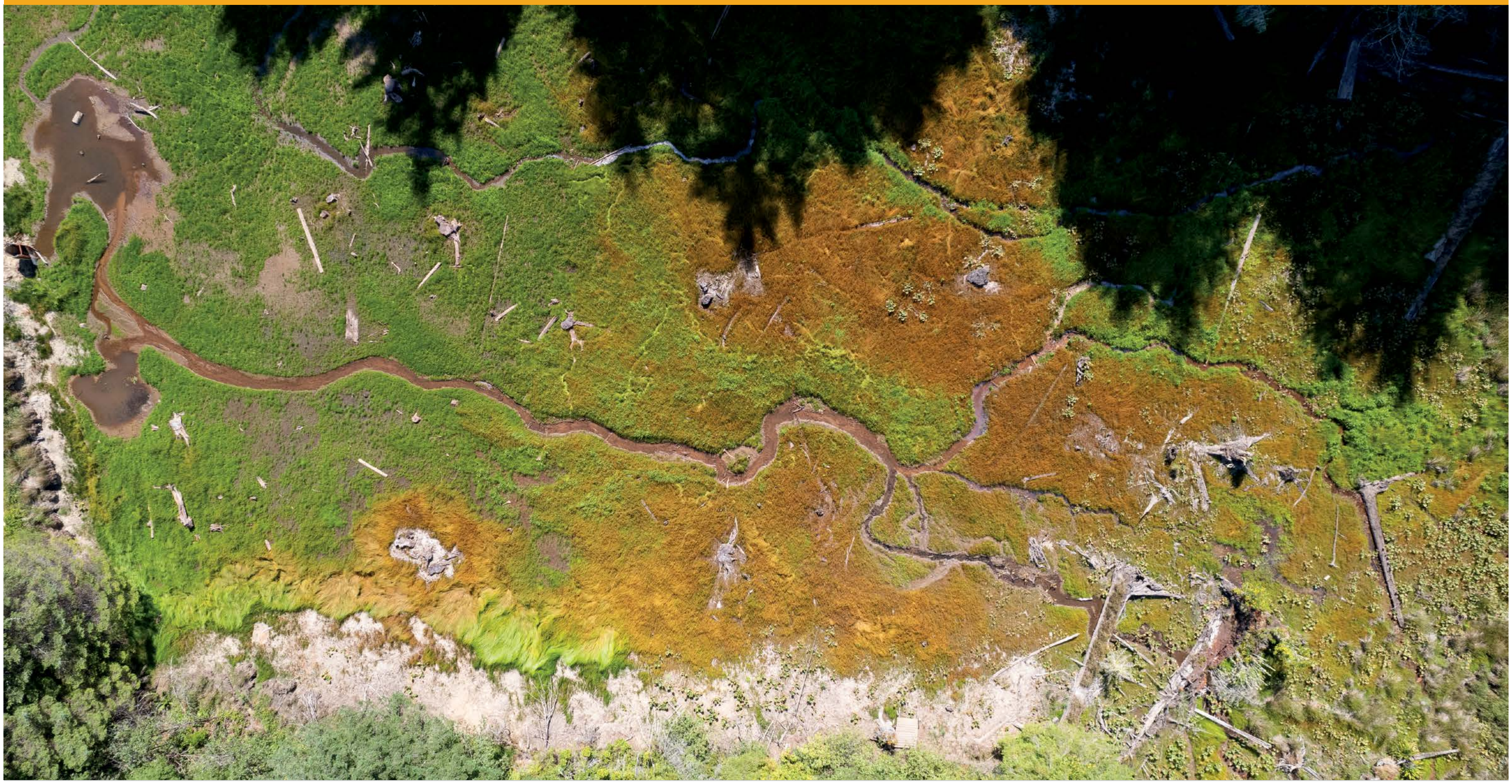
Strategic Action Plan for Coho Salmon Recovery

~ The Coquille Basin ~



Coastal Coho juveniles: John McMillan. Cover photos: Paul Jeffrey and Brady Holden. Back cover photo: Alamy.

