Lower Columbia River Conservation and Recovery Plan for Oregon Populations of Salmon and Steelhead

12-Year Assessment
2010-2022

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Appendices

List of Acronyms

Acronym	Definition
ABM	Abundance Based Management
A/P	Abundance/Productivity
BCH	Big Creek Hatchery
BLM	Bureau of Land Management
BiOp	Biological Opinion
CCLME	California Current Large Marine Ecosystem
CCS	California Current System
ChF	Fall Chinook
ChS	Spring Chinook
CLT	Columbia Land Trust
COP	City of Portland
CRBC	Clackamas River Basin Council
CREST	Columbia River Estuary Task Force
CRS	Chum Recovery Strategy
CSL	California Sea Lion
CTWS	Confederated Tribes of the Warm Springs
DPS	Distinct Population Segment
eDNA	Environmental DNA
ELS	Electronic Licensing System
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FCRPS	Federal Columbia River Power System
FERC	Federal Energy Regulatory Commission
FIP	Focused Investment Partnership
FMP	Fisheries Management Plan
FR	Federal Register
FWT	Freshwater Trust
GOCWC	Greater Oregon City Watershed Council
GRH	Grays River Hatchery
GRTS	Generalized Random Tessellation Stratified
HGMP	Hatchery and Genetic Management Plan
HQH	High Quality Habitat
HRPP	Hood River Production Program
HRWG	Hood River Working Group
IPCC	Intergovernmental Panel on Climate Change
JCWC	Johnson Creek Watershed Council
LCEP	Lower Columbia Estuary Partnership
LCR	Lower Columbia River
LCRFRB	Lower Columbia River Fish Recovery Board
LWD	Large Woody Debris
MMPA	Marine Mammal Protection Act

MSA	Magnuson-Stevens Act
MWMT	Maximum Weekly Maximum Temperature
NA	Not Applicable
NCWA	North Coast Watershed Association
NCWC	North Clackamas Watershed Council
NE	Not Evaluated
NFCP	Native Fish Conservation Policy
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPCC	Northwest Power and Conservation Council
NRCS	Natural Resource Conservation Service
NS	Not Sampled
OAH	Ocean Acidification and Hypoxia
OAR	Oregon Administrative Rule
OASIS	Oregon Adult Salmonid Inventory and Sampling
ODFW	Oregon Department of Fish and Wildlife
OFWC	Oregon Fish and Wildlife Commission
OWEB	Oregon Watershed Enhancement Board
PFMC	Pacific Fisheries Management Counsel
PGE	Portland General Electric
pHOS	Proportion Hatchery Origin Spawners
PIT	Passive Integrated Transponder
PVA	Population Viability Analysis
PWB	Portland Water Bureau
RCP	Representative Concentration Pathways
RME	Research Monitoring Evaluation
SAP	Strategic Action Plan
SBWC	Scappoose Bay Watershed Council
SMU	Species Management Unit
SST	Sea Surface Temperature
SWCD	Soil and Water Conservation District
StS	Summer Steelhead
StW	Winter Steelhead
SWW	Southwest Washington
TCWC	Tryon Creek Watershed Council
TU	Trout Unlimited
USACOE	United States Army Corps of Engineers
USDA	Unites States Department of Agriculture
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
UWR	Upper Willamette River
VIC	Variable Infiltration Capacity
VSP	Viable Salmonid Populations
WLC-TRT	Willamette Lower Columbia Technical Review Team

Executive Summary

The *Lower Columbia River Conservation and Recovery Plan for Oregon Populations of Salmon and Steelhead* (Plan) was approved by the Oregon Fish and Wildlife Commission (OFWC) in August 2010. The Plan serves as both a recovery plan under the federal Endangered Species Act (ESA) and a State of Oregon conservation plan under Oregon's Native Fish Conservation Policy (NFCP). The Plan provides a framework and roadmap for the conservation and recovery of salmon and steelhead found within the lower Columbia River (LCR) Evolutionary Significant Unit (ESU), including fish populations from Hood River to Youngs Bay and the Willamette River below Willamette Falls.

The Plan calls for a comprehensive assessment of the status of each ESU twelve years after Plan approval, including performance of the fish populations, trends in habitat, and implementation and effectiveness of restoration and management commitments. This document is the first 12-year assessment and includes a review of Plan implementation since adoption in 2010, a status assessment of LCR salmon and steelhead populations based on measurable criteria identified in the Plan, and an assessment of measurable criteria relating to ESA listing factors. Consistent with the Plan and Oregon Department of Fish and Wildlife's (ODFW's) Climate and Ocean Change Policy, this 12-year assessment also reviews climate and ocean change projections relevant to Plan species, summarizes climate change vulnerability, and identifies adaptation strategies and actions to promote population resilience.

Key Assessment Takeaways:

- Progress toward recovery goals varied among populations during the first 12 years of Plan implementation. In general, salmon and steelhead populations in the Clackamas and Sandy basins (Cascade stratum) made significant progress toward or attained delisting scenario goals, while populations in other strata (Coastal and Gorge) did not.
- Most of the actions identified in the Plan to address threats and limiting factors have been implemented, are in progress, or are ongoing. Goals for limiting harvest impacts were achieved, and the percentage of hatchery fish on the spawning grounds (pHOS) is below Plan limits or declining in most populations.
- Strong habitat restoration efforts in the Clackamas, Sandy, and Hood basins achieved or made significant progress towards restoration goals identified in the Plan. Capacity of organizational partners played a major role in getting projects on the ground.
- Climate change is expected to exacerbate existing limiting factors and threats, and some populations are particularly vulnerable. Habitat protection, restoration, and enhancement are the key to reducing climate change risk and achieving recovery.
- Achieving desired status goals in the Plan will require long-term, sustained action. Furthermore, uplift across the entire ESU, including populations in Washington, will be needed to achieve recovery and delisting.

Key Assessment Findings by Species

LCR Coho Salmon ESU

- The Plan identifies eight LCR coho populations in Oregon, one of which (Lower Gorge) is shared with Washington. Only the Clackamas population attained the interim abundance/productivity (A/P) goal[1] identified in the Plan, although two others (Youngs Bay and Big Creek) likely attained the goal. The Sandy coho population did not attain the interim A/P goal, but showed improvements in abundance and spatial structure.
- Most coho salmon populations attained the delisting scenario goal for the proportion of hatchery origin spawners (pHOS). Among the three populations that did not attain the goal, only one has hatchery releases within the population area and pHOS showed a declining trend there.
- Management of ocean and Columbia River fisheries consistently maintained fishery impacts below established limits for the ESU.

LCR Chinook Salmon ESU

- The Plan identifies 12 LCR Chinook populations in Oregon, two of which (Lower Gorge and Upper Gorge) are shared with Washington. Sandy spring and fall Chinook both attained the interim A/P goal and had an increasing abundance trend since Plan approval; Sandy spring Chinook abundance also consistently exceeded the delisting scenario goal.
- The Clatskanie and Scappoose fall Chinook populations, which are identified as primary populations in the delisting scenario, appear to be functionally extirpated[2].
- The delisting scenario goal for pHOS was attained in the Sandy spring Chinook salmon population due to implementation of actions identified in the Plan. Several fall Chinook salmon populations also attained the delisting scenario goal for pHOS.
- Management of ocean and Columbia River fisheries maintained fishery impacts below established limits, although a few Chinook salmon populations could not be fully assessed due to additional monitoring needs.

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[1] Interim goals are benchmarks intended to serve as measures of progress towards achieving recovery goals in the absence of full viability analyses, which require long term data trends to show progress.

[2] Describes a species that no longer plays a significant role in its ecosystem, even if some individuals may still be present. The population has declined so drastically that the remaining members cannot breed successfully, or their numbers are too low to maintain a meaningful presence.

LCR Steelhead Distinct Population Segment (DPS)

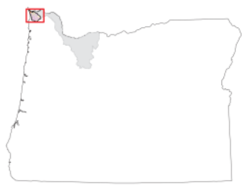
- There are six LCR Steelhead populations in Oregon, two of which are shared with Washington. Steelhead populations in Youngs Bay, Big Creek, Clatskanie, and Scappoose belong to the SW Washington DPS, which is not listed under the ESA.
- The Sandy winter steelhead population attained the interim A/P goal and also exceeded the broad sense recovery abundance goal in most years. Hood winter steelhead attained the interim A/P goal, but spawner abundance was well below the delisting scenario goal. The Clackamas winter steelhead population did not attain the interim A/P goal.
- The Clackamas and Sandy populations both attained the delisting scenario goal for pHOS. In the Hood population, high hatchery stray rates contributed to an adaptive management decision to end the winter steelhead hatchery program.
- Returns of Hood summer steelhead, the only native summer steelhead population in the Oregon portion of the LCR, were consistently very low compared to Plan goals.
- Fishery impact rates were consistently below Plan limits in all monitored populations.

Columbia River Chum Salmon ESU

- Monitoring results support the Plan conclusion that chum salmon have been functionally extirpated in the Oregon portion of the Columbia River Chum ESU. Although chum salmon have been observed on the spawning grounds or detected by environmental DNA (eDNA) surveys in several population areas, ODFW only observed significant numbers of chum salmon spawners in Coastal stratum populations where reintroduction efforts have occurred.
- The Chum Recovery Strategy (CRS) directed ODFW to begin reintroductions in the Coastal stratum with an emphasis on the Clatskanie and Scappoose recovery populations. As part of the framework for CRS implementation, ODFW conducted habitat suitability surveys in the Coastal stratum. As a result of the surveys, which found poor quality habitat for chum salmon in the Scappoose population, select streams in the Big Creek population replaced the Scappoose population for reintroduction efforts.
- ODFW successfully established a conservation hatchery program for chum salmon at Big Creek Hatchery and recent returns have been large enough to support significant outplanting in the Clatskanie and Big Creek recovery populations (see Appendix II of the 12-year assessment for more information on Chum Recovery Strategy implementation).

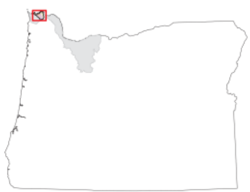
Key Assessment Findings by Population Area

Youngs Bay



- Youngs Bay has large hatchery programs that contribute to intensive Select Area fisheries, as well as ocean and Columbia River sport and commercial fisheries.
- In the delisting scenarios for LCR coho and Chinook salmon, Youngs Bay populations are expected to have a high or very high viability risk. As a result, viable salmonid population (VSP) metric thresholds and habitat restoration goals are relatively low. Interim habitat restoration and coho high quality habitat (HQH) goals have been met.

Big Creek

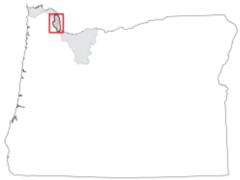


- Similar to Youngs Bay, Big Creek has large hatchery programs that contribute to intensive Select Area fisheries, as well as ocean and Columbia River sport and commercial fisheries.
- In the delisting scenario goals for LCR coho and Chinook salmon, Big Creek populations are expected to have a high or very high viability risk. As a result, VSP metric thresholds and habitat restoration goals are relatively low for this population. Interim habitat restoration and coho HQH goals have not yet been met.
- Big Creek Hatchery is the source hatchery for Oregon's Columbia River chum salmon reintroduction efforts. Chum salmon have been outplanted to Bear and Gnat creeks when returns exceed broodstock needs.
- Habitat restoration in the Big Creek population area has been limited by local capacity to implement and the ability to secure restoration funding.

Clatskanie

- Clatskanie coho and fall Chinook salmon are designated as primary populations targeted to achieve a low extinction risk in the delisting scenario. The coho population continues to require significant improvements to reach desired status under the delisting scenario and the fall Chinook population appears to be functionally extirpated. The winter steelhead population has shown a lack of progress toward broad sense recovery goals in the Plan.
- The Clatskanie population area is a focus for chum reintroduction efforts. Natural production has been observed in recent years as a result of adult outplanting.
- There are no hatchery programs in the Clatskanie population area and hatchery straying is typically concentrated in Plympton Creek, which has a similar headwater source area as Big Creek.
- Goals for coho HQH and stream restoration have not been met in this population area. This watershed is the furthest away from interim restoration goals and needs assistance to enhance capacity and gain community support. Increasing the pace and scale of restoration in this population area is critical to achieving delisting scenario goals.

Scappoose

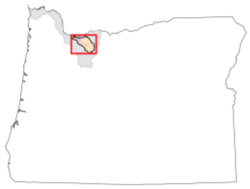


- Scappoose coho and fall Chinook salmon are designated as primary populations targeted to achieve a low extinction risk in the delisting scenario. The coho population continues to require significant improvements to reach desired status under the delisting scenario and the fall Chinook population appears to be functionally extirpated. The winter steelhead population has shown a lack of progress toward broad-sense recovery goals in the Plan.
- The Plan goal for miles of coho HQH has been achieved, but trends in coho VSP metrics indicate that additional HQH will be needed to achieve delisting scenario goals. Interim watershed restoration goals for off-channel and riparian restoration were met, but interim goals for large woody debris (LWD) and side channel habitat were not.
- Restoration achievements by the watershed council and other partners since Plan approval will need to be expanded to achieve delisting scenario goals and mitigate expected climate change impacts in this population area.

Clackamas

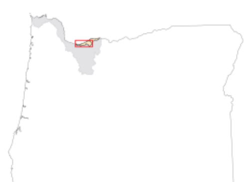
- Clackamas coho salmon and steelhead are designated as primary populations targeted to achieve a low extinction risk, while fall Chinook are considered a contributing population with a moderate gap to close to meet desired status under the delisting scenario. The Clackamas spring Chinook population belongs to the Upper Willamette River (UWR) ESU and is not part of this assessment.
- The Clackamas coho salmon population achieved the interim A/P goal and spawner abundance has surpassed the delisting scenario goal in recent years. Clackamas winter steelhead have not shown the same trend and significant improvements are needed to achieve Plan goals.
- All populations achieved delisting scenario pHOS goals.
- Habitat improvements by restoration practitioners have met the goals for riparian and off-channel habitat, but significant needs remain for LWD and side channel habitat. The goal for coho HQH was attained.
- The two hydropower-related criteria were attained through significant investment and coordination by Portland General Electric (PGE).
- The Clackamas Partnership was formed in 2018 and is currently implementing an Oregon Watershed Enhancement Board (OWEB) Focused Investment Partnership (FIP) initiative. The goal of the Partnership is to build off PGE's success in providing passage through the Clackamas hydroelectric project by restoring access and improving side channel conditions in the mainstem Clackamas River.

Sandy



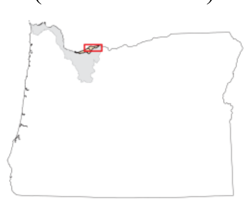
- The Sandy population area has coho, fall Chinook, late fall Chinook, spring Chinook, and winter steelhead populations. All populations except fall Chinook (which currently can't be differentiated from the late fall Chinook population) are primary populations targeted to achieve a low extinction risk.
- All populations showed progress toward desired status goals. Spring Chinook and winter steelhead consistently exceeded delisting scenario goals for abundance, fall Chinook achieved the interim A/P goal, and coho salmon showed an increasing trend for A/P and spatial structure.
- All populations achieved delisting scenario pHOS goals.
- Interim goals were achieved for all watershed restoration metrics. The goal for miles of coho HQH was not achieved, but this may be due in part to a change in methodology for determining this metric.
- The Freshwater Trust, US Forest Service (USFS) and Bureau of Land Management (BLM) are restoring access to miles of side channel and acres of off-channel habitat, in addition to enhancing miles of stream every year since Plan approval. Removal of Marmot and Little Sandy Dams and infrastructure, combined with the level of restoration work, are strongly contributing to recovery of Sandy fish populations.

Lower Gorge
(shared OR/WA)



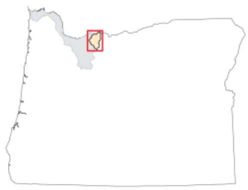
- Lower Gorge coho and steelhead are primary populations targeted to achieve a low extinction risk, while fall Chinook are considered a contributing population with a moderate gap to close to meet desired delisting status. Lower Gorge coho are meeting spatial structure and harvest goals but are not meeting A/P or pHOS goals. Fall Chinook and steelhead were not assessed due to a lack of monitoring data.
- The Lower Gorge population area did not achieve interim restoration goals or the goals for miles of coho HQH. Stream restoration is limited by the low amount of historical habitat available and significant infrastructure impacts (interstate highway, railroad, etc.) that are unlikely to change.
- As noted in the Plan, there is a need to re-evaluate the Gorge stratum's historical status and population structure.

Upper Gorge
(shared OR/WA)



- Upper Gorge winter steelhead and fall Chinook were not assessed due to a lack of monitoring data. Coho in the Upper Gorge are part of the combined Upper Gorge/Hood population and are discussed in the Hood River section below.
- The Upper Gorge population area did not achieve interim restoration goals. Stream restoration is limited by the low amount of historical habitat and the lack of watershed restoration sponsors.

Hood



- Hood coho, fall Chinook, spring Chinook, winter steelhead, and summer steelhead are designated as primary populations and therefore targeted to achieve a low extinction risk. All populations have large gaps to close to meet the delisting scenario goals. As noted in the Plan, mortality rate reductions necessary to achieve the delisting scenario goal for coho, fall Chinook and summer steelhead are likely not attainable.
- The indigenous stock of Hood River spring Chinook is believed to have been extirpated by the early 1970s. The Hood River Production Program (HRPP) introduced an out-of-ESU stock from the Deschutes Basin. Naturally produced progeny of hatchery-origin adults from the program are not considered part of the LCR ESU. Spring Chinook hatchery management in the Hood is consistent with the Hatchery and Genetic Management Plan (HGMP) for this reintroduction/recovery and integrated harvest hatchery program.
- Upper Gorge/Hood coho and Hood winter steelhead did not meet delisting scenario pHOS goals. There is no coho hatchery program in the Hood and the winter steelhead hatchery program was recently terminated as an adaptive management action.
- Interim stream restoration goals were not achieved and coho HQH remains far below the Plan target, which may be unattainable given intrinsic characteristics of the basin. Significant restoration accomplishments have occurred or are in progress, including fish passage improvements and stream flow restoration.

Implementation Highlights

The Plan identified actions to address threats and limiting factors in six general threat categories. Most (≥80 percent) of the actions in each of these categories have been implemented, are in progress, or are ongoing. The following are implementation highlights by general threat category (actions listed below are a small subset of all actions implemented—see Appendix I of the 12-year assessment for a more comprehensive summary).

Tributary Habitat Management

- Every major watershed council within the ESU has updated their strategic actions plans (SAPs) using updated inventories and Plan priorities to implement restoration projects in the highest priority areas and improve the likelihood of achieving desired status goals.
- Metro, the Clackamas Soil and Water Conservation District (SWCD) and Columbia Land Trust (CLT) have secured over 1,000 acres for protection and restoration in priority locations in the Clackamas, Sandy, Hood, and Scappoose population areas.

Estuary Habitat Management

- Between 2010-2021, 1,288 acres of estuarine habitat were preserved, and 3,115 acres were restored to tidal influence through dike breaching on the Oregon side of the LCR.
- All restoration practitioners that operate within the LCR estuary have outreach on invasive plants and conduct invasive control and riparian planting events. The Lower Columbia Estuary Partnership is a leader in this category and offers training sessions to volunteer groups as well as training packets for educators.

Hydropower and Flood Control Management

- The 2019-2021 Spill Operation Agreement implemented a flexible approach to providing additional spill as a tool intended to support spring juvenile fish downstream passage in concert with managing the Columbia River system for multiple purposes.
- PGE's Westside Hydropower Project on the Clackamas River is meeting or exceeding all requirements of their fish passage and protection plan required through the Federal Energy Regulatory Commission (FERC).
- Powerdale Dam on the Hood River was removed in 2010, restoring full fish passage at this site.

Hatchery Management

- ODFW implemented several actions in the Plan intended to reduce risk from the Sandy spring Chinook hatchery program. These efforts have kept stray rates consistently below the Plan's delisting scenario pHOS goal and allowed the program to slowly expand as the natural origin population has consistently exceeded the delisting scenario abundance goal.
- ODFW and partners made significant progress on actions to improve fish passage at Cedar Creek Hatchery (Sandy) and Klaskanine Hatchery (Youngs Bay).

Harvest Management

- NOAA and the states of Washington and Oregon came together to revise the LCR Coho Harvest Matrix, an ocean and Columbia River harvest control rule based on parental escapement and marine survival. The new coho harvest matrix uses escapement across additional coho populations to improve escapement across all populations.
- In 2012, harvest shifted to an abundance-based management strategy for fall chinook, which reduced the exploitation rate for some LCR fall chinook.
- Since 2017, summer steelhead returns have decreased Columbia Basin wide. As a result, additional harvest control was implemented throughout the mainstem, likely reducing overall impacts on Hood River summer steelhead stocks.
- The OFWC adopted administrative rules implementing guiding principles and management strategies for a new fisheries framework for LCR non-tribal fisheries (Columbia River Fisheries Reform). A key provision in the policy was the intent to explore development of alternative commercial gears that would allow further implementation of mark-selective regulations in non-tribal commercial fisheries in the mainstem Columbia River. A variety of different alternative gears and seasons have been evaluated, but no single gear type was successful in all evaluation categories. Implementation of a commercial tangle-net fishery targeting hatchery coho maybe contributing to lower pHOS, but the high costs and limited harvest potential of alternative gears examined to date were assessed to be neither likely to benefit the non-treaty commercial fishery overall, nor individual Columbia River commercial fishers.

Predation

- Sea lion management in the Columbia River Basin has been ongoing since fish and wildlife agencies were first given Marine Mammal Protection Act (MMPA) Section 120 authorization to remove California sea lions observed preying on salmon and steelhead below Bonneville Dam in 2008, and years later at Willamette Falls. After the MMPA was amended in August 2020, NOAA issued a permit to the three Columbia Basin states and six regional Tribes that allowed for lethal removal of California and Stellar sea lions in specific locations where ESA listed salmon and steelhead, and other fish species of concern, are especially vulnerable to predation.
- Actions for reducing salmonid and steelhead predation by Double Crested Cormorants and Caspian Terns are incorporated into their respective management plans and all Plan actions have been implemented. Despite this, predation on juvenile salmonids appears to be increasing based on recent research. Current estimates of avian predation rates are substantially higher than estimates provided in the Plan for all sources of predation combined, suggesting the overall impact by predators is higher than previously estimated.
- Piscine predation management in the LCR has been ongoing for Northern Pikeminnow for more than 35 years. Implementation of the Northern Pikeminnow Sport Reward program has demonstrated a method to reduce predation on juvenile salmonids at the Columbia basin level. However, the patterns in abundance and distribution of non-native piscine predators and subsequent impacts to juvenile salmonids need further study.

Climate Change

The 12-year assessment presents modeled future conditions for stream temperature and flow under a changing climate and describes other environmental changes that could impact Plan populations, including sea level rise and changes in the ocean environment. Changes in summer stream flow and temperature are among the more certain climate change effects and are likely to reduce the quantity and quality of rearing habitat for juvenile salmon and steelhead in the absence of counteracting management actions. These changes are already stressing salmon and steelhead populations within the LCR ESU. Continued changing temperature and flows into the future will only increase fish population stressors. Habitat protection, restoration, and enhancement are the key to reducing climate change risk and achieving recovery of LCR salmon and steelhead populations. Entities are urged to consider future watershed conditions when assessing, planning, and implementing actions so that maximum ecological uplift is maintained into the future. Implementation partners have already taken important actions to adapt and prepare for the future, including major fish passage improvements in several populations, increased temperature monitoring, consideration of climate projections when prioritizing habitat restoration and protection, identification and protection of cold-water refuges, and modeling the potential effects of sea level rise on estuarine habitats.

Conclusions and Next Steps

This first 12-year assessment of Plan measurable criteria indicates that most Oregon populations within the LCR ESU have not yet achieved delisting goals or the more ambitious broad sense recovery goals identified in the Plan. This result is consistent with the expectation that the Plan is a 25-year Plan and that desired delisting and broad sense goals are not necessarily expected to be achieved within this timeframe, given lag time between action completion and both habitat and population responses. The assessment also indicates that progress toward recovery goals is highly variable among strata and populations, which is also consistent with expectations in the Plan. Across multiple species, populations in the Cascade stratum (Clackamas and Sandy) have shown the greatest progress toward desired status goals. Stable or improving status in these populations has coincided with significant habitat restoration work and fish passage improvements.

In the future, LCR salmon and steelhead populations are expected to experience rising water temperatures, decreased summer flows, more frequent marine heat waves, and other climate change impacts. The likelihood of future cycles of poor freshwater and ocean survival and periodic low abundance underscores the importance of resiliency for long-term sustainability. Due to the scope of habitat improvements needed to achieve Plan goals, and differences among watersheds in their potential to support salmon and steelhead into the future, prioritization of habitat protection and restoration work is critical to promoting resilience in LCR populations. Interim habitat restoration goals identified in the Plan remain useful initial targets, but more extensive restoration actions will be needed to mitigate climate change impacts and make progress toward broad sense recovery goals.

Although most of the actions in the Plan have been implemented or are in progress, much work remains. This 12-year assessment identifies priority actions from the Plan that are yet to be implemented, as well as new actions that will contribute to recovery. These adaptive management actions include: 1) incorporating climate change considerations into the development of habitat restoration and protection priorities and actions; 2) updates to the Chum Salmon Recovery Strategy; and 3) research and monitoring actions to clarify the status of some populations. These actions do not represent a major shift in the overall direction of recovery efforts, and the Plan remains the blueprint for achieving desired status for LCR salmon and steelhead populations. Ongoing adaptive management is also needed to achieve recovery goals, and if significant changes in recovery strategies are called for in the future Oregon will need to coordinate with NMFS and the state of Washington to update the recovery plan. Monitoring is a critical component of adaptive management, and ODFW has directed significant resources to monitoring VSP metrics, harvest impacts, and other measurable criteria since Plan adoption. As Plan implementation proceeds over the next 12 years, ODFW will continue to explore ways to efficiently track measurable criteria and fill monitoring gaps. ODFW will also continue to report progress through the ODFW Salmon and Steelhead Recovery Tracker and annual reports (available at: https://www.dfw.state.or.us/fish/crp/lower_columbia_plan.asp).

Section 1: Introduction

The *Lower Columbia River Conservation and Recovery Plan for Oregon Populations of Salmon and Steelhead* (Plan; ODFW 2010b) serves as both a recovery plan under the federal Endangered Species Act (ESA) and a State of Oregon conservation plan under Oregon's Native Fish Conservation Policy (NFCP). The Plan provides a framework and roadmap for the conservation and recovery of three lower Columbia River (LCR) salmon (*Oncorhynchus* species) Evolutionarily Significant Units (ESUs) and one steelhead Distinct Population Segment (DPS; henceforth, the ESUs and DPS will be collectively referred to as ESUs) in Oregon that are listed under the ESA: LCR coho (*O. kisutch*), LCR Chinook (*O. tshawytscha*), LCR steelhead (*O. mykiss*), and Columbia River chum (*O. keta*). These species occupy habitat in Oregon tributaries of the LCR below, and including, the Hood River at river kilometer (rkm) 270 (Figure 1). These species are also present in Washington tributaries to the LCR. The Plan also considers the unlisted steelhead populations in Oregon downstream of the Willamette River belonging to the SW Washington DPS, and the Clackamas spring Chinook population, which is also ESA-listed as threatened as part of the Upper Willamette River Chinook ESU.

