinook Salmon ESU/SMU/DPS still have greater than 70% proportion hatchery-origin reported harvest, with fall Chinook Salmon proportions all less than ~60%. This demonstrates the importance of hatcheries in sustaining popular individual fisheries and angling throughout the state.

Mitigation hatchery programs exist to mitigate the impacts to fish habitat from the construction and operation of dams and other human developments. A large percentage, if not all, of the hatchery programs supporting ESU/SMU/DPSs in the Lower Columbia, Middle Columbia, Upper Willamette, Snake River, and Rogue-South Coast, as well as Oregon Coast Coho Salmon, are at least partially mitigation programs. These hatchery programs generally provide mitigation for dams, including those on the mainstem Columbia River and Snake River, in the Willamette and Rogue basins, and elsewhere in the state. As long as these dams continue to exist, there will be a future need for these mitigation hatchery programs to mitigate their impacts to fish habitat.

Harvest augmentation hatchery programs exist to increase fishing and harvest opportunity in areas where no mitigation programs exist. A substantial proportion of the hatchery programs supporting ESU/SMU/DPSs in the Lower Columbia and Oregon Coast, as well as Rogue-South Coast, are solely harvest augmentation or partially harvest augmentation programs. License, tag, and endorsement sale

trends suggest the potential for lower demand for hatchery-supported salmon and steelhead fisheries in the future. This lower level of demand and support does not necessarily indicate a reduced future need and is unlikely to affect all fisheries in the same way or to the same degree. Obtaining additional metrics of the importance and popularity of specific fisheries and the importance of hatchery origin fish to those fisheries will be valuable in managing future need.

Conservation hatchery programs use hatchery fish to enhance the viability of natural populations while limiting impacts to those populations within acceptable bounds or use the best available broodstock to establish a population in habitat currently vacant for that native species. Relatively few conservation hatchery programs currently exist in the state of Oregon. However, federal/state listing status and climate vulnerability demonstrate a need to continue all existing conservation hatchery programs and increase the need for conservation hatchery programs targeting many ESU/SMU/DPSs throughout the state. Finally, a population's rating within this needs assessment should not be misconstrued as discounting any ecological, social, or cultural value associated with those populations.

Climate change is a substantial, additional uncertainty for both harvest augmentation and conservation hatchery programs. Wild ESU/SMU/DPSs are unlikely to be able to absorb more harvest demand. However, under climate change, the most important consideration may not be current harvest opportunity but the risk of ongoing harvest to the continued existence of the ESU/SMU/DPS. This could be further influenced by changing angler preferences. The evolving dynamics of climate change and interacting with angler demand and preferences create substantial uncertainty in future needs and will require flexible management approaches.

This assessment substantiates a future need for a combination of mitigation, harvest augmentation and conservation hatchery programs for a variety of different species in multiple regions. This mix of hatchery programs will continue to support fishery and conservation goals and objectives throughout the state of Oregon.

1 Introduction

Once abundant in their home range, Pacific salmon and steelhead (*Oncorhynchus* species) have decreased substantially as a result of stressors that include habitat degradation and fragmentation, temperature regime alterations, competition and predation, overharvest, and pathogens (ODFW and NMFS 2011; Lorenzen et al. 2012; Quinn 2018). To combat these losses and increase fishery resource availability, intervention has occurred locally, regionally, nationally, and internationally to bolster Pacific salmon and steelhead populations. The Oregon Department of Fish and Wildlife (ODFW) currently supports many efforts to both naturally and artificially increase Pacific salmon and salmonid productivity. As part of ODFW's mission statement, "To protect and enhance Oregon's fish and wildlife and their habitats for use and enjoyment by present and future generations," the agency currently participates in a robust fish hatchery program that produces different stocks of Chinook Salmon *O. tshawytscha*, Coho Salmon *O. kisutch*, Chum Salmon *O. keta*, and steelhead *O. mykiss*. There are 33 hatcheries that ODFW operates, with 77 hatchery production programs that exist within these facilities (ODFW 2024a), although not all facilities produce Pacific salmon species.

There are currently two hatchery program types: conservation and harvest, which are further sub-divided into program types (detailed definitions of hatchery types and programs can be found in Section 4). Conservation hatcheries include supplementation, recovery (restoration), captive brood, captive rearing, egg banking, cryopreservation, and experimental. However, only supplementation and recovery are discussed within this report. Harvest hatcheries have two different program types: harvest augmentation and mitigation. All salmon and steelhead, and some trout hatcheries that are anticipated to interact with listed species, are operated under specific hatchery genetic management plans (HGMPs) or Section 10 permits that permit specific production levels as approved by the National Oceanic and Atmospheric Administration (NOAA).

The Oregon State Legislature directed ODFW to undertake a climate vulnerability assessment of state-owned fish hatcheries, including an assessment of the likely impact of climate change on the future need for hatchery programs. This report aims to identify these future hatchery needs by assessing the status and trends of Evolutionary Significant Unit (ESU)/Species Management Unit (SMU)/Distinct Population Segments (DPSs) while considering climate change vulnerability, hatchery production of Pacific salmon and steelhead species, and recreational angler use. While we recognize that there are slight differences in the boundaries of similarly named ESU/SMU/DPSs based on species, the boundaries and regions are similar enough to produce comparisons that successfully achieve the goal of identifying future hatchery needs.

Terminology was a challenge when attempting to aggregate status and trends, climate assessments, hatchery programs and recreational angling metrics across multiple management documents and data sources authored by state and federal agencies. Terms such as ESU, SMU, and DPS have specific legal definitions but also common meanings, which can lead to confusion. It is tempting and common to use, for instance, "ESU" to describe both the Upper Willamette ESU Chinook Salmon (a specific species within a location) and the Upper Willamette ESU as a physical location. However, ESU as a physical location might not describe the same area or set of rivers/streams for the different species.

In an attempt to limit confusion in this report, we adopt the following naming conventions. ESU, DPS, and SMU will be used consistent with their legal definitions to describe combinations of location and

species as defined by National Marine Fisheries Service (NMFS) or the state (e.g., Upper Willamette DPS winter steelhead). When referring to a grouping of these location and species combinations, "ESU/SMU/DPS" will be used. When describing or aggregating data and results by a physical location, "region" will be used. In some cases that physical location may also be consistent with the location component of an ESU/SMU/DPS designation. Finally, species and/or species/run-type will be used when aggregating ESUs, SMUS, or DPSs across locations by species and run-type.

This report is organized into discrete sections (i.e., Section 2 Status and Trends, Section 3 Climate Change Vulnerability, Section 4 Hatchery Programs, and Section 5 Angler Licenses, Tags, Endorsements, and Harvest) designed to provide details on the biological status and trends, vulnerability to climate change, existing hatchery program status, and recreational angler use and harvest. Each of these sections will present existing data down to the lowest level available. In the case of biological status and trends and vulnerability to climate change, risk scores are given, taken from existing literature and standardized assessments. These risk scores are then aggregated into biological vulnerability score by ESU/SMU/DPS. For certain sections (e.g., Anglers Licenses and Tags and Endorsements) some or all of the data lack sufficient resolution to develop risk scores down to the level of ESU/SMU/DPS. In those cases, data are discussed down to the lowest defensible level. The overall vulnerability and hatchery status by ESU/SMU/DPS for each section are then combined, using a standardized methodology, described in Section 6 Assessment and Conclusions, to arrive at an assessment of future needs for mitigation, harvest augmentation, and conservation hatchery programs for all ESU/SMU/DPSs.

2 Status and Trends

Status and trend data are grouped by region and presented as tables organized into ESU/SMU/DPS and population/major population group (MPG), as appropriate. Each table first identifies the listing status (both federal and state listing) for each species within the ESU/SMU/DPS. Federally listed species are designated as threatened (T) or endangered (E). Species of concern (SOC) is noted where applicable despite it being a separate federal designation used by NMFS to denote species with concerns regarding status and threats, but for which insufficient information is available to list under the Endangered Species Act (ESA) (69 FR 19975). State-listed species are designated as threatened (T) or endangered (E). The State may also designate species as sensitive critical (SC), or sensitive (S). Sensitive species are defined as small or declining populations, are at-risk, and/or are of management concern. Next, the table defines the populations within each ESU/SMU/DPS and lists their risk based on individual and overall viable salmonid population (VSP) parameters (McElhaney et al. 2000). VSP parameters indicate an ESU/SMU/DPS's risk and not necessarily their status. In other words, Low does not mean a population is in poor status but that it is at low risk. Finally, each table reports an overall ESU/SMU/DPS risk.

VSP parameters used within this report include combined abundance/productivity, diversity, and spatial structure. We focused on these parameters because 1) they are reasonable predictors of population health and viability, 2) they reflect general processes that are important to all populations of all species, 3) they allow us to draw general conclusions about an ESU's extinction risk even without detailed, species-specific information, and 4) they are widely accepted and used throughout the salmon and steelhead literature. For a complete discussion of VSP, its parameters, and their application, see McElhaney et al. 2000.

VSP status and overall ESU/SMU/DPS risk were obtained or adapted from the most recent management and/or assessment documents available for each ESU/SMU/DPS. In certain cases, data were not available for some or all VSP parameters or data had to be converted into VSP parameters. For example, VSP parameters are not available for all ESU/SMU/DPS, but similar types of categorical ranking data are available and were translated into the VSP framework. Extirpated populations are also noted within the tables where applicable.

NMFS Status and Viability Assessments and State Management Plans (e.g., Rogue–South Coast Multi-Species Conservation and Management Plan, Coastal Multi-Species Conservation and Management Plan, and Rogue Fall Chinook Plan; ODFW 2024b) were recent sources that provided consistent, comparable biological parameters using standardized methods (i.e., VSP) that facilitated comparisons across ESU/SMU/DPSs. The Implementation Plan for the Reintroduction of Anadromous Fishes into the Oregon Portion of the Upper Klamath Region (ODFW and Klamath Tribes 2021) was also used for Klamath River Coho and Chinook Salmon in particular. Where no more recent management documents existed, status and trends were taken from the Oregon Native Fish Status Report (ODFW 2005). In limited cases, the status of individual major population groups (MPGs)/populations has likely changed from the most recent assessment though a more formal analysis was not available to document the change (e.g., likely status improvement in Clackamas Coho Salmon MPG and decline in Coquille Fall Chinook Salmon MPG). The exact references used for each ESU/SMU/DPS are cited in the tables.

2.1 Snake River Region

In the Snake River Region, both the Snake River spring/summer ESU and fall Chinook Salmon ESU are threatened at both the federal and state level (Table 2-1). The Snake River steelhead DPS is threatened at the federal level and sensitive at the state level.

The status and trends risk evaluation of the Snake River Region (Ford 2022) is summarized in Table 2-1. Within the Snake River Region, fall Chinook Salmon were given an overall ESU risk of Viable, steelhead were Moderate, and spring/summer Chinook Salmon were Moderate to High. The overall VSP status for spring/summer Chinook Salmon ranges from High to Maintained, where five of the six populations rank High and the only Maintained population is in the Minam River. Fall Chinook Salmon had an overall Viable VSP rating. We equated this to a "low to moderate" rating based on Table 18 in Ford 2022, where fall Chinook Salmon were given a low Abundance/Productivity (A/P) score and a moderate Spatial Structure (SS)/Diversity score. This allowed us to convert the fall Chinook Salmon risk score to the same scale used by other ESU/SMU/DPSs. Steelhead ranked Moderate to Low in VSP status, where three of the five steelhead populations ranked as Viable.

Table 2-1. Snake River ESU/DPS federal and state listing status and risk evaluation from existing research and monitoring efforts by species and population.

Species (Citation)	MPG or Population	Listing Status		VSP Risk Status				ESU/SMU/DPS Overall Risk
		Federal	State	A/P	Diversity	SS	Overall	
Spring/Summer Chinook (Ford 2022, Page 33)	Wenaha	Threatened	Threatened	High	Moderate	Moderate	High	Moderate to High
	Lostine			High	Moderate	Moderate	High	
	Minam			Moderate	Moderate	Moderate	Maintained	
	Catherine			High	Moderate	Moderate	High	
	Grand Ronde (Upper)			High	Moderate	High	High	
	Imnaha Mainstem			High	Moderate	Moderate	High	
Fall Chinook (Ford 2022, Page 51)	Lower Snake River	Threatened	Threatened	Low	No Data	Moderate	Viable	Low to Moderate (Viable)
Steelhead (Ford 2022, Page 71)	Lower Grande Ronde	Threatened	Sensitive	High	Moderate	Moderate	High	Moderate
	Joseph Creek			Low	Low	Low	Viable	
	Grand Ronde River (Upper)			Very Low	Moderate	Moderate	Viable	
	Wallowa River			High	Low	Low	High	
	Imnaha River			Very Low	Moderate	Moderate	Viable	

2.2 Middle Columbia Region

In the Middle Columbia region, only the Middle Columbia steelhead DPS is both federal and state listed (threatened and sensitive critical; Table 2-2). Both Middle Columbia spring and fall Chinook Salmon ESUs have no federal listing but are designated by the State as sensitive.

The status and trends risk evaluation of the Middle Columbia region (Ford 2022; ODFW 2005) are presented in Table 2-2. Within the Middle Columbia region, steelhead were the only species that had sufficient data to determine an overall ESU/SMU/DPS risk, leading to a ranking of Moderate. Spring and fall Chinook Salmon populations lacked ESU-wide risk rankings and were ranked only at the population or MPG level. Overall VSP status for steelhead included High, Maintained, Viable, and Highly Viable designations. Steelhead within this DPS included two extirpated populations in Oregon (Crooked River and Willow Creek). Of the extant populations, only one is designated as a High overall risk. Spring and fall Chinook Salmon all carry overall VSP statuses of Viable where not extirpated.

Table 2-2. Middle Columbia ESU/SMU/DPS federal and state listing status and risk evaluation from existing research and monitoring efforts by species and population.

Species (Citation)	MPG or Population	Listing Status		VSP Risk Status[1]				ESU/SMU/DPS Overall Risk
		Federal	State	A/P	Diversity	SS	Overall	
Steelhead (Ford 2022, Page 93)	Fifteenmile	Threatened	Sensitive Critical	Moderate	Low	Low	Maintained	Moderate[3]
	Deschutes River Westside			High	Moderate	Moderate	High	
	Deschutes River Eastside			Moderate	Moderate	Moderate	Maintained	
	John Day Lower Mainstem			Moderate	Moderate	Moderate	Maintained	
	NF John Day River			Very Low	Low	Low	Highly Viable	
	MF John Day River			Very Low	Moderate	Moderate	Viable	
	SF John Day River			Very Low	Moderate	Moderate	Viable	
	John Day Upper Mainstem			Moderate	Moderate	Moderate	Maintained	
	Umatilla River			Moderate	Moderate	Moderate	Maintained	
	Walla Walla River			Moderate	Moderate	Moderate	Maintained	
	Willow Creek			Functionally Extirpated				
	Crooked River			Extirpated				
Spring Chinook (ODFW 2005)	Lower Deschutes[2]		Sensitive	Low	Low	Low	Viable	No Data
	Metolius[2]			Extirpated				
	Crooked River[2]			Extirpated				
	NF John Day River[2]			Low	Low	Low	Viable	
	MF John Day River[2]			Low	Low	Low	Viable	
	Upper John Day River[2]			Low	Low	Low	Viable	
	Umatilla River[2]			Extirpated				
	Walla Walla River[2]			Extirpated				
Fall Chinook (ODFW 2005)	Deschutes River		Sensitive	Low	Low	Low	Viable	No Data
	John Day[2]			Extirpated				
	Umatilla[2]			Extirpated				
	Walla Walla River[2]			Extirpated				
	Mainstem[2]			No Data	No Data	No Data	No Data	
Coho (ODFW 2005)	Umatilla			Extirpated				No Data
	Wallowa			Extirpated				

Note:

1. Some species listed here as “extirpated” may have active re-introduction efforts under way.
2. Data extracted prior to VSP framework was used and translated into VSP terminology by ODFW for ODFW 2005.
3. Middle Columbia DPS Steelhead Overall Risk includes populations in Washington (denoted with +)

2.3 Lower Columbia River Region

Within the Lower Columbia River region, the Lower Columbia River Chinook, Coho, and Chum Salmon ESUs, and the Lower Columbia River steelhead DPS all carry a federal Threatened listing (Table 2-3). All species are also state listed as sensitive critical, except for Coho Salmon, which have an endangered state status.

The status and trends risk evaluation of the Lower Columbia region (NOAA 2022) is presented in Table 2-3. All species are designated as having a Moderate overall ESU risk ranking. For all species and populations within this ESU, there is not sufficient information to fulfill conditions required for the VSP framework to produce a population-specific overall VSP status. Abundance/productivity was the only parameter that was evaluated, and abundance/productivity status designations ranged from Very High to Low. Of the 31 populations, 15 carry a designation of Very High, while 9 are designated as High.

Table 2-3. Lower Columbia ESU/DPS federal and state listing status and risk evaluation from existing research and monitoring efforts by species and population.