Contributors and Acknowledgments

The "Strategic Action Plan for Coho Salmon Recovery in the Coquille Basin" (SAP) was developed by a team dedicated to the restoration of Coho in the Coquille Basin. The team was comprised of state and federal resource managers, conservation professionals, scientists, and landowners:

- **Coos Soil and Water Conservation District (CSWCD)**
- **Coquille Watershed Association (CoqWA)**
- **National Marine Fisheries Service (NMFS)**
- **National Oceanic and Atmospheric Administration (NOAA) Restoration Center**
- **Oregon Department of Fish and Wildlife (ODFW)**
- **Oregon Department of Environmental Quality (ODEQ)**
- **Oregon Watershed Enhancement Board (OWEB)**
- **Port of Bandon**
- **The Nature Conservancy (TNC)**
- **Wild Rivers Land Trust (WRLT)**
- **Wild Salmon Center (WSC)**
- **United States Forest Service (USFS)**
- **United States Bureau of Land Management (BLM)**

This team would like to thank members of the Coast Coho Partnership (CCP), made up of the following agencies and NGOs: OWEB, ODFW, NOAA Fisheries, NOAA Restoration Center, and Wild Salmon Center (WSC). These organizations provided important facilitation and technical support for all aspects of the planning process, without which this plan would not have been possible. We would also like to acknowledge the critical contributions of several project consultants, including: TerrainWorks for generating the Netmap layers and conducting the initial spatial analyses and Barbara Taylor for technical writing.

The Coquille Coho SAP team acknowledges the cooperative partnership formalized in 2022 between the Coquille Indian Tribe and Oregon Department of Fish and Wildlife to collaborate, share resources, and develop and carry out plans to protect, restore, and enhance fish and wildlife populations and their habitat in areas of southwest Oregon, including the Coquille River basin.

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Acronyms

AQI	Aquatic Inventories Project
BMP	Best Management Practice
CAP	Conservation Action Plan
CCP	Coast Coho Partnership
CFS	Cubic Feet per Second
CWA	Clean Water Act
DEQ	Oregon Department of Environmental Quality
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FPA	Oregon Forest Practices Act
IP	Intrinsic Potential
KEA	Key Ecological Attribute
LNWC	Lower Nehalem Watershed Council
LSR	Late Successional Reserves
MDN	Marine-Derived Nutrients
NFWF	National Fish and Wildlife Foundation
NGOs	Non-governmental Organizations
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRCS	National Resources Conservation Service
NWFSC	Northwest Fisheries Science Center
OC	Oregon Coast
ODA	Oregon Department of Agriculture
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
OWEB	Oregon Watershed Enhancement Board
RM	River Mile
SAP	Strategic Action Plan
SWCD	Soil and Water Conservation District
TEP	Tillamook Estuaries Partnership
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
UNWC	Upper Nehalem Watershed Council
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
WRLT	Wild Rivers Land Trust
WSC	Wild Salmon Center

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Photo: Paul Jeffrey / Alamy

Executive Summary

Coho salmon (*Oncorhynchus kisutch*) have returned year after year to the Coquille River, its tributaries, and the estuaries for millennia. Coho salmon in the Coquille Basin evolved unique adaptations that have allowed them to survive and flourish in the ever-changing, diverse coastal environment. Prior to the arrival of European settlers, the estimated historical abundance of Coho salmon ranged between 310,000 and 417,000 adults returning annually to the Coquille Basin to spawn.

Around the Pacific Rim, salmon have been the foundation of a social-ecological system supporting Indigenous Peoples since time immemorial. European settlers arrived in the Coquille Basin in the 1800s. Their arrival of which initiated over 150 years of resource extraction for gold, fisheries, timber, and agriculture, substantially affecting watershed health and function. These practices impaired habitats and ecosystem processes throughout the Coquille Basin, reducing habitat quantity and quality and, ultimately, the abundance and productivity of Coho and other salmonid populations. Factors leading to salmonid declines include fish passage barriers, loss of stream complexity, degraded water quality, and conversion of estuary and wetlands into agricultural lands. In addition to reduced habitat quantity and quality, the combined effects from Coho hatchery production, high harvest rates, and poor ocean conditions contributed to the collapse of Oregon Coast (OC) Coho in the 1990s.