Population structure in the Oregon portion of the LCR ESU varies by species and ranges from six to twelve independent populations (Table 1). The independent populations of LCR salmon and steelhead are further grouped into three geographic strata: Coastal, Cascade, and Gorge (Figure 1). There are currently no identified dependent populations where persistence is dependent upon interactions with independent populations.

Oregon's Species Management Unit (SMU) and designated populations in the LCR area differ somewhat from the ESUs and populations defined under the ESA (Table 1). The Oregon approach for describing SMUs, which rely more on life history criteria, designated two SMUs for LCR Chinook and two SMUs for LCR steelhead, with separate spring and fall Chinook SMUs and separate winter and summer steelhead SMUs. The boundaries set by the state and federal governments are also different. For steelhead, the Oregon Lower Columbia Winter Steelhead SMU extends from the mouth of the Columbia River up to and including the winter[3] steelhead population in Fifteenmile Creek (ODFW 2005), while the boundary for the LCR steelhead DPS reaches only from the mouth of the Willamette River up to and including the Hood River. Winter steelhead populations downstream of the Willamette River are assigned to the SW Washington Steelhead DPS (not ESA-listed). Steelhead populations upstream of Hood River are included in the ESA-listed Middle Columbia River Steelhead DPS (Busby et al. 1996, 71 FR 834).) and are addressed in the Conservation and Recovery Plan for Oregon Steelhead Populations in the Middle Columbia River Steelhead Distinct Population Segment (ODFW 2010a). Oregon's two Chinook SMUs are contained within the boundaries of the LCR Chinook ESU. However, while both Oregon and the National Marine Fisheries Service (NMFS) placed

[3] The Fifteenmile Creek steelhead population is classified as a winter run in the Middle Columbia River Steelhead Recovery Plan (NMFS 2009); 10+ years of tagging determined that very few Fifteenmile Creek steelhead return at a time consistent with winter steelhead run timing (Pierson et al. 2017).

the Clackamas fall Chinook population in the LCR, NMFS placed the Clackamas spring Chinook population with the Upper Willamette River ESU, which is also listed as federally Threatened (Myers et al. 1998, 70 FR 37160). Recent genetic analysis (O'Malley et al. 2020) supports previous work that placed Clackamas spring Chinook in the Upper Willamette River ESU. Therefore, the population will hereafter be considered part of the Willamette spring Chinook SMU, is not considered in this assessment, and will be addressed in a future assessment of the Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead (ODFW 2011).

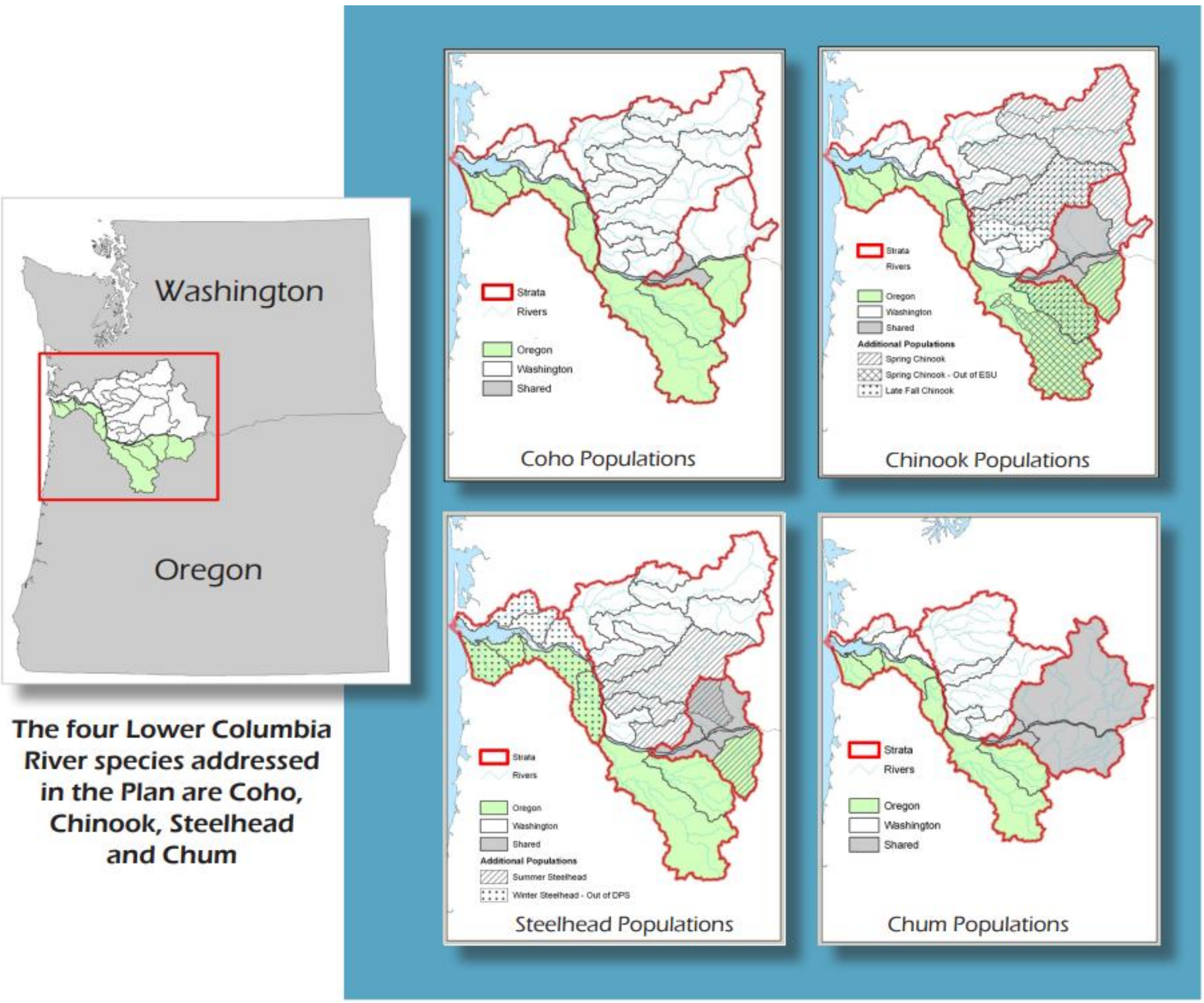


Figure 1. LCR recovery sub-domain by species.

Designations of individual breeding populations also differ somewhat between the State of Oregon and federal conventions (ODFW 2010b), reflecting both the differences in ESU verses SMU boundaries and some alternative population divisions within the ESUs and SMUs (Table 1). The federal convention also takes populations in Washington into consideration and several populations that cross state boundaries. The federal and state conventions similarly include only anadromous *O. mykiss* (steelhead) and exclude resident rainbow trout. Finally, the Plan calls for a reconsideration of Gorge Stratum population designations due to the small amount of historical habitat available compared to other populations within the ESU. This action has not yet been implemented and so this assessment uses the Gorge stratum population designations in the Plan.

Table 1. Federal and Oregon State conservation management units (ESUs, SMUs, and populations) in the LCR.

Federally Listed Species (ESU or DPS)	Federally Recognized Populations	Federal Listing Status	Corresponding State Management Unit (SMU)	State Recognized Populations	State Status
Lower Columbia River Coho	Youngs Bay Big Creek Clatskanie Scappoose Clackamas Sandy Lower Gorge Upper Gorge/Hood	Threatened	Lower Columbia Coho	Youngs Bay Big Creek Clatskanie Scappoose Clackamas Sandy Bonneville	Endangered
Lower Columbia River Chinook (spring and fall runs)	Youngs Bay (*fall*) Big Creek (*fall*) Clatskanie (*fall*) Scappoose (*fall*) Clackamas (*fall*) Sandy (*fall*) Sandy (*late fall*) Lower Gorge (*fall*) Upper Gorge (*fall*) Hood (*fall*) Sandy (*spring*) Hood (*spring*)	Threatened	Lower Columbia Fall Chinook	Youngs Bay Big Creek Clatskanie Scappoose Clackamas Sandy (tule) Sandy (late) Hood	Sensitive-Critical
			Lower Columbia Spring Chinook	Sandy Hood	Sensitive-Critical
Lower Columbia River Steelhead (winter and summer runs)	Clackamas (*winter*) Sandy (*winter*) Lower Gorge (*winter*) Upper Gorge (*winter*) Hood (*winter*) Hood (*summer*)	Threatened	Lower Columbia Winter Steelhead	Youngs Bay Big Creek Clatskanie Scappoose Clackamas Sandy Gorge Hood Fifteenmile	Sensitive-Critical
			Lower Columbia Summer Steelhead	Hood	Sensitive-Critical
Columbia River Chum	Youngs Bay Big Creek Clatskanie Scappoose Clackamas Sandy Lower Gorge Upper Gorge	Threatened	Lower Columbia Chum	Youngs Bay Big Creek Clatskanie Scappoose Clackamas Sandy Gorge	Sensitive-Critical

Oregon has adopted two recovery goals for LCR salmon and steelhead. The Plan discusses the current status, desired status, and strategies and actions needed to achieve these recovery goals, which are two:

1) achieve delisting from the federal ESA threatened and endangered species list, and
2) achieve "broad sense recovery", defined as having Oregon populations of naturally produced salmon and steelhead sufficiently abundant, productive, and diverse (in terms of life histories and geographic distribution) that the ESUs as a whole (a) will be self-sustaining, and (b) will provide significant ecological, cultural, and economic benefits.

The Plan calls for a comprehensive assessment of the status of each ESU twelve years after Plan adoption (through return year 2022), including performance of fish populations, trends in habitat, and implementation and effectiveness of restoration and management commitments. This document is the first 12-year assessment of the Plan, and it includes a review of Plan implementation since adoption in 2010; a status assessment of LCR salmon and steelhead populations based on measurable criteria identified in the Plan, including evaluation of progress toward delisting goals; and an assessment of measurable criteria relating to ESA listing factors. Consistent with the Plan and ODFW's Climate and Ocean Change Policy, the 12-year assessment also reviews climate and ocean change projections relevant to Plan species, summarizes climate change vulnerability, and identifies adaptation strategies and actions to ameliorate potential negative impacts and promote population resilience. Finally, the 12-year assessment provides recommendations for adaptive management based on the Plan implementation review, population status assessments, and climate and ocean change vulnerability.

ESU and Population Status

In 2007, NMFS and ODFW completed a status assessment of the fish populations covered by the Plan to inform recovery planning (McElhany et al. 2007). The assessment evaluated extinction risk for LCR populations based on the four Viable Salmonid Population (VSP) attributes identified by McElhany et al. (2000): abundance, productivity, diversity, and spatial structure. The results were used in the Plan to describe current status and to develop scenarios for delisting and broad sense recovery that represent the desired status for these populations and ESUs (Table 2). The following section briefly describes the listing status of LCR ESUs/SMUs, status of their component populations at the time of Plan adoption, and desired status under a delisting scenario.

This report uses the term "current status" throughout the document and its appendices. Current status was determined in 2007 using population viability assessment models which predicts extinction risk by population. This 12-year assessment does not include re-running the models to evaluate the most current extinction risk but uses evaluation criteria informed by research and monitoring to evaluate progress in status improvement.

NMFS also conducts periodic status reviews (NMFS 2016; NMFS 2022). Section 4(c)(2) of the ESA directs the Secretary of Commerce to review the listing classification of threatened and endangered species at least once every five years. A 5-year review is a periodic analysis of a species' status conducted to ensure that the listing classification of a species as threatened or endangered on the List of Endangered and Threatened Wildlife and Plants (List) (50 CFR 17.11 – 17.12; 50 CFR 223.102, 224.101) is accurate (USFWS and NMFS 2006; NMFS 2020). The periodic review is like Oregon's in that it evaluates VSP and listing factor metrics and does not model extinction risk class. NMFS evaluates status at the ESU level (Oregon and Washington populations).

LCR Coho Salmon ESU / Lower Columbia Coho SMU

The LCR Coho Salmon ESU was originally listed as threatened under the ESA in 2005 (70 FR 37160) and subsequent status reviews have concluded that no reclassification is warranted (NMFS 2016; NMFS 2022). The Lower Columbia Coho Salmon SMU is listed as endangered by the state of Oregon and is provided with specific management and recovery guidelines by Oregon Administrative Rule (OAR 635-100-0125, OAR 635-100-0190 to 0194). During the 2007 status assessment, the most probable conservation status for six of Oregon's eight LCR coho ESU populations was a classification of high or very high extinction risk. The most probable status classification for the Scappoose and Clackamas populations was a moderate extinction risk (Figure 2). Desired status in the de-listing scenario described in the Plan is a low or very low extinction risk for all populations except Youngs Bay and Big Creek (Figure 2).

LCR Chinook Salmon SMU / Lower Columbia Fall Chinook and Spring Chinook SMUs

The LCR Chinook Salmon ESU was originally listed as threatened under the ESA in 1999 (64 FR 14308), with a final listing occurring in 2005 (70 FR 37160). Subsequent status reviews of the ESU have concluded that no reclassification is warranted (NMFS 2016; NMFS 2022). In the 2007 status assessment, only one Oregon population, Sandy late fall Chinook, was determined to have a low extinction risk (i.e., viable). Sandy spring Chinook had a moderate extinction risk and the remaining ten Oregon populations had extinction risk classifications in the high and very high categories (Figure 2). Desired status in the de-listing scenario described in the Plan is a low or moderate extinction risk for all fall Chinook populations except Youngs Bay and Big Creek, very low extinction risk for Sandy late fall Chinook, and low or very low extinction risk for the two spring Chinook populations in the ESU (Figure 2).

LCR Steelhead DPS / Lower Columbia Winter Steelhead and Summer Steelhead SMUs

The LCR Steelhead DPS was originally listed as threatened under the ESA in 1998 (63 FR 13347), with a final listing occurring in 2006 (NMFS 2006). Subsequent status reviews of the DPS have concluded that no reclassification is warranted (NMFS 2016; NMFS 2022). In the 2007 status assessment, all five winter steelhead populations in Oregon were classified as having a moderate to high extinction risk, and Hood summer steelhead were classified as having a very high extinction risk (Figure 2). Desired status in the de-listing scenario described in the Plan is a low to very low extinction risk for all populations except the Upper Gorge (Figure 2). Status assessment results for the Oregon portion of the SW Washington DPS (not ESA-listed) indicated that steelhead populations were most likely in the very low or low extinction risk categories (Figure 2). Desired status for these populations is a very low extinction risk consistent with broad sense recovery.

Columbia River Chum Salmon ESU / Lower Columbia Chum SMU

The Columbia River Chum ESU was originally listed as threatened under the ESA in 1999 (64 FR 14508), with a final listing occurring in 2005 (70 FR 37159). Subsequent status reviews of the ESU have concluded that no reclassification is warranted (NMFS 2016; NMFS 2022). In the McElhany et al. (2007) status review, Oregon's Columbia River chum salmon populations were considered either extremely depressed or functionally extirpated (Figure 2). Desired status for the Oregon portion of the ESU is six restored populations with low to moderate extinction risk (Figure 2).

Table 2. Summary of current status and delisting scenario from the Plan's scenario analysis. The desired status (overall risk class) for populations which are not part of an ESA-listed ESU are indicated by italics. For shared populations, the overall risk class for both the Oregon portion and the entire population (in parenthesis, determined by Washington), are indicated. Note that there is no current status or delisting scenario for chum salmon. Confidence tags are Plan estimations of the ability of salmonid populations to achieve the delisting scenario. Populations listed as unlikely to achieve are typically associated with low amounts of historical habitat and anthropogenic impacts unlikely to change in the near future.

		Current		Delisting Scenario				
Species / Stratum (Run)	Population	Abundance	Overall Risk Class	Contribution to Delisting	Abundance	A&P Gap	Overall Risk Class	Confidence
COHO								
Coast								
	Youngs Bay	4	VH	Stabilizing	7	3	VH	Exceed
	Big Creek	8	VH	Stabilizing	12	4	VH	Exceed
	Clatskanie	1,363	H	Primary	3,201	1,838	VL	Achieve
	Scappoose	1,942	M	Primary	3,208	1,266	VL	Exceed
Cascade								
	Clackamas	6,548	M	Primary	11,232	4,684	VL	Exceed
	Sandy	1,622	VH	Primary	5,685	4,063	L	Achieve
Gorge								
	Lower Gorge*	22	VH	_Support WA (L)_	962	940	H (L)	Achieve
	Upper Gorge/Hood	41	VH	Primary	5,203	5,162	L	Unlikely
CHINOOK								
Coast (Fall)								
	Youngs Bay	379	H	Stabilizing	505	126	H	Exceed
	Big Creek	216	VH	Contributing	577	361	H	Achieve
	Clatskanie	6	VH	Primary	1,277	1,271	L	Exceed
	Scappoose	356	H	Primary	1,222	866	L	Exceed
Cascade (Fall)								
	Clackamas	558	VH	Contributing	1,551	993	M	Exceed
	Sandy	144	VH	Contributing	1,031	887	M	Achieve
Gorge (Fall)								
	Lower Gorge*	74	VH	_Support WA (M)_	387	313	H (M)	Achieve
	Upper Gorge*	17	VH	_Support WA (M)_	87	70	VH (M)	Achieve
	Hood	33	VH	Primary	1,245	1,212	L	Unlikely
Cascade (Late Fall)								
	Sandy	1,794	L	Primary	3,858	2,064	VL	Achieve
Cascade (Spring)								
	Clackamas	1,371	M	_N / A_	8,377	7,006	(VL)	Achieve
	Sandy	714	M	Primary	1,230	516	L	Exceed
Gorge (Spring)								
	Hood	327	VH	Primary	1,493	1,166	VL	Exceed
STEELHEAD								
Coast (Winter)								
	Youngs Bay	2,486	VL	_N / A_	4,733	2,247	_(VL)_	Achieve
	Big Creek	1,143	L	_N / A_	3,182	2,039	_(VL)_	Achieve
	Clatskanie	2,451	VL	_N / A_	3,982	1,531	_(VL)_	Achieve
	Scappoose	3,245	VL	_N / A_	5,169	1,924	_(VL)_	Achieve
Cascade (Winter)								
	Clackamas	3,897	M	Primary	10,671	6,774	L	Unlikely
	Sandy	674	H	Primary	1,519	845	VL	Exceed
Gorge (Winter)								
	Lower Gorge*	550	M (H)	_Support WA (L)_	881	331	M (L)	Achieve
	Upper Gorge*	151	VH (H)	_Support WA (H)_	235	84	VH (H)	Achieve
	Hood	1,127	M	Primary	2,079	952	L	Exceed
Gorge (Summer)								
	Hood	35	VH	Primary	2,008	1,973	L	Unlikely

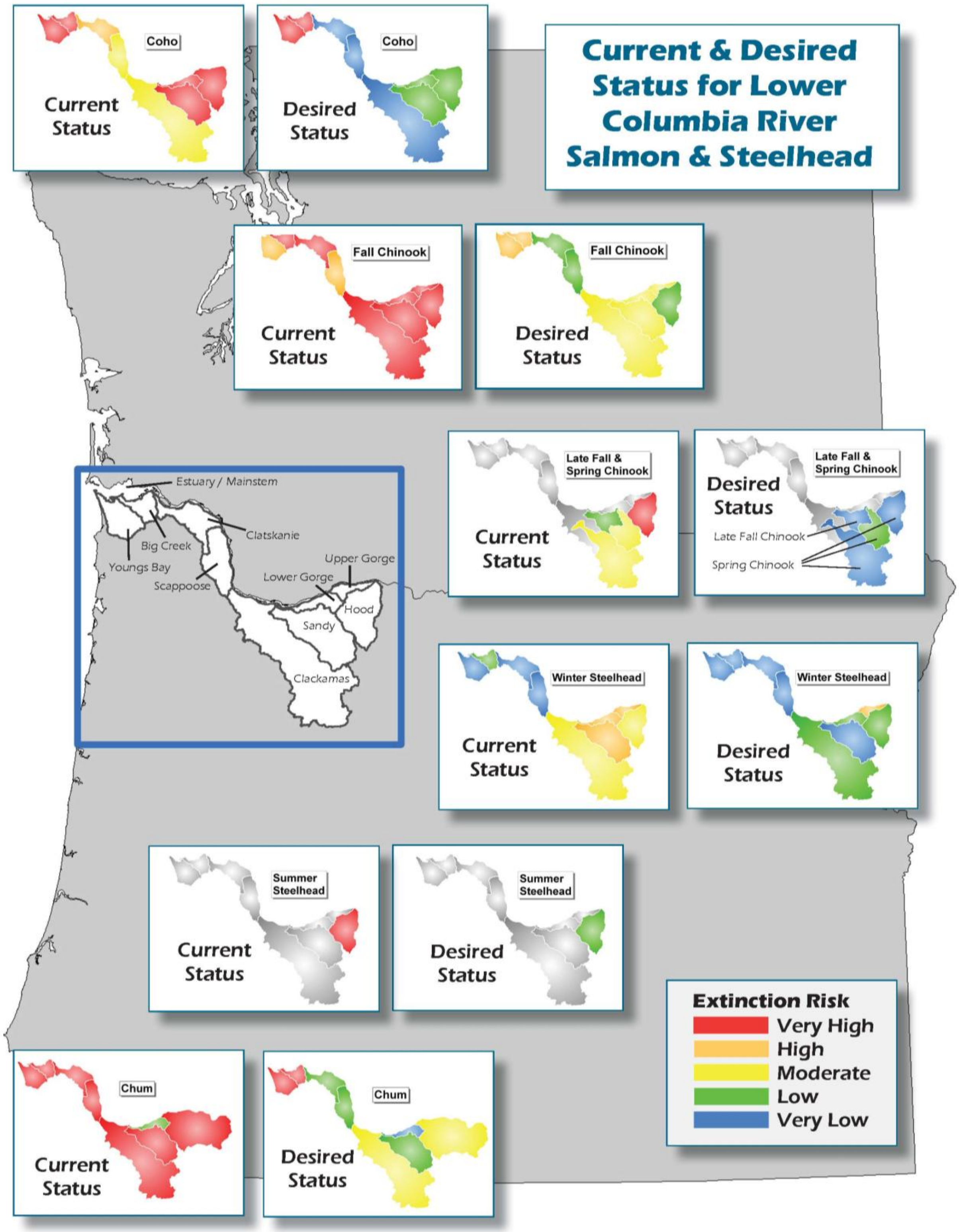


Figure 2. Current (2007) and desired status of LCR salmon and steelhead populations in the Plan.

Section 2: Plan Implementation

Strategies and actions were identified in the Plan from the best available science to address threats and limiting factors and recover LCR salmon and steelhead in Oregon. The Plan is based primarily on voluntary implementation of proposed recovery actions, and existing laws, regulations, and agreements, although it is acknowledged that regulatory agencies may use the Plan to guide their decisions. The Plan is intended to provide structure and guidance to local efforts to protect and restore salmonids and their habitat throughout the ESU while providing the flexibility for some actions to be determined locally (e.g., through landowners, watershed groups, etc.) with technical guidance and funding support from local, state and federal natural resource agencies.

General threats, defined as human actions that cause or contribute to limiting factors for LCR salmon and steelhead, are defined in the Plan (Table 3). From these identified threats, strategies and actions were developed to reduce the mortality rates associated with each general threat to meet the delisting scenarios developed in the Plan. Development of strategies in combination with their relevance to the six general threats (tributary habitat, estuary habitat, predation, harvest, hatcheries, and hydropower) assisted the planning and stakeholder teams with the development of a list of general actions applicable to the entire ESU, as well as specific actions for independent populations at specific locations. Each of the identified actions was also given a time frame for implementation. These time periods varied from immediately to 25 years—well beyond the initial 12-year period covered by this assessment.

Most actions identified in the Plan must be implemented through a coordinated effort of multiple organizations and land managers/owners with an interest in the resource involved. Therefore, it will take a concerted effort on the part of all local, state, federal, tribal, private, corporate, non-governmental, and other interested and affected entities within the LCR and beyond to achieve the goals of the Plan. Furthermore, protection and enhancement efforts will likely need to be sustained over several decades to achieve delisting and broad sense recovery goals. Estimated costs to implement recovery actions identified in the Plan are expected to exceed $750 million over a 25-year period.

Chum and fall Chinook salmon habitat restoration will be particularly difficult given that larger human population centers overlap with high use areas for these species, making habitat restoration more challenging. Additionally, there are threats associated with a changing climate that, while uncertain, will likely have significant impacts on these habitats.

Over 300 actions, some with multiple sub-actions, are listed in the Plan. Of these actions, 264 (86 percent) have been completed, are in progress, or are ongoing. For actions listed as “to be completed within the first 10 years”, 80 percent have been completed, are in progress, or are ongoing. The following sections summarize Plan implementation for each general threat category, as well as implementation of Oregon’s Columbia River Chum Salmon Recovery Strategy. See Appendix I and Appendix II for detailed information about implementation of Plan actions.

Table 3. General threat categories and definitions in the Plan.

Threat Category	How Threats Cause or Contribute to Limiting Factors
Tributary Habitat Management	Tributary habitat conditions are impacted both by current and past land use practices which promote limiting factors and impair fish populations. These practices include agricultural, timber harvest, mining and grazing activities, diking, damming, development of transportation corridors, and urbanization.
Estuary Habitat Management	Land and water management activities, combined with the effects of the hydropower/flood control system, have changed estuarine habitat conditions in the Columbia River estuary. Complex habitats have been lost or modified through flow alterations, channelization, diking, development, and other practices.
Hydropower and Flood Control Management	Hydropower and flood control management cause a loss or alteration of stream habitat. Management includes dam construction and operations, conversion of riverine habitat to reservoir, and water withdrawals and flow alterations.
Harvest Management	Fisheries cause direct and incidental mortality to naturally produced fish. Direct mortality is associated with fisheries that are managed to specifically harvest target stocks. Incidental mortality includes mortality of fish that are caught and released, encounter fishing gear but are not landed, or are harvested incidentally to the target species or stock. Fisheries can also result in genetic selection (e.g. size or age).
Hatchery Management	Hatchery programs can harm salmonid viability in several ways: hatchery-induced genetic change can reduce fitness of natural origin fish; hatchery-induced ecological effects—such as increased competition for food and space—can reduce population productivity and abundance; hatchery-imposed environmental changes can reduce a population's spatial structure by limiting access to historical habitat. Hatchery programs can potentially benefit salmonid viability by contributing to increasing natural-origin fish abundance and spatial distribution, by serving as a source population for repopulating unoccupied habitat and by conserving genetic resources. Hatchery practices that affect natural fish production include removal of adults for broodstock, breeding practices, rearing practices, release practices, number of fish released, reduced water quality, and blockage of access to habitat.
Predation	Predation on, and consumption of, lower Columbia salmon and steelhead by birds, piscivorous fish, marine mammals, and other species can affect salmonid viability by reducing abundance, productivity, and/or diversity.