Species (Citation)	MPG or Population	Listing Status		VSP Risk Status				ESU/SMU/DPS Overall Risk[1]
		Federal	State	A/P	Diversity	SS	Overall	
Fall Chinook (NOAA 2022 Pages 36, 37, 40 and Ford 2022, Page 130)	Big Creek	Threatened	Sensitive Critical	Very High	No Data	No Data	No Data	Moderate
	Clatskanie			Very High	No Data	No Data	No Data	
	Youngs Bay			High	No Data	No Data	No Data	
	Scappoose			No Data	No Data	No Data	No Data	
	Clackamas (Late)			High	No Data	No Data	No Data	
	Sandy (Late)			High	No Data	No Data	No Data	
	Sandy			Low	No Data	No Data	No Data	
	Hood			High	No Data	No Data	No Data	
	Upper Gorge			High	No Data	No Data	No Data	
	Lower Gorge			Low	No Data	No Data	No Data	
Spring Chinook (NOAA 2022, Pages 36, 37, 40 and Ford 2022, Page 130)	Sandy	Threatened	Sensitive Critical	Low	No Data	No Data	No Data	
	Hood			Very High	No Data	No Data	No Data	
Coho (NOAA 2022, Pages 36, 37, 40 and Ford 2022, Page 143)	Clatskanie	Threatened	Endangered	Very High	No Data	No Data	No Data	Moderate
	Scappoose			High	No Data	No Data	No Data	
	Youngs Bay			Low	No Data	No Data	No Data	
	Big Creek			Low	No Data	No Data	No Data	
	Clackamas			Very High	No Data	No Data	No Data	
	Sandy			High	No Data	No Data	No Data	
	Lower Gorge			Very High	No Data	No Data	No Data	
	Upper Gorge/Hood			Very High	No Data	No Data	No Data	
Chum (NOAA 2022, Pages 36, 37, 40 and Ford 2022, Page 156)	Youngs Bay	Threatened	Sensitive Critical	Very High	No Data	No Data	No Data	Moderate
	Big Creek			Very High	No Data	No Data	No Data	
	Clatskanie			Very High	No Data	No Data	No Data	
	Scappoose			Very High	No Data	No Data	No Data	
	Clackamas			Very High	No Data	No Data	No Data	
	Upper Gorge			Very High	No Data	No Data	No Data	
	Lower Gorge			Low	No Data	No Data	No Data	
Winter Steelhead (NOAA 2022, Pages 36, 37, 40 and Ford 2022, Page 156)	Clackamas	Threatened	Sensitive Critical	High	No Data	No Data	No Data	Moderate
	Sandy			Low	No Data	No Data	No Data	
	Lower Gorge			Very High	No Data	No Data	No Data	
	Hood			High	No Data	No Data	No Data	

Species (Citation)	MPG or Population	Listing Status		VSP Risk Status				ESU/SMU/DPS Overall Risk[1]
		Federal	State	A/P	Diversity	SS	Overall	
Summer Steelhead (NOAA 2022, Pages 36, 37, 40 and Ford 2022, Page 156)	Hood	Threatened	Sensitive Critical	Very High	No Data	No Data	No Data	

Note:

1. Overall Risk for Lower Columbia Region ESU/DPSs also includes populations in Washington. This is why overall risk does not necessarily align with population level risk.

2.4 Upper Willamette Region

Within the Upper Willamette region, the Upper Willamette spring Chinook Salmon ESU is federally listed as threatened and state designated as sensitive critical. The Upper Willamette DPS Steelhead is federally listed as threatened and state designated as sensitive (Table 2-4).

The status and trends risk evaluation for the Upper Willamette region (Ford 2022) is presented in Table 2-4. Spring Chinook Salmon were designated as having a Moderate overall ESU risk ranking, and Steelhead are designated as having a Moderate to High overall ESU risk ranking. There was insufficient information to develop an overall VSP risk for either spring Chinook Salmon or steelhead. For both species, abundance/productivity was the only parameter available for evaluation. Abundance/Productivity risk designations ranged from Very Low to Very High for spring Chinook Salmon. All populations of steelhead in this ESU are designated as High risk for abundance/productivity.

Table 2-4. Upper Willamette ESU/DPS federal and state listing status and risk evaluation from existing research and monitoring efforts by species and population.

Species (Citation)	MPG or Population	Listing Status		VSP Risk Status				ESU/SMU/DPS Overall Risk
		Federal	State	A/P	Diversity	SS	Overall	
Spring Chinook (Ford 2022, Page 179)	Clackamas	Threatened	Sensitive Critical	Very Low	No Data	No Data	No Data	Moderate
	Molalla			Very High	No Data	No Data	No Data	
	North Santiam			Very High	No Data	No Data	No Data	
	South Santiam			High	No Data	No Data	No Data	
	Calapooia			Very High	No Data	No Data	No Data	
	McKenzie			High	No Data	No Data	No Data	
	Middle Fork Willamette			Very High	No Data	No Data	No Data	
Winter Steelhead (Ford 2022, Page 189)	Willamette Falls Count	Threatened	Sensitive	High	No Data	No Data	No Data	Moderate to High
	Molalla				No Data	No Data	No Data	
	North Santiam				No Data	No Data	No Data	
	South Santiam				No Data	No Data	No Data	
	Calapooia				No Data	No Data	No Data	

2.5 Rogue-South Coast Region

Within the Rogue-South Coast region, Southern Oregon and Northern California Coast (SONCC) Coho Salmon are the only species listed at the federal level (Threatened; Table 2-5). Rogue-South Coast SMU summer steelhead and spring Chinook Salmon are designated as sensitive by the state but are not federally listed. Rogue-South Coast SMU winter steelhead and Rogue-South Coast SMU fall Chinook Salmon do not have a federal or state designation.

The Klamath Mountain Province DPS winter and summer steelhead and SONCC ESU Coho Salmon are discussed under this region, as the Oregon populations included in those federal ESU/DPSs have substantial, if not total, overlap with those included in the Rogue-South Coast Multi-Species Conservation and Management Plan. SONCC ESU Coho Salmon are threatened at the federal level and are listed as sensitive critical by the state. Also note that all these ESU/DPSs include populations in northern California.

SONCC ESU Coho Salmon in the upper Klamath River are effectively extirpated from Oregon waters, though they continue to exist in California waters of the lower Klamath River. This is anticipated to change in the near future with the removal of dams on the Klamath River allowing SONCC Coho Salmon access to the mainstem Klamath River and tributaries up to at least Keno Dam (ODFW and Klamath Tribes 2021). Currently, reoccupation of historical habitat will be allowed via volitional movement and dispersion upstream of former dam sites. However, ODFW and the Klamath Tribes (2021) have also developed a reintroduction plan, should that be necessary, and California Department of Fish and Game has a draft version of a similar plan at the time of this writing.

The status and trends risk evaluation for the Rogue-South Coast region (ODFW 2021; ODFW and Klamath Tribes 2021; NOAA 2023) is presented in Table 2-5. Rogue-South Coast SMU winter Steelhead have a Very Low overall ESU/SMU/DPS risk ranking, and both Rogue-South Coast SMU summer steelhead and SONCC ESU Coho Salmon have Moderate ESU/SMU/DPS overall risk rankings. Overall VSP status for Rogue-South Coast SMU winter steelhead populations were either Viable or Highly Viable, Rogue-South Coast SMU summer steelhead populations were Viable, and SONCC ESU Coho Salmon designations were either Moderate or High Risk.

Data for Rogue River fall and spring Chinook Salmon are monitored and managed under different management plans (ODFW 2013; ODFW 2019) using different criteria than other species within this region (ODFW 2021). Therefore, the standardized VSP criteria have not been calculated for them. However, abundance and spawner distribution and density have been calculated and are reasonably equivalent to the abundance and productivity criteria of the VSP. Moreover, the management plans define conservation and desired thresholds for abundance and spawner distribution and density for both these run-types. Therefore, to allow standardization with the metrics in this report, we have defined the abundance and productivity (A/P) criteria as follows for Rogue-South Coast SMU fall and spring Chinook Salmon:

- Low: below Conservation Criterion
- Moderate: between Conservation Criterion and Desired Status
- High: above Desired Status

This allows a standardized way of translating existing management criteria into qualitative categories for evaluation within this report. The SONCC Chinook Salmon ESU, which include populations in the Rogue spring and fall Chinook SMUs in Oregon and additional populations in north California, has an overall ESU/SMU/DPS risk ranking of Low and overall VSP status for populations within the ESU range from Viable to Moderate to Highly Viable.

Table 2-5. Rogue-South Coast ESU/SMU/DPS federal and state listing status and risk evaluation from existing research and monitoring efforts by species and population.

Species (Citation)	MPG or Population	Listing Status		VSP Risk Status				ESU/SMU/DPS Overall Risk
		Federal	State	A/P	Diversity	SS	Overall	
Winter Steelhead (ODFW 2021, Page 24)	Elk			Very Low	Very Low	Very Low	Highly Viable	Very Low
	Euchre			Very Low	Very Low	Very Low	Highly Viable	
	Hunter			Very Low	Very Low	Very Low	Highly Viable	
	Pistol			Very Low	Very Low	Very Low	Highly Viable	
	Chetco			Very Low	Very Low	Very Low	Highly Viable	
	Winchuck			Very Low	Very Low	Very Low	Highly Viable	
	Lower Rogue			Low	Very Low	Very Low	Viable	
	Illinois			Low	Very Low	Very Low	Viable	
	Middle Rogue/Applegate			Low	Very Low	Very Low to Low	Viable	
	Upper Rogue			Low	Low	Low	Viable	
Summer Steelhead (ODFW 2021, Page 24)	Middle Rogue/Applegate		Sensitive	No Data	Low	Very Low	Viable	Moderate
	Upper Rogue			No Data	Low	Low	Viable	
Coho (ODFW 2021, Page 24; ODFW and Klamath Tribes 2021, Page 13)	Elk	Threatened	Sensitive Critical	High	Low	Low to Moderate	High Risk	Moderate
	Illinois			Moderate	Low	Low to Moderate	Moderate	
	Middle Rogue/Applegate			Moderate	Low	Low	Moderate	
	Upper Rogue			Moderate	Low	Low to Moderate	Moderate	
	Upper Klamath River and Tributaries		Sensitive	EXTIRPATED				
Spring Chinook (ODFW 2019, Page 7 and NOAA 2024, Page 129)	Rogue		Sensitive	Moderate	No Data	No Data	No Data	Low

Species (Citation)	MPG or Population	Listing Status		VSP Risk Status				ESU/SMU/DPS Overall Risk
		Federal	State	A/P	Diversity	SS	Overall	
Fall Chinook (NOAA 2024, Page 129 and ODFW 2022, page 2 and 9)	Lower Rogue			Very Low	Very Low	Very Low to Low	Highly Viable	Low
	Upper Rogue			Very Low	Low to Moderate	Low	Highly Viable to Viable	
	Hunter			Low to Moderate	Very Low to Low	Low	Viable to Moderate	
	Pistol			Low	Very Low to Low	Very Low to Low	Viable	
	Chetco			Low	Low to Moderate	Very Low to Low	Viable	
	Winchuck			Low	Very Low to Low	Very Low to Low	Viable	

2.6 Oregon Coast Region

Within the Oregon Coast region, one of the six species is listed at the federal or state level (Table 2-6). Only Oregon Coast ESU Coho Salmon are federally designated as threatened and are listed as sensitive by the state. Oregon Coast SMU spring Chinook are listed as sensitive at the state level but do not have federal listings. Chum Salmon are sensitive critical at the state level but do not have federal listings. Oregon Coast SMU winter and summer steelhead are both federal species of concern. Oregon Coast SMU summer steelhead are listed as sensitive by the state, and Oregon Coast SMU winter steelhead do not have a state designation.

The status and trends risk evaluation for the Oregon Coast region is presented in Table 2-6. Overall, ESU/SMU/DPS risk rankings were either Very Low for Oregon Coast SMU Chinook and Oregon Coast SMU winter steelhead or Moderate to High for Oregon Coast SMU spring Chinook and Chum Salmon. Where sufficient data were available, most populations across species were given overall VSP status of Viable. Three populations—Elk River Chinook Salmon, South Umpqua River spring Chinook Salmon, and Netarts Chum Salmon—were found to be not viable. There was insufficient information to fulfill conditions required for the VSP framework to produce a population-specific overall VSP status for Oregon Coast ESU Coho Salmon, and in most cases, there was insufficient information to fulfill these requirements for Oregon Coast SMU Chum Salmon. However, note that both had sufficient information to make determinations of overall ESU risk, as reported above.

Table 2-6. Oregon Coast ESU/SMU/DPS federal and state listing status and risk evaluation from existing research and monitoring efforts by species and population.

Species (Citation)	MPG or Population	Listing Status		VSP Risk Status				ESU/SMU /DPS Overall Risk
		Federal	State	A/P	Diversity	SS	Overall	
Chinook (ODFW 2014, Page 161)	Necanicum			Very Low	Moderate	Low	Viable	Very Low
	Nehalem			Low	Moderate	Very Low	Viable	
	Tillamook			Low to Moderate	Moderate to High	Very Low to Low	Viable	
	Nestucca			Low	Moderate to High	Very Low to Low	Viable	
	Salmon			Very Low	Moderate	Low to Moderate	Viable	
	Siletz			Very Low	Moderate	Very Low	Viable	
	Yaquina			Very Low	Moderate	Very Low	Viable	
	Alsea			Very Low	Moderate	Very Low	Viable	
	Yachats Aggregate			No Data	Moderate	Very Low	Viable	
	Siuslaw			Very Low	Moderate	Very Low	Viable	
	Lower Umpqua			No Data	Moderate	Very Low	Viable	
	Middle Umpqua			No Data	Moderate	Very Low	Viable	
	South Umpqua			Very Low	Moderate	Very Low	Viable	
	Coos			Very Low	Moderate	Very Low	Viable	
	Coquille			Very Low	Moderate to High	Very Low	Viable	
	Floras			Low	Moderate	Very Low	Viable	
	Sixes			Very Low	Moderate	Very Low	Viable	
	Elk			Moderate	Moderate	Very Low	Not Viable	
Spring Chinook (ODFW 2014, Page 161)	North Umpqua		Sensitive	Very Low	Moderate	Very Low	Viable	Moderate
	South Umpqua			Moderate	Moderate	Moderate	Not Viable	
Chum (ODFW 2014, Page 161)	Necanicum		Sensitive Critical	No Data	No Data	No Data	No Data	Moderate to High
	Nehalem			Very Low	No Data	No Data	Viable	
	Tillamook			Low	No Data	No Data	Viable	
	Netarts			Moderate	No Data	No Data	Not Viable	
	Nestucca			No Data	No Data	No Data	No Data	
	Salmon			No Data	No Data	No Data	No Data	
	Siletz			No Data	No Data	No Data	No Data	
	Yaquina			Very Low	No Data	No Data	Viable	
	Alsea			No Data	No Data	No Data	No Data	
	Siuslaw			No Data	No Data	No Data	No Data	
	Umpqua			No Data	No Data	No Data	No Data	
	Coos			No Data	No Data	No Data	No Data	
	Coquille			No Data	No Data	No Data	No Data	

Species (Citation)	MPG or Population	Listing Status		VSP Risk Status				ESU/SMU /DPS Overall Risk
		Federal	State	A/P	Diversity	SS	Overall	
Winter Steelhead (ODFW 2014, Page 162)	Necanicum	Species of Concern		No Data	Low	Low	Viable	Very Low
	Nehalem			Very Low	Low	Very Low	Viable	
	Tillamook			No Data	Low	Very Low	Viable	
	Nestucca			No Data	Low	Very Low	Viable	
	Salmon			No Data	Low	Low	Viable	
	Siletz			No Data	Low	Very Low	Viable	
	Yaquina			No Data	Low	Very Low	Viable	
	Alsea			No Data	Low	Very Low	Viable	
	Yachats Aggregate			No Data	Low	Very Low	Viable	
	Siuslaw			No Data	Low	Very Low	Viable	
	Lower Umpqua			No Data	Low	Very Low	Viable	
	Middle Umpqua			No Data	Low	Very Low	Viable	
	North Umpqua			Very Low	Low	Very Low	Viable	
	South Umpqua			No Data	Low	Very Low	Viable	
	Tenmile			No Data	Low	Low	Viable	
	Coos			No Data	Low	Very Low	Viable	
	Coquille			No Data	Low	Very Low	Viable	
	Floras			No Data	Low	Very Low	Viable	
	Sixes			No Data	Low	Low	Viable	
Summer Steelhead (ODFW 2014, Page 162)	Siletz	Species of Concern	Sensitive	Very Low	Low	Very Low	Viable	Moderate
	North Umpqua			Very Low	Low	Very Low	Viable	
Coho (Ford 2022, Page 267)	Necanicum	Threatened	Sensitive	No Data	No Data	No Data	No Data	Low to Moderate
	Nehalem			No Data	No Data	No Data	No Data	
	Tillamook			No Data	No Data	No Data	No Data	
	Nestucca			No Data	No Data	No Data	No Data	
	Salmon			No Data	No Data	No Data	No Data	
	Siletz			No Data	No Data	No Data	No Data	
	Yaquina			No Data	No Data	No Data	No Data	
	Alsea			No Data	No Data	No Data	No Data	
	Yachats Aggregate			No Data	No Data	No Data	No Data	
	Siuslaw			No Data	No Data	No Data	No Data	
	Lower Umpqua			No Data	No Data	No Data	No Data	
	Middle Umpqua			No Data	No Data	No Data	No Data	
	North Umpqua			No Data	No Data	No Data	No Data	
	South Umpqua			No Data	No Data	No Data	No Data	
	Tenmile			No Data	No Data	No Data	No Data	

Species (Citation)	MPG or Population	Listing Status		VSP Risk Status				ESU/SMU /DPS Overall Risk
		Federal	State	A/P	Diversity	SS	Overall	
	Coos			No Data	No Data	No Data	No Data	
	Coquille			No Data	No Data	No Data	No Data	
	Floras			No Data	No Data	No Data	No Data	
	Sixes			No Data	No Data	No Data	No Data	

2.7 Section Summary

In summary, fourteen ESU/SMU/DPSs are federally listed as Threatened, one is state-listed as Endangered (Lower Columbia Coho Salmon SMU), eight are state-listed as Sensitive-Critical, and 11 are state-listed as Sensitive (Table 2-7). Five have no federal or state listing status.