The decline of the Coquille Coho population mirrored that of OC Coho across their range. Due to the widespread decline, the OC Coho "evolutionarily significant unit" (ESU) was listed as "threatened" by the National Marine Fisheries Service (NMFS) in 1998. The ESU declined to an estimated low of 23,661 spawning adults in 1997, and the Coquille Coho population declined to a low of 2,622 spawning adults in 1998. Since the federal Endangered Species Act (ESA) listing over 25 years ago, OC Coho have experienced cycles of increasing abundance trends throughout their range. The estimated ESU average between 2020 and 2023 was 188,398 spawners. However, the ESU remains listed due to inadequate habitat protections and degraded watershed conditions. Climate change is projected to further hinder the abundance and productivity of OC Coho and other salmonid populations throughout the Pacific Northwest.

After the federal ESA listing, two conservation plans were developed to help guide recovery efforts for OC Coho: the "Oregon Coast Coho Conservation Plan." published by the State of

Oregon in 2007, and the "Final ESA Recovery Plan for Oregon Coast Coho Salmon," a federal plan produced by NMFS in 2016. These plans provide a road map for conservation and recovery and include broad strategies to restore and protect populations within the ESU. The overall goal of both the state and federal plans is to recover OC Coho so that ESA protection is no longer necessary. The Coquille Coho Strategic Action Plan (SAP) builds upon these plans by identifying specific locations and actions within the Coquille Basin where habitat protection and restoration can have the greatest benefits to watershed function and Coho production.

The process of developing the Coquille Coho SAP began in 2022 when restoration practitioners and local fisheries managers agreed that a comprehensive Coquille Basin-specific plan was needed to: 1) determine specific locations where protection and restoration strategies would have the greatest positive impact toward increasing watershed function and habitat productivity over the long term, 2) coordinate project implementation and leverage funding in the short term, and 3) formalize the commitment of a robust set of partners who have collaborated on Coho recovery and will continue to do so into the future. The Coquille Watershed Association (CoqWA) convened this effort with the support of the Coast Coho Partnership, a team of public and private agencies and organizations working to accelerate the pace of Coho recovery throughout the Oregon Coast.

These efforts focus on Coho salmon because they are a "keystone" species, meaning that numerous other plant and animal species rely on them for their survival during some part of their life cycle. Coho spend over a year in freshwater, making them an excellent year-round indicator of watershed health. And because they spend a full year in freshwater, Coho occupy a wide range of habitats that other salmonids utilize over space and time. Consequently, the protection and restoration of Coho habitats (and the watershed processes that generate them) often directly benefit other salmonids and aquatic species.

The Coquille Coho salmon population is one of 21 independent populations that comprise the OC Coho Salmon ESU. While important variations exist in the "standard" Coho life history, generally, Coho spend approximately 18 months in freshwater before migrating to the sea. During this freshwater and estuary residency, they rely heavily on instream pools and off-channel habitats connected to mainstem and tributary channels. These off-channel habitats include alcoves, beaver ponds, side channels, and tidal and freshwater wetlands. In addition to providing food resources, these habitats generate and maintain clean, cool water in the summer and serve as refuge areas from high-velocity flows in the winter.

LONG-TERM GOALS	
1	By 2045, the wild Coquille Coho population provides annually stable returns that can sustain commercial, recreational, and traditional harvest needs.
2	By 2045, restoration efforts (i.e., riparian enhancement and protection of cold water sources) in mainstems and tributaries have maintained, or lowered, summer stream temperatures to 2024 levels (averaged temperature between 2020-2024).
3	By 2045, instream habitats in mainstems, tributaries, and the estuary have sufficient complexity to provide year-round rearing for all juvenile Coho (i.e., fry, parr, and smolts) produced in the Coquille Basin.