Tributary Habitat Management

Over the last two hundred years, many once important habitat areas for LCR salmon and steelhead populations have been degraded through widespread development and land use activities that affected habitat quality and complexity, floodplain connectivity, watershed hydrology, and water quality in many LCR subbasins. Elevated stream temperatures often exist because of a combination of factors, including water withdrawals and/or altered hydrology and a lack of intact, functional, and contiguous riparian management zones and sufficient streamside buffers. In some areas, water quality has also been reduced because of contaminants for agricultural use.

The planning team identified actions in the Plan to address threats and limiting factors associated with tributary habitat management and to improve the survivorship and viability of LCR salmon and steelhead populations. Table A-I: 1 in Appendix I contains the Plan actions associated with Tributary Habitat Management and describes implementation progress during the 12 years since Plan adoption. Tributary habitat actions are focused on protecting and restoring stream habitat (adequate pools/glides/riffles, side channels, cover structures, spawning gravels) and water quality/quantity.

Since Plan adoption, 83 percent of the actions associated with Tributary Habitat Management are in progress, ongoing, or completed. Every major watershed council within the ESU has updated their strategic actions plans (SAPs) to use updated inventories and Plan priorities to improve the likelihood of achieving desired watershed status goals and implement restoration projects in the highest priority areas. Following approval of the Plan, ODFW identified initial 15-year goals for restoration in all independent populations consistent with the delisting scenario and feasibility considerations (Brick 2012). Two population areas (Youngs Bay and Sandy) have achieved all the initial restoration goals, and several population areas have achieved the initial goals for off-channel and riparian habitat restoration (see Table A-III: 4 and Figure A-III: 60 in Appendix 3).

For the ESU to meet the initial revised goals for habitat restoration, additional funding and capacity is needed, particularly within the Coastal and Gorge strata. Partners within the Sandy and Clackamas population areas (Cascade stratum) are implementing multiple restoration projects yearly. The Hood population area is also receiving multiple projects yearly, but there is no entity conducting restoration in the Upper Gorge population area and limited restoration in the Lower Gorge population area. Restoration in the Coastal stratum population areas is led by the Scappoose, but restoration in the Big Creek and Clatskanie population areas has been very limited relative to delisting scenario goals.

Having a large metropolitan area within the ESU poses challenges for recovery but has also provided opportunities and resources for habitat protection and improvement. All municipalities, cities and road departments have requirements to treat contributing storm water. The City of Portland also has a non-mandatory program, initially called the Grey to Green program, and revitalized in the Green Streets program, which has implemented dozens of voluntary storm water projects every year. Metro, through voter approved Parks and Nature bonds, has worked strategically with partners, including ODFW to identify priority habitat locations to purchase property. Over 1,000 acres of habitat has been secured in priority locations in the Clackamas, Sandy, and Scappoose population areas. These purchases are followed up with restoration and contribute to restoration goals in addition to protecting some of the best available habitat.

Estuary Habitat Management

Estuarine habitat conditions have been modified by land and water management activities, combined with the effects of the hydropower/flood control system, resulting in reduced habitat quality, food sources, and access to off-channel habitats. Habitat alteration through dredging, disposal of sand/gravel, wetland filling, instream and over-water structures, dikes, and navigational structures have significantly altered estuary size and function and reduced connectivity with peripheral wetland and side channel habitat. As a result of these changes, LCR estuary surface area has decreased by approximately 20 percent over the past 200 years (Fresh et al. 2005). Land and water development activities in the Columbia River basin have also led to reduced water quality in the estuary. These conditions affect salmonid abundance, productivity, spatial structure, and diversity.

The planning team identified actions in the Plan to address threats and limiting factors associated with estuary habitat management and to improve the survivorship and viability of LCR salmon and steelhead populations. Table A-I: 2 in Appendix I contains actions associated with the Estuary Habitat Management threat in the Plan and describes implementation progress during the 12 years since Plan adoption. Estuary habitat actions seek to protect and restore habitat complexity (shallow waters, side channels, cover vegetation and structures, riparian areas, wetlands), habitat accessibility (tide gates, other structures) and water quality/quantity. Many of these actions came from the Estuary Module (LCREP 2006) and apply to the mainstem Columbia River from its mouth to Bonneville Dam and the Lower Willamette River below Willamette Falls.

Since Plan adoption, 81 percent of the actions associated with Estuary Habitat Management are in progress, ongoing, or completed. The Columbia River Estuary Ecosystem Restoration Program is funded by the Federal Columbia River Power System (FCRPS) Action Agencies (US Army Corps of Engineers, Bonneville Power Administration, and the Bureau of Reclamation) through NOAA's biological opinion (BiOp) for operation of the FCRPS. The Lower Columbia Estuary Partnership administers the program with an overall goal to implement and monitor strategic, well-coordinated, scientifically sound projects designed to rehabilitate, enhance, protect, conserve, create, and restore 16,000 acres of tidal wetlands and other key habitats to support native species from the river's mouth to Bonneville Dam. Since 2010, over 1,700 acres were protected and access to over 3,100 acres of wetland has been restored.

Hydropower and Flood Control Management

Hydropower and flood control management have caused the loss or alteration of stream habitat due to dam construction and operations, conversion of riverine habitat to reservoir, and water withdrawals. The ability of juvenile salmon to access and benefit from habitat depends greatly on instream flow (Fresh et al. 2005). Management of the Columbia River system for hydropower, flood control and other uses has significantly altered the lower Columbia River's natural hydrograph through a change in the quantity and timing of flows entering the Columbia River estuary and plume (NMFS 2008b). Changes in the magnitude, timing, and frequency of flows over the last 200 years have resulted in corresponding changes in formation and availability of salmonid habitats.

Hydropower projects on several lower Columbia River tributaries also affect salmon and steelhead viability. Dams in the Willamette River system alter the flow regime in the lower Willamette River by controlling downstream flooding in the winter, nearly doubling the flow in the summer, and altering channel dynamics (Primozich and Bastasch 2004). These flow alterations, along with changes in channel structure, are responsible for decreasing habitat complexity in the lower Willamette River. Hydropower projects in the Clackamas, Sandy and Hood River population areas have also restricted habitat access, influenced population traits, and degraded habitat quality.

The planning team identified actions in the Plan to address threats and limiting factors associated with hydropower and flood control management and to improve the survivorship and viability of LCR salmon and steelhead populations. Table A-I: 3 in Appendix I contains the Plan actions associated with Hydropower and Flood Control Management and describes implementation progress during the 12 years since Plan adoption. Hydropower actions generally have ties to legal requirements associated with operations. Since Plan adoption, all actions associated with hydropower and flood control management are in progress, ongoing, or completed.

Most hydropower actions associated with the mainstem Columbia River were developed from reasonable and prudent alternatives (RPAs) associated with the NOAA's 2008 BiOp for operating the Federal Columbia River Hydropower system. Since that time, the BiOp was supplemented in 2010 and 2014 and a new BiOp was released in 2019. The 2019 Columbia River system BiOp incorporated the 2019-2021 Spill Operation Agreement that resulted from collaboration between the action agencies, the states of Oregon and Washington, and the Nez Perce tribe. The operation implemented a flexible approach to providing additional spill as a tool intended to support spring juvenile fish downstream passage in concert with managing the Columbia River System for multiple purposes. The Agreement called for increased spill to aid juvenile passage when power prices are low and reduced spill to allow additional power generation when prices are higher. In general, spill was decreased for 16 hours of the day and increased for eight hours. The Agreement represents a milestone—for the first time in decades, parties with divergent ideas on how dams in the lower Snake and Columbia Rivers should be operated have worked together to develop a plan that may benefit multiple competing interests. While it is still too early to gauge the full efficacy of these new operations, ODFW believes the agreement itself, signed or supported by every regional sovereign, was a step in a direction towards providing greater protections for Columbia River salmon and steelhead.

Portland General Electric (PGE) operates the Westside Hydropower Project on the Clackamas River and is meeting or exceeding all requirements of their fish passage and protection plan required through the Federal Energy Regulatory Commission (FERC). The number of natural origin adult coho salmon returning to the upper Clackamas in 2022 was over 13,000 fish, the largest return observed at North Fork Dam since its construction and the start of data collection in 1958. Survival rates of juvenile salmonids through the bypass pipeline are approximately 99 percent, and collection rates are among the highest in the region. Juvenile fish using the new fish passage facilities realized a reduction in travel time from as many as twelve days down to only two and half hours. This allows juveniles to arrive in the lower Willamette River a bit earlier when water temperatures are cooler and predators are less active, increasing their odds of survival to the ocean. These survival gains, compounded by beneficial ocean conditions, have resulted in stronger adult returns in recent years.

In addition to improvements at the Clackamas Hydroelectric project, Powerdale Dam on the Hood River was removed in 2010, restoring full fish passage at this site. Clear Branch Dam (Laurance Lake Dam) in the Middle Fork Hood River is the only remaining project where fish passage has not been restored. The U.S. Department of Agriculture Natural Resources Conservation Service (USDA-NRCS) in Oregon, in cooperation with the U.S. Forest Service (USFS) and the Middle Fork Irrigation District, is currently considering alternatives for the rehabilitation of Clear Branch Dam.

Harvest Management

LCR salmon and steelhead may be caught in ocean, estuary, mainstem Columbia River, or tributary fisheries depending on their distribution, run timing relative to fishery openings, and vulnerability to gear. Many natural origin salmon and steelhead populations in the Columbia River are listed under the Federal Endangered Species Act. Therefore, fishery managers must strive to maintain fishery impacts below established limits that are not expected to impede recovery. To meet this objective, managers continuously review population abundances and adjust recreational, commercial, and tribal fisheries accordingly. For many populations, authorized take is guided by Abundance Based Management (ABM) matrices which are approved by NOAA Fisheries to scale take limits to the run size. These limits vary yearly and range from 1-41 percent, depending on the species and/or stock

The plan used an average long-term modeled rate (100-year) of 25 percent for coho and spring Chinook, 35-40 percent for fall Chinook and 10 percent for steelhead in the delisting scenarios. By adhering to the yearly ABM fishery impact rates over a 100-year period the average impact rates will be within the range that the delisting scenario analysis were created. Fishery impacts include direct mortality of target species that are managed by stock for harvest as well as incidental mortality of target and non-target species that are caught and released/not landed.

Fishery managers forecast annual abundance and adjust allowable harvest to achieve established escapement goals or to stay within specified harvest rate limits on natural origin stocks. They generally try to manage fisheries using a combination of gear, time, area, and mark-selective regulations to optimize the harvest of strong (generally hatchery) stocks within the series of constraints for weak stock protection. As a result, fishery impact rates for most hatchery-produced Chinook, coho, and steelhead are higher than for natural origin fish of the same species.

The planning team identified actions in the Plan to address threats and limiting factors associated with harvest management and to improve the survivorship and viability of LCR salmon and steelhead populations. Table A-I: 4 in Appendix I contains the Plan actions associated with Harvest Management and describes implementation progress during the 12 years since Plan adoption. Since Plan adoption, 93 percent of the actions are in progress, ongoing, or completed.

Prior to Plan development, NMFS took a conservative approach to setting exploitation rate limits for LCR coho largely due to the limited data available to inform Oregon's harvest matrices, which were based on data from the only two coho populations (Clackamas and Sandy) for which natural production trends could be estimated (NMFS 2008a; NMFS 2015). Concerns existed over setting annual exploitation rates based on annual escapement to the two strongest populations within the ESU. During 2010-2014 a new harvest control rule for ocean and mainstem Columbia River (including Select Area) fisheries was developed using the average annual escapement across additional coho populations considered "weak populations" to improve escapement across all populations. Use of this harvest control rule was initiated in 2015 and has been used annually since to establish the harvest limit for natural origin coho.

Columbia River Mainstem Fisheries:

Mainstem Columbia River fish management occurs under the authority of the United States v. Oregon Management Agreement, state laws, the Columbia River Compact, the Pacific Salmon Treaty, and federal laws including the ESA and the Magnuson-Stevens Fishery Conservation and Management Act (MSA). The fisheries management system that impacts Columbia River salmon and steelhead populations has changed over the years because of these governing pacts. Actions which have occurred since Plan adoption, which are believed to have reduced impacts to LCR salmon and steelhead populations are:

- Since 2017, summer steelhead returns have decreased system-wide. As a result, additional harvest control was implemented throughout the mainstem, likely reducing overall impacts on summer steelhead stocks.
- To help reduce LCR fall chinook pHOS, varying amounts of hatchery only retention is incorporated into LCR fall mainstem recreational fisheries.
- In 2012, harvest shifted to an abundance-based management strategy for fall chinook, which reduced the exploitation rate for some LCR fall chinook.
- There has been a general shift in fall net commercial fisheries to zones 4-5, potentially improving escapement to areas downstream of the tributary junction with the Willamette River.

Columbia River Salmon Fishery Management Policy 2012

The current iteration of Columbia River harvest reform was initiated in 2012 by then-governor John Kitzhaber as an alternative to a citizen's initiative seeking to ban non-tribal commercial gill nets and tangle nets in all inland waters of the State. Governor Kitzhaber asked the Oregon Fish and Wildlife Commission (OFWC) to address the "perennial and divisive conflicts" that involve recreational and non-tribal commercial fisheries on the Columbia River, including gear conflicts, allocation of harvest and available wild fish impacts, and conservation needs. Consistent with this vision and direction, OFWC adopted administrative rules implementing guiding principles and management strategies for a new fisheries framework for LCR non-tribal fisheries (Columbia River Fisheries Reform). Harvest reform was not a listed action within the Plan but elements identified as part of the reform process such as researching and developing live capture gear and techniques and implementing mark selective mainstem commercial fisheries if feasible, are listed actions.

The guiding principles of Columbia River Fisheries Reform included shifting allocation of allowable impacts to ESA-listed salmonids to provide a stronger recreational priority in the mainstem, enhancing off-channel hatchery releases to augment commercial harvest, limiting gillnets to off-channel fisheries, developing alternative gears and techniques for commercial mainstem fisheries, and strengthening conservation of native fish. A key provision in the Harvest Reform Policy was the intent to explore development of alternative commercial gears that would allow further implementation of mark-selective regulations in non-tribal commercial fisheries in the mainstem Columbia River.

The reform required an initial review in 2014 and a comprehensive review at the end of the transition period in January 2017. The review and report (ODFW 2019) provide a comprehensive analysis of all the guiding principles including alternative commercial fishing gear feasibility evaluations and alternative gear post-release survival evaluations. Based on an analysis of the evaluation results for 13 combinations of alternative gears and seasons during 2009-2017, ODFW graded each of the alternative commercial gears with respect to key criteria to assess the feasibility of the gears for implementation in mark-selective commercial fisheries in the mainstem LCR.

Most gears evaluated were historically used to commercially harvest salmon in the Columbia River. To facilitate the live release of non-target fish, gears needed to have a design suggesting the potential to capture fish in good condition. The alternative commercial gears described in the report were evaluated based on eight key criteria: catch rate of target species, mark rate of target species, condition of non-retainable catch, potential accrual of ESA impacts, gear/boat investment costs, regulatory requirements, and social issues/concerns.

Some of the key findings for alternative gear feasibility were:

- No single gear type was successful in all evaluated categories; therefore, all alternative gears represented a set of trade-offs.
- Fall purse and beach seines, shad purse seine, fall pound net (2017), and fall tributary weir had moderate target fish catch rates; most alternative gears had low catch rates of target fish.
- Condition of released non-retainable fish was relatively good in all alternative gears.
- Most alternative gears exhibited relatively high handle rates for non-retainable fish (including unmarked fish of the target species), suggesting ESA impact limitation issues even at high post-release survival rates. This was particularly true for steelhead handled during the fall season.
- Due to high costs and limited harvest potential, alternative gears examined to date were assessed to be neither likely to benefit the non-treaty commercial fishery overall, nor many individual Columbia River commercial fishers. High handle of non-retainable fish, particularly steelhead (natural-origin and hatchery), in many of the gears also raises concerns regarding efficient use of limited ESA impacts. Alternative gears may be more effective in smaller scale mark-selective commercial fisheries in particular locations at certain times to achieve specific purposes (e.g. removal of surplus hatchery fish in or around a tributary mouth).

The Columbia River Fisheries Reform process and report show the complexities of mixed-stock commercial harvest management and indicate that trade-offs occur regarding use of ESA impacts in pursuit of harvesting healthy stocks. Mixed-stock fisheries are systems that consist of multiple populations of fish with sizes amenable to resource management and are harvested simultaneously. When different stocks have varying levels of abundance, productivity, and vulnerability to fishing pressure, fishery managers often are faced with the competing objectives of protecting the more vulnerable stocks while maximizing sustainable harvest on remaining healthy stocks (Jensen et al. 2021). Additional actions implemented because of harvest reform which likely improve the status of LCR salmon and steelhead are:

- Since 2016, Columbia River mainstem winter/spring non-treaty commercial fisheries have been significantly reduced contributing to reduced winter and summer steelhead incidental mortality.
- Since 2016, Columbia River mainstem summer non-treaty commercial fisheries have not occurred, reducing impacts to incidental summer steelhead mortality.
- Since 2015, Columbia River mainstem coho-directed gillnet fisheries have not occurred, reducing impacts to LCR coho.
- Since 2013, implementation of non-treaty commercial mark-selective coho tangle net in zones 1-3 occurred, reducing coho pHOS.
- Since 2015, Columbia River mainstem fall Chinook–directed gillnet fisheries have not occurred in zones 1-3, potentially improving escapement to the Scappoose, Clatskanie, Youngs Bay and Big Creek populations.

Hatchery Management

NOAA (2024) reports that 80 percent of salmon and steelhead that return to the Columbia River basin were hatched and reared in hatcheries. Hatcheries are necessary to mitigate the loss of naturally produced salmonids due to the construction and operation of hydroelectric dams. These hatchery fish support crucial commercial, sport, and tribal fishing opportunities as well as the development of conservation hatchery programs to support imperiled populations and reintroduce fish to locations where they have been extirpated. The economic impact of these hatcheries varies yearly but provides tens to hundreds of millions of dollars annually to local communities and supports thousands of jobs (NMFS 2014). Hatchery programs have the potential to benefit or harm salmonid population viability by affecting abundance, productivity, spatial structure, and/or diversity. Hatchery-related risks to salmon population viability include genetic changes that reduce fitness of natural origin fish; potential for disease transmission; and ecological effects, such as increased competition for food and space or amplified predation risk. Hatchery infrastructure can also impose environmental changes, including migration barriers that limit access to historical habitat. Conversely, hatchery programs can benefit salmonid viability by supplementing natural spawning and thereby increasing total fish abundance and/or spatial distribution, by serving as a source population for re-populating unoccupied habitat, and by conserving genetic resources.

Today, hatchery fish dominate salmon and steelhead production in the LCR region. The region contains 25 salmon and steelhead production hatcheries, as well as many associated rearing facilities and acclimation sites. Together these artificial production programs release millions of fall Chinook, spring Chinook, coho, chum and steelhead into LCR subbasins each year. In addition to these releases, hatchery releases made in other ESUs/DPSs in the Columbia River basin migrate through the LCR as juveniles and adults and can also impact populations in this region.

The planning team identified actions in the Plan to address threats and limiting factors associated with hatchery management and to improve the survivorship and viability of LCR salmon and steelhead populations. Table A-I: 5 in Appendix I contains the Plan actions associated with Hatchery Management and describes implementation progress during the 12 years since Plan adoption. Over the 12 years since Plan adoption, 81percent of the actions have been completed, are ongoing, or are in progress. PHOS is used as an indicator of risk from hatchery fish in the Plan. The Plan also lists several actions to shift production from the upper ESU to the lower portions of the ESU, which are designated as higher viability risk in recovery scenarios due to an existing heavy hatchery influence. For example, releases of over 1 million hatchery coho smolts were reprogrammed to the Youngs Bay and Big Creek populations from other locations. Another 1.2 million hatchery coho, reared at Bonneville Hatchery, were eliminated as upper basin coho recolonized, reducing potential effects from hatchery fish on LCR ESU stocks.

ODFW has implemented several actions in the Plan intended to reduce hatchery management risks from the Sandy River spring Chinook hatchery program. All program releases are now acclimated in the Bull Run River, and a weir is used to remove returning hatchery fish not harvested in fisheries. These efforts have kept stray rates consistently below Plan targets and allowed the program to slowly expand as the natural origin population has consistently exceeded the delisting scenario abundance goal.

Predation Management

Predation, while probably always a significant source of mortality for salmonids, has been exacerbated by changes in the Columbia River ecosystem. Ecosystem alterations, attributable to hydropower dams and changes in the hydrological system, and to modification of estuarine habitat, have increased predation on LCR salmon and steelhead populations.

The planning team identified actions in the Plan to address threats and limiting factors associated with predation management and to improve the survivorship and viability of LCR salmon and steelhead populations. Table A-I: 6 in Appendix I contains the Plan actions associated with Predation Management and describes implementation progress during the 12 years since Plan adoption. Actions to address predation focus on reducing the impact of bird, marine mammal, and piscine predators. Since Plan adoption, all the proposed actions have either been completed, are ongoing, or are in progress. There are some sub-actions which are not yet completed.

Actions for reducing salmonid and steelhead predation by double-crested cormorants and Caspian terns are incorporated into their respective management plans (USACOE 2015, USFWS 2005) and all Plan actions have been implemented. Despite this, predation rates on juvenile salmonids appears to be increasing based on recent research (see Avian Predation section in Appendix III). Implemented actions had the unanticipated consequences of bird relocation further upstream where they consume a higher percentage of salmon and steelhead juveniles compared to their diet from primary nesting locations on East Sand Island, where the avian predators foraged on a higher percentage of non-salmonid fish.

Sea lion management in the Columbia River Basin has been ongoing for over a decade since fish and wildlife agencies were first given Marine Mammal Protection Act (MMPA) Section 120 authorization to remove California sea lions observed preying on salmon and steelhead below Bonneville Dam in 2008, and years later at Willamette Falls. Prior to 2020, the States were only allowed to remove California sea lions at these two locations if predation was well-documented, specific criteria were met for removing individuals, and considerable effort was given to non-lethal methods of removal (e.g., hazing, relocation). After the MMPA was amended in August 2020, the National Oceanic and Atmospheric Administration (NOAA) issued a permit to the three Columbia Basin states and six regional Tribes that allowed for lethal removal of California and Stellar sea lions. The new permit issued by NOAA created “safe zones” for fish by giving managers from the Tribes and States the authority to remove, via humane euthanasia, individuals of both species that attempt to prey on fish in safe zones. These safe zones include locations where ESA listed salmon and steelhead, sturgeon, lamprey, and eulachon are especially vulnerable to sea lion predation because they are either spawning or temporarily holding in their spawning migration at the mouth of smaller tributaries or below barriers like Willamette Falls and Bonneville Dam. Removal of problem sea lions has proven to be the most effective means of protecting fish from pinniped predation (see Pinniped Predation section in Appendix III). Given the current level of monitoring, no estimates of predation are available at the LCR ESU or population level but following one year of California sea lion (CSL) removal at Willamette Falls, estimated CSL predation on salmonids in 2019 decreased by 67 percent and maximum single-day CSL abundance decreased by 57 percent (Steingass et al. 2019).

Piscine predation management in the LCR has been ongoing for northern pikeminnow for more than 35 years. Implementation of the Northern Pikeminnow Sport Reward Program has demonstrated a method to reduce predation on juvenile salmonids at the Columbia Basin level. However, the patterns in abundance and distribution of non-native piscine predators and subsequent impacts to juvenile salmonids need further study to provide actionable management information. Piscine predation management should continue to include expanding our understanding of the complex interspecies dynamics from focused removals of Northern Pikeminnow with other piscine predators and the resulting predation effects on juvenile salmonids (see Piscine Predation section of Appendix III).

Implementation of Oregon's Columbia River Chum Salmon Recovery Strategy

The Columbia River Chum Recovery Strategy (CRS) represented the first step in the State of Oregon's plan for recovering chum salmon in tributaries located on the Oregon side of the Columbia River Evolutionarily Significant Unit (ESU). The CRS was developed as a supplement to the Plan and initially sought to gather information and develop techniques that would provide the framework for establishment of viable chum salmon populations on the Oregon side of the LCR.

Together, the Plan and the CRS represent a suite of actions intended to: (1) identify and implement corrective measures to address primary and secondary limiting factors, (2) re-establish chum salmon into a portion of Oregon's Coastal stratum tributaries of the Columbia River, and (3) monitor performance of the program to evaluate success and allow for adaptive management.

The over-arching goal of Oregon's recovery strategy was to develop a science-based approach using the best available technical information to reduce risk, ensure success, and inform adaptive management. As a result, eight framework elements were incorporated which served as a foundation for development of the CRS. From the identified CRS elements, the planning team identified key strategies in three program areas: Habitat, Artificial Propagation and Broodstock Development, and Artificial Propagation and Reintroduction/Out-Planting. For each program area, objectives were formed, risks, benefits and critical uncertainties were identified, and actions were listed to implement the objectives. Appendix II contains a detailed summary of CRS actions and implementation outcomes from 2010-2022, which include:

1. Chum salmon spawning habitat was evaluated in the Coastal stratum and the Clatskanie recovery population was chosen as a focus for reintroduction efforts.
2. To establish a chum salmon conservation broodstock in Oregon, eggs were sourced from the Grays River Hatchery (GRH) in Washington. Big Creek Hatchery (BCH) in Oregon was selected as the facility for the conservation hatchery program.
3. Production goals and artificial propagation techniques were established and are evaluated and summarized in an annual Hatchery Genetic Management Plan (HGMP) report to NOAA Fisheries.
4. The conservation broodstock was established at BCH from 2010-2014 and ran independently from 2015-2017. However, extremely low returns in 2016-2017 caused collection goals to go unmet and meant that further supplementation from the GRH was required in 2018-2019. In recent years (2020-2022), chum salmon returns to BCH have been high enough to meet broodstock collection goals and conduct substantial outplanting in the Clatskanie and Big Creek recovery populations.
5. Due to low returns in most years, reintroduction efforts have been limited in both duration and scope. In general, outplanted adults appeared to spawn successfully and produce outmigrant fry. Outplanted eyed eggs had high egg-to-fry survival and the

advantage of stream imprinting (as opposed to hatchery reared eggs). However, adult returns have not been detected from either reintroduction method.

6. Monitoring of chum salmon in the Coastal stratum primarily consisted of spawning ground surveys based on a developed protocol and operation of juvenile traps in selected watersheds.

Based on a review of implementation actions and outcomes, ODFW developed an update to the CRS that is presented in Appendix II of this assessment.

Section 3: Research, Monitoring, and Evaluation

The Plan includes criteria for tracking progress toward recovery goals. Brief summaries of the monitoring that supports assessment of these criteria are provided below[4]. These criteria and assessment results are further discussed in Section 4 and Appendix III.

Coho Salmon

Since 2002, ODFW's Oregon Adult Salmonid Inventory and Sampling Project (OASIS) has conducted spawning surveys for coho salmon in the LCR planning area. Surveys are selected using a design that facilitates spatially unbiased estimates of spawner abundance and estimates of spawner distribution, timing, and the proportion of hatchery origin spawners in naturally spawning populations (Generalized Random Tessellation Stratified Design, GRTS; Stevens 2002). These surveys are not conducted in some areas where other estimates are available (e.g., above dams and hatchery weirs). In these cases, counts of fish passed upstream are added to GRTS-based abundance estimates for the remainder of the population. Survey effort has varied through time in response to resource limitations and logistical challenges, with a notable reduction in effort in 2020 due to COVID-related budget constraints and safety protocols (Table 4).