ESU/SMU/DPS risk was Moderate or higher for 16 of the 26 ESU/SMU/DPSs examined (Moderate: 11, Moderate to High: 5). Comparatively fewer species (7) were ranked as Moderate or lower ESU/SMU/DPS risk (Moderate to Low: 2; Low: 2; Very Low: 3). All species in the Middle Columbia region, except the Steelhead DPS, lacked sufficient information to be ranked.

Table 2-7. Summary of Federal and State Listing Status and ESU/SMU/DPS Risk Rating.

Region	Species	Federal Listing Status	State Listing Status	ESU/SMU/DPS Risk Rating
Snake River	Fall Chinook	T	T	Low to Moderate
	Spring/Summer Chinook	T	T	Moderate to High
	Steelhead	T	S	Moderate
Middle Columbia	Coho			NA
	Fall Chinook		S	NA
	Spring Chinook		S	NA
	Steelhead	T	SC	Moderate
Lower Columbia	Coho	T	E	Moderate
	Fall Chinook	T	SC	Moderate
	Spring Chinook	T	SC	Moderate
	Chum	T	SC	Moderate
	Winter Steelhead	T	SC	Moderate
	Summer Steelhead	T	S	Moderate
Upper Willamette	Spring Chinook	T	SC	Moderate
	Steelhead	T	S	Moderate to High
Rogue-South Coast	Coho	T	S/SC	Moderate
	Fall Chinook			Low
	Spring Chinook		S	Low
	Winter Steelhead			Very Low
	Summer Steelhead		S	Moderate
Oregon Coast	Coho	T	S	Low to Moderate
	Fall Chinook			Very Low
	Spring Chinook		S	Moderate
	Chum		SC	Moderate to High
	Winter Steelhead			Very Low
	Summer Steelhead		S	Moderate

3 Climate Change Vulnerability

Climate change in Oregon is predicted to have an adverse impact on salmon and steelhead populations. According to a 2023 report lead by the Oregon Climate Change Research Institute (OCCRI 2023), air temperature has increased by approximately 2.2°F every century since 1895 and at the current rate, Oregon is projected to experience annual temperature increase of 5°F by the 2050s and 8.2°F by the 2080s, with the greatest increase during summer. OCCRI also found that precipitation is projected to increase during the winter and decrease during the summer. Additionally, OCCRI indicated that there will be an increase in extreme temperature events and a greater frequency and intensity of droughts. All of these factors (see OCCRI 2023 for full listing and detailed discussion) can have adverse effects on fish populations and require proper consideration to ensure sustainability of populations and species within Oregon.

Climate change vulnerability of ESU/SMU/DPS was identified based on an Exposure and Sensitivity Ranking (vulnerability) and the species' Adaptive Capacity (Crozier et al. 2019). Exposure and Sensitivity Rankings range from Low to High, where the low end of the scale indicates lower exposure and/or sensitivity to a changing climate. Adaptive capacity ranges from Low to High as well, where High adaptive capacity indicates a greater ability to adapt to changing climatic conditions.

The exposure metric is used to describe the magnitude of projected environmental changes that could occur by mid-century. Exposure considers both freshwater and marine stages. In freshwater, stream temperature, summer water deficit, flooding, and hydrologic regime are evaluated (Crozier et al. 2019). In the marine environment, sea level rise, sea surface temperature, ocean acidification exposure, upwelling, and ocean currents are evaluated (Crozier et al. 2019). Scorers independently read the collated data regarding each species within each DPS and assigned each exposure attribute described above as Low, Moderate, High, or Very High (Crozier et al. 2019).

The sensitivity metric is used to describe biological sensitivity to changes in climate by considering different life-stages, biological characteristics and geographic range within each DPS (Crozier et al. 2019). Sensitivity evaluates early life history, juvenile freshwater stage, estuary stage, marine stage, adult freshwater stage, cumulative life-cycle effects, hatchery influence, other non-climate stressors, population viability, and ocean acidification sensitivity (Crozier et al. 2019). Scorers independently read the collated data regarding each species within each DPS and assigned each exposure attribute described above as Low, Moderate, High, or Very High (Crozier et al. 2019).

Adaptive capacity is defined as "the potential for a system to respond to environmental change by genetic adaptation or by a non-genetic phenotypic change that mitigates negative environmental impacts" (Crozier et al. 2019; Working Group II Report 2). Proxies used to measure this capacity included stressors, population status, hatchery influence, and life cycle complexity, and were scored as Low, Moderate, or High (Crozier et al. 2019).

Sufficient data were not available to determine adaptive capacity for all ESU/SMU/DPSs. These species include the Oregon Coast Chum Salmon and steelhead SMUs (winter steelhead and summer steelhead), Rogue-South Coast Chinook Salmon SMUs, and Middle Columbia fall Chinook and Coho Salmon SMUs. Also, Crozier et al. (2019) did not always produce separate rankings for different run types of the same species. Exposure and sensitivity and adaptive capacity rankings are reported down to either the species or run-type within species, if available.

3.1 Snake River Region

Overall, the Snake River Region scored High to Very High in exposure and sensitivity rating and Moderate to High in adaptive capacity (Table 3-1). Exposure scores were driven by Moderate to High freshwater exposure attributes and Very High ocean acidification exposure despite scoring Low to Very Low in marine exposure (Crozier et al. 2019). Life cycle sensitivity scores for this region ranged from Low to High, driven by high sensitivity at adult freshwater, juvenile freshwater, and cumulative life cycle stages though early life history was ranked as Low.

Snake River ESU spring/summer Chinook Salmon have the greatest exposure and sensitivity to climate change and is ranked as Very High (Table 3-1). Both Snake River ESU Fall Chinook Salmon and Snake River DPS steelhead are categorized as having a High exposure and sensitivity ranking. While all runs of Snake River ESU Chinook Salmon in this region have a high adaptive capacity, Snake River DPS steelhead only have a Moderate adaptive capacity.

Crozier et al. (2019) determined that the juvenile freshwater stages and adult stage of the spring/summer Chinook Salmon were vulnerable to stream temperature increases. Crozier et al. (2019) also determined that the adult stages of steelhead were most vulnerable to higher stream temperatures. Freshwater in the Snake River is highly dominated by snow fall and has large implications for both hydrologic regimes and stream temperatures (Crozier et al. 2019). The loss of snowpack in these regions is reflected in the freshwater exposures scores. Additionally compounding these threats are the run timing (spring and summer) and longer migration routes, which increase time of freshwater exposure (Crozier et al. 2019).

Table 3-1. Snake River ESU/DPS vulnerability and adaptive capacity.

Species/Run-Type	Exposure and Sensitivity Ranking	Adaptive Capacity
Spring/Summer Chinook	Very High	High
Fall Chinook	High	High
Steelhead	High	Moderate

Source: Crozier et al. 2019

3.2 Middle Columbia River Region

Climate data sufficient to conduct a climate analysis and provide exposure and sensitivity and adaptive capacity scores only existed for Middle Columbia spring Chinook Salmon ESU and steelhead DPS. Middle Columbia spring Chinook Salmon ESU and steelhead DPS scored High for exposure and sensitivity and Moderate for adaptive capacities (Table 3-2). Exposure scores were driven by High rankings for stream temperature and hydrologic regime. Marine exposure was driven by sea surface temperature and ocean acidification exposure. Life cycle sensitivity was ranked High for Middle Columbia ESU spring Chinook Salmon; however, steelhead ranked Low to Moderate in these categories.

Crozier et al. 2019 cites stream temperatures as being the greatest factor affecting freshwater exposure for both species. Freshwater in the interior Columbia River is highly dominated by snowpack and reduction of snowpack region-wide has large implications for both hydrologic regimes and stream temperatures (Crozier et al. 2019). Crozier et al. (2019) determined that the juvenile freshwater stages and adult stage of the spring Chinook Salmon were vulnerable to stream temperature increases and variation in hydrologic regimes, where adults are particularly affected by seasonal ambient temperature (spring and summer migration timing) and longer migrations. Marine exposure to ocean acidification

also greatly affects both species, which has largely occurred because of increased levels of carbon dioxide in the atmosphere (Doney et al. 2009). Climate sensitivity rankings for the Middle Columbia River region are provided in Table 3-2.

Table 3-2. Middle Columbia River ESU/SMU/DPS vulnerability and adaptive capacity rankings.

Species/Run-Type	Exposure and Sensitivity Ranking	Adaptive Capacity
Spring Chinook	High	Moderate
Fall Chinook	No Data	No Data
Steelhead	High	Moderate
Coho	No Data	No Data

Source: Crozier et al. 2019

3.3 Lower Columbia River Region

Overall, Lower Columbia Chinook and Chum Salmon ESU and Steelhead DPS all were categorized with Moderate exposure and sensitivity rankings, while Lower Columbia ESU Coho Salmon have a High ranking. Adaptive capacity is High for both Lower Columbia DPS steelhead and Lower Columbia ESU Chinook Salmon, and Moderate for both Lower Columbia ESU Coho and Chum Salmon. Freshwater exposure was driven by High rankings for stream temperature increases, where ocean acidification exposure was ranked as Very High for both species (Crozier et al. 2019). Life cycle sensitivity was found to be Low to Moderate for all ESUs in this region (Crozier et al. 2019).

Crozier et al. (2019) identified stream temperature change for Coho Salmon and steelhead as the greatest risk to species in this region with stream temperature posing the greatest risk to the Coho Salmon's juvenile freshwater stage (Crozier et al. 2019). Rankings in freshwater exposure are generally lower for the species in this region, likely the result of different climate types. Note that Crozier et al. (2019) did not differentiate between spring-run and fall-run Chinook Salmon and winter and summer steelhead in their analysis. Climate sensitivity rankings for the Lower Columbia River region are provided in Table 3-3.

Table 3-3. Lower Columbia River ESU/DPS vulnerability and adaptive capacity rankings.

Species/Run-Type	Exposure and Sensitivity Ranking	Adaptive Capacity
Steelhead	Moderate	High
Chinook	Moderate	High
Coho	High	Moderate
Chum	Moderate	Moderate

Source: Crozier et al. 2019

3.4 Upper Willamette River Region

Upper Willamette Chinook Salmon ESU and steelhead DPS have exposure and sensitivity rankings of Very High and High, respectively, and both have Moderate adaptive capacities. Exposure scores were driven by Moderate to High freshwater exposure attributes and Very High ocean acidification exposure despite scoring Low to Very Low in marine exposure (Crozier et al. 2019). Life cycle sensitivity scores for this region ranged from Low to High, driven by high sensitivity at adult freshwater, juvenile freshwater, and cumulative life cycle stages though early life history was ranked as Low.

Crozier et al. (2019) identified a vulnerability to stream temperature increase for Upper Willamette Chinook Salmon and steelhead during the adult freshwater stage. Chinook Salmon are particularly

vulnerable to temperature changes as adults in freshwater because of the seasonal ambient temperatures (spring and summer migrations) and longer migration pathways (Crozier et al. 2019). Upper Willamette ESU spring Chinook Salmon can face serious exposures to high temperatures in modified river systems, which can result in high pre-spawn mortality (Keefer et al. 2015; Bowerman et al. 2017; Crozier et al. 2019). Climate sensitivity rankings for the Upper Willamette region are provided in Table 3-4.

Table 3-4. Upper Willamette River ESU/DPS vulnerability and adaptive capacity rankings.

Species/Run-Type	Exposure and Sensitivity Ranking	Adaptive Capacity
Chinook	Very High	Moderate
Steelhead	High	Moderate

Source: Crozier et al. 2019

3.5 Rogue-South Coast Region

Within this region, exposure and sensitivity rankings ranged from Low to Moderate to High. SONCC ESU Coho Salmon face the greatest exposure and sensitivity, and Rogue-South Coast SMU winter steelhead have the lowest. Rogue-South Coast SMU winter steelhead and summer steelhead were determined to have moderate adaptive capacities, SONCC ESU Coho Salmon were determined to have low adaptive capacities, and Rogue-South Coast SMU spring Chinook and fall Chinook Salmon lacked sufficient data to assign exposure and sensitivity or adaptive capacity ratings.

These species were not analyzed in Crozier et al. 2019, which is the source material from which other rankings in this section here taken. However, ODFW (2021) provided rankings that are directly comparable for Oregon populations only and these are presented here. Climate and ocean change risk (which this report equates to exposure and sensitivity ranking) is Low to moderate for all populations and species, with the exception of one SONCC ESU Coho Salmon population (M. Rogue/Applegate) (ODFW 2021). The ODFW Rogue-South Coast Multi-Species Conservation and Management Plan does not identify specific life-history segments that face the greatest exposure and sensitivity. However, ODFW states both freshwater and ocean conditions are likely to affect species within the ESU in varying degrees (ODFW 2021). Climate sensitivity rankings for the Rogue-South Coast region are provided in Table 3-5.

Table 3-5. Rogue-South Coast ESU/SMU/DPS vulnerability and adaptive capacity rankings.

Species/Run-Type	Exposure and Sensitivity Ranking	Adaptive Capacity
Coho	High	Low
Spring Chinook	No Data	No Data
Fall Chinook	No Data	No Data
Winter Steelhead	Low	Moderate
Summer Steelhead	Moderate	Moderate

Notes: Includes SONCC Chinook and/or Coho Salmon
Source: ODFW 2021

3.6 Oregon Coast Region

Oregon Coast ESU/ SMU steelhead have high exposure and sensitivity and moderate adaptive capacity rankings (Wade et al. 2013). Freshwater exposure for these species was dominated by increasing stream

temperature, which received a High ranking. Oregon Coast SMU steelhead were also found to have increased exposure to changes in hydrologic regimes (i.e., flow).

Crozier et al. determined a climate ranking for Oregon Coast ESU Coho Salmon but not Oregon Coast ESU Chinook Salmon (2019). However, based on findings from Crozier et al. 2019, it is expected that Oregon Coast SMU spring Chinook Salmon and Oregon Coast ESU Coho Salmon will both experience high exposure to increased stream temperatures. Conversely, Oregon Coast fall Chinook Salmon will likely have limited exposure to elevated stream temperature during their juvenile freshwater phase. Further, the findings of Crozier et al. (2019) suggest that more southern coastal populations will face greater challenges in freshwater (High rankings in both increased stream temperature and flooding) and in the marine environment (High to Very High rankings for sea level rise, upwelling, sea surface temperature, and ocean acidification). Wade et al. 2013 present findings that Oregon Coast SMU steelhead face increased exposure to higher stream temperatures and more extreme changes in hydrologic regimes, although locality within the Oregon Coast region may vary slightly. Chum Salmon exposure and sensitivity and adaptive capacity were not determined for the Oregon Coast. Climate sensitivity rankings for the Oregon Coast region are provided in Table 3-6.

Table 3-6. Oregon Coast vulnerability and adaptive capacity rankings.

Species/Run-Type	Exposure and Sensitivity Ranking	Adaptive Capacity
Coho	High	Moderate
Chinook	High[1]	Moderate[1]
Steelhead	High	No Data
Chum	No Data	No Data

Note:

1. A comprehensive review of climate effects for Chinook Salmon does not exist. Given that Coho Salmon were evaluated in this area and that Chinook Salmon are predominately fall-run, Coho Salmon parameters were used for Chinook Salmon in this case.

Source: Crozier et al. 2019 for Coho and Chinook, steelhead was taken from Wade et al. 2013.

3.7 Section Summary

Of the 17 ESU/SMU/DPSs that could be assigned an exposure and sensitivity ranking, 12 had an exposure and sensitivity ranking of High or Very High. There was only one case (Rogue-South Coast SMU winter steelhead) of an exposure and sensitivity ranking being designated as Low. This indicates that the majority of ESU/SMU/DPSs are at substantial risk due to climate change. Adaptive capacity for all ESUs is above Moderate, except for SONCC ESU Coho Salmon, which have been designated as having a Low capacity to adapt to climate change. This indicates that SONCC ESU Coho Salmon likely face a greater risk to climate change than other species due to their low adaptive capacity. Sufficient data were not available to determine the exposure and sensitivity and/or adaptive capacity for all ESU/SMU/DPSs. These species include Oregon Coast Chum Salmon and steelhead SMUs (winter steelhead and summer steelhead), Rogue-South Coast SMU spring and fall Chinook Salmon, and Middle Columbia Coho and fall Chinook Salmon SMUs. Overall, despite being at substantial risk due to climate change, most ESU/SMU/DPSs combinations have moderate or greater capacity to adapt to changes, thereby partially mitigating climate change risk.

Climate exposure and sensitivity likely has the greatest uncertainty around predicted effects on fish populations. Climate change is predicted to affect the region with increased air temperatures and more extreme weather events (OCCRI 2023). Climate-related local extinctions have happened or are currently

occurring worldwide, and a recent study found that 74% of the freshwater species surveyed had experienced local extinctions due to range shifts (Wiens 2016). While Pacific salmon can have high adaptive capacity to climate change, amplification of existing stressors may inhibit adaptive capacity, further increasing the need for future hatchery support.

4 Hatchery Programs

It is the policy of the state of Oregon that wildlife (including fish) must be managed to prevent serious depletion of any indigenous species and to provide the optimum recreational and aesthetic benefits for present and future generations of the citizens of this state (ORS 496.012). Hatchery programs are a management tool that can be used to meet both conservation and recreational needs. In Oregon, hatchery programs are designated as either harvest or conservation programs. Within the harvest hatchery programs, there are two different program types: mitigation and harvest augmentation. Mitigation program types are "used pursuant to an agreement to provide fishing and harvest opportunities lost as a result of habitat deterioration, destruction, or migration blockage" (ODFW 2013). Harvest augmentation program types are "used to increase fishing and harvest opportunities where there is no mitigation program in place" (ODFW 2013). The primary purpose of both these program types is to provide fishery and harvest opportunities regardless of the reason why such harvest opportunity enhancement may be necessary.