The watershed processes that produce and maintain these vital habitats have undergone significant changes since European settlement began in the mid-19th century. The resource extraction economy that fueled the settlement of the region has altered the "key ecological attributes" (KEAs) of the watershed that are essential to the production of high-quality Coho habitats. The modified KEAs that most severely limit Coho production include reduced tributary habitat complexity, reduced lateral connectivity between channels and floodplains, reduced riparian (streamside vegetation) function, reduced beaver ponds, and impaired water quality that includes elevated water temperatures, reduced dissolved oxygen levels, and increased bacteria loading in the Coquille Basin tributaries and mainstems. Most notably in recent years, elevated summer temperatures have reached near-lethal levels for salmonids and are creating thermal barriers that restrict Coho movement between critical habitats, while at the same time increasing the spatial extent of aquatic invasive species.

Our team approached the development of this SAP with the core belief that healthy ecological, economic, and social conditions are needed to ensure a sustainable future for Coquille Coho salmon. Through the implementation of this SAP, local partners hope to achieve the following long-term goals shown on the previous page.

To achieve these goals, this SAP emphasizes the restoration of critical Coho habitats by repairing the watershed processes that generate and maintain them. This process-based approach relies on an anchor habitat strategy, which seeks to identify, protect, and restore stream reaches most capable of supporting Coho across the full spectrum of their freshwater residency, including egg incubation, rearing, smolting, and spawning. The primary strategies presented in this plan seek to conserve and increase the quality and quantity of habitats by enhancing riparian areas in order to increase shade and lead to future large-wood delivery to tributaries; actively installing large-wood structures and recruiting beavers to promote instream complexity and floodplain interaction in and around critical habitats; and reconnecting tidal wetlands. Importantly, however, one of the core tenets of this plan is that ecosystem function can be restored while preserving the working landscape. The ultimate vision is a healthy basin, connected from headwaters to the ocean, that supports a thriving fish population and a vital local economy.

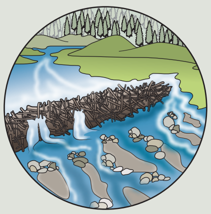
Photo: Doug Lloyd / iStock

The Coquille SAP identified 15 sub-watersheds as "focal areas." These watersheds were selected using a "stronghold" approach that included a robust set of ecological ranking criteria used to evaluate each sub-watershed. The focal areas (6th field Hydrologic Unit Code [HUC]) selected are shown below.

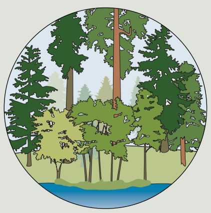
5th Field HUCs	Lower Coquille	North Fork Coquille	East Fork Coquille	Middle Fork Coquille	South Fork Coquille
Focal Sub-Watersheds (6th Field HUCs)	Bear Creek Lampa Creek Beaver Slough Cunningham Creek Hall Creek	Hudson Creek Moon Creek Middle Creek	Yankee Run	Big Creek Rock Creek	Catching Creek Salmon Creek Johnson Creek Headwaters South Fork Coquille
Sub-Watershed Evaluation Criteria	***Fish Parameters*** • Coho spawning habitat • Coho rearing habitat • ODFW spawning surveys • Current temperatures	***Habitat Parameters*** • High-quality Coho habitat • Coho intrinsic potential • Land ownership • Coho anchor habitat • Beaver habitat • Cold water sources • Cold water refugia	***Climate Change Parameters*** • Predicted flow (% change) in 2040 • Predicted flow (% change) in 2080 • Predicted temperature (°C) in 2040 • Predicted temperature (°C) in 2080 • Landward migration zones		

By 2030, the partnership will achieve the following restoration objectives.

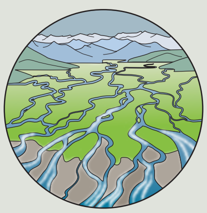
Instream Restoration
Improve water quality within 11.3 miles of tributaries and mainstems.