Table 4. Summary of monitoring for adult coho salmon since approval of the Plan. This table focuses on monitoring that directly informs assessment of the Plan's measurable criteria. GRTS = spawning ground surveys selected using a Generalized Random Tessellation Stratified design; NS = Not Surveyed; NE = No Estimate (i.e., surveys were conducted but data were inadequate to estimate metrics for assessing measurable criteria).

Population	Adult Coho Salmon Monitoring & Reporting												
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Youngs Bay[a]	GRTS			NS									
Big Creek[a]	GRTS			NS									
Clatskanie	GRTS												
Scappoose[b]	GRTS										NE[c]	GRTS	
Clackamas	GRTS below North Fork Dam + Passage Count at North Fork Dam										Dam[c]	GRTS+Dam	
Sandy[d]	GRTS										NE[c]	GRTS	
Lower Gorge	GRTS							NS[e]	GRTS		NS[c]	NE	GRTS
Gorge/Hood[f]	GRTS							NS[e]	GRTS		NS[c]	GRTS	

[a]GRTS surveys are not conducted above the Klaskanine and Big Creek hatchery weirs (Youngs Bay and Big Creek populations, respectively); weir passage counts are added to GRTS-based abundance estimates. GRTS surveys in both populations were discontinued after 2012 due to budget constraints. Passage counts at hatchery weirs provide an index of abundance.

[b]GRTS surveys in the Scappoose population were not conducted upstream of the Bonnie Falls life cycle monitoring site. Until 2019, when that site was discontinued, spawner estimates from that site were included in population abundance estimates. Since 2019, estimates have included surveys above the LCM site or alternative methods for that portion of the population.

[4] Monitoring for chum salmon is discussed with the implementation of Oregon's Columbia River Chum Salmon Recovery Strategy in Section 2 and Appendix II.

[c]Due to budget constraints and COVID-19 safety protocols, monitoring in 2020 was insufficient to generate population-scale criteria estimates in the Scappoose, Sandy, and Clackamas coho salmon populations, and spawning surveys were not conducted in the Lower Gorge, and Gorge/Hood population areas. In 2020, a partial estimate of spawner abundance in the Clackamas population is available from the passage count at North Fork Dam (Portland General Electric).

[d]GRTS surveys are not conducted above the hatchery weir on Cedar Creek in the Sandy population. Passage counts at the weir are added to the GRTS abundance estimate for the remainder of the basin.

[e]The Lower Gorge and Gorge/Hood population areas were not sampled in 2017 due to post-wildfire safety concerns.

[f]The Gorge/Hood area consists of Upper Gorge tributaries and the Hood River downstream from the Powerdale Dam site.

Chinook Salmon

The OASIS project also conducts GRTS spawning surveys for fall Chinook salmon in the LCR planning area using the site selection and general survey methods described above for coho salmon. These surveys are intended to provide annual, population-scale estimates of natural origin spawner abundance, estimates of the proportion of hatchery origin fish spawning in naturally spawning populations, and to evaluate the spatial distribution and timing of spawning. Initial surveys using the GRTS survey design began in 2009, and 2011 was the first return year reflecting 100% marking for the full cohort of returning hatchery fish. Methods adjustments, logistical challenges, and budget constraints have resulted in variable effort and have, at times, limited ability to report on measurable criteria for some populations (Table 5). Some significant challenges have included:

- In the Sandy and Clackamas populations, abundance estimates for fall Chinook salmon are likely to be underestimates due to the inherent difficulties of visual survey methods in large non-wadeable mainstem habitats. Survey conditions have been particularly difficult in the mainstem Sandy River, and relaxed criteria for retaining surveys for abundance estimation are often required for mainstem survey reaches in that population.
- There is temporal and spatial overlap of fall and spring Chinook salmon in the Sandy and Clackamas basins. Data for estimating abundance of fall Chinook salmon in the Sandy River are screened to exclude dates during which genetic information indicates the fish present are primarily spring Chinook Salmon. There is no similar means for screening data in the Clackamas population.
- Budget constraints and prioritization of limited resources have limited effort in some population areas. This has constrained the ability to produce annual criteria estimates, particularly in smaller population areas (Table 5).
- In some populations, limited observations of live Chinook have precluded criteria estimates in some years, or observations have been at or near zero for the duration of the GRTS monitoring effort (e.g., Scappoose Population).

Despite these challenges, monitoring of fall Chinook salmon in the LCR planning area have generally indicated that, outside of the Sandy and Clackamas populations, there are relatively few natural origin spawners and high proportions of hatchery fish in many areas.

In the Sandy River, spring Chinook were historically counted as they passed Marmot Dam. Since removal of the dam and its counting facilities in 2007, spawner abundance estimates have been based on carcass recoveries and redd counts during spawning surveys that are designed to cover the primary upper basin spawning areas (Salmon and Zigzag rivers and Still Creek). Redd counts in each area are partitioned to hatchery and natural origin fish based on mark status of carcasses and analysis of thermal marks in otoliths recovered from carcasses. The peak count of redds is expanded by 2.5 fish per redd to estimate run size. Additional details are available in Whitman et al. (2017).

In the Hood River population, adult spring Chinook salmon were counted at Powerdale Dam. Since dam removal in 2010, abundance has been estimated by ODFW's Hood River Production Program using a modeling approach that relies on Passive Integrated Transponder (PIT) tagging of juvenile outmigrants captured in rotary screw traps. Adult escapement to Bonneville Dam and the mouth of the Hood River is estimated using mark-recapture modeling based on detections of these tagged fish when they return as adults to Bonneville Dam and adult capture facilities located within the Hood River basin. When detections of returning natural origin adults have been insufficient for estimating escapement, abundance estimates are reported as counts of natural origin adults at adult collection weirs in the Hood River basin. These estimates are likely to be underestimates of escapement. Additional details are available in Simpson (2022).

Table 5. Summary of monitoring for adult Chinook salmon since approval of the Plan. This table focuses on monitoring that directly informs assessment of the Plan's measurable criteria. GRTS = spawning ground surveys selected using a Generalized Random Tessellation Stratified design; NS = Not Surveyed; NE = No Estimate (i.e., surveys were conducted but data were inadequate to estimate metrics for assessing measurable criteria).

<table>
<tr><th rowspan="2">Population</th><th colspan="13">Adult Chinook Salmon Monitoring & Reporting</th></tr>
<tr><th>2010</th><th>2011</th><th>2012</th><th>2013</th><th>2014</th><th>2015</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th><th>2020</th><th>2021</th><th>2022</th></tr>
<tr><td colspan="14">Fall Chinook</td></tr>
<tr><td>Youngs Bay</td><td colspan="2">NE[a]</td><td colspan="7">GRTS</td><td>NE</td><td colspan="3">GRTS</td></tr>
<tr><td>Big Creek</td><td colspan="13">GRTS</td></tr>
<tr><td>Clatskanie</td><td colspan="13">GRTS</td></tr>
<tr><td>Scappoose</td><td colspan="6">NE</td><td>NS</td><td colspan="6">NE</td></tr>
<tr><td>Clackamas</td><td>NE</td><td colspan="12">GRTS</td></tr>
<tr><td>Sandy[b]</td><td colspan="2">NE</td><td colspan="11">GRTS</td></tr>
<tr><td>Lower Gorge[c]</td><td colspan="8">NE</td><td>NS</td><td>GRTS</td><td colspan="3">NS</td></tr>
<tr><td>U. Gorge/ Hood[c]</td><td colspan="2">NS</td><td colspan="2">NE</td><td colspan="4">NS</td><td colspan="2">NE</td><td>NS</td><td colspan="2">NE</td></tr>
<tr><td colspan="14">Spring Chinook</td></tr>
<tr><td>Sandy</td><td colspan="13">Redd Surveys in Primary Spawning Areas</td></tr>
<tr><td>Hood[d]</td><td>Dam</td><td colspan="2">NE</td><td colspan="8">PIT-Tag Mark Recapture Model/Adult Trap Counts</td><td colspan="2">NE</td></tr>
</table>

[a] NE (No Estimate) frequently results from insufficient carcass recoveries, few observations of live fish, or limited surveys due to resource constraints, landowner denials, or poor survey conditions.

[b]An alternative dataset for the Sandy fall Chinook salmon population is based on expansion of peak redd counts on a standard index survey, expanded by a fish:redd conversion factor and extrapolated to the spawning distribution miles for fall Chinook in the Sandy River basin.

[c]Low survey effort and limited observations of carcasses and live observations frequently results in NE for the Lower Gorge and Upper Gorge/Hood population areas.

[d]Counts of Spring Chinook passing Powerdale dam were the basis for monitoring Hood River spring Chinook salmon prior to dam removal in 2010. Since dam removal, detections of PIT-tagged adult spring Chinook salmon have been insufficient to produce mark-recapture abundance estimates; abundance estimates are based on counts at adult collection facilities and are likely to be underestimates of escapement.

Steelhead

In 2003, ODFW's OASIS program began monitoring spawning winter steelhead within the LCR planning area using the GRTS survey design previously described for coho salmon and fall Chinook salmon (Table 6). Due to the difficulty of observing live adult winter steelhead or recovering post-spawn carcasses, abundance estimates for winter steelhead are based on cumulative estimates of steelhead redd abundance. Redd abundance is then expanded to spawner abundance using a redds-to-fish expansion factor based on the relationship between abundances of redds and fish at sites where independent estimates of fish abundance were available (e.g., dam counts or mark-recapture estimates; ODFW 2013). In addition to providing estimates for assessing Plan abundance criteria, these surveys also facilitate assessment of the Plan's spatial structure and diversity criteria for winter steelhead.

In the Hood River, abundances of adult winter steelhead and summer steelhead were estimated based on the passage counts at Powerdale dam through 2010. Since removal of the dam and its counting station, steelhead spawning escapement has been estimated using the mark-recapture modelling approach previously described for Hood River spring Chinook salmon. This approach has facilitated annual abundance estimates for Hood River winter steelhead, but detections of returning adult summer steelhead have been insufficient to produce robust escapement estimates in most years. For these years, abundance is reported as the number of adult summer steelhead counted at adult capture facilities in the Hood River basin. These estimates are likely to be underestimates of spawner abundance.

Table 6. Summary of monitoring for adult steelhead since approval of the Plan. This table focuses on monitoring that directly informs assessment of the Plan's measurable criteria. GRTS = spawning ground surveys selected using a Generalized Random Tessellation Stratified design; NS = Not Surveyed; NE = No Estimate (i.e., surveys were conducted but data were inadequate to estimate metrics for assessing measurable criteria).

<table>
<tr><th rowspan="2">Population</th><th colspan="13">Adult Steelhead Monitoring & Reporting</th></tr>
<tr><th>2010</th><th>2011</th><th>2012</th><th>2013</th><th>2014</th><th>2015</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th><th>2020</th><th>2021</th><th>2022</th></tr>
<tr><td colspan="14">Winter Steelhead</td></tr>
<tr><td>Youngs Bay[a]</td><td colspan="2">NS</td><td colspan="2">GRTS</td><td colspan="9">NS</td></tr>
<tr><td>Big Creek[a]</td><td colspan="2">NS</td><td colspan="2">GRTS</td><td colspan="9">NS</td></tr>
<tr><td>Clatskanie[b]</td><td colspan="2">NS</td><td colspan="2">GRTS</td><td>NS</td><td colspan="8">GRTS</td></tr>
<tr><td>Scappoose[b]</td><td colspan="2">NS</td><td colspan="2">GRTS</td><td>NS</td><td colspan="8">GRTS</td></tr>
<tr><td>Clackamas[c]</td><td colspan="2">Dam</td><td colspan="8">GRTS below NF Dam + Passage Count at NF Dam</td><td>Dam</td><td colspan="2">GRTS+Dam</td></tr>
<tr><td>Sandy</td><td colspan="13">GRTS</td></tr>
<tr><td>U & L Gorge[d]</td><td colspan="2">NS</td><td>GRTS</td><td colspan="10">NS</td></tr>
<tr><td>Hood[e]</td><td>Dam</td><td colspan="11">PIT-Tag Mark Recapture Model</td><td>NE</td></tr>
<tr><td colspan="14">Summer Steelhead</td></tr>
<tr><td>Hood[f]</td><td>Dam</td><td colspan="3">NE</td><td colspan="7">PIT-Tag Mark Recapture Model or Trap Counts</td><td colspan="2">NE</td></tr>
</table>

[a]GRTS spawning are not conducted upstream of the Klaskanine and Big Creek hatchery weirs (Youngs Bay and Big Creek populations, respectively); weir passage counts are added to GRTS-based abundance estimates. GRTS surveys in both populations were discontinued after 2013 due to budget constraints. Counts of fish passed above hatchery weirs provides an index of abundance.

[b]Surveys were not conducted in 2014 in the Clatskanie and Scappoose populations due to budget constraints. Surveys were insufficient to produce criteria estimates in the Scappoose population in 2021.

[c]Prior to implementation of GRTS surveys in 2012, estimates available for the Clackamas population are partial estimates based on passage counts at North Fork Dam (Portland General Electric). Estimates since 2012 are GRTS-based estimates for areas below North Fork Dam combined with the passage count at the dam, except 2020 which is passage count only.

[d]Surveys in the Upper and Lower Gorge tributaries (excl. Hood River) are selected across both areas in aggregate. These surveys were discontinued after 2012 due to budget constraints.

[e]Prior to 2011, estimates winter steelhead abundance in the Hood River population were based on passage counts at Powerdale Dam. After Dam removal, estimates have been based on a mark-recapture model.

[f]Abundance estimates for 2010 for Hood River summer steelhead reflect a partial count of fish passing Powerdale dam prior to its decommissioning in the same year; no estimates for summer steelhead are available in 2011-2013 due to data limitations; insufficient detections of PIT-tagged natural origin adult fish in 2014, 2015, and 2021 preclude mark-recapture based estimates. Abundance estimates in these years are from adult capture facilities and are likely to be underestimates of spawner escapement.

Juvenile Salmonids

Spatially balanced, random surveys (GRTS) of juvenile salmonids have provided annual estimates of the summer distribution, abundance, and habitat occupancy rate of juvenile coho salmon and steelhead within the LCR planning area since 2006. Selected reaches are surveyed using daytime snorkeling during the base flow period from mid-July to mid-October. Metrics, including coho salmon and steelhead parr abundance[5] and site occupancy, are reported annually for the LCR planning area. Survey effort has also varied through time in response to resource constraints (e.g., budget reductions in 2014; COVID protocols in 2020) and methodological changes (Figure 3). In 2016, snorkel surveys were incorporated into habitat survey protocols to accommodate budget reductions while maintaining capacity for juvenile surveys (see *Habitat*, below). Additional details on survey design, field methods, and changes over time can be found in Constable and Suring (2020). Metrics from these juvenile surveys are not estimated at the population scale, so they are not directly comparable to Plan spatial structure criteria.

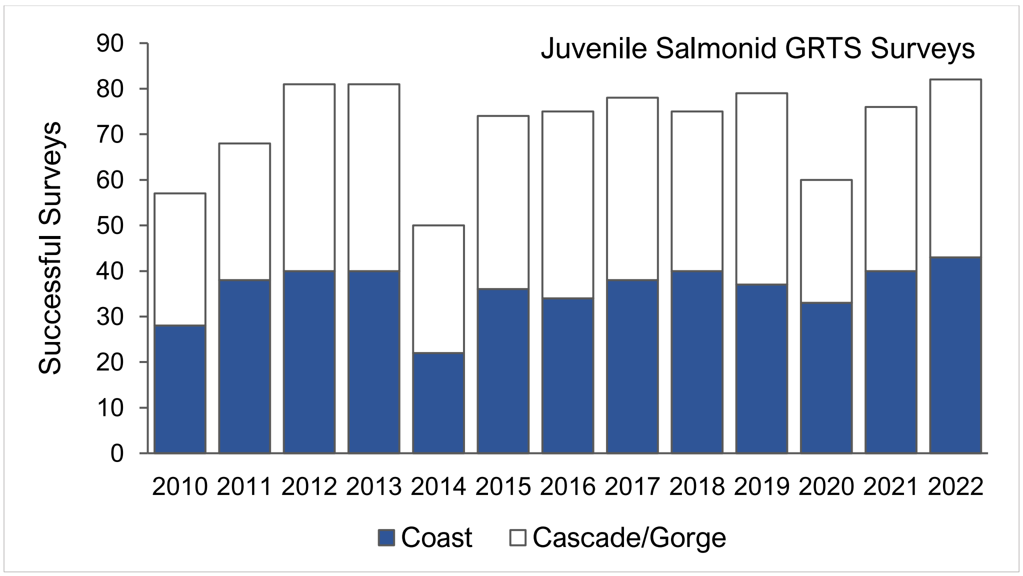


Figure 3. Annual number of GRTS juvenile salmonid snorkel surveys in first to third order (wadeable) streams in the LCR planning area since Plan adoption. Additional snorkel surveys in higher order streams were conducted in 2010–2011.

Habitat

ODFW's Aquatic Inventories project conducts aquatic habitat surveys at GRTS-selected survey reaches within the LCR planning area. These surveys are conducted in mid-June through late September at sites selected from within the distribution of coho salmon and steelhead spawning and rearing. Beginning in 2015, sites above the distribution of salmon and steelhead were also incorporated into the sample frame to describe habitat conditions upstream of anadromous salmonid rearing and spawning habitat. This project provides estimates of a broad array of instream physical habitat, channel features, and riparian conditions. Habitat metrics are also applied to the Habitat Limiting Factors Model to estimate the capacity of habitat to support juvenile coho salmon during winter. This provides estimates of the miles of High Quality Habitat

[5] Abundance estimates are based on uncalibrated snorkel counts in pools that meet size criteria; they are not estimates of total abundance but are useful for assessing trend.

(HQH) in each LCR population area and facilitates assessment of HQH relative to the goals identified in the Plan to support delisting and broad sense recovery. Additional details on survey methods can be found in Moore et al. (2007) and Strickland and Constable (2022).

Harvest

Harvest impact assessment is monitored in the Pacific Ocean, Columbia River and tributaries. Ocean salmon fisheries off the West Coast are managed by the Pacific Fishery Management Council (PFMC) under the Pacific Coast Salmon Fishery Management Plan (FMP; PFMC 2022). In season management requires updating information on the fisheries daily. Thus, data is collected by sampling the landings, exit/trailer counts, radio reports, electronic media reports, and telephone interviews. In general, data necessary for in season management is gathered by one or more of the following methods. Port exit counts, radio or electronic media reports, and processor reports used to obtain information on the distribution, amount, and type of commercial fishing effort. Data on the current harvests by commercial and treaty Indian ocean fishermen are obtained by telephoning selected (key) fish buyers, by sampling the commercial landings daily, and from fish landings submitted through radio or electronic media reports (E-Tix). Data on the current effort of, and harvests by, the recreational fisheries is obtained by port exit counts, trailer counts, contacting selected charter boat and boat rental operators and by sampling landings at selected ports. Analyses of fish scales, recovered fish tags, genetic stock identification samples, and other methods provide information on the age and composition of the stocks being harvested.

Columbia River recreational and non-tribal commercial fisheries harvest hatchery and natural origin salmonids and are co-managed by the states of Oregon and Washington where the river forms a common border between the two states. Fishery sampling and harvest estimation are coordinated between the states and all reported estimates of catch and effort represent the entirety of the fishery(ies). To gauge whether management strategies are meeting conservation and fishery goals, total fishery mortality is estimated for commercial and recreational fisheries. Estimates of retained catch in recreational fisheries are made by applying estimates of catch per unit effort from creel survey data to estimates of angler effort (primarily from aerial effort flights but occasionally augmented with shore- or boat-based effort counts). Estimates of landed catch in commercial fisheries are derived from total weight provided on mandatory fish tickets and average weight per fish from state catch-sampling programs. As in any fishery that includes substantial encounters of non-retained fish, estimating the total catch of fish not retained by fishers is challenging, and may require different methodologies than those used to estimate retained catch. For mark-selective recreational fisheries and for fisheries encountering multiple salmonid species with species-specific retention regulations, estimates of non-retained fish are made using the same methodology as for retained catch (estimates of retained and released fish are standard outputs of the states' recreational fishery monitoring programs). Released catch estimates are inherently based on voluntary responses by anglers interviewed during creel surveys and are reliant on anglers' ability to recall how many and what type of fish were released during their trip. For commercial mark-selective and/or live-capture salmon fisheries, ODFW conducts onboard observations of a sample of commercial fishers to collect data used to estimate catch of non-retained fish (e.g., steelhead, unmarked spring Chinook, and unmarked coho). Mortalities of non-retained fish for recreational and commercial fisheries are estimated by multiplying estimated total handle by species- and fishery-specific post-release mortality rates. Analysis of scale samples and coded-wire tags recovered from the states' fishery monitoring programs are used to estimate the age- and stock-composition of harvest.

Tributary fisheries are only subject to recreational fisheries. Since 2019, recreational harvest estimates are based on an expansion of self-reported harvest by anglers using ODFW's electronic licensing system (ELS). Recreational harvest estimates prior to 2019 are based on an expansion of self-reported harvest on paper tags (punch cards) returned to ODFW by anglers. Indirect mortality in recreational fisheries is estimated based on encounter rates made through run reconstruction from hatchery and natural origin returns and estimated hooking mortality rates.

Section 4: Evaluation of Measurable Criteria

The Plan contains measurable criteria to assess progress toward two goals identified in the Plan, delisting and broad sense recovery:

Delisting criteria: Criteria incorporated into ESA recovery plans that define both biological and listing factors (i.e., threats or factors for decline) statuses that, when met, could result in a determination that a species is no longer threatened or endangered and can be proposed for delisting. The biological viability criteria identified by the Willamette-Lower Columbia Technical Recovery Team (WLC-TRT) are considered the biological delisting criteria. These criteria are based on the population-level parameters of Abundance/Productivity (A/P), Spatial Structure, and diversity, which describe an independent population, stratum, and ESU with a negligible risk of extinction over a 100-year time frame (i.e., a VSP). These criteria are used as technical input into the recovery planning process and provide a technical foundation for development of biological recovery criteria. Listing factors, or threats, criteria are based on the five listing factors in ESA section 4(a)(1). Final delisting criteria and delisting decisions are a NMFS determination and may include both technical and policy considerations.

Broad sense recovery criteria: Criteria that go beyond the requirements for delisting to attain goals defined in the recovery planning process, generally by local stakeholder groups, that, for example, address other legislative mandates or social, economic, and ecological values.

This section of the assessment briefly describes the measurable criteria identified in the Plan and summarizes results of the assessment of LCR salmon and steelhead populations based on these criteria. Appendix III contains more detailed information about the criteria and results of the assessment for each population and listing factor.

Measurable Criteria

Measurable criteria related to biological recovery (Table 7) are based on the specific goals for each LCR salmon and steelhead population established in the Plan. With regards to the assessment of biological criteria (i.e., A/P, spatial structure, and diversity), the benchmarks are intended to serve as interim measures of progress towards achieving recovery goals absent full viability analyses (as conducted for development of the Plan), which require long term data trends to show progress. The suite of research, monitoring, and evaluation (RME) tasks identified as necessary to evaluate these measurable criteria will also ultimately provide the foundation for more comprehensive viability analyses, such as those described in McElhany et al. (2007) that follow the viability criteria framework established by the WLC-TRT (McElhany et al. 2006).

In contrast to the measurable criteria developed for biological recovery (which have a direct connection to assessments of population viability), the measurable criteria described below for the listing factors (Table 7) are primarily related to tracking the success of actions designed to reduce the impact of current threats or serve as an early warning for emerging threats. In some cases, measurable criteria apply to listing factors and biological recovery.

Table 7. Plan measurable criteria evaluated in the 12-year assessment. Appendix III provides more detailed information about these criteria and the assessment.

Criteria Type	Category	Metric	Species	Evaluation Criteria
Biological	Abundance/ Productivity	Abundance	All	The observed spawner abundance is > the abundance modeled for delisting at least six times in any 12-year period and the average observed spawner abundance is > the average modeled abundance for delisting over that same period.
	Spatial Structure	Occupancy	All	The percentage of sites not occupied by spawning adults or rearing juvenile salmon or steelhead is < the thresholds shown in Table 8 at least six times during a 12-year period *and* the overall average percentage of sites not occupied during that same period is < than the thresholds shown in Table 8.
	Diversity	Effective Population Size	All	Same criteria as Abundance/Productivity metric.
Biological/ Listing Factor	Diversity / Listing Factor E	Stray rate (pHOS)	All	Over a nine-year period, the average percentage of the total number of spawners that are of hatchery origin is on average less than or equal to that shown in Table 9.
	Diversity / Listing Factor B	Harvest Rate	Coho	Harvest rates of natural origin coho do not exceed the seeding and ocean condition category specific harvest rates shown in Table 10 in any given year more than once in 10 years (> 90 percent compliance).
			ChF	Harvest rates of natural origin fall and late fall Chinook do not exceed those contained in a sliding scale harvest matrix (see Table 11) in any given year more than once in 10 years (> 90 percent compliance).
			ChS, StW	The average harvest rate over a 12-year period does not exceed the impact shown in Table 12.
Listing Factor	Listing Factor A	Habitat Trend	All	Positive trend in the status of the habitat degradation metrics.
		Habitat Restoration	All	Restoration action quantities equal or exceed "x"/15 of those shown in Table 13, where "x" is the number of years after adoption of the Plan and 15 is the number of years the Plan allows for tributary habitat restoration.
		High Quality Habitat	Coho	The number of additional/new miles of HQH (as determined by ODFW's Habitat Limiting Factors Model) equals or exceeds that shown in Table 14.
		Hydropower (Passage and Habitat)	All	Achievement of fish passage goals outlined in the Clackamas River Hydroelectric Project (FERC Project No. 2195) Fish Passage and Protection Plan.
			All	Achievement of habitat goals outlined in the Clackamas River Hydroelectric Project (FERC Project No. 2195) Fish Passage and Protection Plan.
			Coho, StW	Provision of passage for adult and juvenile coho and winter steelhead at Laurance Lake Dam.
	Listing Factor C	Predation Mortality Rate	All	The average cumulative mortality of Oregon LCR populations of coho, Chinook, and steelhead due to predation by Caspian terns, double-crested cormorants, marine mammals, and northern pikeminnow over a 12-year period due to anthropogenic influences is equal to or less than that shown in Table 15.

Table 8. Occupancy thresholds for Oregon Lower Columbia River coho salmon and steelhead populations. Watershed size is from McElhany et al. (2006). Thresholds indicate percentage of sites not occupied.