Within conservation hatchery programs, there are seven program types: supplementation, recovery/restoration, captive brood, captive rearing, egg banking, cryopreservation, and experimental. Of these seven program types, only supplementation and recovery/restoration are discussed in this report. Supplementation program types are designed to route "a portion of an imperiled wild population through a hatchery for part of its life cycle to gain a temporary survival boost or brings in suitable hatchery produced fish or naturally produced native fish from outside the target river region to supplement the imperiled local population" (ODFW 2013). Recovery program types (also listed as "restoration" in other documents) outplant "suitable non-local hatchery produced or naturally produced native fish to establish a population in habitat currently vacant for that native species using the best available broodstock" (ODFW 2013). All hatchery programs and program types considered within this report produce Pacific salmon and steelhead for various purposes and uses that coincide with predetermined goals and desired outcomes while aligning with the agency's mission.

This report categorized each hatchery program into one of the four program types discussed above (harvest augmentation, mitigation, supplementation, and recovery/restoration). In some cases, a hatchery may serve two or more program types and some hatchery programs will have harvest and conservation functions. It was not possible to apportion production from a given hatchery into the different hatchery program types when operating within the same hatchery. ODFW hatchery programs were grouped and reported below by ESU/SMU. Species, program name, hatchery stock, hatchery name, program type, and smolt release target are listed for each ESU/SMU. Some hatcheries produce smolts for more than one species. Hatcheries that are not managed by ODFW were excluded from this evaluation, including those operated by a federal agency, tribe, or private entity.

4.1 Snake River Region

There are three hatcheries in the Snake River region that produce five different stocks of spring/summer Chinook Salmon and two different summer steelhead stocks (Table 4-1). Mitigation hatchery programs for fall Chinook Salmon do exist but are not administered by the State of Oregon. There are 1,390,000 spring Chinook Salmon smolts and 1,015,000 summer steelhead smolts released from these hatcheries annually. Program specific smolt and pre-smolt annual release targets range from 150,000 to 800,000 individuals within this region. All spring/summer Chinook Salmon program types within this region are a

combination of mitigation and supplementation. Summer steelhead program types, likewise, are either mitigation or a combination of mitigation and supplementation. The hatchery production in this region is dominated by mitigation programs, with all seven hatchery programs mitigation based.

While not part of the ODFW hatchery system, there are fall Chinook Salmon mitigation hatcheries in two neighboring states: one in Washington, and two in Idaho. Additionally, there is the "Acclimation Ponds Program," which contains three separate ponds that occur in both Washington, Idaho, and Oregon (two located on the Snake River, and one located on the Clearwater River), where all fish are sourced from Lyons Ferry Hatchery (Washington). These hatcheries and acclimation sites receive resources from Idaho Power, U.S. Fish and Wildlife Service, Nez Perce Tribe, and Bonneville Power. These mitigation hatcheries not owned or operated by Oregon, are discussed here but are not included in Table 4-1.

Table 4-1. Summary of Snake River region hatchery programs.

Species/Run	Program Name	Hatcheries	Program Type	Release Target
Spring Chinook	Lower Snake River Compensation Plan (LSRCP) Imnaha Spring/Summer Chinook	Lookingglass	Mitigation/ Supplementation	490,000
	Lookingglass Hatchery Catherine Creek Spring/Summer Chinook	Lookingglass	Mitigation/ Supplementation	150,000
	Grande Ronde Endemic Spring Chinook Salmon Supplementation Program (GRESCSP)	Lookingglass, Wallowa	Mitigation/ Supplementation	250,000
	Lookingglass Creek Spring/Summer Chinook	Lookingglass, Irrigon	Mitigation/ Supplementation	250,000
	GRESCSP; Lostine River stock	Lookingglass	Mitigation/ Supplementation	250,000
Summer Steelhead	LSRCP Grande Ronde Region Summer Steelhead	Wallowa, Irrigon	Mitigation	800,000
	LSRCP Little Sheep Creek Summer Steelhead	Wallowa, Irrigon	Mitigation/ Supplementation	215,000

Note: Data sourced from Hatchery Program Management Plans and Hatchery Genetic Management Plans for the respective Hatcheries. (https://www.dfw.state.or.us/fish/hatchery/)

4.2 Middle Columbia Region

There are four hatcheries in the Middle Columbia region that produce one stock of Coho Salmon, one stock of fall Chinook Salmon, two spring Chinook Salmon stocks, and two summer steelhead stocks (Table 4-2). Annual release targets include 1,500,000 fall Chinook Salmon smolts, 1,120,000 spring Chinook Salmon smolts, 312,000 summer steelhead smolts, and 1,000,000 Coho Salmon smolts. Program-specific smolt and pre-smolt release targets range from 150,000 to 1,500,000 individuals within this region. The Coho and fall Chinook Salmon program types are both mitigation. Spring Chinook Salmon program types are supplementation or a combination of mitigation and recovery. Summer steelhead program types are, likewise, supplementation or a combination of mitigation and recovery. The hatchery production in this region is dominated by mitigation programs, with four of the six hatchery programs mitigation based.

Table 4-2. Summary of Middle Columbia River region hatchery programs.

Species/Run	Program Name	Hatcheries	Program Purpose	Smolt/Pre-Smolt Release Target
Coho Salmon	Umatilla River Coho	Bonneville, Irrigon, Cascade	Mitigation	1,000,000
Fall Chinook	Umatilla River Fall Chinook	Umatilla, Bonneville	Mitigation	1,500,000
Spring Chinook	Round Butte Hatchery Deschutes River Spring Chinook	Round Butte	Mitigation/ Recovery	310,000
	Umatilla Spring Chinook	Umatilla	Supplementation	810,000
Summer Steelhead	Round Butte Hatchery Summer Steelhead	Round Butte	Mitigation/ Recovery	162,000
	Umatilla River Summer Steelhead	Umatilla	Supplementation	150,000

Note: Data sourced from Hatchery Program Management Plans and Hatchery Genetic Management Plans for the respective Hatcheries. (https://www.dfw.state.or.us/fish/hatchery/)

4.3 Lower Columbia River Region

There are 17 hatcheries that produce fish released in the Lower Columbia region including three stocks of Coho Salmon, three stocks of fall Chinook Salmon, four spring Chinook Salmon stocks, and one Chum Salmon stock (Table 4-3). Annual release targets include 9,050,000 fall Chinook Salmon smolts, 4,780,000 spring Chinook Salmon smolts, 3,635,000 Coho Salmon smolts, 300,000 Chum Salmon smolts, 565,000 winter steelhead, and 250,000 summer steelhead. Program-specific smolt and pre-smolt release targets range from 200,000 to 5,200,000 individuals within this region. Coho Salmon program types are either mitigation or a combination of mitigation and harvest augmentation. Fall Chinook Salmon program types are either harvest augmentation or mitigation. Spring Chinook Salmon program types are either mitigation, a combination of mitigation and harvest augmentation, or harvest augmentation and recovery/restoration. Chum Salmon program types are entirely recovery oriented. The hatchery production in this region is dominated by mitigation programs, with eight of the twelve hatchery programs mitigation based.

Table 4-3. Summary of Lower Columbia River region hatchery programs.

Species/Run	Program	Hatcheries	Program Purpose	Smolt/Pre-Smolt Release Target
Coho Salmon	Sandy River Coho Salmon	Sandy	Mitigation/ Harvest Augmentation	300,000
	Big Creek Coho Salmon	Big Creek	Mitigation/ Harvest Augmentation	535,000
	Bonneville Hatchery Coho Salmon	Bonneville, Cascade	Mitigation	300,000-1,000,000
	SAFE Coho Salmon	Bonneville, Sandy, Cascade, Clackamas	Mitigation	1,800,000
Fall Chinook	Big Creek Hatchery Tule Fall Chinook Salmon	Big Creek, Klaskanine	Harvest Augmentation	5,200,000

Species/Run	Program	Hatcheries	Program Purpose	Smolt/Pre-Smolt Release Target
	Bonneville Hatchery Tule Fall Chinook Salmon	Bonneville, Washougal (WA)	Mitigation	1,600,000
	Select Area Bright (SAB) Fall Chinook Salmon	Klaskanine, SF Klaskanine, Big Creek	Harvest Augmentation	2,250,000
Spring Chinook	Sandy Hatchery Spring Chinook	Sandy, Clackamas, Oxbow, Cascade	Mitigation/ Harvest Augmentation	200,000
	Clackamas Hatchery Spring Chinook	Clackamas, Bonneville	Mitigation/ Harvest Augmentation	880,000
	Hood River Production	Moving Falls Fish Facility, Parkdale Fish Hatchery, Round Butte	Recovery/ Harvest Augmentation	250,000
	SAFE Spring Chinook Salmon	Clackamas, Minto, Marion Forks, South Santiam, Gnat Creek, Big Creek	Mitigation	3,450,000
Chum Salmon	Big Creek Hatchery Chum Salmon Recovery Program	Big Creek	Recovery	300,000
Winter Steelhead	Big Creek Hatchery Winter Steelhead	Big Creek, Klaskanine, Gnat Creek	Harvest Augmentation	140,000
	Clackamas River Winter Steelhead	Clackamas, Oak Springs, Bonneville	Harvest Augmentation	265,000
	Sandy River Winter Steelhead	Sandy, Oak Springs, Bonneville	Mitigation /Harvest Augmentation	160,000
Summer Steelhead	Clackamas River Summer Steelhead	Clackamas South Santiam, Bonneville	Harvest Augmentation	175,000
	Sandy River Summer Steelhead	Sandy, South Santiam, Bonneville, Oak Springs	Harvest Augmentation	75,000

Note: Data sourced from Hatchery Program Management Plans and Hatchery Genetic Management Plans for the respective Hatcheries. (https://www.dfw.state.or.us/fish/hatchery/)

4.4 Upper Willamette River Region

There are eight hatcheries in the Upper Willamette region that produce four stocks of spring Chinook Salmon and one stock of out-of-basin summer steelhead for the Upper Willamette River Region (Table 4-4). There are no native summer steelhead populations in the Upper Willamette DPS. Annual release targets include 4,229,750 spring Chinook Salmon smolts and 547,500 summer steelhead smolts. Program-specific smolt and pre-smolt release targets range from 547,500 to 1,900,000 individuals within this region. The Upper Willamette River region spring Chinook Salmon and summer steelhead hatchery programs are entirely for mitigation.

Table 4-4. Summary of Upper Willamette River region hatchery programs.

Species/Run	Program	Hatcheries	Program Purpose	Smolt/Pre-Smolt Release Target
Spring Chinook	McKenzie River Spring Chinook Salmon	McKenzie	Mitigation	604,750
	Middle Fork Willamette Spring Chinook Salmon	Willamette	Mitigation	1,900,000
	North Santiam River Spring Chinook Salmon	Marion Forks, Minto	Mitigation	704,000
	South Santiam River Spring Chinook Salmon	South Santiam, Willamette	Mitigation	1,021,000

Species/Run	Program	Hatcheries	Program Purpose	Smolt/Pre-Smolt Release Target
Summer Steelhead	Upper Willamette Summer Steelhead	Leaburg, Minto, Roaring River, South Santiam, Willamette	Mitigation	547,500

Note: Data sourced from Hatchery Program Management Plans and Hatchery Genetic Management Plans for the respective Hatcheries. (https://www.dfw.state.or.us/fish/hatchery/)

4.5 Rogue-South Coast Region

There are three hatcheries in the Rogue-South Coast region that produce one Coho Salmon stock, two stocks of fall Chinook Salmon, one spring Chinook Salmon stock, three winter steelhead stocks, and one summer steelhead stock (Table 4-5). Annual release targets include 290,000 fall Chinook Salmon smolts, 1,700,000 spring Chinook Salmon smolts, 100,000 Coho Salmon smolts, 313,000 winter steelhead smolts, and 220,000 summer steelhead smolts. Program-specific smolt and pre-smolt release targets range from 50,000 to 1,700,000 individuals within this region. Coho Salmon, spring Chinook Salmon, and summer steelhead programs within this region are entirely for mitigation. Fall Chinook Salmon hatchery programs are all harvest augmentation, and winter steelhead programs are all mitigation or harvest augmentation. The hatchery production in this region is dominated by mitigation programs, with five of the eight hatchery programs that are mitigation-based.

Table 4-5. Summary of Rogue-South Coast region hatchery programs.

Species/Run	Program	Hatcheries	Program Purpose	Smolt/Pre-Smolt Release Target
Coho Salmon	Cole Rivers Hatchery Coho Salmon	Cole Rivers	Mitigation	100,000
Fall Chinook	Indian Creek STEP Hatchery (Fall Chinook Salmon)	Indian Creek (STEP)	Harvest Augmentation	90,000
	Chetco River Fall Chinook Salmon	Elk River	Harvest Augmentation	200,000
Spring Chinook	Rogue River Spring Chinook Salmon	Cole Rivers	Mitigation	1,700,000
Winter Steelhead	Rogue River Winter Steelhead	Cole Rivers	Mitigation	132,000
	Cole Rivers Hatchery Winter Steelhead (Applegate River)	Cole Rivers	Mitigation	131,000
	Chetco Winter Steelhead	Elk River	Harvest Augmentation	50,000
Summer Steelhead	Cole Rivers Hatchery Summer Steelhead	Cole Rivers	Mitigation	220,000

Note: Data sourced from Hatchery Program Management Plans and Hatchery Genetic Management Plans for the respective Hatcheries. (https://www.dfw.state.or.us/fish/hatchery/)

4.6 Oregon Coast Region

There are 19 hatcheries that produce fish stocked into the Oregon Coast region including three stocks of Coho Salmon, eight fall Chinook Salmon stocks, three spring Chinook Salmon stocks, 10 winter steelhead

stocks, and three summer steelhead stocks (Table 4-6). Annual release targets include 3,263,000 fall Chinook smolts, 972,000 spring Chinook Salmon smolts, 1,125,000 winter steelhead smolts, 150,000 summer steelhead smolts, and 260,000 Coho Salmon smolts. Program-specific smolt and pre-smolt release targets range from 60,000 to 2,093,000 individuals within this region. Summer steelhead, winter steelhead, and spring Chinook Salmon hatchery programs within this region are all harvest augmentation program types. Coho Salmon hatchery programs are either mitigation or harvest augmentation. Fall Chinook Salmon hatchery programs are predominantly harvest augmentation with a single recovery program for the Coquille River. This is the only region where hatchery production is not dominated by mitigation with only one of 27 programs mitigation based.

Table 4-6. Summary of Oregon Coast region hatchery programs.

Species/Run	Program	Hatcheries	Program Purpose	Smolt/Pre-Smolt Release Target
Coho Salmon	Nehalem Hatchery Coho Salmon	Nehalem	Harvest Augmentation	100,000
	Trask Hatchery Coho Salmon	Trask	Harvest Augmentation	100,000
	Umpqua River Region Coho Salmon	Rock Creek (Cole Rivers)	Mitigation	60,000
Fall Chinook	Trask Hatchery Fall Chinook Salmon	Trask	Harvest Augmentation	150,000
	Cedar Creek Hatchery/Rhoades Pond Fall Chinook Salmon (Nestucca)	Cedar Creek, Rhoades Pond (STEP)	Harvest Augmentation	100,000
	Salmon River Fall Chinook Salmon	Salmon River	Harvest Augmentation	200,000
	Lower Umpqua River Region Fall Chinook Salmon	Rock Creek (Elk River), GRWB Facility (STEP)	Harvest Augmentation	170,000
	Coos River Fall Chinook Salmon	Bandon, Cole Rivers, Morgan Creek (STEP), Noble Creek (STEP), Millicoma Interpretive Center (STEP)	Harvest Augmentation	2,093,000
	Coquille River Fall Chinook Salmon	Bandon, Cole Rivers	Harvest Augmentation	175,000
	Coquille Fall Chinook Conservation Hatchery Program	Bandon, Elk River	Recovery	100,000
	Elk River Fall Chinook Salmon	Elk River	Harvest Augmentation	275,000
Spring Chinook	Trask River Hatchery Spring Chinook Salmon/Whiskey Creek Hatchery Spring Chinook Salmon	Trask, Whiskey Creek (STEP)	Harvest Augmentation	400,000
	Cedar Creek Hatchery Spring Chinook Salmon (Nestucca)	Cedar Cr	Harvest Augmentation	230,000
	Umpqua River Spring Chinook Salmon	Rock Cr (Cole Rivers)	Harvest Augmentation	342,000

Species/Run	Program	Hatcheries	Program Purpose	Smolt/Pre-Smolt Release Target
Winter Steelhead	Nehalem Hatchery Winter Steelhead	Nehalem	Harvest Augmentation	130,000
	Trask Hatchery Winter Steelhead	Trask	Harvest Augmentation	150,000
	Cedar Creek Hatchery Winter Steelhead Program (Nestucca)	Cedar Creek	Harvest Augmentation	140,000
	Siletz River Winter Steelhead	Alsea	Harvest Augmentation	50,000
	Alsea Hatchery Winter Steelhead	Alsea	Harvest Augmentation	140,000
	Siuslaw River Winter Steelhead	Alsea, Roaring River, Letz Creek (STEP)	Harvest Augmentation	100,000
	Umpqua River Winter Steelhead	Rock Creek (Cole Rivers)	Harvest Augmentation	150,000
	Tenmile Region Steelhead	Bandon, Cole Rivers	Harvest Augmentation	25,000
	Coos River Winter Steelhead	Bandon, Cole Rivers	Harvest Augmentation	125,000
	Coquille River Winter Steelhead	Bandon	Harvest Augmentation	115,000
Summer Steelhead	Cedar Creek Hatchery Summer Steelhead	Cedar Creek	Harvest Augmentation	100,000
	Siletz River Summer Steelhead	Cedar Creek, Roaring River	Harvest Augmentation	50,000
	Umpqua River Region Summer Steelhead	Rock Creek	Program terminated by Oregon Fish and Wildlife Commission in 2022	

Note: Data sourced from Hatchery Program Management Plans and Hatchery Genetic Management Plans for the respective Hatcheries. (https://www.dfw.state.or.us/fish/hatchery/)

4.7 Section Summary

The overwhelming majority of hatchery programs examined here (68) were harvest programs (i.e., mitigation, harvest augmentation, a combination of both or mitigation combined with a conservation component) (Table 4-7). Mitigation programs or combinations involving mitigation account for thirty-four programs. However, eight of these are combinations that include a conservation (I.e., recovery or supplementation) component. Mitigation programs make up nearly two-thirds or more of hatchery programs in four of six regions. The only exception is the Oregon Coast, where 24 of 26 active hatchery programs are harvest augmentation. Of the remaining two, one is mitigation (i.e., harvest) and the single conservation program is a recovery program for Coquille fall Chinook Salmon. Of all the hatchery programs examined, only four programs were solely conservation programs with two supplementation programs and two recovery/restoration programs. As noted above, other programs have a conservation component, but they were also combined with a harvest component. This clearly shows the predominance of harvest programs, specifically mitigation programs.