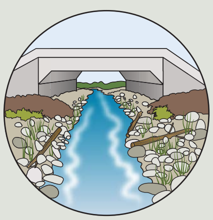
Instream Complexity
Increase instream complexity on 29.9 acres of tributaries and mainstems.



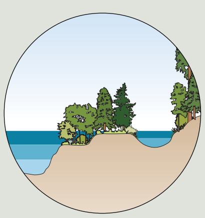
Riparian Enhancement
Enhance a minimum of 116.5 acres of riparian areas.



Longitudinal Connectivity
Increase longitudinal connectivity on 16.4 miles of tributaries and mainstems.



Reconnection
Remove or upgrade 11 fish passage barriers.



Lateral Connectivity
Increase lateral connectivity on 2,036.8 acres of tidal and freshwater floodplains.

Assessment
Perform sub-watershed assessment in 11 high-priority focal basins.

Artwork by Elizabeth Morales

Through the implementation of the short-term projects identified in this SAP, the team intends to reach the following restoration outcomes by 2030 in these 15 sub-watersheds:

- Improve water quality within 11.3 miles of tributaries and mainstems.
- Increase instream complexity on 29.9 acres of tributaries and mainstems.
- Enhance a minimum of 116.5 acres of riparian areas.
- Increase longitudinal connectivity on 16.4 miles of tributaries and mainstems.
- Remove or upgrade 11 fish passage barriers.
- Increase lateral connectivity on 2,036.8 acres of tidal and freshwater floodplains.
- Perform sub-watershed assessment in 11 high-priority focal basins.

The team developed a monitoring framework to evaluate both the rate at which the SAP is being implemented and the degree to which it is producing the desired results at a meaningful scale. The monitoring framework also presents several important data gaps, which, once filled, may redirect the team's priorities in order to adapt the plan.

This SAP, like all plans, has been generated with imperfect and evolving information. Most notably, considerable uncertainty exists regarding how global climate change predictions will challenge many of the assumptions made about future local watershed conditions and how aquatic systems may respond to restoration actions. Additionally, the implementation of projects identified in the SAP relies on willing landowners. Thus, adaptive management is essential to the long-term success of this plan and the partnership's ability to reach stated outcomes.

Chapter 1

Introduction

1.1 Why Coho?

Coho salmon (*Oncorhynchus kisutch*) are a “keystone” species, meaning that many other organisms rely on the annual influx of adults and outmigration of juvenile Coho for survival. At every stage of life (eggs, fry, parr, smolt, and adults), Coho salmon provide essential sustenance for a diversity of other aquatic and terrestrial organisms. Coho eggs provide food for macroinvertebrates and other salmonids, while Coho fry, parr, and smolts feed other aquatic species and many bird species, like great blue herons and gulls. Adult Coho are directly consumed by humans, and spawned-out adult carcasses, carried away from the riverbanks and eaten by scavengers, bring needed marine-derived nitrogen, phosphorus, and other nutrients far inland from the ocean. Thus, declining Coho salmon abundance leads to an ecological cascade of effects throughout a food web that evolved with abundant Coho salmon runs.

Salmon have been the foundation of a social-ecological system supporting Indigenous Peoples since time immemorial (Atlas et al. 2021). In the Coquille Basin, Oregon Coast (OC) Coho salmon have played a significant role culturally, ecologically, and economically for thousands of years. Resource extraction has resulted in the degradation of essential Coho habitat for over 150 years, causing the decline of not only the Coquille population of OC Coho but the entire evolutionarily significant unit (ESU). This plan focuses on protecting and restoring critical habitats that will allow the Coquille Coho population to meet federal recovery goals for long-term viability and thrive into the future. All the restoration actions proposed here for Coho salmon will have secondary positive benefits for other salmonids and aquatic organisms, as well as local human communities.