Coho					
Stratum	Population Area	Watershed Size	Delisting Risk Goal	Occupancy Threshold	
				Delisting	Broad Sense (Very Low Risk)
Coast	Youngs Bay	Small	Very High	100%	5%
	Big Creek	Small	Very High	100%	5%
	Clatskanie	Medium	Very Low	10%	10%
	Scappoose	Medium	Very Low	10%	10%
Cascade	Clackamas	Large	Very Low	15%	15%
	Sandy	Large	Low	25%	15%
Gorge	Lower Gorge	Small	High	50%	5%
	Upper Gorge/Hood	Medium	Low	20%	10%
Chinook					
Stratum	Population Area	Watershed Size	Delisting Risk Goal	Occupancy Threshold	
				Delisting	Broad Sense
Coast	Youngs Bay	Small	High	50%	5%
	Big Creek	Small	High	50%	5%
	Clatskanie	Small	Low	15%	5%
	Scappoose	Small	Low	15%	5%
Cascade	Clackamas	Large	Moderate	50%	15%
	Clackamas spring	Medium	Very Low	10%	10%
	Sandy	Medium	Moderate	40%	10%
	Sandy Late	Medium	Very Low	10%	10%
	Sandy Spring	Medium	Low	20%	10%
Gorge	Lower Gorge	Small	High	50%	5%
	Upper Gorge	Small	Very High	100%	5%
	Hood	Small	Low	15%	5%
	Hood Spring	Medium	Very Low	10%	10%
Steelhead					
Stratum	Population Area	Watershed Size	Delisting Risk Goal	Occupancy Threshold	
				Delisting	Broad Sense
Coast*	Youngs Bay	Small	NA	NA	5%
	Big Creek	Small	NA	NA	5%
	Clatskanie	Medium	NA	NA	10%
	Scappoose	Medium	NA	NA	10%
Cascade	Clackamas	Large	Low	25%	15%
	Sandy	Large	Very Low	15%	15%
Gorge	Lower Gorge	Small	Moderate	25%	5%
	Upper Gorge	Small	Very High	100%	5%
	Hood	Medium	Low	20%	10%
	Hood Summer	Medium	Low	20%	10%

* Coast stratum steelhead are not listed under ESA.

Table 9. Hatchery stray rate, proportion of Hatchery fish On Spawning ground (pHOS) targets to achieve delisting for Oregon populations of coho, fall Chinook (CHF), spring Chinook (CHS), winter steelhead (STW), and summer steelhead (STS).

Population and Species	Average Allowable Hatchery Stray Rates				
	CHF	CHS	Coho	STW	STS
Youngs	90%		86%	10%	
Big Creek	90%		86%	10%	
Clatskanie	10%		10%	5%	
Scappoose	10%		5%	5%	
Clackamas	30%	10%	9%	10%	
Sandy	30%	10%	10%	10%	
Gorge L	60%		10%	10%	
Gorge U	60%			10%	
Hood	0%	10%	0%	10%	0%
Sandy late	10%				

Table 10. Allowable harvest impacts as determined from parental status and marine survival index for LCR coho (except Youngs Bay, Big Creek, and Upper Gorge/Hood populations[6]).

Parental Escapement (rate of full seeding)		**Marine Survival Index (based on return of jacks per hatchery smolt)**					
		Very Low (≤ 0.06%)	**Low (≤ 0.08%)**	**Medium (≤ 0.17%)**	**High (≤ 0.40%)**	**Very High (> 0.40%)**	
Normal	≥ 0.30	10%	15%	18%	23%	30%	Allowable exploitation rate
Very Low	< 0.30	≤ 10%	≤ 15%	≤ 18%	≤ 23%	≤ 30%	

[6] Terminal fisheries within the Youngs Bay and Big Creek areas will increase impacts on these two coho populations relative to the base rate indicated in Table 10. Maximum allowable harvest impacts for these populations should be commensurate with those indicated in Table 10 plus the difference in long-term modeled harvest rate between these populations and those to which Table 10 applies directly (i.e., annually, the Table 10 rate plus 45 percent [Youngs Bay] and 25 percent [Big Creek]). The Delisting Scenario for the Upper Gorge/Hood population indicates a long-term modeled harvest rate which is well below the base rate applied to other populations. Efforts should be made to decrease harvest impacts on this population approximately 20 percent over the long-term relative to other populations to which Table 10 applies directly; however, given the mixed stock nature of harvest impacts, it is likely that the annual harvest rate of Upper Gorge/Hood coho will be the base rate indicated in Table 10.

Table 11. Variable fishing exploitation rate limits for LCR tule fall Chinook salmon[7] based on abundance tier as proposed by the PFMC (from McIsaac 2011).

Lower River Hatchery (LRH) Abundance Forecast	Total Exploitation Rate Limit
0 – 30,000	0.30
30,000 – 40,000	0.35
40,000 – 85,000	0.38
>85,000	0.41

Table 12. Maximum allowable average harvest rates for Oregon populations of spring Chinook salmon and steelhead in the LCR.

Species	Population	Harvest Impact
Spring Chinook	Sandy, Hood	25%
Winter Steelhead	Youngs Bay, Big Creek, Clatskanie, Scappoose, Clackamas, Sandy, Lower Gorge	10%
	Upper Gorge, Hood	15%
Summer Steelhead	Hood	15%

Table 13. Summary of the quantity of specific restoration actions needed for listed species within population areas of the LCR and associated restoration standards based on the maximum feasible and delisting scenarios (revision of Table 9-2 from the Plan).

Population area	LWD Placement (miles)	Side channel increase (miles)	Riparian Planting (miles)	Off-channel Wetland Complex Increase (m^2)
Youngs Bay	2.3	0	0.9	263.7
Big Creek	23.7	1.8	7.5	8,445.0
Clatskanie	65.8	0	16.4	21,358.0
Scappoose	23.2	7.5	8.1	2,730.0
Clackamas	62.5	64.6	34.8	19,780.3
Sandy	34.9	17.5	18.5	5,446.6
Lower Gorge	15	8.8	8.4	6,783.6
Upper Gorge	4	1.8	1.8	1,422.0
Hood	33.6	20.1	19.2	15,501.3
Total	265	122.1	115.6	81,730.5
	*20 m^3 of LWD/ 100m of stream		*30 m width on each side of stream	

[7] Given additional fisheries that affect Youngs Bay, Big Creek, and Upper Gorge (and Hood, though see below) fall Chinook (CHF) populations, similar considerations as those applied to Youngs Bay and Big Creek coho metrics are needed for these populations. Hood CHF likewise have similar considerations as Upper Gorge/Hood coho (i.e., threat reductions which are well below the baseline for the species, and which are unlikely to be met due to mixed stock harvest). The Sandy late CHF population should have harvest impacts at least 5 percent below the long-term average for other populations to which the base rate applies, based on historical impacts on this population relative to the others and desired threat reductions.

Table 14. Additional miles of HQH[8] needed to achieve delisting and broad sense recovery abundance goals for coho[9].

Population	Additional Miles of High-Quality Coho Habitat Needed	
	Delisting	Broad Sense
Youngs Bay	0[a]	>135
Big Creek	0[a]	76
Clatskanie	19	19
Scappoose	10	24
Clackamas	0[a]	61
Sandy	37	37
Lower Gorge	10	31
Upper Gorge/Hood	53	>53

[a] Although the modeling approach indicated that no additional miles of HQH are needed for several populations to strictly reach the delisting desired status, Oregon fully supports efforts to protect and restore habitat to assure healthy populations into the future, meet broad sense recovery goals, and be precautionary against model and future uncertainty. The most probable scenario for Youngs Bay and Big Creek is between the delisting and broad sense scenarios, where additional HQH is necessary; the most probable scenario for Clackamas is the same as the broad sense goal presented here.

Table 15. Cumulative mortality rate targets for Oregon populations of coho, fall Chinook (CHF), spring Chinook (CHS), winter steelhead (STW), and summer steelhead (STS).

Population and Species	**Predation Mortality Rate**				
	CHF	CHS	Coho	STW	STS
Youngs	4%		3%	6%	
Big Creek	4%		3%	6%	
Clatskanie	5%		4%	7%	
Scappoose	5%		4%	7%	
Clackamas	6%	7%	4%	7%	
Sandy	6%	7%	4%	7%	
Gorge L	6%		4%	7%	
Gorge U	7%			10%	
Hood	7%	7%	5%	10%	8%
Sandy late	6%				

[8] HQH is defined as habitat with a capacity to support > 1,850 juvenile coho salmon (parr) per kilometer during winter based on the Habitat Limiting Factors Model (Nickelson 1998). See Strickland and Constable (2022) for additional information.
[9] Based on an evaluation of the amount of HQH available for coho at the time of plan development (Anlauf et al. 2006).

Measurable Criteria Assessment Results

Coho Salmon

Results of the measurable criteria assessment for Oregon populations of LCR coho salmon are summarized in Table 16; assessment details are presented in Appendix III.

Since adoption of the Plan in 2010, annual natural origin coho spawner abundance in the Oregon portion of the LCR ESU has varied from a low of approximately 3,000 spawners to a high of over 23,000 spawners. Among the eight Oregon populations, only one population attained (Clackamas) and two likely attained (Youngs Bay, Big Creek) the interim abundance/productivity (A/P) goal (Table 16). Coho abundance in the Clackamas population has shown an increasing trend and additionally attained the delisting scenario goal in 2022. A/P goals for the Youngs Bay and Big Creek populations are very low due to their high viability risk status in the delisting scenario, and it is likely that they are exceeding goals based on the limited monitoring information available. Youngs Bay and Big Creek coho are therefore achieving the listed goals, not because the populations are recovering, but because the goals are set very low and the Plan allows a high risk of extinction to support other management actions. The other five coho populations in the Oregon portion of the LCR ESU did not achieve the interim goal. Average spawner abundance in the Scappoose, Clatskanie, Lower Gorge and Hood populations are well below the delisting scenario goals, and no significant trends in abundance were observed. Several populations had at least one year with critically low spawner abundance in the period from 2015–2018 and have shown modest increases in abundance more recently.

Spatial structure status reflects relatively low abundance across the ESU and the only populations to achieve delisting goals were the Youngs Bay, Big Creek and Lower Gorge populations (Table 16), where occupancy goals range from zero to 50 percent. Three populations (Scappoose, Clackamas, and Sandy) attained delisting goals for the pHOS. The two Gorge stratum populations and the Clatskanie population did not attain delisting goals for pHOS; of these, only the Lower Gorge has hatchery releases within the population area. In the Clatskanie population, recent increases in pHOS are due in large part to very low natural origin spawner escapement, which has magnified the effect of straying from nearby hatchery programs. The highest hatchery stray rates in the Clatskanie population are observed in Plympton Creek, where there is little natural coho production.

Management of ocean and lower Columbia River fisheries has consistently maintained fishery impacts below established limits for the ESU, and so most populations attained the harvest rate goal (Table 16). Harvest criteria could not be assessed for three populations (Youngs Bay, Big Creek, and Upper Gorge/Hood) due to established monitoring methodology that does not allow for total impact assessment in these populations.

Assessment of measurable criteria related to Listing Factor A (present or threatened destruction, modification, or curtailment of its habitat or range) indicated that habitat restoration occurred in all coho populations, but the pace and scale varies considerably across the ESU. Based on the delisting scenario, all interim habitat restoration goals were achieved in the Youngs Bay and Sandy population areas, and riparian and off-channel interim habitat restoration goals were achieved in the Clackamas and Scappoose population areas. In contrast, there was limited progress toward interim habitat restoration goals in the Big Creek, Clatskanie, Lower Gorge, and Upper Gorge/Hood population areas (Table 16). Due to sample size limitations, habitat trends could not be evaluated at the population scale. At the stratum scale, most habitat metrics showed no significant trend, but there was a negative trend in the percent gravel substrate in the Coastal stratum and a positive trend in winter parr capacity (an indicator of habitat complexity) in the combined Cascade/Gorge strata.

In addition to measurable criteria for specific restoration types, the Plan identified goals for HQH in each population (see Table 14 for additional information). The amount of additional HQH needed was estimated based on the limited habitat data that existed when the Plan was developed. Since that time, annual habitat surveys by ODFW's Aquatic Inventories Project have provided much more data on tributary habitat conditions in the ESU. For some populations, collection of more robust data suggests that Plan assumptions about the quantity of existing HQH may have been inaccurate. As a result, goals for additional HQH needed may have also been inaccurate. Nevertheless, the HQH criteria can still be assessed by comparing current conditions to the total amount of HQH needed under the delisting scenario. The 12-year assessment indicates that HQH goals have been attained in the Youngs Bay, Scappoose, and Clackamas populations. Although the original Plan analysis also found that the Youngs Bay and Clackamas populations had sufficient HQH to meet delisting scenario goals, the current assessment indicates that HQH was underestimated in the Plan or has significantly increased since Plan adoption. In either case, HQH in these populations currently exceeds delisting scenario goals. The same is true for the Scappoose population, which was assumed to have little or no HQH based on data available during Plan development but now appears to exceed the delisting scenario goal. The Plan concluded that the Big Creek population had sufficient HQH to meet the delisting scenario, but the current assessment indicates that the original estimate was inaccurate or that HQH in the Big Creek population area has been lost. As a result, additional HQH may be needed in this population to meet the delisting scenario. Both the Plan and this assessment indicate that there is currently no HQH in the Upper Gorge/Hood population. Given the large gap between current conditions and the delisting scenario, it is worth reconsidering whether the HQH goal for this population is attainable under any plausible restoration scenario.

The Plan identified three hydropower related criteria for Listing Factor A. Both criteria, that apply to the Clackamas population area, have been attained through significant investment and coordination by PGE, and these actions have very likely contributed to the improving status of Clackamas coho. The third criteria, fish passage at Laurance Lake Dam (Clear Branch Dam) in the Hood population area, has not yet been attained, but options for providing passage are currently being considered.

Finally, there is insufficient information to assess the criteria related to predation (Listing Factor C) for any population or the ESU. Available information suggests that predation mortality rates may exceed those identified in the Plan, but there is high uncertainty about predation rates at different life stages by different predators, potential population-specific differences, and the extent to which current predation rates can be attributed to anthropogenic influences.

Table 16. Summary of measurable criteria assessment results for Oregon LCR coho salmon populations. Green = population attained or likely attained interim criteria goal; Gray = population has not yet attained interim criteria; White = metric not assessed (NA) due to insufficient monitoring data; Black = no metrics identified for the population). For metrics that have not yet attained interim criteria, arrows indicate metric trend direction: increasing (up), decreasing (down) or no clear trend (horizontal). Arrow color indicates whether biological criteria trend is in the desired direction (blue), opposite of the desired direction (orange), or where there is no clear directional trend (yellow). Populations in **bold** are primary populations with a delisting desired status of low or very low extinction risk. See Appendix III for detailed graphics for each population.

			Biological Criteria		Biological/ Listing Factor Criteria		Listing Factor Criteria			
Stratum	**Coho Salmon Population**	**Contribution to Delisting**	**Abundance/ Productivity**	**Spatial Structure**	Diversity/ Listing Factor E **pHOS**	Diversity/ Listing Factor B **Harvest Rate**	Listing Factor A **Habitat Restoration**	Listing Factor A **High Quality Habitat**	Listing Factor A **Hydropower**	Listing Factor C **Predation**
Coastal	Youngs Bay	Stabilizing	Likely Attained	Attained	NA	NA	Attained	Attained		NA
	Big Creek	Stabilizing	Likely Attained	Attained	NA	NA	↑	↓		NA
	Clatskanie	**Primary**	↔	↓	↑	Attained	↑	↑		NA
	Scappoose	**Primary**	↔	↔	Attained	Attained	↑	Attained		NA
Cascade	**Clackamas**	**Primary**	Attained	NA	Attained	Attained	↑	Attained	Attained	NA
	Sandy	**Primary**	↑	↑	Attained	Attained	Attained	↑		NA
Gorge	Lower Gorge	*Support WA*	↔	Attained	↓	Attained	↑	NA		NA
	Upper Gorge/ Hood	**Primary**	↔	↔	↔	NA	↑	↔		NA

Fall and Late Fall Chinook Salmon

Results of the measurable criteria assessment for Oregon populations of LCR fall Chinook salmon are summarized in Table 17; assessment details are presented in Appendix III. ODFW has investigated the possibility of estimating separate population parameters for fall and late fall Chinook in the Sandy basin but has not found a way to reliably differentiate the two runs. Therefore, Sandy fall Chinook data for the assessment represent combined fall and late fall Chinook returns. For purposes of the assessment, measurable criteria for the fall and late fall components of the run were combined for the total Sandy fall Chinook return.

Since Plan adoption in 2010, annual natural origin fall Chinook spawner abundance in the Oregon portion of the LCR ESU (excluding Gorge stratum populations, which generally have not been monitored) has varied from less than 1,000 spawners to a high of over 5,000 spawners. In most years, a majority of these fish are Sandy fall/late fall Chinook, the only population that attained the interim A/P goal (Table 17). Sandy fall/late fall Chinook abundance has shown an increasing trend since Plan adoption and neared the delisting scenario goal twice in recent years. For most other populations, the A/P criteria could not be formally assessed due to limited data on observed abundance and a limited time series for determining annual goals. Nevertheless, available information indicates that fall Chinook spawner abundance in these populations remains far below delisting scenario goals. ODFW has consistently monitored the Clatskanie and Scappoose populations, which are identified as primary populations in the delisting scenario. The number of natural origin fall Chinook spawners in the Clatskanie population has been very low (0–13 spawners annually) and no fall Chinook (hatchery or natural origin) have been observed in the Scappoose population since monitoring began in 2012. Both populations appear to be functionally extirpated. Spatial structure status reflects low abundance across most of the ESU and the only population that attained the delisting goal is Youngs Bay (Table 17), where the occupancy threshold is 50 percent under the delisting scenario.

Clackamas and Sandy fall Chinook pHOS have declined significantly over time and both populations attained the delisting scenario goals in recent years. Given the location of fall Chinook hatchery programs and intensive fisheries, the Youngs Bay and Big Creek populations are expected to have high pHOS under the delisting scenario. The Youngs Bay population attained the delisting scenario goal, while the Big Creek population did not. In the Clatskanie population, pHOS has been very high relative to the delisting goal, due in large part to extremely low returns of naturally produced fish. As observed for coho, hatchery fall Chinook strays in the Clatskanie population are concentrated in Plympton Creek, which originates in the same headwater source area as Big Creek. It does not appear that the Clatskanie Basin has a self-sustaining population, and hatchery strays likely contribute to the limited natural production observed. No hatchery strays were observed in the Scappoose population, but we did not consider the criteria to be assessed because no natural origin spawners have been observed since Plan adoption. The pHOS criteria could not be assessed in Gorge stratum populations, but the limited monitoring that has occurred in these populations indicates that hatchery stray rates are relatively high, as expected for the Lower Gorge and Upper Gorge populations under the delisting scenario.

Management of ocean and LCR fisheries has consistently maintained fishery impacts below established limits for the ESU, and so most populations attained the harvest rate goal (Table 17). Harvest criteria could not be assessed for four populations (Youngs Bay, Big Creek, Upper Gorge, and Hood) due to established monitoring methodology that does not allow for total impact assessment in these populations.

Assessment of measurable criteria related to Listing Factor A (present or threatened destruction, modification, or curtailment of its habitat or range) indicated that habitat restoration occurred in all populations except the Upper Gorge, which is shared with Washington. Based on the delisting scenario, all habitat restoration goals were achieved in the Youngs Bay and Sandy population areas, and riparian and off-channel habitat restoration goals were achieved in the Clackamas and Scappoose population areas. In contrast, there was limited progress toward habitat restoration goals in the Big Creek, Clatskanie, Lower Gorge, and Hood population areas. Restoration of mainstem habitats used by fall Chinook is particularly challenging due to the size of the channel, significant constraints from roads and other infrastructure, and the dependence of these habitats on processes occurring at the watershed scale. Furthermore, monitoring habitat conditions in mainstem habitats is more difficult than in smaller, wadeable streams where most ODFW habitat monitoring is focused. ODFW is actively investigating methods for monitoring larger mainstem habitats, but currently we do not have adequate information to assess trends for fall Chinook habitat in the LCR ESU.

The Plan identified three hydropower related criteria for Listing Factor A. Both criteria that apply to the Clackamas population area have been attained and the third criteria, which applies to the Hood population area, has not yet been attained. These criteria have very limited applicability to fall Chinook due to their distribution in these basins.

Finally, there is insufficient information to assess the criteria related to predation (Listing Factor C) for any population or the ESU. Available information suggests that predation mortality rates may exceed those identified in the Plan, but there is high uncertainty about predation rates at different life stages by different predators, potential population-specific differences, and the extent to which predation has been exacerbated by anthropogenic factors.

Table 17. Summary of measurable criteria assessment results for Oregon LCR fall Chinook salmon populations. Green = population attained or likely attained interim criteria goal; Gray = population has not yet attained interim criteria; White = metric not assessed (NA) due to insufficient monitoring data; Black = no metrics identified for the population). For metrics that have not yet attained interim criteria, arrows indicate metric trend direction: increasing (up), decreasing (down) or no clear trend (horizontal). Arrow color indicates whether biological criteria trend is in the desired direction (blue), opposite of the desired direction (orange), or where there is no clear directional trend (yellow). Populations in **bold** are primary populations with a delisting desired status of low or very low extinction risk. See Appendix III for detailed graphics for each population.

Stratum	Fall Chinook Population	Contribution to Delisting	Biological Criteria		Biological/ Listing Factor Criteria		Listing Factor Criteria		
			Abundance/ Productivity	Spatial Structure	Diversity/ Listing Factor E pHOS	Diversity/ Listing Factor B Harvest	Listing Factor A Habitat Restoration	Listing Factor A Hydropower	Listing Factor C Predation
Coastal	Youngs Bay	Stabilizing	NA	Attained	Attained	NA	Attained		NA
	Big Creek	Contributing	NA	↔	↔	NA	↑		NA
	Clatskanie	**Primary**	↔	↓	↔	Attained	↑		NA
	Scappoose	**Primary**	↔	↔	NA	Attained	↑		NA
Cascade	Clackamas	Contributing	NA	↔	Attained	Attained	↑	Attained	NA
	Sandy Fall/ Late Fall	**Primary**	Attained	↔	Attained	Attained	Attained		NA
Gorge	Lower Gorge	*Support WA*	NA	NA	NA	Attained	↑		NA
	Upper Gorge	*Support WA*	NA	NA	NA	NA	↔		NA
	Hood	**Primary**	NA	NA	NA	NA	↑		NA

Spring Chinook Salmon

Results of the measurable criteria assessment for Oregon populations of LCR spring Chinook salmon are summarized in Table 18; assessment details are presented in Appendix III. There are two historical spring Chinook populations in the Oregon portion of the ESU, the Sandy and Hood populations. The indigenous stock of Hood River spring Chinook is believed to have been extirpated by the early 1970s. The current population of naturally reproducing Hood River spring Chinook salmon was introduced as part of the Hood River Production Program (HRPP) using stock from the Deschutes Basin (stock 66), which is part of the Middle Columbia Chinook ESU. The naturally produced progeny of hatchery-origin adults from the program are not considered part of the LCR ESU and are not listed under the federal ESA (50 C.F.R. 17§ 223.4 2014). The goals of HRPP are to re-establish and maintain a naturally sustaining spring Chinook population in the Hood River and provide sustainable and consistent in-basin tribal and sport harvest opportunities.

The Sandy spring Chinook population attained the interim A/P goal and has shown an increasing abundance trend since Plan adoption. Natural origin spring Chinook abundance in the Sandy population exceeded the delisting scenario goal in all but one year since 2010 and average spawner abundance during this period was more than double the delisting scenario goal. In 2018, ODFW conducted a population viability analysis (PVA) for Sandy spring Chinook based on recent returns (2002-2017) and the results supported the Plan conclusion that this population has a low extinction risk. In contrast, returns of naturally produced spring Chinook in the Hood population have consistently been very low relative to annual A/P goals. Current monitoring methods for spring Chinook populations do not provide the data needed to evaluate measurable criteria for spatial structure.

In the Sandy population, pHOS dropped significantly following Plan adoption due to implementation of several actions identified in the Plan (see Table 5 in Appendix 1), and the population has now attained the delisting goal (Table 18). In the Hood population, pHOS has consistently exceeded the goal identified in the Plan. However, current management is consistent with the Hatchery Genetic Management Plan (HGMP) for this reintroduction/recovery and integrated harvest program, which allows all hatchery fish not collected for broodstock to spawn in the wild as a potential method to increase natural production (CTWS and ODFW 2017).

The harvest rate goal for Sandy spring Chinook was attained. ODFW does not have sufficient data to assess the harvest rate criterion for the Hood population.

Assessment results for measurable criteria related to Listing Factor A (present or threatened destruction, modification, or curtailment of its habitat or range) are the same as those described above for fall Chinook. The Sandy population area has attained interim habitat restoration goals and additional restoration work is planned or underway. Progress toward restoration goals has been slower in the Hood population area, but there are ongoing efforts to improve habitat and restore instream flow. As with other LCR ESUs and populations, there is insufficient information to assess criteria related to predation (Listing Factor C) for LCR spring Chinook.

Table 18. Summary of measurable criteria assessment results for Oregon LCR spring Chinook salmon populations. Green = population attained or likely attained interim criteria goal; Gray = population has not yet attained interim criteria; White = metric not assessed (NA) due to insufficient monitoring data; Black = no metrics identified for the population). For metrics that have not yet attained interim criteria, arrows indicate metric trend direction: increasing (up), decreasing (down) or no clear trend (horizontal). Arrow color indicates whether biological criteria trend is in the desired direction (blue), opposite of the desired direction (orange), or where there is no clear directional trend (yellow). Populations in **bold** are primary populations with a delisting desired status of low or very low extinction risk. See Appendix III for detailed graphics for each population.

Stratum	Spring Chinook Population	Contribution to Delisting	Biological Criteria		Biological/ Listing Factor Criteria		Listing Factor Criteria		
			Abundance/ Productivity	**Spatial Structure**	Diversity/ Listing Factor E **pHOS**	Diversity/ Listing Factor B **Harvest**	Listing Factor A **Habitat Restoration**	Listing Factor A **Hydropower**	Listing Factor C **Predation**
Cascade	**Sandy**	**Primary**	Attained	NA	Attained	Attained	Attained		NA
Gorge	**Hood**	**Primary**		NA	Not Applicable	NA			NA

Winter Steelhead

The Plan covers winter steelhead populations in the LCR Steelhead DPS and the SW Washington (SWW) Steelhead DPS. Winter steelhead populations in the ESA-listed LCR Steelhead DPS have delisting goals, while populations in the unlisted SWW DPS only have broad sense recovery goals. Results of the measurable criteria assessment for Oregon populations of winter steelhead in the LCR DPS and SWW DPS are summarized in Table 19; assessment details are presented in Appendix III.

Since adoption of the Plan in 2010, annual natural origin winter steelhead spawner abundance in the Oregon portion of the LCR ESU (excluding the Lower Gorge and Upper Gorge populations, which generally have not been monitored) has varied from a low of around 2,000 spawners to a high of over 10,000 spawners. Sandy winter steelhead attained the interim A/P goal, and natural origin spawner abundance in the Sandy has exceeded the delisting scenario goal every year since 2013. Sandy winter steelhead abundance has also exceeded the broad sense recovery scenario goal in all but one of those years. The Hood winter steelhead population attained the interim A/P goal, but spawner abundance in the Hood population was well below the delisting scenario goal in all years and the interim A/P criteria do not appear to be a good indicator of progress toward recovery. The Clackamas winter steelhead population did not attain the interim A/P goal, but average spawner escapement since Plan adoption was nearly double that of the previous decade.