Table 4-7. Hatchery Programs by Program Type summarized across region.

Region	Number of Programs (#)	Mitigation Programs (#)	Harvest Augmentation Programs (#)	Conservation Programs (#)
Snake River	10	10	--	--
Middle Columbia	6	4	--	2
Lower Columbia	17	9	6	2
Upper Willamette	5	5	--	--
Rogue-South Coast	8	5	3	--
Oregon Coast	26	1	24	1

Considered by species and run-type, spring Chinook Salmon have the most programs at 19 with 11 classified as harvest, 1 conservation and 7 a combination. Fall Chinook Salmon rank next, with 17 programs split between 16 harvest and 1 conservation. All 16 winter steelhead programs are harvest (2 mitigation, 13 harvest augmentation, and 1 a combination of both). Summer steelhead's 10 programs are harvest (7), a combination (2), and conservation (1). There are 9 Coho Salmon programs, which are all harvest. Finally, Chum Salmon has a single conservation-oriented recovery program in the Lower Columbia ESU.

Figure 4-1 displays the number of hatchery programs by species and run type for the six regions considered in this report. The Oregon Coast region has the most hatchery programs followed by the lower Columbia and Snake River regions. Figure 4-2 displays the total number of salmon or steelhead released by program type for the same six regions. The Lower Columbia region releases by far the largest number of fish despite having far fewer programs than the Oregon Coast region. As noted above, in all regions except the Oregon Coast, production for mitigation programs is a far greater proportion than any other program type. In the Oregon Coast region, production is dominated by harvest augmentation.

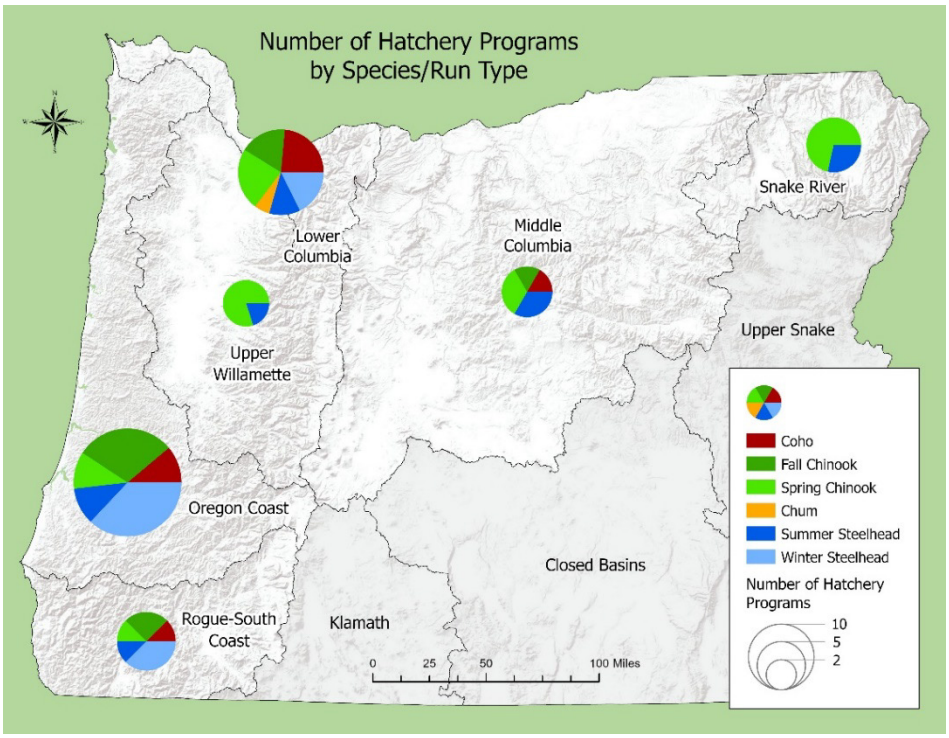


Figure 4-1. Number of hatchery programs by species and run-type.

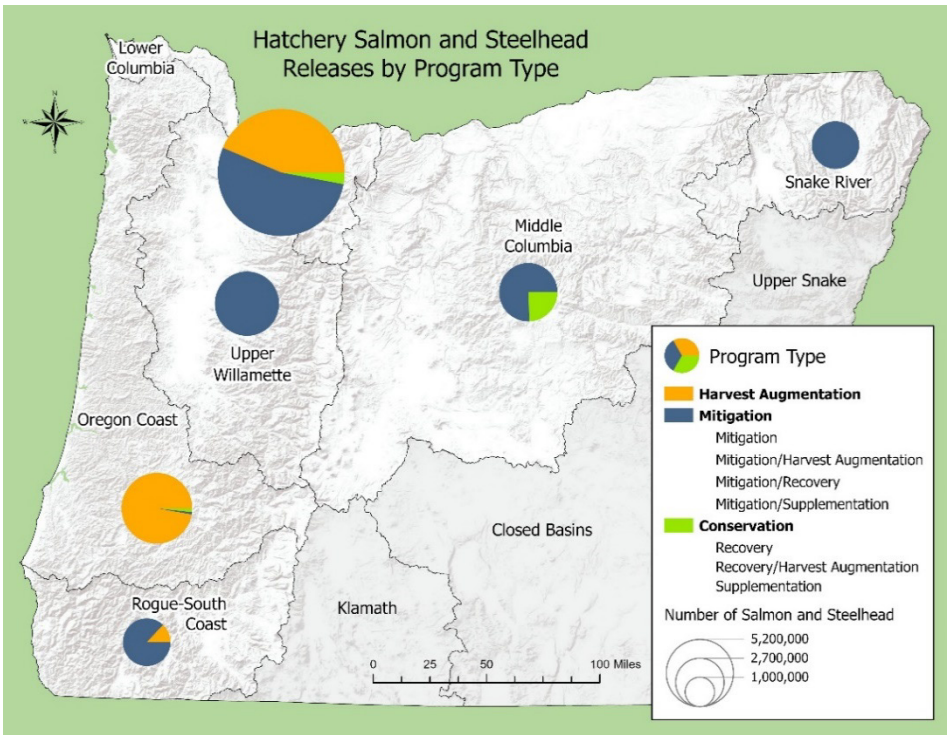


Figure 4-2. Hatchery salmon and steelhead releases (number of fish) by program type.

5 Angler Licenses, Tags, Endorsement Sales, and Harvest

5.1 Angler Licenses

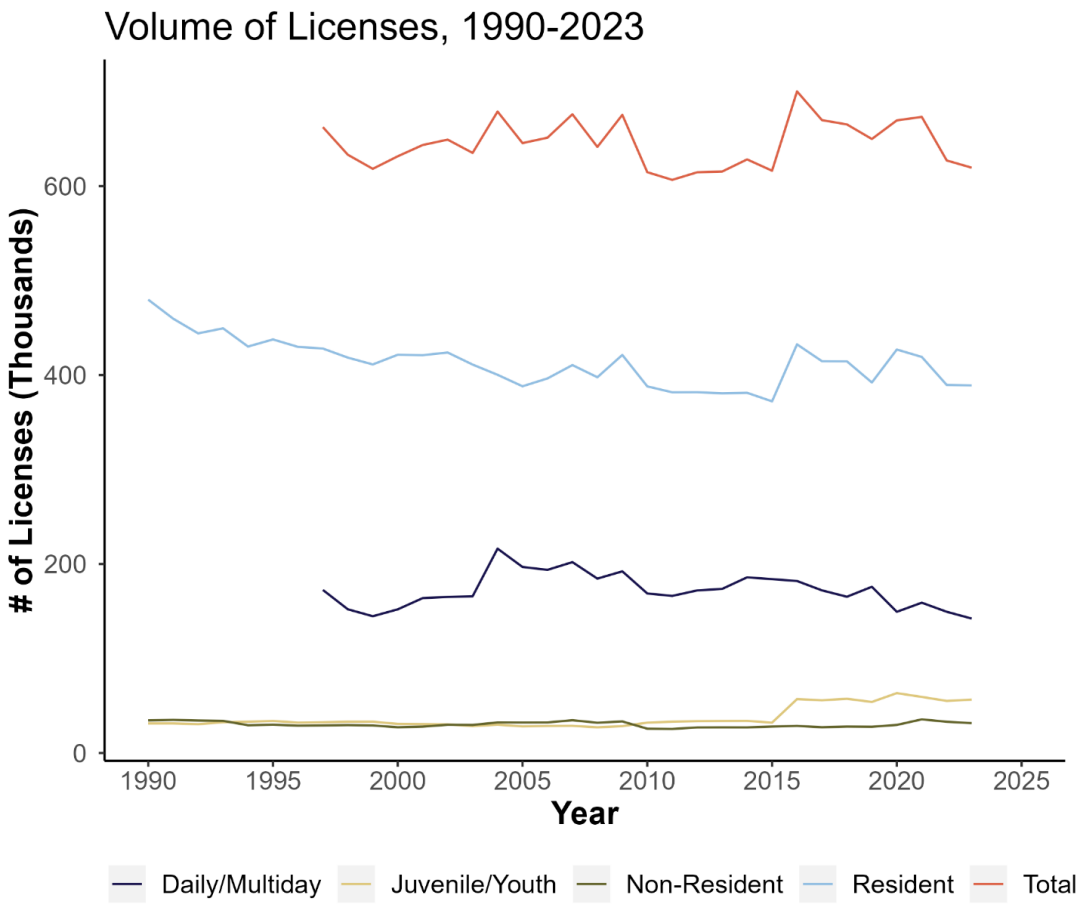
Angler engagement and interest is an important component of fisheries management and should inform decisions on future hatchery need and production. The volume of angler licenses and tags sold can be used as a proxy to 1) gauge the popularity of Oregon fisheries in general, 2) to determine the approximate number of recreational fishery resource users, and 3) to examine trends in fisheries use over time. Using the annual number of licenses sold, we assessed the general trends in angler use (Figure 5-1). License sales provided a longer and more consistent time-series than other fishing-related products sold by the state, such as endorsements and tags, and provided a better overall view of general angler trends.

Resident angling licenses have experienced a statistically significant decrease ($p << 0.001$; $R^2 = 0.42$) since 1990. However, this decrease primarily occurred in the 1990s and license sales have experience interannual variation, but have been relatively stable since about 1997. Non-resident license sales have stayed relatively consistent since 1997 ($p = 0.14$) though there has been a slight increase in the last 2 to 3 years which, if continued, could become a significant trend in the future.

Juvenile/youth license sales have experienced a statistically significant increase ($p << 0.001$; $R^2 = 0.50$)) driven primarily by a sharp increase in 2016, which has since visually appeared to level out. This was due to the elimination of the Juvenile Resident and Juvenile Non-Resident Angling License and the implementation of a single Youth License, which covers both hunting and fishing. It is unknown how many youth may be purchasing the license for fishing only, hunting only, or both.

Sales of daily/multiday licenses fluctuated year-to-year but displayed no upward or downward trend ($p = 0.45$) across the entire time-series. Daily/multiday sales were enumerated using a different method prior to 1997 that, when combined with current methods, artificially inflated the estimate of the total number of licenses sold prior to 1997 and, thus, were not included in the analysis. Total license sales were therefore not calculated or shown prior to 1997 to ensure that total number were based on the same set of licenses. If Daily/Multiday license sales were included prior to 1996, it produced the erroneous appearance of a large increase in license sales from 1996 to 1997. Therefore, the total number of licenses (annual and daily/multiday) in Figure 5-1 prior to 1996 is conservative because of exclusion of the Daily/Multiday license during the 1990 to 1996 period.

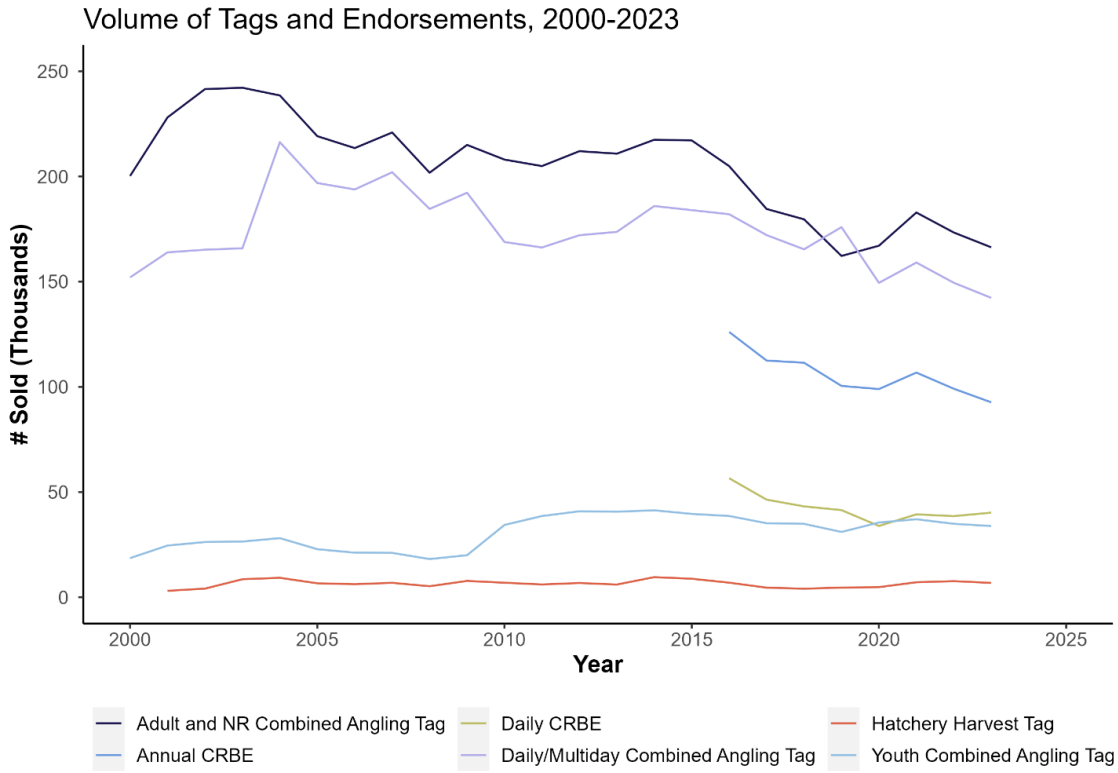
Total licenses from 1997 to present show no significant trend upward or downward ($p = 0.72$). However, this could be an artifact of the inability to include pre-1997 data in the total. Given that resident licenses make up the largest portion of total license sales, it is likely that downward trends in resident licenses would manifest in total license sales if the entire period of record since 1990 could be analyzed. The significant but numerically much smaller increase in Youth licenses seems unlikely to counteract the downward trend in resident licenses. This suggests that overall angler interest and engagement, analyzed using angling license sales as a proxy, experienced a downward shift through the late 1990s and stabilized after. This may represent a stable but lower level of demand for general angling opportunity that seems likely to continue into the future.



Note: Daily/Multiday licenses prior to 1996 are not included.

Figure 5-1. Volume of licenses sold from 1990 to 2023.

The volume of tags and endorsements from 2000 to present were assessed to evaluate trends in Columbia River Region fishing (Columbia Region River Endorsement; CRBE), fishing for steelhead or salmon generally for residents and non-residents (Combined Angling Tag), and hatchery harvest (Hatchery Harvest Tag) (Figure 5-2). Although a combined angling tag is included with SportsPac, daily and multi-day angling licenses, there is no way to know how many of these anglers are targeting salmon and steelhead. The CRBE endorsement and non-resident Combined Angling Tag were implemented in 2016 and are therefore only presented from 2016 to present. Rogue-South Coast Steelhead Validation and Rogue-South Coast Wild Steelhead Harvest Tag are not included; 2023 was the first year that they were required for angling for steelhead in that area and no meaningful analysis would be possible on a single year of data. However, they represent an interesting future data source as they will be the only tag/endorsement that indicates at least the intent (i.e., angler interest) to fish a specific ESU/SMU/DPS. The CRBE can likewise be seen as indicating at least intent to fish the Lower Columbia, Upper Willamette, Mid-Columbia, or Snake River ESU/SMU/DPSs. However, it is not species-specific nor restricted to a single ESU/SMU/DPS so is more likely a general proxy for interest in salmon and steelhead fishing.



Notes: Tags included are hatchery harvest tag and the combined angling tag for residents, non-residents, and youth. Only Columbia River Region endorsements (CRBE) were considered at the time of this report. Combined angling tags for Adults and Youth offered through the SportsPac license are included in totals.

Figure 5-2. Volume of tags and endorsements sold from 2000 to 2023.