1.2 A Watershed Indicator

Ecologically, Coho salmon are an indicator species for ecosystem health. Due to their unique life histories and prolonged freshwater residency —up to 18 months before migrating out to the


Photo: Seth Mead

ocean—Coho salmon utilize most riverine habitats. Coho use small, low-gradient upper basin tributaries for adult spawning and juvenile rearing, and mainstem rivers for upstream and downstream movement and migration. Intermediate tidal wetlands and estuary habitats are increasingly understood to be critical for rearing Coho juveniles, and they provide population stability from year to year (Sloat and Ebersol, 2024 in-press). Therefore, Coho abundance is, in part, a reflection of the water and habitat quality found within a basin. Longitudinal barriers such as dams (i.e., physical barrier) and warm water (i.e., chemical barrier) prevent adults from reaching spawning grounds or cold water refuges. In contrast, latitudinal barriers such as tide gates prevent juvenile Coho from reaching highly productive off-channel tidal marsh areas required for rearing. All these landscape-level factors work in concert, influencing Coho abundance, which in turn affects a myriad of other species. As Coho habitat is restored, many other species benefit directly and indirectly. Salmon and trout species utilize these same habitats during freshwater residence, and most habitat improvements result in benefits for other native fish and aquatic species as well. Therefore, protection and restoration of Coho habitats directly benefits all of the Coquille

Basin's native aquatic species, including Fall Chinook, winter steelhead, cutthroat trout, lamprey, mussels, and many more.

1.3 A Threatened Species and a Changing Climate

Evolutionarily Significant Unit: An ESU is a group of Pacific salmon that is discrete from other groups of the same species and that represents an important component of the evolutionary legacy of the species. Under the Endangered Species Act, an ESU is treated as a species.

The Coquille Coho population is one of 21 independent Coho populations that make up the Oregon Coast (OC) Coho salmon evolutionary significant unit (ESU). An ESU is a group of closely related populations that have had enough genetic intermixing to represent an important component of the evolutionary legacy of a particular species (geographically proximate populations are more genetically similar than geographically distant populations). An ESU is treated as its own unique species under the federal Endangered Species Act (ESA). Since 1998, all Coho populations within the OC Coho ESU, have been listed as "threatened" under the ESA. The cause of the listing is primarily, though not entirely, due to habitat loss and degraded habitat quality over the last 150 years. Following several years of review by the National Marine Fisheries Service (NMFS) and the Northwest Fisheries Science Center (NWFSC), it was determined that OC Coho's long-term decline mirrored deteriorating conditions in their freshwater habitats and that the remaining available habitat was likely inadequate to sustain Coho productivity, especially during periods of poor ocean conditions (Stout et al. 2012). The findings of these reviews led to the NMFS recovery plan for OC Coho, published in 2016, and numerous efforts to stop the decline of this species. Recent scientific reviews have found the species remains at risk of extinction and that continued implementation of sound management actions, habitat restoration, and protection efforts are needed to ensure OC Coho's long-term viability (NWFSC 2021).

Climate change impacts pose increasing risks for OC Coho and other cold water fishes. Records

Adult Coho. Photo: Danita Delimont / Shutterstock

Coquille River in the fall. Photo: Adobe Stock.

spanning up to several thousand years demonstrate that warming of the global climate system, as well as ocean warming and acidification, are currently occurring and the rate of change since the 1950s is unprecedented (IPCC 2014). There is overwhelming scientific evidence that this 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 released into our atmosphere (IPCC 2014). Ocean acidification is expected to continue through the end of the century under most greenhouse gas emission scenarios and has the potential to accelerate as the oceans buffering capacity diminishes (Jiang et al. 2019).

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 patterns and increased drought frequency are also expected (Dalton and Fleishman 2021), with important ramifications for stream flow volume and flow timing. In the absence of counteracting management actions, summer stream temperatures are expected to increase due to rising air temperatures and decreased base flows. These changes could affect Coho salmon growth and survival through numerous pathways during their life cycle (Wainwright and Weitkamp 2013). The effect of increasing summer water temperature on juvenile Coho abundance and smolt 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, and the quality and quantity of overwinter habitat available to juvenile fish that survive the summer period. The projected scope of temperature change and the ecological consequences for Coho salmon will vary across the ESU; however, no Coho population will be unaffected.