Spatial structure criteria could not be assessed for Gorge stratum populations due to a lack of monitoring data. In the Clackamas, ODFW conducts spawning ground surveys only in the lower portion of the basin below North Fork Dam. The assessment indicated that the SS goal was not attained, but results from these surveys are likely not representative of occupancy within the entire basin. In the Sandy population, site occupancy was over 70 percent in most years, but only exceeded the delisting goal of 85 percent in one year.

The Clackamas and Sandy populations both attained the delisting scenario goal of less than 10 percent pHOS. The delisting scenario goal for pHOS was not attained in the Hood population and as result of continued high stray rates, the winter steelhead hatchery program has ended (the final hatchery smolt release occurred in 2021). Additional years of information are needed to definitively assess the criterion for fishery impacts, but no monitored population has exceeded the 10 percent maximum impact rate in any year, and the objective has very likely been attained in all populations.

Assessment results for measurable criteria related to Listing Factor A (present or threatened destruction, modification, or curtailment of its habitat or range) for LCR winter steelhead populations are the same as those described above for coho and fall Chinook. The Sandy population area has attained interim habitat restoration goals and additional restoration work is planned or underway. In the Clackamas, there has been significant progress toward interim restoration goals and measurable criteria related to hydropower threats have been attained. Progress on interim habitat restoration goals has been slower in the Hood population area, but there are ongoing efforts to improve habitat and restore instream flow. As with other LCR ESUs and populations, there is insufficient information to assess criteria related to predation (Listing Factor C) for LCR winter steelhead.

There are four winter steelhead populations in the Oregon portion of the SWW DPS. In the Clatskanie and Scappoose populations, where consistent population-scale monitoring has occurred, there has been a decreasing trend in abundance and significant progress will be needed to achieve broad sense recovery goals. Due to limited monitoring data, abundance trends in the Youngs Bay and Big Creek populations could not be evaluated, but these populations also appear to be well below broad sense recovery goals. Spatial structure status for Oregon populations in the SWW DPS reflect the low abundance relative to broad sense recovery goals, and none of the populations attained goals for adult steelhead occupancy.

The Clatskanie and Scappoose winter steelhead populations both attained broad sense recovery goals for pHOS and harvest rate. Based on limited data, pHOS in the Youngs Bay and Big Creek populations appears to be higher than the broad sense goals, but additional monitoring in these populations would be needed to assess the criterion and determine if there are trends in pHOS. Likewise, the harvest rate criterion could not be assessed for these two populations until additional years of data become available.

Assessment results for measurable criteria related to Listing Factor A (present or threatened destruction, modification, or curtailment of its habitat or range) indicate limited progress toward restoration goals in most populations. Restoration goals under the delisting scenario (for LCR coho and fall Chinook) were attained in the Youngs Bay population area. However, additional habitat restoration above and beyond delisting scenario goals will be needed to achieve broad sense recovery goals in Youngs Bay and the other SWW DPS winter steelhead populations. As for other ESUs and populations, there is insufficient information to assess measurable criteria related to predation (Listing Factor C).

Summer Steelhead

The LCR Steelhead DPS contains only one native population of summer steelhead on the Oregon side of the Columbia River. Results of the measurable criteria assessment for this population are summarized in Table 19; assessment details are presented in Appendix III.

Hood summer steelhead abundance was consistently low compared to interim annual A/P goals and the delisting scenario goal. Given the small size of the population, monitoring is difficult and abundance estimates could not be obtained in all years. Monitoring methods for this population do not provide data needed to assess the spatial structure criterion. There is no hatchery summer steelhead program in the Hood and most stray hatchery fish are removed at monitoring weirs. The delisting goal of zero percent pHOS has been attained in most recent years and the nine-year average has recently dropped below 10 percent. Additional data is needed to definitively assess the harvest rate criterion, but available information indicates that fishery impacts are typically very low for this population and the objective has very likely been attained. Assessment results for measurable criteria related to Listing Factor A indicate limited progress toward interim habitat restoration and hydropower goals, but there are ongoing efforts to improve habitat and restore instream flow. As for other ESUs and populations, there is insufficient information to assess measurable criteria related to predation (Listing Factor C) for Hood summer steelhead.

Table 19. Summary of measurable criteria assessment results for Oregon SWW and LCR steelhead populations. Green = population attained or likely attained interim criteria goal; Gray = population has not yet attained interim criteria; White = metric not assessed (NA) due to insufficient monitoring data; Black = no metrics identified for the population). For metrics that have not yet attained interim criteria, arrows indicate metric trend direction: increasing (up), decreasing (down) or no clear trend (horizontal). Arrow color indicates whether biological criteria trend is in the desired direction (blue), opposite of the desired direction (orange), or where there is no clear directional trend (yellow). Populations in **bold** are primary populations with a delisting desired status of low or very low extinction risk. See Appendix III for detailed graphics for each population.

				Biological Criteria		**Biological/ Listing Factor Criteria**		**Listing Factor Criteria**		
DPS	**Stratum**	**Steelhead Population**	**Contribution to Delisting**	**Abundance/ Productivity**	**Spatial Structure**	Diversity/ Listing Factor E **pHOS**	Diversity/ Listing Factor B **Harvest**	Listing Factor A **Habitat Restoration**	Listing Factor A **Hydropower**	Listing Factor C **Predation**
SWW	Coastal	Youngs Bay (winter)	*Not Applicable*	NA	NA	NA	NA	Attained		NA
		Big Creek (winter)	*Not Applicable*	NA	NA	NA	NA	↑		NA
		Clatskanie (winter)	*Not Applicable*	↓	↔	Attained	Likely Attained	↑		NA
		Scappoose (winter)	*Not Applicable*	↓	↓	Attained	Attained	↑		NA
LCR	Cascade	**Clackamas (winter)**	**Primary**	↔	NA	Attained	Likely Attained	↑	Attained	NA
		Sandy (winter)	**Primary**	Attained	↑	Attained	Attained	Attained		NA
	Gorge	Lower Gorge (winter)	*Support WA*	NA	NA	NA	NA	↑		NA
		Upper Gorge (winter)	*Support WA*	NA	NA	NA	NA	↔		NA
		Hood (winter)	**Primary**	Attained	NA	↔	Likely Attained	↑		NA
	Gorge	**Hood (summer)**	**Primary**	NA	NA	↓	Likely Attained	↑		NA

Section 5: Climate and Ocean Change

Background

Records spanning up to several thousand years demonstrate that warming of the global climate system, as well as warming and acidification of the ocean, are occurring and that the rate of change since the 1950s is unprecedented (IPCC 2021). There is strong scientific support for projections that warming will continue through the 21st century and that the magnitude and rate of change will be influenced substantially by the amount of greenhouse gas emissions (IPCC 2021). Ocean acidification is also expected to continue through the end of the century under most greenhouse gas emission scenarios and could accelerate as the ocean's buffering capacity diminishes (Jiang *et al*. 2019). In 2020, the OFWC adopted a Climate and Ocean Change Policy (OAR 635-900-0001) to ensure that ODFW prepares for and responds appropriately to the impacts of a changing climate and ocean. The policy provides high level direction to ensure that ODFW understands the risks and opportunities associated with changing climate and ocean conditions and incorporates that understanding into agency actions.

The Plan recognized that climate change, as well as increases in human population, would undoubtedly impact LCR salmon and steelhead populations in the future. The Plan described general impacts of these future threats, but did not prioritize their impacts for each population, geographic area, and salmonid life-stage due to the difficulty of predicting specific impacts. To account for likely negative future impacts, a precautionary buffer was embedded in recovery scenarios by increasing conservation gap mean abundances by 20 percent for each population. The Plan also identified a wide range of recovery actions that address future threats from climate change (see Table 7-3 in the Plan), which will generally exacerbate existing limiting factors.

In the 12 years since Plan adoption, progress in climate change modeling and projection has provided much greater detail about the potential timing, magnitude, and spatial distribution of climate change effects on freshwater and marine environments. The Plan anticipated that better estimates of the impacts of future threats would be developed over time, and that the adaptive management process used to implement the Plan could adjust the level and types of actions needed to address future threats. The Plan also calls for research to provide information at the population scale on 1) potential patterns and impacts of future human population growth and climate change; 2) critical areas and parameters for monitoring; and 3) recommendations for specific actions to address these impacts.

Consistent with the Plan and ODFW's Climate and Ocean Change Policy, this section presents updated climate and ocean change projections relevant to LCR salmon and steelhead, including patterns within and among populations; summarizes results of a climate change vulnerability assessment for Plan species by Crozier et al. (2019); and identifies adaptation strategies and actions to ameliorate potential negative impacts and promote population resilience.

Climate and Ocean Change Projections

Increases in global air temperature, ocean temperature, and ocean acidification will continue to drive changes in climate and ocean conditions in the Pacific Northwest. If greenhouse gas emissions continue at current levels, the average annual air temperature in Oregon is projected to increase by 5°F (2.8°C) by the 2050s and 8.2°F (4.6°C) by the 2080s, with the largest seasonal increases occurring in summer (Dalton and Fleishman 2021). Seasonal changes in precipitation and increased drought frequency are also expected (Dalton and Fleishman 2021), with important consequences for stream flow volume and timing. The following sub-sections outline changes expected to occur, based on currently available science, for several key metrics (*stream temperature*, *flow volume and timing*, *sea level rise, sea surface temperature*, *upwelling*, *ocean acidification, and piscine predator distribution*) linked to freshwater or marine habitat for LCR salmon and steelhead populations.

Stream Temperature

In the absence of counteracting management actions, summer stream temperatures in the LCR ESU are expected to increase in the future due to rising air temperatures and decreased base flows (see *Flow Volume and Timing* section below). The projected scope of temperature change and ecological consequences will vary widely within populations and the ESU. Maximum Weekly Maximum Temperature (MWMT), the peak annual seven-day average daily maximum temperature for a given stream reach (Figure 4), is projected to increase by 7.7–30.9% by the 2080s, depending on location (Figure 5).

The largest percentage increases in MWMT are projected for higher elevation streams in the Cascade and Gorge strata (Figure 5). Temperatures in these streams are projected to remain relatively cool (Figure 6), but summer flows are expected to decrease significantly (see *Flow Volume and Timing* section). Smaller percentage increases are projected for some lower elevation streams and mainstem rivers (Figure 5), but many of those locations already have limited rearing potential due to high stream temperatures (Figure 4) and further warming will only exacerbate existing temperature limitations.

Higher stream temperatures have the potential to impact distribution and survival of LCR salmon and steelhead at multiple life stages. For juvenile coho salmon and steelhead, which spend at least one year rearing in freshwater before outmigration, stream temperatures above 20°C can severely limit growth (Richter and Kolmes 2005) and increase susceptibility to parasites (Cairns et al. 2005). In the absence of counteracting management actions, the percentage of streams with MWMT ≤ 20°C[10] is projected to decrease substantially in all LCR population areas (Table 20). Projected near-term (2040s) and long-term (2080s) losses vary among population areas depending on current temperatures and the scope of expected warming. Coastal stratum population areas, especially Scappoose, are expected have the largest losses, while streams in the Gorge stratum are generally expected to maintain MWMT ≤ 20°C.

[10] Reach-specific MWMT values from NorWeST shown in Figure 4 and summarized in Table 20 are modeled estimates (Isaak *et al*. 2017) and are not indicative of status relative to Oregon water quality standards.

The effect of increasing summer water temperature on juvenile salmonid production will depend on many factors, including temperature heterogeneity and the presence of thermal refuges within reaches, food resource availability to support increased metabolic needs, changes in the distribution and abundance of non-native warmer water piscine predators, and the quality and quantity of overwinter habitat available to juvenile fish that survive the summer period. Projections indicate that substantial areas of cold-water habitat will remain later in the century, but these areas will generally be in higher elevation streams that may not provide as much benefit to species that depend on mainstem habitats (Chinook and chum salmon) or low gradient streams (coho salmon). It is also crucial to note that future temperature projections presented here do not account for management actions that can mitigate increases due to warming air temperatures. For example, the potential to cool water by increasing stream shading can be greater than projected water temperature increases due to climate change (Wondzell et al. 2019).

Research in other systems has shown that fish community structure can shift from one dominated by native species to warmer adapted non-native species (e.g., smallmouth bass) as water temperatures increase past the ideal range for native, cool water species (e.g., Van Zuiden et al. 2016). Recent modeling of temperature increases of the magnitude forecast through 2080 indicate that new habitat will be available to smallmouth bass that is currently colder than the ideal range for this species (Rubenson and Olden 2020). While non-native smallmouth bass and walleye are already widely distributed in the mainstem Columbia and Snake Rivers, predicted range expansions due to elevated temperatures will allow smallmouth bass (and potentially walleye) access to tributary areas that were formerly inaccessible (Rubenson and Olden 2020). This will provide more areas for warmer water tolerant fish to feed and reproduce in areas that are increasingly important, relative to the mainstem rivers, for salmonid spawning and rearing. This may lead to differential negative impacts to salmonid populations relative to smallmouth bass populating mainstem habitats, as they may directly compete for space with salmonids as well as expanding the area available for smallmouth bass to predate upon juvenile salmonids. Smallmouth bass have been shown to negatively impact the feeding behavior of juvenile Atlantic salmon and antagonistic behavior between smallmouth bass and Atlantic salmon increased with increasing temperatures (Ramberg-Pihl et al. 2023).

Finally, warming air temperatures are expected to drive increased water temperature across all seasons, not just summer. The scope of these changes will vary geographically depending on seasonal shifts in flow volume and timing (see below) and other factors. Increased temperatures in winter, spring, or fall could affect egg incubation and fry emergence timing, juvenile growth and survival, and pre-spawn mortality in returning adults (Reeves et al. 2018). There is low certainty about these effects and their potential impact on productivity at the population scale.

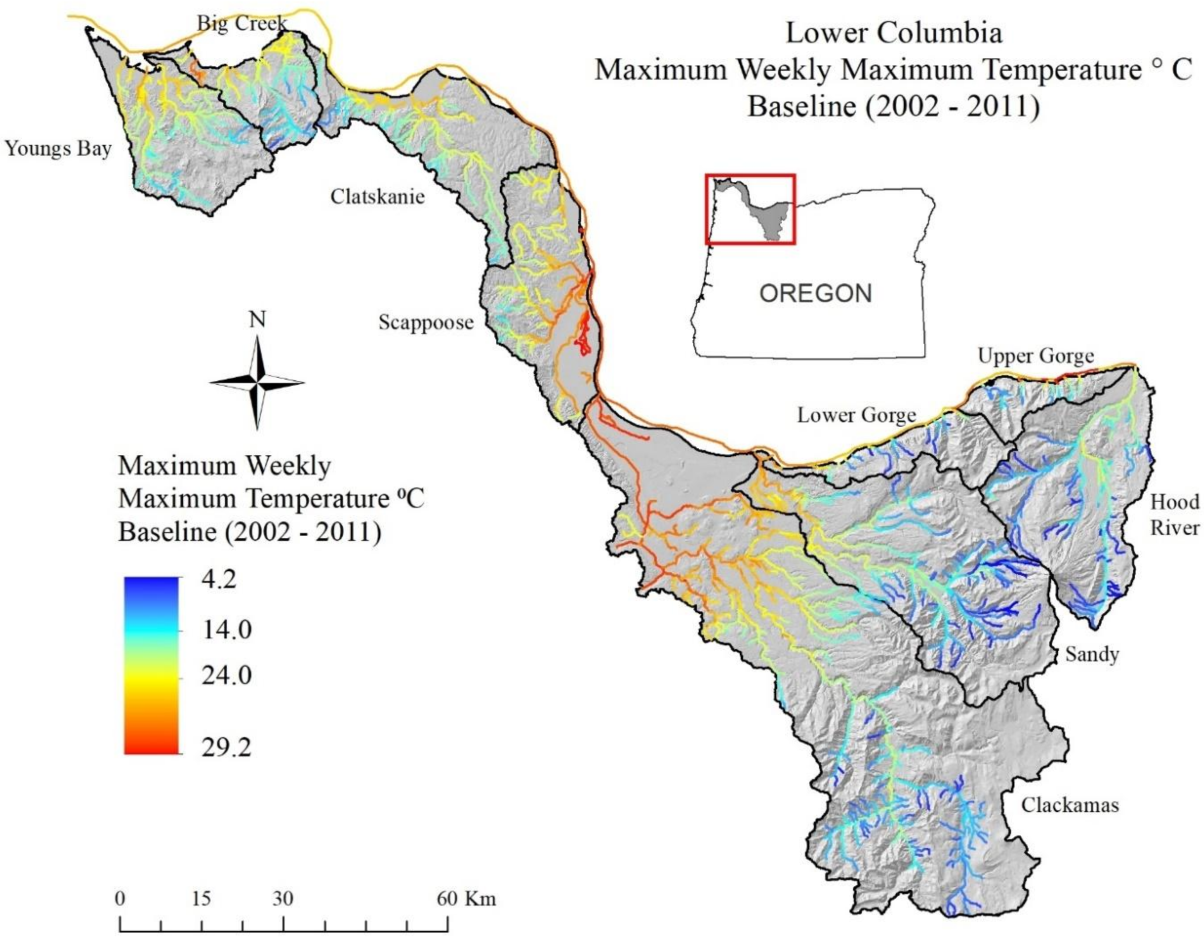


Figure 4. Baseline (2002-2011 average) Maximum Weekly Maximum Temperature (MWMT) estimates (°C) for stream reaches in the Oregon portion of the Lower Columbia River ESU. Reach specific estimates were obtained from NorWeST (Isaak et al. 2016).

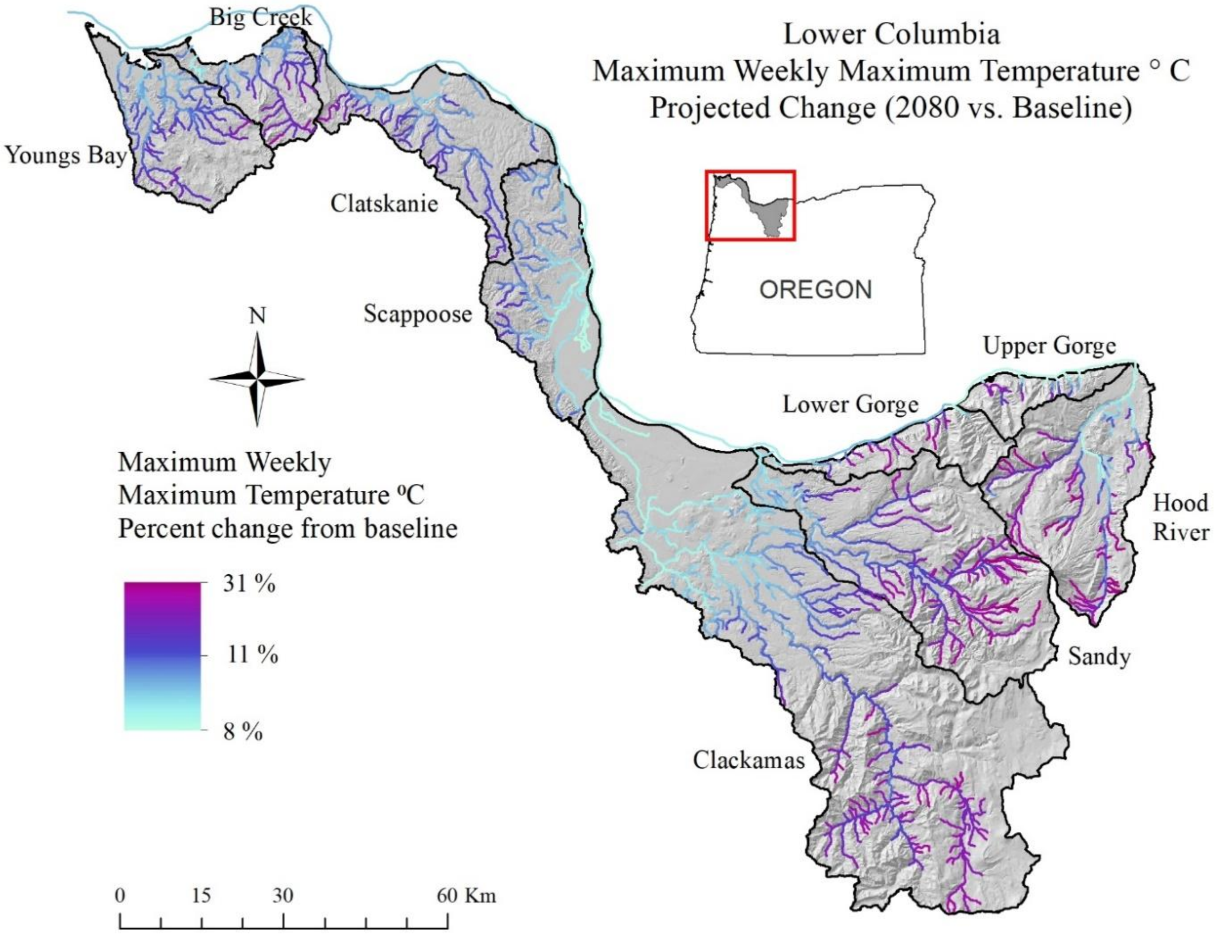


Figure 5. Projected percent change in Maximum Weekly Maximum Temperature (MWMT) estimates (°C) in the 2080s (2070-2099) relative to the baseline (2002-2011 average) under the A1B emissions scenario. Reach specific estimates were obtained from NorWeST (Isaak et al. 2016). NorWeST predictions of stream temperature change in the future assume no changes to surrounding land management, which can either exacerbate or mitigate the changes expected as a result of climate change.

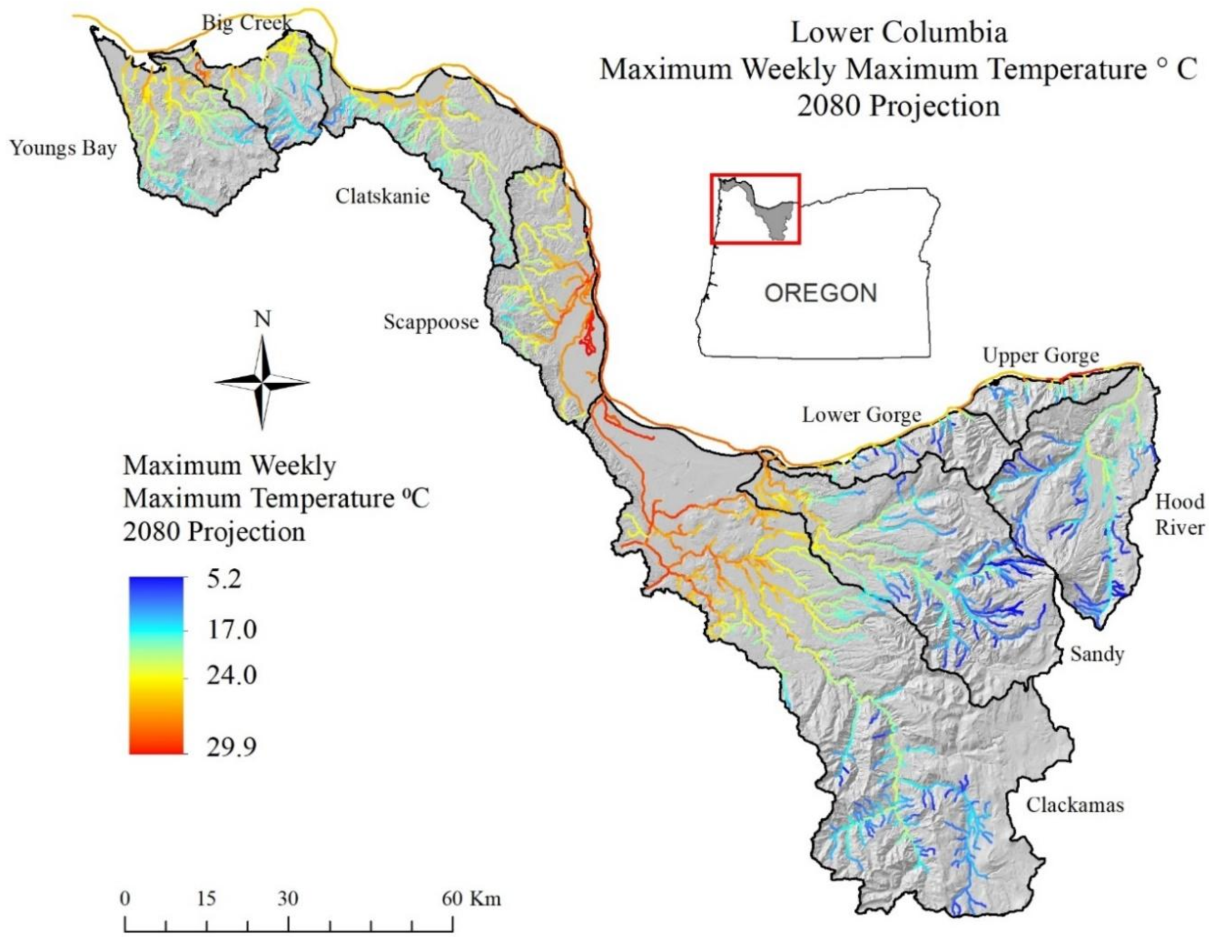


Figure 6. Projected Maximum Weekly Maximum Temperature (MWMT) estimates (°C) in the 2080s (2070-2099) under the A1B emissions scenario. Reach specific estimates were obtained from NorWeST (Isaak et al. 2016). NorWeST predictions of stream temperature change in the future assume no changes to surrounding land management, which can either exacerbate or mitigate the changes expected because of climate change.

Table 20. Baseline (2002-2011 average) and projected future (2040s and 2080s) stream length within anadromous fish distribution with MWMT ≤ 20°C in each of the populations of the LCR ESU. Reach specific estimates were obtained from NorWeST (Isaak et al. 2016); future estimates are based on the A1B emissions scenario. NorWeST predictions of stream temperature change in the future assume no changes to surrounding land management, which can either exacerbate or mitigate the changes expected as a result of climate change.

Population Area	Total Stream Length (km)[1]	Total stream length (km) ≤ 20°C			Percent stream length (%) ≤ 20°C		
		Baseline	2040s	2080s	Baseline	2040s	2080s
Youngs Bay	259	169	114	80	65	44	31
Big Creek	174	110	98	83	63	56	48
Clatskanie	232	158	115	86	68	49	37
Scappoose	296	68	25	13	23	9	4
Clackamas	868	492	408	353	57	47	41
Sandy	494	418	377	332	85	76	67
Lower Gorge	57	47	42	42	82	74	74
Upper Gorge	40	35	31	29	87	78	73
Hood River	304	300	276	255	98	91	84

[1] Total length of anadromous fish habitat based on ODFW Fish Habitat Distribution data for coho salmon, Chinook salmon and steelhead.