In general, there is a noticeable decreasing trend in anglers purchasing tags and endorsements. Initially, there were increases on an annual basis from 2000 to 2003. However, this trend reversed starting in 2004 and has steadily declined since. The Adult Combined Angling Tag showed the most significant decrease in overall sales ($p << 0.001$; $R^2 = 0.66$) and the Daily/Multi-day Combined Angling Tags also showed a marginally significant decrease in sales ($p = 0.05$; $R^2 = 0.12$), though this trend would likely be more highly significant if not for relatively low sales in the early 2000s. Prior to 2016, the Combined Angling Tag was not split based on residency. In order to keep comparisons and trends consistent across the time-series, resident and non-resident Adult Combined Angling Tags are presented as a single line in the figure. The Youth Combined Angling Tag shows an increase in sales ($p <<0.001$; $R^2 = 0.43$), though this is primarily driven by the creation of the Youth SportsPac in 2010. Both daily ($p < 0.05$; $R^2 = 0.48$) and annual ($p < 0.01$; R2 = 0.73) CRBE sales have also declined significantly since their implementation in 2016. Hatchery Harvest tag sales are the only tag or endorsement that has stayed relatively stable since 2000 ($p = 0.93$). The similar observed trends across tags/endorsements are not unexpected since combinations of multiple tags are often required to fish a given location and species combination (e.g., Combined Angling Tag and CRBE).

Hatchery Harvest Tags have the lowest sales relative to the other tags and endorsements. This is likely because a Hatchery Harvest Tag is not required, and hatchery harvest information may be placed onto

the Combined Angling Tag. Hatchery Harvest Tags can be used to record harvest of hatchery-origin fish only in lieu of placing them on a Combined Angling Tag. If a Hatchery Harvest Tag is purchased, or not, a Combined Angling Tag is still required when fishing for steelhead or salmon, which likely is a stronger proxy for angler engagement in salmon and steelhead fishing.

Most angling licenses have shown a stable trend recently despite decreases in the 1990s. However, most tags and endorsements have steadily declined across the last 10 to 25 years depending on when they were implemented. This decline is most pronounced for adult tag sales and there appears to be a gap opening between angling license sales, salmon and steelhead tags, and endorsements. This suggests that anglers may be shifting from salmon and steelhead to other types of fisheries. Which fisheries these anglers are shifting to and what their motivations are is an interesting set of questions beyond the scope of the current study.

While license sales have been relatively stable since a decline through the 1990s, tag and endorsement sales have declined over the same period. This seems to indicate slightly declining or stable but variable demand for general angling opportunity and a reduced demand for salmon and steelhead angling opportunity that seems likely to continue into the future.

5.2 Harvest

Harvest can be used as a measure of the importance of hatchery-origin fish to the maintenance of fisheries for specific species within ESUs. The larger a proportion of the harvest that is made up of hatchery fish, the more important hatchery production may be to that fishery. Therefore, fisheries with high proportions of hatchery origin fish may need continuing, and perhaps increased, hatchery production, while fisheries with low proportions are generally less dependent on hatchery production to support angler demand.

Mark-selective fisheries impact the proportion of hatchery fish in the harvest. If unmarked fish cannot be retained at all, or only at certain times of year and/or locations, this affects hatchery-origin harvest as a proportion of the total harvest. However, mark-selective fisheries are usually implemented where too few natural-origin fish return to provide a viable fishery or where hatchery fish are providing harvest opportunity and “protecting” threatened natural-origin populations. Therefore, in mark-selective situations the total number of fish is likely the most important indicator of hatchery production’s importance to the fishery.

Harvest numbers also cannot capture the importance or impact of catch-and-release fisheries or angling. Certain locations may have catch-and-release fisheries at certain times of the year that are popular with anglers. However, generally catch-and-release fisheries target natural-origin populations, which are not supported by hatchery production. Therefore, the impact of catch-and-release fisheries on the populations of interest to this study remains unclear.

Harvest data examined here was reported through ODFW’s Electronic Licensing System (ELS). This system provides anglers with the ability to report date, location, and species/run-type in real-time via a smartphone application. This reporting is mandatory for anglers who select the ELS, and all salmon or steelhead harvested must be immediately reported via the app. However, it is important to note that anglers are not required to report unless they harvest a fish, so catch-and-release angling and/or angling effort with no harvest will not be represented. Also, since the data are self-reported by anglers, there

may be some reporting error in location, species/run-type and/or hatchery versus natural-origin. This will result in certain mark-selective/hatchery-only fisheries reporting a proportion of hatchery harvest slightly less than 100%. For the purposes of this study, this reporting error has negligible influence. Over-reporting is unlikely as anglers are only allotted a certain number of fish on their tags after which they must purchase another. Finally, in some fisheries, hatchery fish with no adipose fin clip or other distinguishing mark may be present. These fish would not be reported as hatchery origin fish in ELS, which introduce some certainty into the analysis.

The ELS data reported here does not include paper harvest cards still available and in-use by a majority of Oregon anglers. Therefore, ELS numbers reported here are useful for evaluating the proportion of hatchery fish in the harvest and the scale of harvest in a given area, but do not represent total harvest.

The ELS data are summarized as total harvest over the 5 years from 2019 to 2023 by species within region. The proportion of harvest over the same time period made up of hatchery-origin fish is used as a measure of hatchery-origin fish importance and impact in this assessment except in mark-selective fisheries as discussed above. Since this is a rate and not an absolute number, unless it is believed the angling behavior (i.e., location, catch rate, reporting rate, mis-identification rate, etc.) of anglers choosing ELS reporting is significantly different to those choosing paper harvest cards, these numbers should represent a reasonable approximation of hatchery importance and impact on specific species, run-types, and ESU/SMUs.

5.2.1 Snake River Region

Figure 5-3 shows total harvest for all species and run types for the Snake River region. Summer steelhead represents the largest part of the harvest within the ESU with nominal harvest of Coho Salmon and spring and fall Chinook Salmon. No winter steelhead harvest was reported. Almost the entire reported harvest of summer Steelhead (99%) consisted of hatchery-origin fish. Hatchery origin fish make up a substantial percentage of Coho Salmon (83%), fall Chinook Salmon (62%), and spring Chinook Salmon (91%) harvested, as well.

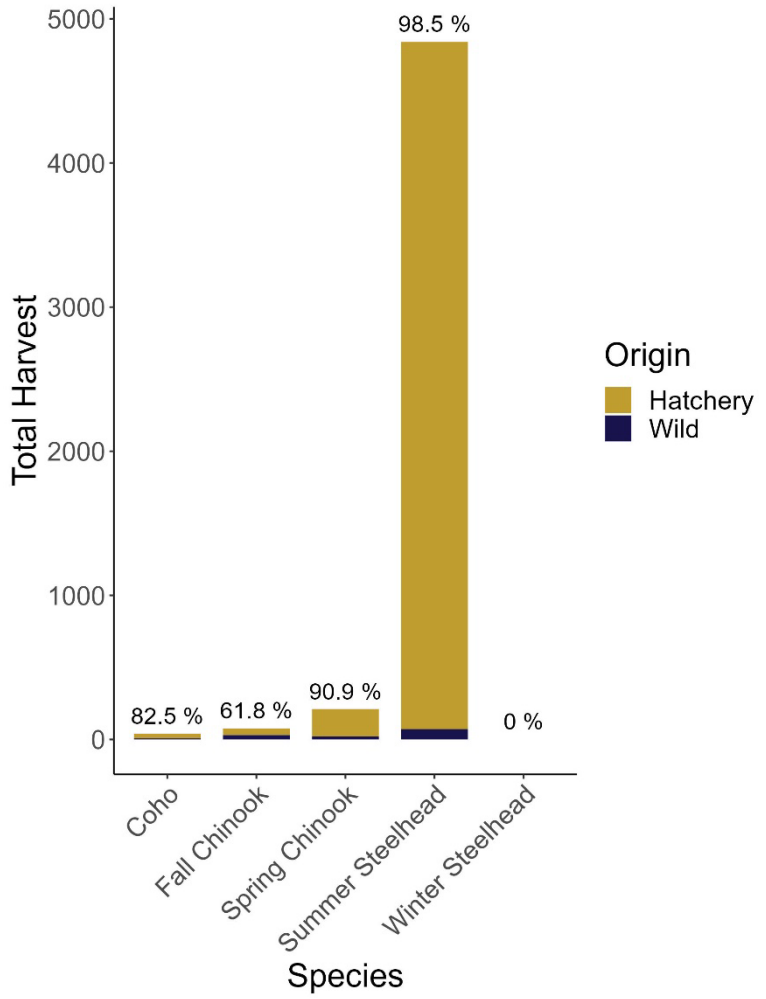


Figure 5-3. Total harvest with the proportion of hatchery-origin fish within the total harvest as reported in the ELS for species and run type within the Snake River region, 2019 to 2023.

5.2.2 Middle Columbia Region

Figure 5-4 shows total harvest for all species and run types for the Middle Columbia region. These totals include upriver fish stocks that are not returning to rivers in this region. Fall Chinook Salmon comprise the largest portion of the reported harvest with Coho Salmon, summer steelhead, and spring Chinook Salmon following in descending order. No winter steelhead were reported harvested. Hatchery-origin fish make up almost the entire reported harvest of spring Chinook Salmon (98%) and summer steelhead (98%), while hatchery-origin fish make up a large majority of Coho Salmon reported harvest (70%) and a third of fall Chinook Salmon reported harvest (33%).

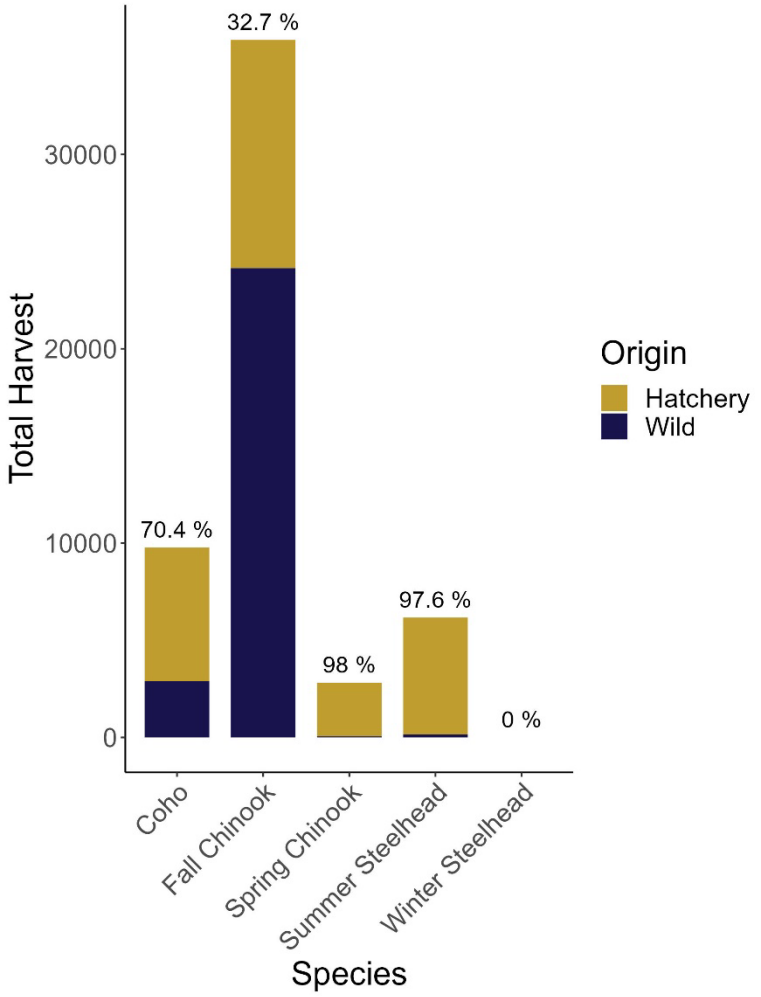


Figure 5-4. Total harvest as reported in the ELS for species and run type within the Middle Columbia region, 2019 to 2023.

5.2.3 Lower Columbia Region

Figure 5-5 shows total harvest for all species and run-types for the Lower Columbia region. These totals include upriver fish stocks that are not returning to rivers in this region. Fall Chinook Salmon comprise the largest portion of the total reported harvest with Coho Salmon, summer steelhead, and spring Chinook Salmon following in descending order. Hatchery-origin fish constitute nearly the entire harvest of summer steelhead (97%), winter steelhead (98%), Coho Salmon (98%), and spring Chinook Salmon (95%). Hatchery origin fish make up most of the fall Chinook Salmon reported harvest (53%).

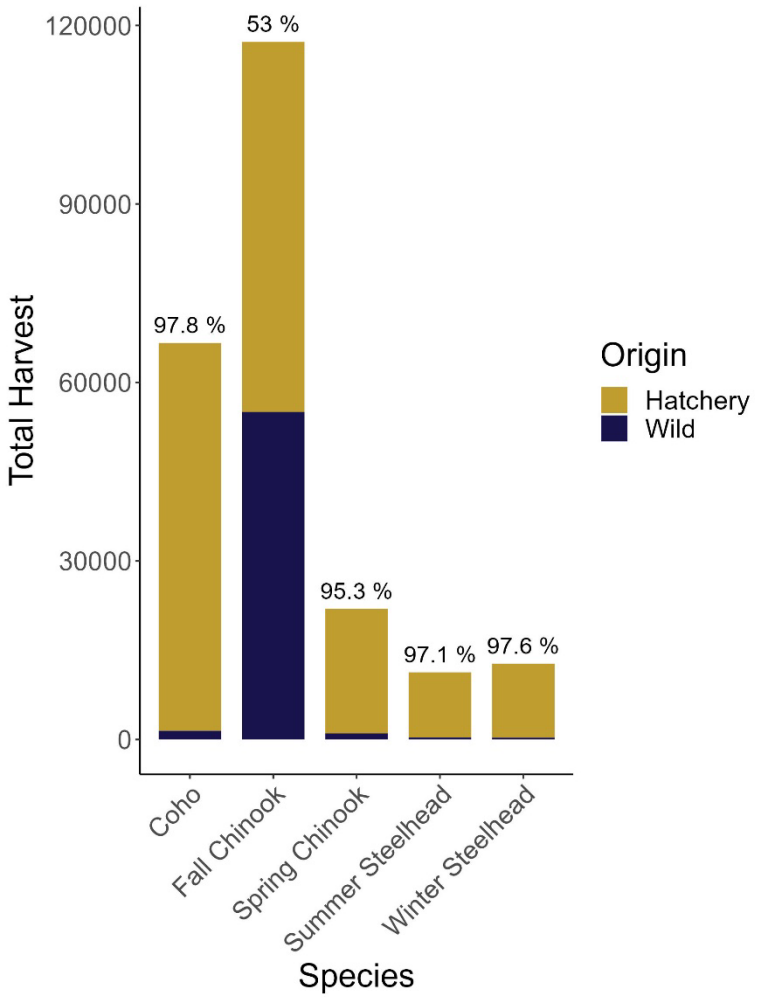


Figure 5-5. Total harvest as reported in the ELS for species and run type within the Lower Columbia region, 2019 to 2023.

5.2.4 Upper Willamette Region

Figure 5-6 shows total harvest for all species and run types for the Upper Willamette region. Spring Chinook Salmon comprise the largest portion of the total reported harvest with Coho Salmon and summer steelhead, making up most of the remainder. There are also nominal numbers of fall Chinook Salmon and winter steelhead reported harvested. Hatchery-origin fish make up nearly the entire total reported harvest for spring Chinook Salmon (98%), summer steelhead (95%), and winter steelhead (96%). Hatchery-origin fish make up a smaller proportion of fall Chinook Salmon reported harvest (33%) and a negligible portion of the Coho Salmon harvest (7%).

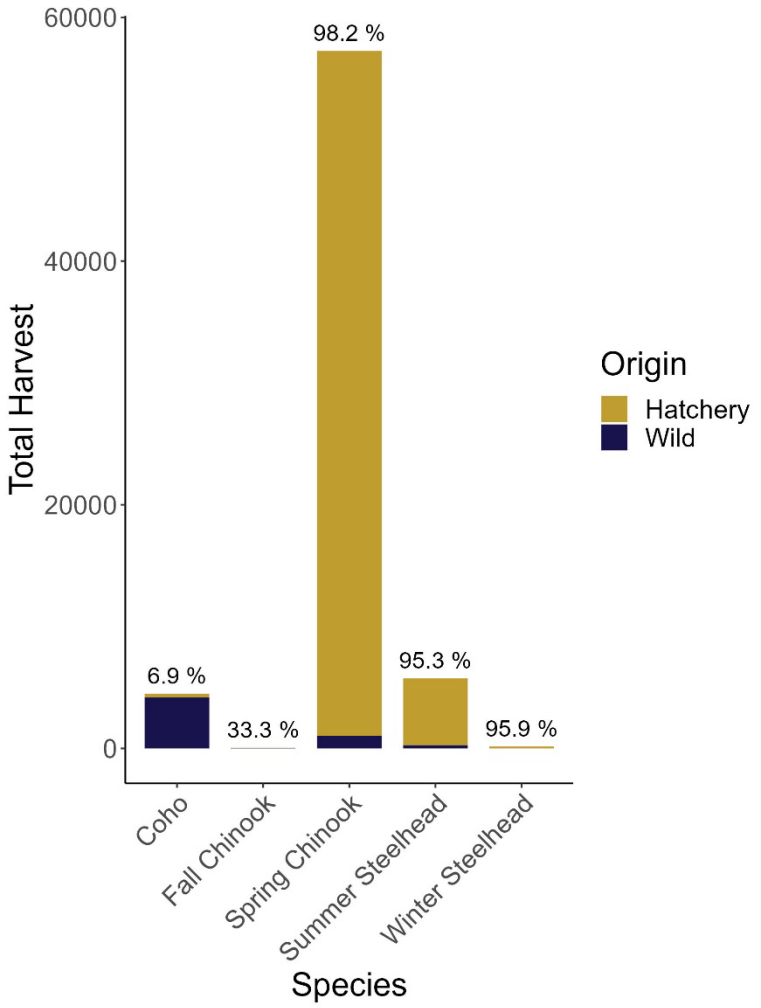


Figure 5-6. Total harvest as reported in the ELS for species and run type within the Upper Willamette region, 2019 to 2023.