Flow Volume and Timing

The timing and magnitude of stream flow affect all aspects of salmonid life history during the freshwater portion of their life cycle, including spawn timing and distribution, redd scour and egg survival, habitat quantity and quality for rearing juveniles, overwinter survival, and outmigration timing of smolts. The projected impact of climate change on stream flows varies substantially among seasons and strata, but some general patterns are evident. Throughout the ESU, late fall and winter flows are projected to increase, while late spring, summer, and early fall flows are expected to decrease (Figure 7). This shift is projected to be most extreme in Cascade Stratum and Gorge Stratum population areas, where reduced snowpack and a shift toward a rainfall dominated hydrograph is expected in the future. Projected seasonal shifts are smaller in the Coastal Stratum, with the largest changes expected in late summer.

Decreased summer and early fall flows would directly affect rearing capacity by reducing the depth and volume of stream habitats available to juvenile salmonids, changes that could be exacerbated by water temperature increases described above. Connectivity within stream reaches could also be reduced, limiting the ability of juvenile fish to make adaptive movements between habitats or seek out temperature refuges and limiting access for returning adults to holding and spawning grounds. It is important to note that flow projections presented here are for late century, will not necessarily result in a corresponding decrease in habitat, and may be mitigated by management actions.

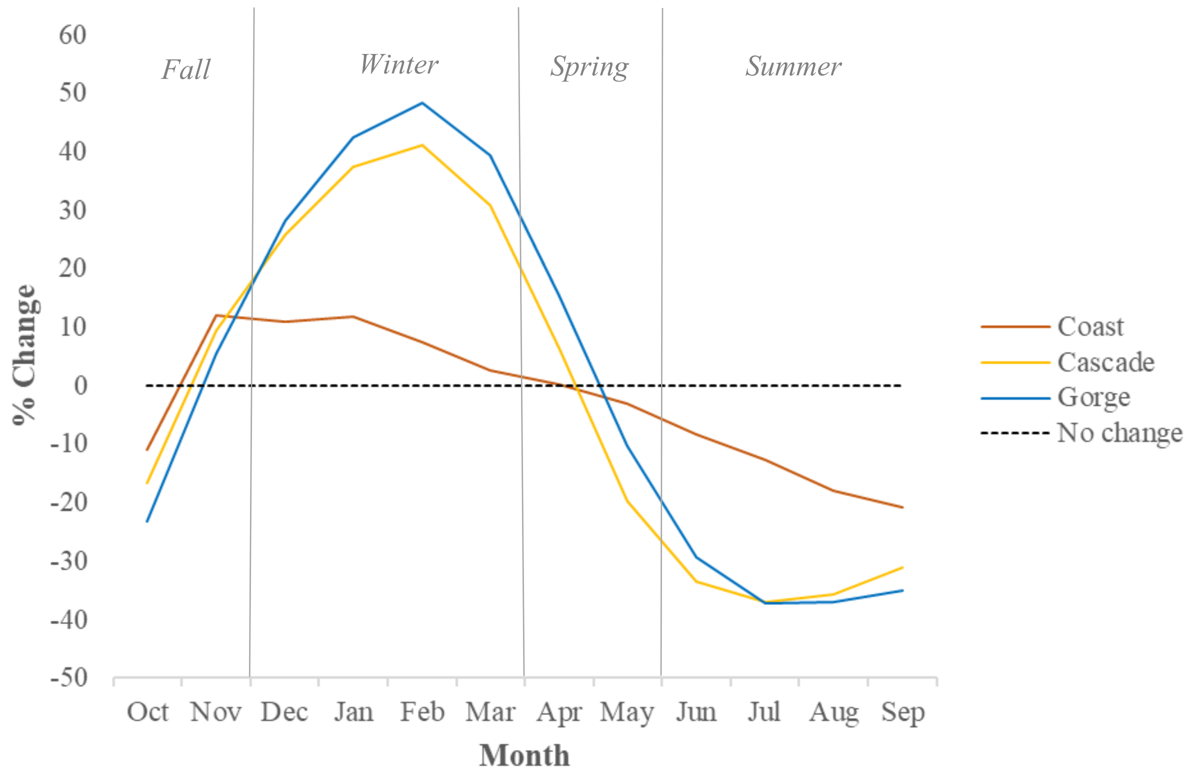


Figure 7. Projected percentage change in median monthly stream flow in 2080 relative to the historical baseline (1915–2006) for the three strata in the Oregon portion of the LCR ESU. Projections were developed using the Variable Infiltration Capacity (VIC) model (Liang et al. 1994; Hamman et al. 2018) based on the A1B emissions scenario.

Projected changes in stream flow in other seasons are smaller in scope but could have important positive or negative consequences for salmon and steelhead. For example, increased winter flows and flooding may reduce habitat quality and overwinter survival in the short term but could also improve habitat conditions in the long term if sources of large wood are available (Reeves *et al*. 2018). Reduced spring flows could affect smolt out-migration timing and survival, as well as dispersal and survival of newly emerged fry. Additional details on projected seasonal changes in flow are presented in the sections below.

Fall Stream Flow

Median stream flow during fall is projected to remain similar or increase slightly in most streams due to increased precipitation (Figure 8). An exception is higher elevation streams in the Cascade Range, which are projected to have lower flows in fall due to reduced snowpack. Although fall flows are expected to remain stable or increase overall, early fall flows are expected to decrease along with late summer flows (Figure 7).

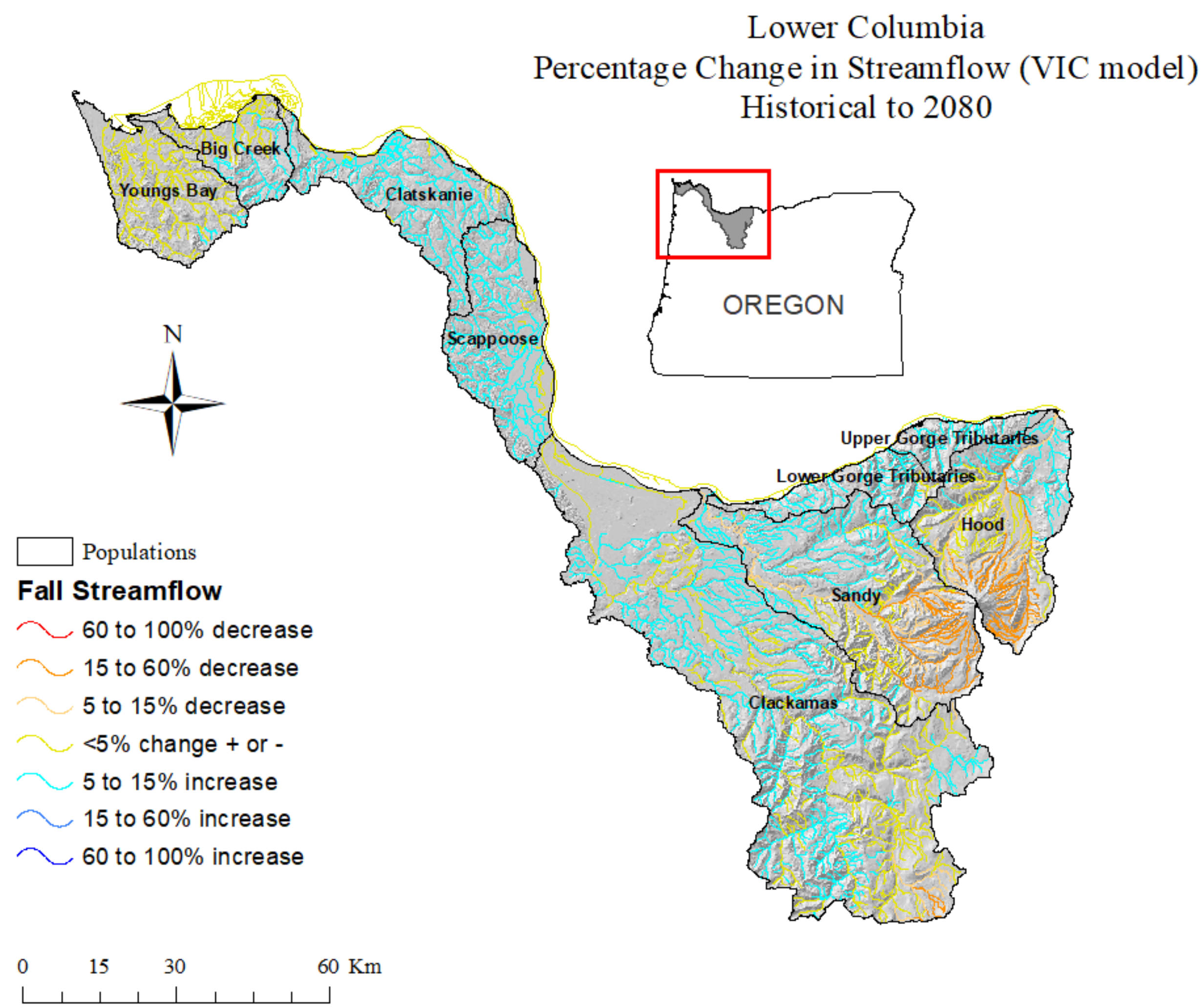


Figure 8. Projected percentage change in median fall stream flow in 2080 relative to the historical baseline (1915–2006) in the Oregon portion of the LCR ESU. Projections were developed using the VIC model (Liang et al. 1994; Hamman et al. 2018) based on the A1B emissions scenario.

Winter Stream Flow

Winter stream flow is projected to increase throughout most of the ESU due to increased precipitation (Figure 9). Projected increases are ≤15% for most Coastal stratum streams, but larger changes are expected in most Cascade stratum and Gorge stratum streams due to a shift in winter precipitation from snow to rain. In addition to overall increases in winter flow, the frequency of major storms and high flow events is expected to increase in the future. Major winter storm events tend to be associated with the occurrence of atmospheric rivers that carry large quantities of warm, wet air from the Pacific Ocean (Warner et al. 2015). Warner et al. (2015) project a 20% increase in the frequency of atmospheric river events by 2080 relative to the period 1970-99. Similarly, Mote et al. (2019) projected a 10% increase in extreme precipitation events in winter in western Oregon by mid-century.

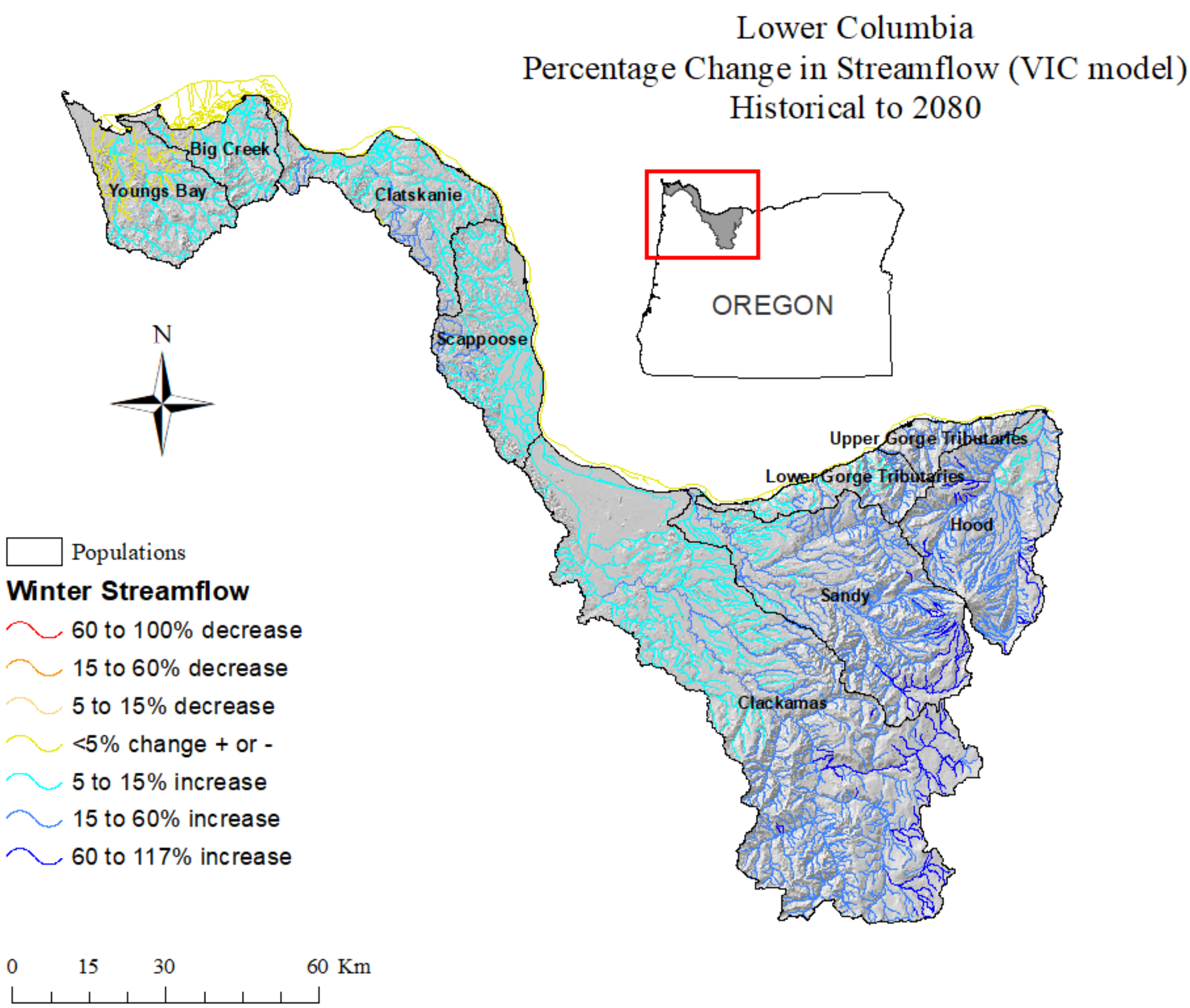


Figure 9. Projected percentage change in median winter stream flow in 2080 relative to the historical baseline (1915–2006) in the Oregon portion of the LCR ESU. Projections were developed using the VIC model (Liang et al. 1994; Hamman et al. 2018) based on the A1B emissions scenario.

Spring Stream Flow

In the Coastal stratum, projections indicate little or no change in spring stream flow (Figure 10). In the Cascade stratum and Gorge stratum, projected changes vary depending on elevation. Spring flow in mid-elevation streams is expected to decrease overall due to reduced snowpack, while earlier snowmelt is projected to increase spring flows in high elevation streams (Figure 10).

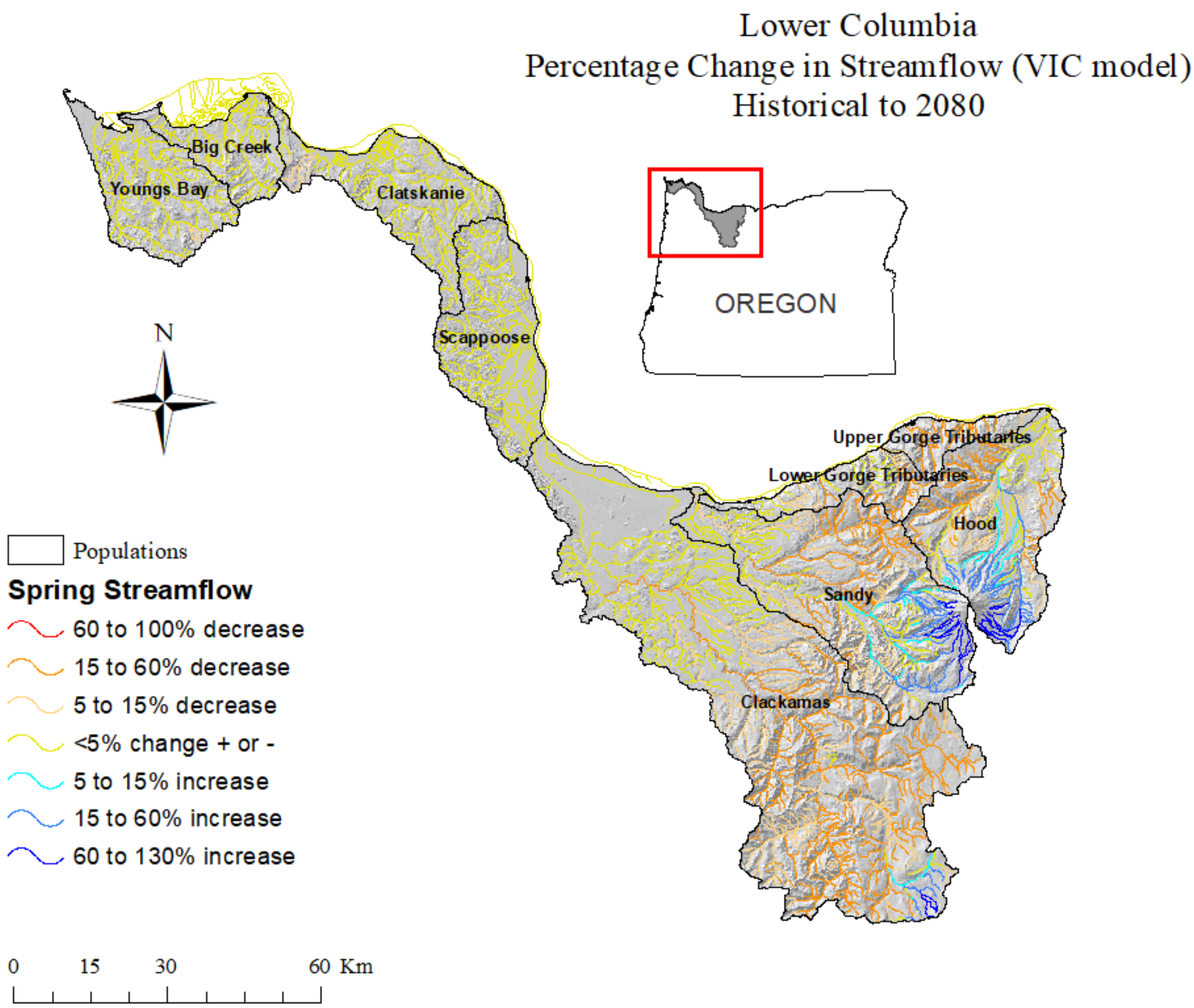


Figure 10. Projected percentage change in median spring stream flow in 2080 relative to the historical baseline (1915–2006) in the Oregon portion of the LCR ESU. Projections were developed using the VIC model (Liang et al. 1994; Hamman et al. 2018) based on the A1B emissions scenario.

Summer Stream Flow

Summer stream flow is projected to decrease in nearly all streams in the Oregon portion of the LCR ESU (Figure 11). The Clatskanie and Scappoose population areas have the smallest projected decreases. The largest decreases are expected in mid to high elevation streams in the Cascade Stratum and Gorge Stratum due to decreased snowpack and earlier snowmelt. Summer stream flow could also be affected by aspects of climate change that are not incorporated in the modeling presented in Figure 11. For example, changes in vegetation due to increased wildfire or insect induced tree mortality may initially increase water yield by decreasing canopy interception and transpiration (Halofsky et al. 2020), but if such disturbances keep forests in earlier seral stages, an increase in transpiration may reduce low flows (Perry and Jones 2017).

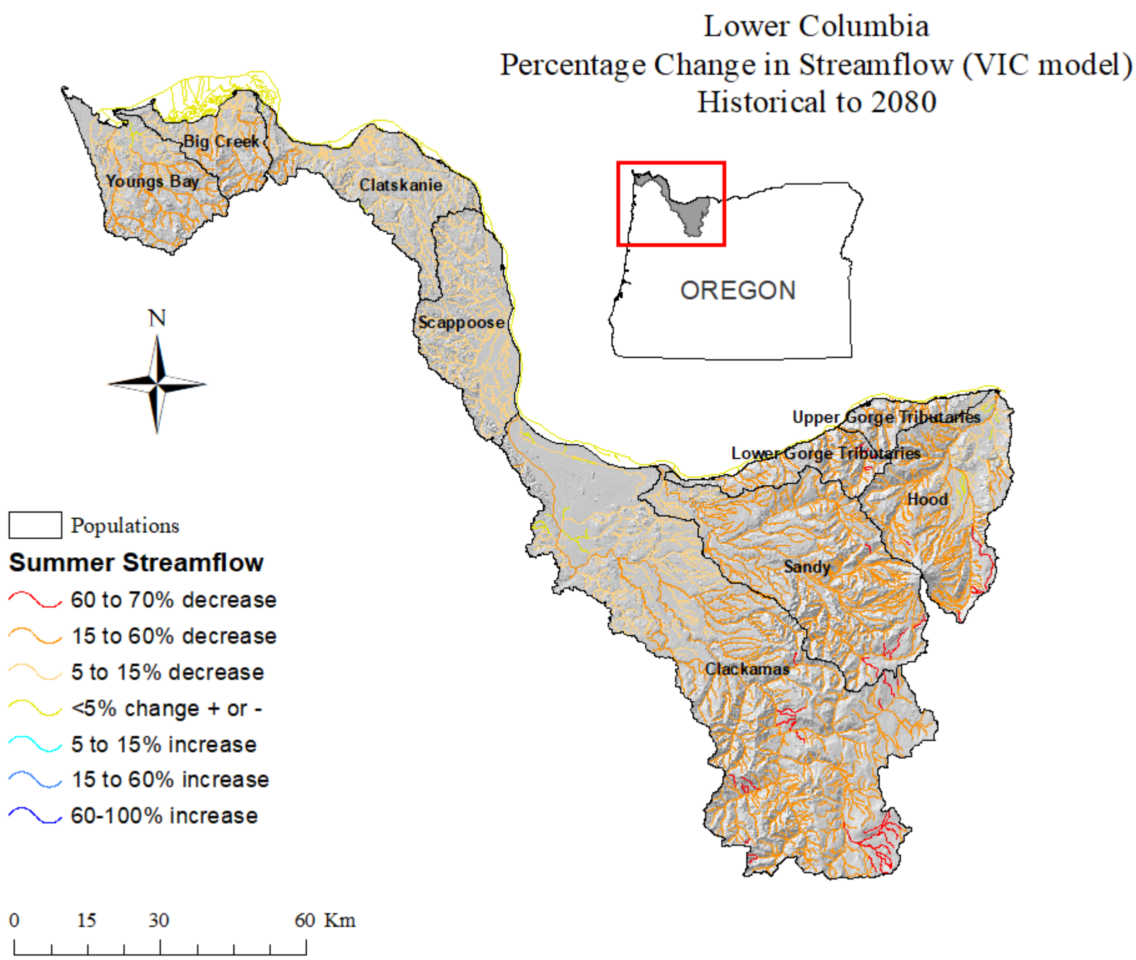


Figure 11. Projected percentage change in median summer stream flow in 2080 relative to the historical baseline (1915–2006) in the Oregon portion of the LCR ESU. Projections were developed using the VIC model (Liang et al. 1994; Hamman et al. 2018) based on the A1B emissions scenario.

Sea Level Rise

Estuarine habitats utilized by LCR salmon and steelhead will be affected by ongoing sea level rise, which is projected to continue past 2100 under all likely climate scenarios (IPCC 2019). Under Representative Concentration Pathway (RCP) 8.5, the highest greenhouse gas concentration trajectory adopted by the IPCC (IPCC 2014; see Schwalm et al. [2020] for additional details on RCP 8.5), the projected global mean sea level rise is 0.71 m (likely range: 0.51–0.92 m) for 2081–2100 and 0.84 m (likely range: 0.61–1.10 m) in 2100 (IPCC 2019). Regional and local effects of global sea level rise vary depending on a variety of factors (Sweet et al. 2022). In the Columbia River estuary, sea level rise is influenced by vertical land motion due to tectonic uplift, which has slowed relative sea level rise (Talke et al. 2020; Fleishman 2023). NOAA recently released sea level rise scenarios from 2000–2150 that incorporate estimates of uplift (Sweet et al. 2022). These projections indicate a wide range of possible outcomes for sea level rise in the Columbia River estuary (Table 21). Furthermore, the effects of sea level rise on estuary habitat are complex and depend on topographic and anthropogenic constraints on tidal influence and habitat development (Thorne et al. 2018). Modeling by the Lower Columbia Estuary Partnership has highlighted the important role that leveed floodplain systems may serve in potential tidal wetland migration and the overall loss or gain of wetland habitat under different sea level rise scenarios (*https://www.estuarypartnership.org/sea-level-rise-impacts-lower-columbia-river-and-estuary*).

Table 21. Projected sea level rise (cm) over time at Astoria, Oregon given scenarios of low, intermediate, and high global mean sea level (GMSL) rise by the year 2100 (Sweet et al. 2022).

	Relative Sea Level Rise (cm) at Astoria		
GMSL Rise Scenario	2040	2070	2100
Low: 0.3 m (1ft)	3	7	12
Intermediate: 1.0 m (3.3 ft)	6	25	69
High: 2.0 m (6.6 ft)	12	68	167

Sea Surface Temperature (SST)

Annual average SST is projected to increase by 2.4–3.6°F by the end of century (based on RCP 8.5 scenario) within the northeastern Pacific (Figure 12). The largest increases are expected to occur in the northern portion of the northeastern Pacific. Additionally, marine heat waves have doubled in frequency since 1982 and are increasing in intensity. They are projected to further increase in frequency, duration, extent, and intensity. Their frequency, compared to pre-industrial levels, will be 20 times higher at 3.6°F warming, and they will occur 50 times more often if emissions continue to increase strongly (IPCC 2019). Marine survival of Columbia River salmon and steelhead is correlated with SST, and higher SST is generally associated with lower smolt-to-adult survival (Logerwell et al. 2003; Sharma et al. 2013; Wilson et al. 2021). SST is also linked to upwelling and other processes that regulate biological productivity and vary with large-scale climate patterns (Koslow et al. 2002; Malick et al. 2015). Thus, ocean warming poses a significant risk, but the specific consequences of rising SST for salmon and steelhead survival are difficult to predict due to the complexity of marine ecosystem responses (Crozier et al. 2019).

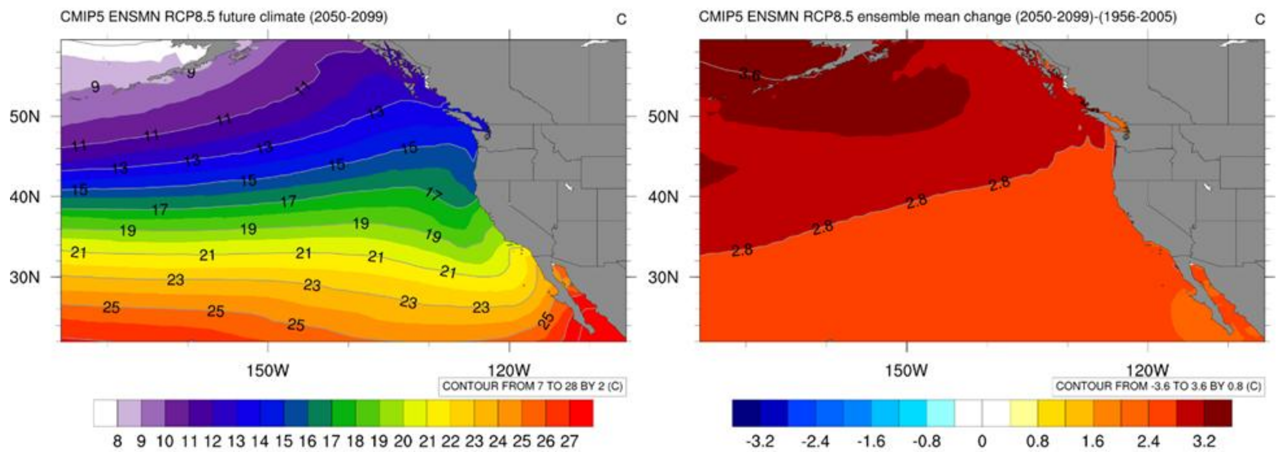


Figure 12. Left Panel: RCP 8.5 future SST for the period 2050-2099; Right Panel: Difference in mean SST between future (2050-2099) and reference period (1956-2005). SST interpolated on a 1°x1° grid for the entire year. Figure downloaded from the Climate Change Web Portal of the NOAA Earth Systems Research Laboratory (*https://www.esrl.noaa.gov/psd/ipcc/ocn/*).

Upwelling

The marine survival of salmon, particularly at ocean entry, is linked to the occurrence and intensity of upwelling (Nickelson 1986; Holtby et al. 1990; Logerwell et al. 2003), which brings deeper, colder, nutrient-rich waters to the surface. The most recent models suggest that in the northern California Current System (CCS), upwelling will become more intense in the spring and less intense in the summer because of anthropogenic climate change (Rykaczewski et al. 2015). Changes in upwelling due to climate change will emerge primarily late in the second half of the century (Brady et al. 2017). Recent work using a high-resolution regional circulation model coupled with a biogeochemical model also suggests increased upwelling in the northern CCS under the RCP 8.5 scenario, but effects on nearshore primary productivity are uncertain due to increasing stratification and other factors (Pozo Buil et al. 2021).

Ocean Acidification

Ocean pH levels have been declining because of ocean uptake of CO_2 from the atmosphere. The California Current Large Marine Ecosystem (CCLME) is experiencing greater ocean acidification because of the combination of upwelling currents that transport dissolved inorganic carbon rich water from the deep ocean and high productivity of the shelf that increases potential for remineralization (Chan et al. 2017). Within the CCLME, the nearshore region (<10 km from shore) is most strongly affected by current, and likely future, acidification resulting in reduced abundance and increased corrosion in the shells of calcifying organisms (Feely et al. 2016). In offshore areas (>10 miles from shore) within the ocean feeding grounds of LCR coho salmon, the surface is expected to decrease by 0.24-0.32 pH by the end of the century (Figure 13). Data collected off the Oregon coast indicate that ocean pH is significantly lower within the nearshore area (<10 miles from shore) (pH 7.43) than the global mean (pH 8.1), and it is expected that this area will be more susceptible to acidification (Chan et al. 2017). Although direct impacts of pH have been shown for many taxa in the CCLME (Busch and McElhany 2016), including salmon (Williams et al. 2019), there is considerable uncertainty in projecting future impacts.

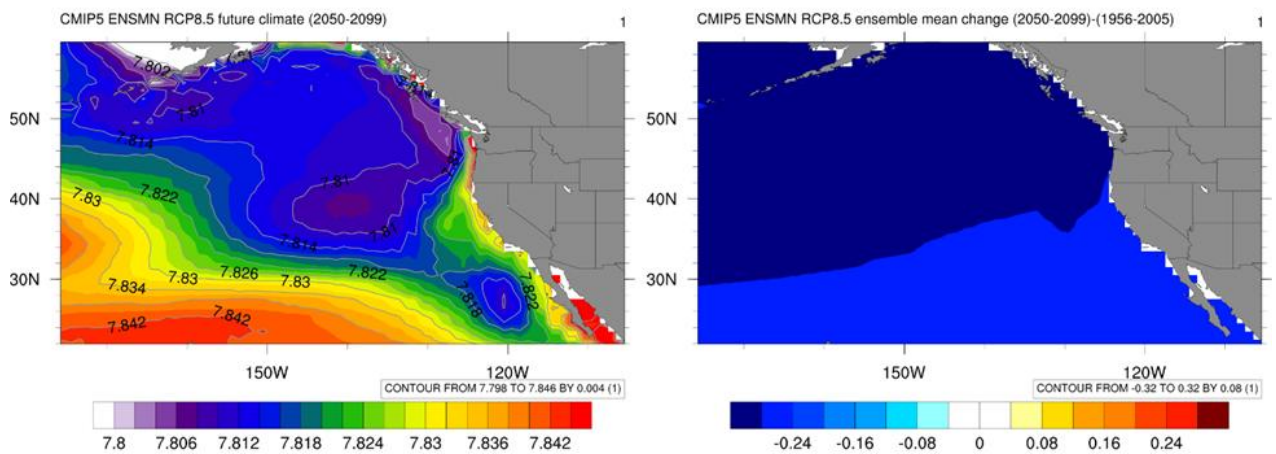


Figure 13. Left Panel: RCP 8.5 future surface pH for the period 2050-2099; Right Panel: Difference in mean surface pH between future (2050-2099) and reference period (1956-2005). Surface pH interpolated on a 1°x1° grid for the entire year. Figure downloaded from: *https://www.esrl.noaa.gov/psd/ipcc/ocn/*.

Climate Change Vulnerability

Crozier et al. (2019) conducted a climate vulnerability assessment for salmon and steelhead distinct population segments (DPSs) listed under the federal ESA, including LCR Coho Salmon, LCR Chinook Salmon, Columbia River Chum Salmon, and LCR Steelhead. The assessment used an expert-based scoring system to rank 20 attributes that captured:

1) Biological sensitivity: Life-stage specific metrics that largely reflect the intrinsic biological characteristics and geographic range of each DPS.
2) Climate exposure: The magnitude of projected change in the physical environment by mid-century.
3) Projected changes: Temperature and flow patterns
4) Adaptive capacity: 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.

Based on the scores, each DPS (or ESU) was assigned one of four vulnerability categories: low, moderate, high, and very high. The assessment indicated high climate vulnerability for LCR coho salmon based on high climate exposure and high biological sensitivity (Table 22). The assessment identified the juvenile freshwater stage of LCR coho salmon as a highly vulnerable life stage based on consistently high scores for the stream temperature exposure attribute. Adaptive capacity was identified as moderate for LCR coho salmon, which likely have some flexibility in juvenile rearing as seen in other coho populations (Crozier et al. 2019).

LCR Chinook salmon, Columbia River chum salmon, and LCR steelhead were all found to have moderate climate vulnerability in the assessment (Table 22). Biological sensitivity was moderate for all three, but climate exposure was moderate for Columbia River chum salmon and high for LCR Chinook salmon and LCR steelhead. Adaptive capacity also differed among these units, with Columbia River chum salmon ranked as moderate and LCR Chinook salmon and LCR steelhead ranked as high. LCR Chinook salmon ranked high in adaptive capacity largely due to high diversity in both juvenile and adult run timing across the ESU, but this does not necessarily apply to all populations (Crozier et al. 2019).

Table 22. Climate vulnerability assessment results for LCR coho salmon, LCR Chinook salmon, Columbia River chum salmon, and LCR steelhead (Crozier et al. 2019).

ESU/DPS	Climate Vulnerability	Exposure	Sensitivity	Adaptive Capacity
LCR Coho Salmon	**High**	High	High	Moderate
LCR Chinook Salmon	**Moderate**	High	Moderate	High
Columbia River Chum Salmon	**Moderate**	Moderate	Moderate	Moderate
LCR Steelhead	**Moderate**	High	Moderate	High

Future Outlook and Management

Climate change driven alterations of freshwater and marine habitat are expected to impact the abundance and productivity of LCR salmon and steelhead. The extent and timing of those impacts are difficult to predict due to uncertainty at multiple levels, ranging from the global trajectory of greenhouse gas emissions to local ecosystem responses. In addition, impacts are expected to vary substantially across the ESU, with some populations more vulnerable than others due to current habitat status and the magnitude of expected change. Climate change risks will also depend on the scope and effectiveness of actions taken to promote resilience of LCR salmon and steelhead populations. Given the current status of these populations, and their moderate to high climate change vulnerability, there is an urgent need to reduce viability risk.

The primary management strategy to minimize the long-term impacts of climate and ocean change on LCR salmon and steelhead centers on the protection, restoration, and enhancement of key freshwater and estuarine habitats. Maintaining and restoring diverse and productive rearing habitats will support the expression of the full complement of life history diversity and help sustain populations through cycles in ocean productivity, which may become more extreme and unfavorable in the future. Many of the changes in the freshwater habitat expected with climate change are lower in magnitude than those observed following alteration of habitat for human uses, so there is clear potential to mitigate against climate effects with actions to restore or enhance habitat. Table 23 lists specific habitat-focused strategies and actions that could reduce risk from climate and ocean change. Many of the actions in Table 23 are also identified in the Plan and are being implemented to address limiting factors.

Changes in summer stream flow and temperature are among the more certain climate change effects and are likely to reduce the quantity and quality of rearing habitat for juvenile salmon and steelhead in the absence of counteracting management actions (Table 23). For coho salmon, winter parr capacity will likely continue to limit smolt production in the near term due to a lack of stream complexity. However, increasing water temperatures and decreasing base flows in the future could eventually create an even more severe summer habitat bottleneck. In addition, thermally stressful summer rearing conditions could reduce subsequent overwinter survival (Ebersole et al. 2006), worsening the winter bottleneck that may also be exacerbated by increased flows. Thus, there is a need to continue work to restore stream complexity, while also prioritizing actions that mitigate expected changes in summer temperature and flow (Table 23). Many actions to reduce stream temperatures or increase base flows could take many years to produce peak benefits, and so initiating these actions now in priority locations is critical. This is particularly important in the Scappoose population area, where summer temperature and flow conditions are most likely to become a primary limiting factor in the foreseeable future. ODFW is also working with partners to improve stream temperature monitoring, which will increase our understanding of the thermal characteristics of streams in all seasons and track changes in temperature over time.

Projected changes in the ocean environment are largely outside of management control, and so adaptation strategies are focused primarily on restoring and enhancing freshwater and estuarine habitats (Table 23). However, there may be opportunities to mitigate the impacts of increasing ocean acidification and hypoxia by reducing other stressors. In 2017, the Oregon Coordinating Council on Ocean Acidification and Hypoxia (OAH Council) was created to provide recommendations and guidance for the State of Oregon on how to respond to this issue. The ODFW has had a leadership role in the OAH Council and will continue to look for ways to mitigate and respond to OAH.

Habitat protection, restoration, and enhancement are the key to reducing climate and ocean change risk and achieving recovery of LCR salmon and steelhead populations. Due to the long timeframe for potential habitat actions and the complexities associated with predicting and monitoring the outcome of those habitat improvement or restoration actions, a suite of other management actions identified in the Plan should also be implemented. These include predator monitoring and management, harvest and hatchery management, and ongoing hydrosystem improvements. These management actions will continue to play an important role in improving survival of juvenile and adult salmonids, maintaining genetic and life history diversity, re-establishing extirpated populations, and supporting fishing opportunity consistent with ESU recovery.

Many actions to mitigate climate change risks and prepare for the future have occurred in the LCR. Examples include:

- Implementation partners have increased monitoring of stream temperatures in several population areas. This information will help identify high priority areas for restoration and protection, track environmental changes that affect plan species, inform projections about future conditions, and help identify actions most likely to provide long-term uplift.
- Watershed councils in the Clackamas and Scappoose are already examining projected future conditions when prioritizing restoration actions and locations.
- The Lower Columbia Estuary Partnership has conducted a sea level rise impact study and is adjusting habitat restoration targets and conducting strategic planning for tidal marsh restoration.
- The Environmental Protection Agency created a Columbia River Cold Water Refuge Plan (2021) with actions identified to protect cold water sources along the migration corridor, including several in the Oregon portion of the LCR.
- Major fish passage improvements have been achieved in the Clackamas, Sandy, and Hood populations.

Plan implementation partners will need to build on these actions, and others like them (Table 23), to achieve delisting and broad sense recovery goals.

Table 23. Key projected climate and ocean change effects, potential consequences, adaptation strategies, and priority actions for LCR salmon and steelhead. Adapted from Beechie et al. (2013), Wainwright and Weitkamp (2013), and Reeves et al. (2018).

Projected Effect	Potential Consequences	Adaptation Strategies	Priority Actions
Increased summer water temperatures	• Reduced juvenile rearing habitat • Reduced or increased juvenile growth rates depending on temperature and food resources • Increased susceptibility to parasites and disease • Increased predation risk from non-native warmwater fish species	• Prioritize restoration actions in watersheds (e.g. fifth-field HUCs) with cooler water • Increase stream shading • Protect and restore instream flows • Increase surface-subsurface water exchange • Restore lateral and longitudinal connectivity	• Increase temperature monitoring • Restore riparian vegetation • Purchase or lease water rights from willing sellers to place instream • Restore incised channels • Increase floodplain connectivity • Remove artificial barriers to restore access to cooler water • Develop monitoring and control mechanisms for non-native fish species
Reduced summer flows	• Reduced juvenile rearing habitat • Reduced juvenile growth rates	• Protect and restore instream flows • Restore floodplain aquifer storage • Manage watersheds to reduce evapotranspiration loss	• Purchase or lease water rights from willing sellers to place instream • Promote beavers and beaver-related pond habitat • Restore incised channels • Research forest management options to increase base flows
Increased winter flows and major storm events	• Increased sediment input and transport • Increased large wood recruitment and transport • Increased redd scour and egg mortality • Reduced juvenile overwinter survival	• Increase stream complexity • Increase estuary rearing habitat	• Restore riparian vegetation • Protect and enhance large wood sources in landslide-prone areas • Restore incised channels • Increase floodplain connectivity • Promote beavers and beaver-related pond habitat • Restore and improve access to key estuary habitats

Projected Effect	Potential Consequences	Adaptation Strategies	Priority Actions
Sea level rise	• Reduced or increased tidal wetland habitat • Altered estuarine food web • Reduced or increased estuarine rearing habitat	• Reduce anthropogenic barriers to tidal influence and estuarine habitat expansion • Improve estuary water quality • Improve fish access to estuary habitat	• Restore natural tidal flow where possible • Support land acquisition and easements along estuaries • Reduce nonpoint pollution to improve coastal water quality • Prioritize and implement tidegate fish passage improvements
Increased sea surface temperature	• Altered marine food web • Increased predation risk • Increased thermal stress • Reduced marine growth and survival	• Increase freshwater and estuarine rearing habitat • Promote life history diversity	• Monitor ocean ecosystem indicators • *See freshwater and estuarine habitat actions listed above*
Increased ocean acidification	• Altered marine food web • Sensory impacts • Reduced marine growth and survival	• Increase freshwater and estuarine rearing habitat • Promote life history diversity • Reduce local stressors that increase ocean acidification impacts	• Monitor ocean ecosystem indicators • *See freshwater and estuarine habitat actions listed above* • Reduce nonpoint pollution to improve coastal water quality

Section 6: Conclusions and Next Steps

Through this 12-year assessment, ODFW has identified priority actions to facilitate progress toward the Plan's delisting and broad sense goals. These actions are binned into two categories in the following tables: 1) actions identified in the Plan that have not been initiated and/or full implemented and are a high priority for implementation (Table 24); and 2) proposed adaptive management actions identified based on the information gained during the first 12 years of Plan implementation (Table 25). While priority actions are identified in Table 24 and Table 25, it is acknowledged that the Plan is voluntary and implementation of these actions may be potentially constrained by funding, capacity and feasibility to address these high priority actions.

Table 24. High priority actions that were not completed during the first 12 years of Plan implementation.

Category	Location	Action ID	Action
Tributary Habitat Management	All Populations	Trib-14	Conduct sediment source analysis and then implement actions to reduce sediment from identified sources.
Tributary Habitat Management	Clackamas	CM-172	Identify and implement flow improvements.
Tributary Habitat Management	Clackamas	CM-174	Identify priority areas for increased instream flows.
Tributary Habitat Management	Hood	HD-281	Improve floodplain connectivity in the Powerdale Corridor
Estuary Management	Estuary	Mxd-66	CRE-3: Establish minimum instream flows for the lower Columbia River mainstem that would help prevent further degradation of the ecosystem
Estuary Management	Estuary	Mxd-67	CRE-4: Adjust the timing, magnitude, and frequency of flows (especially spring freshets) entering the estuary and plume to better reflect the natural hydrologic cycle, improve access to habitats, and provide better transport of coarse sediments and nutrients in the estuary, plume and littoral cell.
Harvest Management	Hood	HD-296	Discuss Zone 6 fishery actions with Tribes to reduce potential additional impacts. Potential actions include extending sanctuaries from mouths, and/or modifying season length or timing.
Hatchery Management	All Populations	Trib-62	Identify the most appropriate stock, timing, and strategies for a reintroduction program and implement, if fish managers determine that reintroductions are needed to recover any fall Chinook population.
Research	Clatskanie	CT-149	Explore adding a life cycle monitoring site in the Clatskanie population.

Table 25. Proposed adaptive management actions based on findings in ODFW's 12-year assessment of Plan implementation.

Category	Location	Action
Tributary Habitat Management	All populations	Identify priority watersheds based on potential to support Plan species now and in the future under climate change scenarios; focus habitat protection and restoration in these watersheds.
Tributary Habitat Management	All populations	Identify cold water refuges and prioritize protection and restoration of these areas.
Tributary Habitat Management	All populations	Work with municipalities to protect watersheds and hydrology strata wide. Protection includes strengthening and enforcing riparian and floodplain development ordinances as well as future urban growth boundary locations.
Tributary Habitat Management	Clatskanie	Find a non-profit organization with capacity to support implementation of watershed restoration activities in the Clatskanie population.
Tributary Habitat Management	Scappoose	Implement instream restoration to increase summer habitat capacity in the upper Scappoose population and develop a partnership with local communities to increase the delivery of riparian restoration projects across the watershed.
Tributary Habitat Management	Hood	Modify Plan Action 281-HD to include: "Improve floodplain connectivity in the Powerdale Corridor".
Tributary Habitat Management	Willamette River	Modify Plan Action 194-CM to include: "Work with regulatory agencies to ensure overwater structures are compliant with ODFW's residential dock guidelines."
Tributary Habitat Management	All populations	Replace interim restoration goals with broad sense restoration goals listed in the Plan.
Tributary Habitat Management	All populations	Remove inline ponds that increase summer-time stream temperature.
Estuary Habitat Management	All populations	Modify plan action 69-Mxd to include: Reduce the export of sand and gravels via dredge operations by using dredged material beneficially for salmonids.
Hatchery Management	All populations	Work with NOAA to implement conditions of the next Mitchell Act Hatchery Bi-Op.
Harvest Management	ChF populations	Consider mark-selective fall Chinook fisheries when monitoring indicates a meaningful net conservation benefit based on catch rates and hooking mortality.
Predation	All populations	Seek reauthorization of the section 120(f) permit for managing sealions in the Columbia basin under the Marine Mammal Protection Act.
Predation	All populations	Create a platform or a way to collect public input and observations on the problem interactions in areas identified as Categories 2 and Category 3.rivers segments under the section 120(f) permit.

Category	Location	Action
RME	All populations	Incorporate climate change projections and considerations into the development of conservation, restoration and management action plans for LCR fish populations. ODFW will continue to develop tools to support this, including temperature and flow projections and work to improve understanding of thermal tolerances for Oregon's native fishes.
RME	All populations	Conduct research to examine how changes in the physical environment (temperature and flow) may lead to changes in interactions between native salmonids and warm water adapted species (e.g. non-native warm water fishes).
RME	All populations	Investigate the effects of wildfires on salmonid habitat when baseline data exists.
RME	All populations	Support research, assessments and mitigation techniques for the chemical 6PPD-quinone and other toxic chemicals in stormwater run-off.
RME	Coastal stratum populations	Re-evaluate monitoring strategy in the Coastal Stratum to more accurately describe the distribution, spatial structure and diversity of fall chinook.
RME	Sandy	Evaluate the feasibility of differentiating Sandy fall and late fall Chinook; based on conclusions, determine how to evaluate measurable criteria for Sandy fall and late fall Chinook.
RME	Hood	Clarify status and management objectives for hatchery and natural origin spring Chinook in the Hood River, including listing status of natural origin spring Chinook and applicability of measurable criteria.
RME	Hood	Develop and find funding for a monitoring program for Hood River salmon and steelhead populations.
RME	All populations	Revise interim measurable criteria for abundance/productivity used to track progress toward recovery goals: 1) compare observed abundance to delisting scenario abundance goal instead of annually modeled abundance/productivity goals, which have not proved useful for evaluating progress.
CRS	All populations	Implement the updated Chum Recovery Strategy described in Appendix II of the 12-year assessment.

This first 12-year assessment of Plan measurable criteria indicates that most Oregon populations within the LCR ESU have not yet achieved delisting goals or the more ambitious broad sense recovery goals identified in the Plan. This result is consistent with expectation that the Plan is a 25-year plan and that desired delisting and broad sense goals are not necessarily expected to be achieved within this timeframe, given lag time between action completion and both habitat and population responses (ODFW 2010b). The evaluation of measurable criteria in this 12-year assessment also indicates that progress toward desired delisting status is highly variable among strata and populations. This result is also consistent with Plan expectations, which determined that populations differed in their current status and likelihood of achieving delisting desired status goals.

Across multiple species, populations in the Cascade stratum (Clackamas and Sandy) have shown the greatest progress toward desired status goals, with most populations exceeding either delisting scenario or broad sense recovery goals in recent years. Stable or improving status in these populations has coincided with significant habitat restoration work and fish passage improvements. In addition, due to harvest and hatchery management actions, all populations in the Cascades stratum attained goals for limiting harvest impacts and the percentage of hatchery fish on the spawning grounds (pHOS).

Less progress toward desired status has been observed in the Coastal and Gorge strata, where most populations remain well below delisting goals for abundance and spatial structure, and some populations could not be assessed due to a lack of monitoring data. It was recognized in the Plan that attaining recovery goals for many of these populations would be challenging given their status during Plan development and the need for significant habitat improvement to increase productivity. The extent of habitat restoration since Plan adoption varies among populations in the Coastal and Gorge strata. Only one of seven populations in these two strata (Youngs Bay) met interim goals for all habitat restoration types, and restoration goals there were modest due to its limited role in recovery scenarios for coho and Chinook salmon. In general, Plan goals for limiting harvest impacts in Coastal and Gorge strata populations have been achieved through harvest management actions, but there were data gaps that precluded assessment of this criterion for some populations. Data gaps also precluded assessment of hatchery stray rate criteria for several populations. Among populations that could be assessed, the assessment found mixed results. Most populations that failed to meet pHOS targets do not have a hatchery program and elevated pHOS is due to limited straying from other programs and very low natural origin fish abundance. In the Hood River, straying from the winter steelhead hatchery program consistently exceeded pHOS targets and led to the elimination of the program as an adaptive management action.

For populations in all three strata, the magnitude and consequences of predation by piscivorous birds, fish, and marine mammals is difficult to assess. There are indications that predation rates may be higher than targets identified in the Plan and although actions to reduce marine mammal predation have likely reduced risk for some populations, recent changes in the distribution of avian predators may have increased impacts. Moving forward, targeted and strategic research and monitoring will be needed to assess risk from different predators and inform appropriate adaptive management actions.

In the future, all populations are expected to experience rising water temperatures, decreased summer flows, more frequent and severe marine heat waves, and other climate change impacts. The likelihood of future cycles of poor freshwater and ocean survival and periodic low abundance underscores the importance of resiliency to long-term sustainability. For some populations, existing freshwater productivity has sustained the population through periods of low ocean survival and supported subsequent improvement in its biological status. This offers optimism that some Oregon populations within these ESUs will be resilient to similar periods in the future. For other populations, long-term sustainability will depend on substantial improvements in freshwater productivity, estuarine habitat capacity, survival through hydropower systems, and other limiting factors. Freshwater productivity improvements, to date, have proven difficult to achieve in certain locations given the pace and scale of restoration relative to the legacy of historical impacts, demands on the freshwater system, existing infrastructure, and ongoing human population impacts. Due to the scope of habitat improvements needed, and differences among watersheds in their potential to support salmon and steelhead into the future, effective prioritization of habitat protection and restoration work is critical to promoting resilience in LCR populations. Conservation hatchery programs may also play a role in the future for populations that have or could reach critically low levels.

Although significant effort has gone into plan implementation and over 80 percent of Plan actions are ongoing, in-progress, or have been completed, much work remains. Only two population areas have achieved watershed restoration goals and less than 25 percent of the 17 primary fish populations in the Oregon portion of the ESU have achieved abundance goals identified in the delisting scenario analysis. Given the current status of Oregon LCR populations and the lag time between action implementation and fish response, it is safe to assume that achieving desired status goals in the Plan will require long-term, sustained action. Furthermore, uplift across the entire ESU, including populations in Washington, will be needed to achieve recovery and delisting.

ODFW and our partners are looking forward to implementing the new, on-going and remaining actions over the next 12 years. Recovery of LCR salmon and steelhead populations will continue to face challenges from climate and ocean change, new and existing land development, and changes in implementation resources and capacity. The Plan and the priority actions identified in this assessment remain the important blueprint for navigating these challenges. The Plan serves as both a conservation plan for the state of Oregon and a component of the federal recovery plan for LCR salmon and steelhead populations in Oregon and Washington. The adaptive management actions identified in this 12-year assessment are expected to improve plan implementation and contribute to recovery, but do not represent a major shift in the overall direction of recovery efforts. If such a shift is needed in the future, substantive changes in the recovery plan would require a more formal update in coordination with NMFS and the state of Washington.

Acknowledgements

The Oregon LCR Implementation Team was formed right after the Plan was adopted and is a diverse group representing different interests, missions, and geographic areas. The Team's overall objective is to collectively and synergistically work together to achieve and advance Plan goals. The Implementation Team's invaluable participation and insightful feedback have been, and will continue to be, instrumental in planning, implementing, monitoring and reporting Plan actions.

Oregon LCR Implementation Team

Organization	Representative	Organization	Representative
BLM	Cory Sipher	NCWA	Graham Klagg
ClackSWCD	Chris Lapp	NCWC	Neil Shulmen
ClatsopSWCD	Misty Metcalf Ogier	NMFS	Amy Kocourek
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ColSWCD	Taylor Murray	NPCC	Patty O'Toole
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CRBC	Mary Logaboo	ODFW	Ben Walczak
CREST	Jason Smith	ODFW	Jamie Anthony
CTWS	Christine Longjohn	ODFW	Jason Seals
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FWT	Mark McCollister	ODFW	Robert Bradley
GOCWC	Tom Gaskill	ODFW	Tucker Jones
HRWG	Alex Danielson	PGE	Maggi David
HRWG	Cindy Thieman	PWB	Burk Strobel
JCWC	Jennifer Hamilton	Redd Zone	Tod Jones
LCEP	Catherine Corbett	SBWC	Rachell Meyers
LCEP	Jenny Dezo	TCWC	Alexis Barton
LCRFRB	Amilea Johnson	TU	Mark Rogers
LCRFRB	Steve Manlow	USFS	Greg Wanner
Metro	Johnathan Soll	USFS	Kari McClellan
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