5.2.5 Rogue-South Coast Region

Figure 5-7 shows total harvest for all species and run types for the Rogue-South Coast region. Fall Chinook Salmon, spring Chinook Salmon, summer steelhead, and winter steelhead all made up substantial portions of the total reported harvest for this SMU. Coho Salmon made up a much smaller portion of the total reported harvest. Hatchery-origin fish made up nearly the entire reported harvest for summer steelhead (94%) and a large majority of the reported harvest for Coho Salmon (92%) and spring Chinook Salmon (80%). Hatchery-origin fish made up most of the reported harvest for winter steelhead (59%), but only a negligible portion of the fall Chinook Salmon reported harvest (10%).

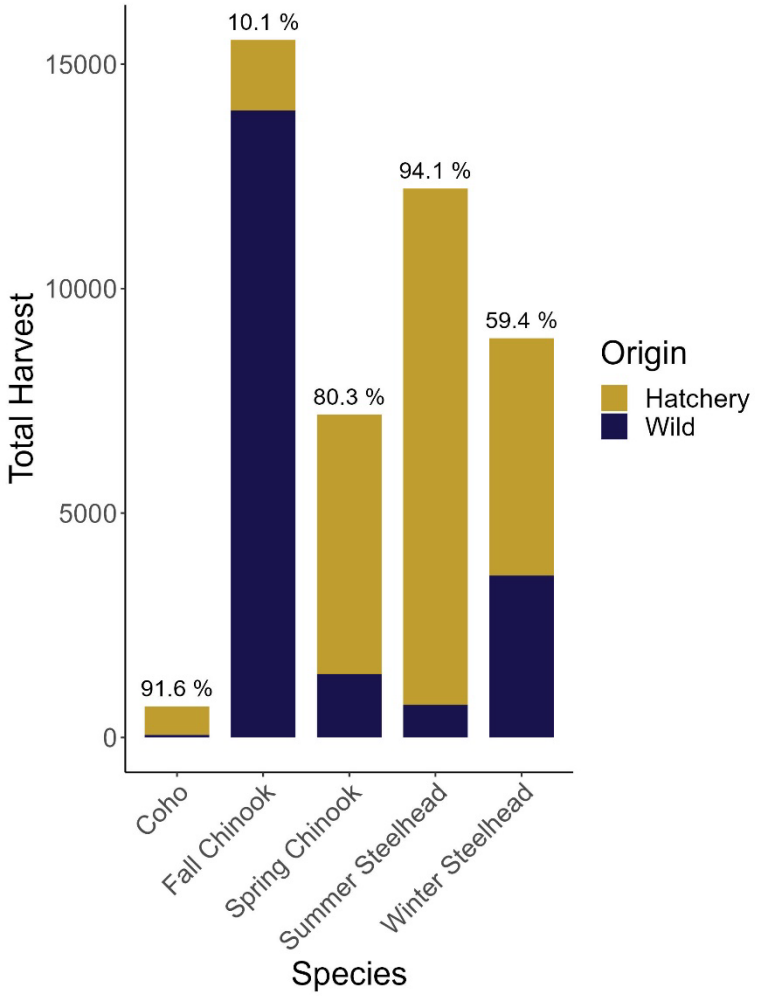


Figure 5-7. Total harvest as reported in the ELS for species and run type within the Rogue-South Coast region, 2019 to 2023.

5.2.6 Oregon Coast Region

Figure 5-8 shows total harvest for all species and run types for the Oregon Coast region. Fall Chinook Salmon and winter steelhead made up the majority of total reported harvest with Coho Salmon and spring Chinook Salmon making up most of the rest. Summer steelhead constituted a substantially smaller portion of the total reported harvest. Hatchery-origin fish made up nearly the entire reported harvest for winter steelhead (97%) and summer steelhead (97%). Hatchery-origin fish made up a large majority of the reported harvest for spring Chinook Salmon (72%), but only a quarter of fall Chinook (24%) and Coho Salmon (25%) reported harvest.

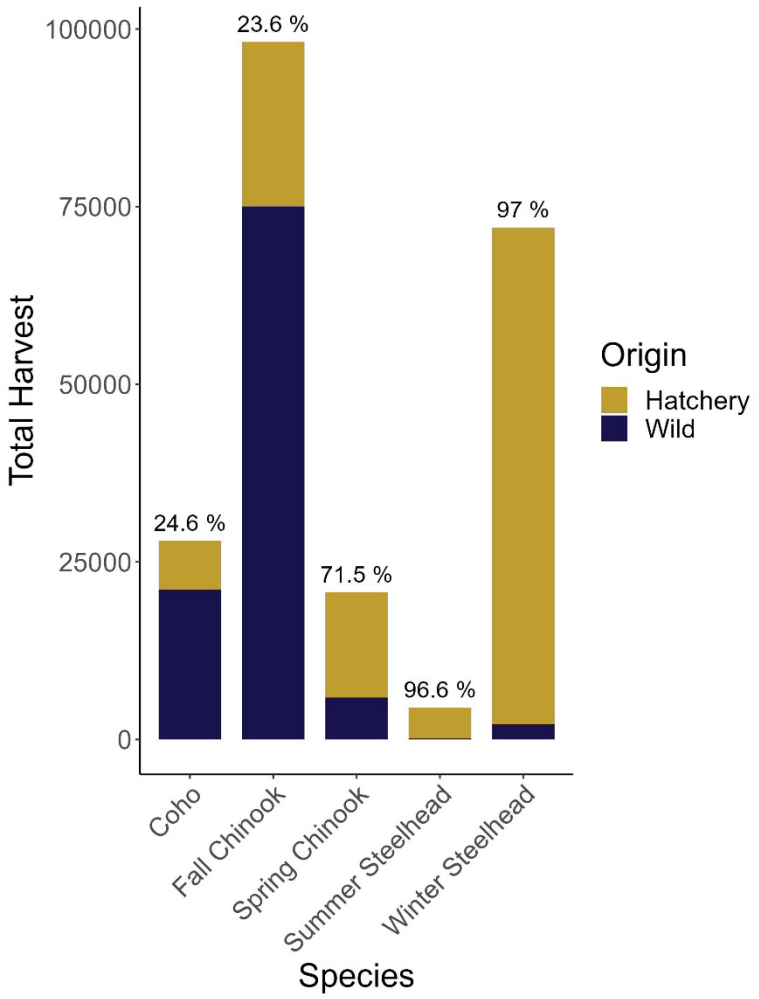


Figure 5-8. Total harvest as reported in the ELS for species and run type within the Oregon Coast region, 2019 to 2023.

5.2.7 Ocean Coho Salmon Harvest

The ocean Coho Salmon fishery is an important fishery for this species constituting nearly five times the total harvest (~326,000 fish) of the next largest fishery (Lower Columbia region). Hatchery origin Coho Salmon make up the majority (80%) of Coho Salmon harvest reported for the ocean fishery.

5.3 Section Summary

Resident angling license sales, the bulk of the license sales in the state, have been relatively stable since a decline through the 1990s. This seems to indicate recently stable but annually variable future demand for general angling opportunity in Oregon. However, purchases of salmon and steelhead tags and endorsements have steadily declined across a comparable period. This decline could be caused by a number of factors including generational shifts in recreational preferences, individual angler shifts in preference, or real or perceived decline in opportunity for salmon and steelhead harvest, which are beyond the scope of this assessment. Also, it is not possible to determine if this reflects a shift into warmwater (e.g., bass, panfish, walleye) or trout fisheries. Trout fisheries, including those supported by hatchery trout releases, will be an important part of the future of Oregon fisheries but were beyond the scope of this report. Depending on what is driving the decrease in tags and endorsement sales, it does

indicate the potential for lower demand and support for hatchery-supported salmon and steelhead fisheries in the future.

This lower level of demand and support since the late 1990s is likely to affect all fisheries but not necessarily in the same way or to the same degree across all fisheries. Currently available license, tag, and endorsement data lack sufficient spatial resolution to indicate anything about the popularity or importance of specific fisheries. Considering how to obtain additional metrics of the importance and popularity of specific fisheries and the importance of hatchery origin fish to those fisheries would be valuable. As mentioned in Section 5.1, the Rogue-South Coast Steelhead Validation represents an interesting opportunity to collect such information while also contributing financial support to an SMU-specific species.

Coho Salmon made up the largest reported harvest from 2019 to 2023 (~435,000 fish over all 5 years combined) of all species and run types across the state, with most of the reported harvest coming from the ocean fishery. Chinook Salmon (~402,000 over all 5 years combined) are a close second with most of that total reported harvest represented by fall Chinook Salmon (~267,000 over all 5 years combined from estuary and freshwater only). Steelhead are the smallest proportion of total harvest (~124,000 over all 5 years combined) with the winter run-type making up the large majority (~94,000 over all 5 years combined).

A large majority of total reported harvest for most fisheries is made up of hatchery-origin fish. Hatchery origin fish made up the largest proportion of the steelhead reported harvest (94%) with a proportion of hatchery-origin harvest greater than 95% in all steelhead ESU/SMU/DPSs, with the exception of the Rogue-South Coast region winter steelhead fishery (59%). Likewise, hatchery-origin fish made up the large majority (78%) of the Coho Salmon fishery, although that proportion has been on a consistent year-over-year decline from 2019 (90%), to 2021 (86%), and to 2023 (57%). This may be due to strong runs of wild Coho Salmon in recent years. However, the causes of this decline in hatchery proportion are beyond the scope of this report. Hatchery-origin fish make up a slight majority (52%) of total reported harvest for Chinook Salmon across both run-types. However, most spring Chinook ESU/SMUs still have greater than 70% proportion hatchery-origin reported harvest with fall Chinook Salmon proportions all less than ~60%. Overall statewide, hatchery-origin salmon and steelhead make up 70% of reported ELS harvest, demonstrating the importance of hatcheries in sustaining popular individual fisheries and angling throughout the state.

While species within each ESU/SMU vary greatly in harvest numbers, that does not discount the importance or significance of any given population. Harvest numbers also do not consider the number of people participating in catch and release angling. To sustain angler utilization of fishery resources, region and species-specific angler metrics are a valuable source of information when guiding and identifying the recreational importance of hatchery programs.

6 Assessment and Conclusions

Future need will be driven by multiple factors including wild fish conservation status, climate vulnerability, ongoing habitat impacts requiring mitigation and angling opportunity demand. If, for example, wild fish vulnerability is high and climate vulnerability is high, that may indicate a higher need for conservation measures to include hatchery supplementation. Assessment of future hatchery need considered specific components from the previous four sections that represented vulnerability, status, and need. The preceding four sections were used to assess biological vulnerability (Section 2), climate vulnerability (Section 3), current hatchery status (Section 4), and angler trends/need (Section 5). These criteria were used to inform an assessment of future hatchery need by region and ESU/SMU/DPS.

6.1 Assessment Methods

Biological vulnerability for each ESU/SMU/DPS was determined based on federal and state listing status and climate exposure and sensitivity risk. These two metrics were selected to evaluate biological and climate vulnerability because they were available for most populations and were representative at a broad enough scale to identify needs at the ESU/SMU/DPS scale.

Federal and state listing scores were assigned a score from 1 to 5 according to a pre-defined rule set (Table 6-1). In cases where a federal and state listing were not consistent (e.g., federal = Threatened but state = Sensitive Critical), the higher of the two scores was assigned. In cases where multiple ESU/SMU/DPSs were combined within a region and the ESU/SMU/DPSs had different listings, the higher of the two scores was also assigned. This was appropriate to ensure biological vulnerability reflected the highest possible need rather than risk understating vulnerability.

Table 6-1. Federal/state listing scoring criteria for biological vulnerability assessment.

Federal Listing	State Listing	Federal/State Listing Score	Federal/State Listing Category
None	None	1	Very Low
None	Sensitive	2	Low
None	Sensitive Critical	3	Moderate
Threatened	Threatened	4	High
Endangered	Endangered	5	Very High

Climate exposure and sensitivity scores were also assigned a score from 1 to 5 (Table 6-2). These were based primarily on climate exposure and sensitivity categories assigned in Crozier et al. 2019. However, in cases where Crozier et al. did not assign a category, alternative comparable sources (e.g., Wade et al. 2013) were used. In situations where no source could be found to assign categories, a species with similar run timing and life history may have been used to approximate an exposure and sensitivity score (e.g., Oregon Coast Coho used for Oregon Coast Chinook).

Table 6-2. Climate exposure and sensitivity scoring criteria used for biological vulnerability assessment.

Climate Exposure and Sensitivity Category	Climate Vulnerability Score
Very Low	1
Low	2
Moderate	3

Climate Exposure and Sensitivity Category	Climate Vulnerability Score
High	4
Very High	5

Values for federal/state listing category and climate vulnerability were then averaged to create an overall Biological Vulnerability score.

Table 6-3 displays status and vulnerability metrics for federal/state listing categories and climate vulnerability and the vulnerability scores generated by applying the criteria presented in Table 6-1 and Table 6-2 above. Then it displays their average to calculate an overall Biological Vulnerability Score and assigns that score a categorical ranking (e.g., very low, low, moderate) for overall biological vulnerability.

To assess future need for hatchery programs, all ESU/SMU/DPSs were evaluated in each of three categories (mitigation, harvest augmentation, and conservation) according to a set of decision rules established for each category. Future needs for a given ESU/SMU/DPS may differ between categories. For instance, an ESU/SMU/DPS may have “no” future need for mitigation hatchery programs as there is no dam requiring mitigation in that ESU/SMU/DPS. However, it may be “increasing” in future need for conservation hatchery programs due to high biological vulnerability and no current conservation hatchery programs.

For mitigation hatchery programs, as long as the associated dams or other impacts to fish habitat continue to exist, there will be a future need for mitigation hatchery programs. Therefore, ESU/SMU/DPSs with existing mitigation needs were classified as having future need (i.e., “yes”) for mitigation hatchery programs and those without have been identified as having no future need (i.e., “no”) for mitigation hatchery programs.

For harvest augmentation hatchery programs, we considered biological vulnerability, existing mitigation hatchery programs, existing harvest augmentation programs, and climate vulnerability. If an ESU/SMU/DPS had an existing harvest augmentation hatchery program, that ESU/SMU/DPS was classified as having an ongoing future need (i.e., “yes”). For these ESU/SMU/DPSs, we did not evaluate whether the need was likely to increase or decrease due to uncertainty about future trends in angler demand. If an ESU/SMU/DPS did not have an existing harvest augmentation program but had an existing mitigation program, that ESU/SMU/DPS was not rated (i.e., “--") because future needs potentially could be addressed by mitigation hatchery programs. If an ESU/SMU/DPS did not have existing mitigation or harvest augmentation program and had a climate vulnerability of greater than low, it was classified as having “increasing” need for a harvest augmentation hatchery program. Note that this instance did not occur in practice.

For conservation hatchery programs, the biological vulnerability score, as calculated above, was used to determine the future need. This seemed most appropriate since conservation hatchery programs are intended to recover and or support an ESU/SMU/DPS independent of mitigation or harvest needs. Therefore, the primary drivers of future need for conservation hatcheries would be the population status as reflected in the federal/state listing status and vulnerability to future climate impacts as reflected in climate vulnerability and exposure. If an ESU/SMU/DPS had an existing conservation hatchery program, that ESU/SMU/DPS was classified as having an ongoing future need (i.e., “yes”). If an

ESU/SMU/DPS did not have an existing conservation hatchery program, but had a biological vulnerability greater than low, that ESU/SMU/DPS was classified as having an “increasing” future need.

Table 6-3. Summary table of ESU/SMU/DPS Biological Vulnerability.

ESU/SMU/DPS	Species	Biological Vulnerability						
		Federal Listing Status	State Listing Status	Listing Score	Climate Exposure & Sensitivity	Climate Vulnerability Score	Biological Vulnerability Score	Biological Vulnerability Status
Snake River	Fall Chinook	T	T	4	High	4	4	High
	Spring/Summer Chinook	T	T	4	Very High	5	4.5	High to Very High
	Steelhead	T	S	4	High	4	4	High
Middle Columbia	Coho			1	NA		1	*Insufficient Data*
	Fall Chinook		S	2	NA		2	*Insufficient Data*
	Spring Chinook		S	2	High	4	3	Moderate
	Steelhead	T	SC	4	High	4	4	High
Lower Columbia	Coho	T	E	5	High	4	4.5	High to Very High
	Fall Chinook	T	SC	4	Mod	3	3.5	Moderate to High
	Spring Chinook	T	SC	4	Mod	3	3.5	Moderate to High
	Chum	T	SC	4	Mod	3	3.5	Moderate to High
	Winter Steelhead	T	SC	4	Mod	3	3.5	Moderate to High
	Summer Steelhead	T	S	4	Mod	3	3.5	Moderate to High
Upper Willamette	Spring Chinook	T	SC	4	Very High	5	4.5	High to Very High
	Steelhead	T	S	4	High	4	4	High
Rogue-South Coast	Coho	T	S/SC	4	High	4	4	High
	Fall Chinook			1	NA		1	*Insufficient Data*
	Spring Chinook		S	2	NA		2	*Insufficient Data*
	Winter Steelhead			1	Low	2	1.5	Very Low to Low
	Summer Steelhead		S	2	Mod	3	2.5	Low to Moderate
Oregon Coast	Coho	T	S	4	High	4	4	High
	Fall Chinook			1	High	4	2.5	Low to Moderate
	Spring Chinook		S	2	High	4	3	Moderate
	Chum		SC	3	NA		3	*Insufficient Data*
	Winter Steelhead			1	High	4	2.5	Low
	Summer Steelhead		S	2	High	4	3	Moderate

6.2 Assessment Results and Discussion

6.2.1 Mitigation Programs

Mitigation hatchery programs exist to mitigate the impacts to fish habitat from the construction and operation of dams and other human developments. These programs are important to supporting non-tribal (i.e., recreational and commercial) and tribal (i.e., commercial and subsistence) fisheries. Some mitigation programs (about seven) operate in combination with all three other types of hatchery programs (i.e., harvest augmentation, recovery, and supplementation).

A large percentage, if not all, of the hatchery programs supporting ESU/SMU/DPSs in the Lower Columbia, Middle Columbia, Upper Willamette, Snake River, and Rogue-South Coast, as well as Oregon Coast Coho Salmon, are either solely mitigation or partially mitigation programs (Table 6-4). These hatchery programs provide mitigation for dams, including those on the mainstem Columbia River and Snake River, in the Willamette and Rogue basins, and elsewhere in the state. As long as these dams continue to exist, there will be a high future need for these mitigation hatchery programs to mitigate their impacts to fish habitat. This classification applies only to mitigation programs. ESU/SMU/DPSs identified as having no future need (i.e., “no”) for mitigation hatchery programs may have a different classification based on harvest augmentation or conservation need as discussed in the following two sections.

Table 6-4. Summary table of federal and state listing status, hatchery status, and future need for mitigation hatchery programs.

ESU/SMU	Species	Biological Vulnerability		Hatchery Status		Future Mitigation Need
		Federal Listing Status	State Listing Status	Mitigation Program (#)	Mitigation Production (# of fish)	
Snake River	Fall Chinook	T	T	3	UNK	Yes
	Spring/Summer Chinook	T	T	5	1,650,000	Yes
	Steelhead	T	S	2	1,015,000	Yes
Middle Columbia	Coho			1	1,000,000	Yes
	Fall Chinook		S	1	1,500,000	Yes
	Spring Chinook		S	1	310,000	Yes
	Steelhead	T	SC	1	162,000	Yes
Lower Columbia	Coho	T	E	4	3,635,000	Yes
	Fall Chinook	T	SC	1	1,600,000	Yes
	Spring Chinook	T	SC	3	4,530,000	Yes
	Chum	T	SC	0	0	No
	Winter Steelhead	T	SC	1	160,000	Yes
	Summer Steelhead	T	S	0	0	No
Upper Willamette	Spring Chinook	T	SC	4	4,229,750	Yes
	Steelhead	T	S	1	547,500	Yes
Rogue-South Coast	Coho	T	S/SC	1	100,000	Yes
	Fall Chinook			0	0	No
	Spring Chinook		S	1	1,700,000	Yes
	Winter Steelhead			2	263,000	Yes
	Summer Steelhead		S	1	220,000	Yes
Oregon Coast	Coho	T	S	1	60,000	Yes
	Fall Chinook			0	0	No
	Spring Chinook		S	0	0	No
	Chum		SC	0	0	No
	Winter Steelhead			0	0	No
	Summer Steelhead		S	0	0	No

6.2.2 Harvest Augmentation Programs

Harvest augmentation hatchery programs exist to increase fishing and harvest opportunity in areas where no mitigation programs exist. These programs support non-tribal (i.e., recreational and commercial) and tribal (i.e., commercial and subsistence) fisheries. Some of these programs (about four) operate in combination with other types of hatchery programs, including mitigation and recovery.

A substantial proportion of the hatchery programs supporting ESU/SMU/DPSs in the Lower Columbia and Oregon Coast, as well as Rogue-South Coast, are solely harvest augmentation or partially harvest augmentation programs (Table 6-5). All ESU/SMU/DPSs within the Oregon Coast ESU/SMU/DPS, as well as Lower Columbia summer steelhead and the Rogue-South Coast fall Chinook Salmon, had a future need for harvest augmentation hatchery programs. All other ESU/SMU/DPS were not classified under harvest augmentation due to substantial mitigation programs. Lower Columbia Chum Salmon ESU and Oregon Coast Chum Salmon ESU were not applicable because fisheries do not currently exist and populations are likely to be handled under conservation hatchery programs for the foreseeable future.

Future fishery demand is directly linked to future need for harvest augmentation programs as harvest augmentation primarily exists to support fisheries. We considered a number of metrics to estimate future fishery demand for inclusion into the harvest augmentation future need metric. However, as discussed above in Section 5.1, it is not possible to break fishery demand down by ESU/SMU/DPS using currently available data. One alternative would have been to apply declining tag and endorsement sales to all ESU/SMU/DPSs uniformly, for example, by reducing the future need rating downwards for all ESU/SMU/DPSs. However, given that the cause of the decline is not clear (e.g., generational preferences, individual angler preferences, real/perceived decline in opportunity) and since this alternative would be applied uniformly across all ESU/SMU/DPS, it would not provide any real differentiation between ESU/SMU/DPS, would be uninformative, and was not included.

Another alternative was to include the proportion of hatchery fish in the ELS-reported harvest. The larger a proportion of the fishery is made up of hatchery fish, the more dependent that fishery is on hatchery production and, presumably, the more popular hatchery fish are within that fishery. While that metric can be broken down by region and species/run-type, many fisheries (e.g., most Lower Columbia River fisheries) are mark-selective meaning only hatchery fish may be harvested. This is typically driven by the wild ESU/SMU/DPS having too poor a status to support harvest and would obviously substantially increase the proportion of hatchery fish in reported harvest. Given the ongoing stressors of climate change, the wild ESU/SMU/DPSs are unlikely to recover to the point of sustaining regular harvest of wild fish. Therefore, unless the status of the wild ESU/SMU/DPS changed substantially, hatchery proportion is still a good indicator of the importance of hatchery production to the fishery.

Though declining tag sales (see Section 5.1) indicate a possible ongoing reduction in demand for future salmon and steelhead angling opportunity, this does not necessarily represent a clear indication that there will not be some future need for harvest augmentation. Angler demand is highly variable depending on weather, run forecasts, and actual size and economic conditions (e.g., increase in license sales during the COVID 19 pandemic) and could change rapidly. For example, angler demand may increase rapidly if real or perceived harvest opportunity increased rapidly. This could alter the future need for harvest augmentation for specific species and programs without changes to overall angler demand (i.e., demand shifts from steelhead to spring Chinook Salmon or shifts from Columbia River to

coastal fisheries). Future ESA listing/delisting of various ESU/SMU/DPSs (e.g., consideration of the Oregon Coast and SONCC Chinook ESUs for listing) could impact future need for harvest augmentation to allow continued harvest opportunity while protecting ESA-listed ESU/SMU/DPSs. Finally, factors beyond the control of management agencies (e.g., ocean productivity declines) may impact future need to the point where programs are no longer advantageous and/or cannot be maintained.

Table 6-5. Summary table of climate exposure and sensitivity, hatchery status, and future need for harvest augmentation hatchery programs.

ESU/SMU	Species	Climate Exposure & Sensitivity	Hatchery Status		Future Harvest Augmentation Need [1]
			Harvest Augmentation Program	Harvest Augmentation Production	
Snake River	Fall Chinook	High	0	0	--
	Spring/Summer Chinook	Very High	0	0	--
	Steelhead	High	0	0	--
Middle Columbia	Coho	NA	0	0	--
	Fall Chinook	NA	0	0	--
	Spring Chinook	High	0	0	--
	Steelhead	High	0	0	--
Lower Columbia	Coho	High	2	835,000	Yes
	Fall Chinook	Mod	2	7,450,000	Yes
	Spring Chinook	Mod	3	1,330,000	Yes
	Chum[2]	Mod	0	0	NA
	Winter Steelhead	Mod	3	565,000	Yes
	Summer Steelhead	Mod	2	250,000	Yes
Upper Willamette	Spring Chinook	Very High	0	0	--
	Steelhead	High	0	0	--
Rogue-South Coast	Coho	High	0	0	--
	Fall Chinook	NA	2	290,000	Yes
	Spring Chinook	NA	0	0	--
	Winter Steelhead	Low	1	50,000	Yes
	Summer Steelhead	Mod	0	0	--
Oregon Coast	Coho[3]	High	2	200,000	Yes
	Fall Chinook	High	7	3,163,000	Yes
	Spring Chinook	High	3	972,000	Yes
	Chum[2]	NA	0	0	NA
	Winter Steelhead	High	10	1,125,000	Yes
	Summer Steelhead	High	2	150,000	Yes

Notes:

1. ESU/SMU/DPSs with "--" have mitigation programs.
2. Chum Salmon populations are currently too small to be harvestable and are unlikely to rebound to a level allowing harvest in the foreseeable future.
3. The current mitigation program for Oregon Coast Coho Salmon ESU is relatively small and may not meet future harvest augmentation needs.

6.2.3 Conservation Programs

Conservation hatchery programs (e.g., supplementation and recovery) use hatchery fish to enhance the viability of natural populations while limiting impacts to those populations within acceptable bounds or use the best available broodstock to establish a population in habitat currently vacant for that native species, respectively. Some of these programs (about four) operate in combination with other types of hatchery programs including mitigation and recovery.

Relatively few conservation hatchery programs exist in the state of Oregon (Table 6-6). Based on biological vulnerability scores, all ESU/SMU/DPSs with existing conservation hatchery programs (e.g., Snake River spring/summer Chinook Salmon ESU, Snake River steelhead DPS, Middle Columbia spring Chinook Salmon ESU, and Middle Columbia steelhead DPS, and Columbia River Chum Salmon ESU, and Oregon Coast fall Chinook Salmon SMU) will have an ongoing future need for these programs. The Snake River fall Chinook Salmon ESU, Lower Columbia Coho and fall Chinook Salmon ESU and winter and summer steelhead DPS, the Upper Willamette spring Chinook Salmon ESU and steelhead DPS, the Rogue-South Coast Coho Salmon SMU, the Oregon Coast Coho Salmon ESU, and the Oregon Coast spring Chinook Salmon and summer steelhead SMUs will all have an increasing future need for conservation hatchery programs. The Rogue-South Coast winter and summer steelhead SMUs and Oregon Coast winter steelhead SMU have no foreseeable future need for conservation hatchery programs. The Middle Columbia fall Chinook and Coho Salmon SMUs, the Rogue-South Coast fall and spring Chinook Salmon SMUs, and Oregon Coast Chum Salmon SMU could not be reliably scored since no climate exposure and sensitivity rating could be assigned.

Table 6-6. Summary table of biological vulnerability, hatchery status, and future need for conservation hatchery programs.

ESU/SMU /DPS	Species	Biological Vulnerability							Hatchery Status		Future Conservation Need
		Federal Listing Status	State Listing Status	Listing Score	Climate Exposure & Sensitivity	Climate Vulnerability Score	Biological Vulnerability Score	Biological Vulnerability Status	Conservation Program (#)	Conservation Production (# of Fish)	
Snake River	Fall Chinook	T	T	4	High	4	4	High	0	0	Increasing
	Spring/Summer Chinook	T	T	4	Very High	5	4.5	High to Very High	5	1,650,000	Yes
	Steelhead	T	S	4	High	4	4	High	1	215,000	Yes
Middle Columbia	Coho			1	NA		1	*Insufficient Data*	0	0	*Insufficient Data*
	Fall Chinook		S	2	NA		2	*Insufficient Data*	0	0	*Insufficient Data*
	Spring Chinook		S	2	High	4	3	Moderate	2	1,120,000	Yes
	Steelhead	T	SC	4	High	4	4	High	2	312,000	Yes
Lower Columbia	Coho	T	E	5	High	4	4.5	High to Very High	0	0	Increasing
	Fall Chinook	T	SC	4	Mod	3	3.5	Moderate to High	0	0	Increasing
	Spring Chinook	T	SC	4	Mod	3	3.5	Moderate to High	1	250,000	Yes
	Chum	T	SC	4	Mod	3	3.5	Moderate to High	1	300,000	Yes
	Winter Steelhead	T	SC	4	Mod	3	3.5	Moderate to High	0	0	Increasing
	Summer Steelhead	T	S	4	Mod	3	3.5	Moderate to High	0	0	Increasing
Upper Willamette	Spring Chinook	T	SC	4	Very High	5	4.5	High to Very High	0	0	Increasing
	Steelhead	T	S	4	High	4	4	High	0	0	Increasing
Rogue-South Coast	Coho	T	S/SC	4	High	4	4	High	0	0	Increasing
	Fall Chinook			1	NA		1	*Insufficient Data*	0	0	*Insufficient Data*
	Spring Chinook		S	2	NA		2	*Insufficient Data*	0	0	*Insufficient Data*
	Winter Steelhead			1	Low	2	1.5	Very Low to Low	0	0	No
	Summer Steelhead		S	2	Mod	3	2.5	Low to Moderate	0	0	No
Oregon Coast	Coho	T	S	4	High	4	4	High	0	0	Increasing
	Fall Chinook			1	High	4	2.5	Low to Moderate	1	100,000	Yes
	Spring Chinook		S	2	High	4	3	Moderate	0	0	Increasing
	Chum		SC	3	NA		3	*Insufficient Data*	0	0	*Insufficient Data*
	Winter Steelhead			1	High	4	2.5	Low to Moderate	0	0	No
	Summer Steelhead		S	2	High	4	3	Moderate	0	0	Increasing

This assessment substantiates a future need for a combination of mitigation, harvest augmentation, and conservation hatchery programs for a variety of different species in multiple regions (Table 6-7). This mix of hatchery programs will continue to support fishery and conservation goals and objectives throughout the state of Oregon.

Although producing and releasing more fish would immediately increase population numbers, hatchery fish can introduce both genetic and ecological risks to wild fish, which can lead to further negative impacts to the population (Kostow 2009). Hatchery production under optimized management can help minimize these impacts to aid the natural production of imperiled fish (see also Four Peaks 2024). This future needs assessment provides a review of future hatchery need as it exists today. However, regular and ongoing evaluation of hatchery program objectives and strategies will best support populations.

Climate change is a substantial, additional uncertainty for both harvest augmentation (Section 6.2.2 above) and conservation hatchery programs (Section 6.2.3). Most current climate change scenarios indicate that wild fish ESU/SMU/DPSs are unlikely to be able to absorb more harvest demand. This may lead to increased future need for harvest augmentation programs for additional ESU/SMU/DPSs. However, under climate change, the most important consideration may not be current harvest opportunity but the risk of ongoing harvest to the continued existence of the ESU/SMU/DPS indicating future need for conservation hatchery programs in addition to or in place of harvest augmentation. This could be further influenced by changing angler preferences for the type of fishery (i.e., harvest v. catch-and-release), though, so far, notable catch-and-release fisheries seem to have emerged primarily among steelhead anglers. The evolving dynamics of climate change interacting with angler demand and preferences create uncertain and shifting future needs, which may impact multiple program types and will require flexible and adaptive management approaches.

Rankings for ESU/SMU/DPSs could be further refined within the needs assessment framework based on the addition of information or data not included within the current framework. Refining the future needs of these fish would work to promote the longevity of these populations in areas where biological and climate change risk factors threaten their continued existence. Ideally, hatchery investment level would reflect the associated ecological risk to compensate for potential losses due to non-production related factors (i.e., climate, harvest, human-impacts to habitat).

Table 6-7. Summary table of Future Need for Mitigation, Harvest Augmentation and Conservation Hatchery Programs and Overall Future Hatchery Need.

ESU/SMU	Species	Future Mitigation Need	Future Harvest Augmentation Need	Future Conservation Hatchery Need	Future Hatchery Need
Snake River	Fall Chinook	Yes	--	Increasing	Yes, Increasing
	Spring/Summer Chinook	Yes	--	Yes	Yes
	Steelhead	Yes	--	Yes	Yes
Middle Columbia	Coho	Yes	--	*Insufficient Data*	Yes
	Fall Chinook	Yes	--	*Insufficient Data*	Yes
	Spring Chinook	Yes	--	Yes	Yes
	Steelhead	Yes	--	Yes	Yes

ESU/SMU	Species	Future Mitigation Need	Future Harvest Augmentation Need	Future Conservation Hatchery Need	Future Hatchery Need
Lower Columbia	Coho	Yes	Yes	Increasing	Yes, Increasing
	Fall Chinook	Yes	Yes	Increasing	Yes, Increasing
	Spring Chinook	Yes	Yes	Yes	Yes
	Chum	No	NA	Yes	Yes
	Winter Steelhead	Yes	Yes	Increasing	Yes, Increasing
	Summer Steelhead	No	Yes	Increasing	Increasing
Upper Willamette	Spring Chinook	Yes	--	Increasing	Yes, Increasing
	Steelhead	Yes	--	Increasing	Yes, Increasing
Rogue-South Coast	Coho	Yes	--	Increasing	Yes, Increasing
	Fall Chinook	No	Yes	*Insufficient Data*	Yes
	Spring Chinook	Yes	--	*Insufficient Data*	Yes
	Winter Steelhead	Yes	Yes	No	Yes
	Summer Steelhead	Yes	--	No	Yes
Oregon Coast	Coho	Yes	Yes	Increasing	Yes, Increasing
	Fall Chinook	No	Yes	Yes	Yes
	Spring Chinook	No	Yes	Increasing	Yes, Increasing
	Chum	No	NA	*Insufficient Data*	No
	Winter Steelhead	No	Yes	No	Yes
	Summer Steelhead	No	Yes	Increasing	Yes, Increasing

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