Vulnerability, as described by the IPCC (2007), is 1) a function of the sensitivity of a particular species or system to climate changes, 2) its exposure to those changes, and 3) its capacity

Photo: Barrie Kovish

to adapt to those changes. Crozier et al. (2019) completed a formal vulnerability assessment of ESA-listed Pacific salmon and steelhead ESUs based on these three components of vulnerability. They concluded that OC Coho are highly vulnerable to climate change due to increased exposure and sensitivity. The assessment concluded that the OC Coho ESU had moderate adaptive capacity, meaning that life history diversity may offset some of the exposure and vulnerability to climate change. These findings highlight the importance of implementing actions to restore ecosystem resiliency for these populations.

Projected changes in the ocean environment (e.g., sea-level rise, increasing sea surface temperature, increased ocean acidification) are largely outside of local management control. Therefore, the primary management strategy to minimize the long-term impacts of climate and ocean change on OC Coho 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 of poor ocean productivity, which may become more extreme and unfavorable in the future. Many of the changes in the freshwater habitat that are expected to occur due to climate change are lower in magnitude than those observed following the alteration of habitat for human uses, so there is clear potential to mitigate against climate effects with actions to restore or enhance habitat.

Coho in the Coquille Basin will be exposed to these projected climate conditions; their sensitivity at each life stage and their adaptive capacity will determine their vulnerability to these changes. In the face of such uncertainty, an extra degree of caution must be taken when managing species with complex anadromous life cycles.

1.4 An Opportunity for Recovery

Despite the ongoing listing of OC Coho as threatened under the federal ESA and the potential impacts from a changing climate, this ESU presents a hopeful and unique opportunity for recovery. Since the ESU's crash during the 1990s, which led to ESA listing, both habitat quality and quantity and OC Coho abundance have improved. Many fisheries managers along the Oregon Coast see OC Coho as having the potential to become the first salmonid species delisted from the endangered species list. This hopeful outlook is a direct result of the ESA listing that reduced harvest pressure and hatchery-related impacts, and focused on freshwater habitat restoration. Continued strategic restoration of key habitats and natural watershed processes will improve the Coquille Coho population's likelihood of survival in the face of climate change and recovery in the future.

Locally led restoration partnerships play a critical role in OC Coho recovery and delisting. These partnerships provide the support needed to translate the broad ESU-level recommendations (large spatial scale) found in the federal recovery plan into coordinated and strategic action plans (focused watershed scale). This is the purpose of the Coquille Coho SAP.

Chapter 2

Overview of the Coquille Coho SAP Team and Scope of This Plan

2.1 Team Roles

The process of developing the Coquille Coho Strategic Action Plan began in 2022 with a group of committed local, state, federal, and not-for-profit partners working to recover OC Coho salmon in the Coquille Basin. This group recognized that to recover Coquille Coho, there needed to be a shared, long-term vision and guiding document, so that individual groups could implement the strategic work on the ground necessary to achieve recovery. The participation and guidance from this inclusive and diverse team were critical to the SAP development. The Coquille technical team and full stakeholder team have worked cooperatively over the last several years and are grateful for each member's contribution. These partners, and others, will implement the actions identified in the plan and will monitor progress toward achieving the long-term goals of the SAP.

- Coos Soil and Water Conservation District (CSWCD)
- Coquille Watershed Association (CoqWA)
- National Marine Fisheries Service (NMFS)
- National Oceanic and Atmospheric Administration (NOAA) Restoration Center
- Oregon Department of Fish and Wildlife (ODFW)
- Oregon Department of Environmental Quality (ODEQ)
- Oregon Watershed Enhancement Board (OWEB)
- Port of Bandon
- The Nature Conservancy (TNC)
- Wild Rivers Land Trust (WRLT)
- Wild Salmon Center (WSC)
- United States Forest Service (USFS)
- United States Bureau of Land Management (BLM)

FOUR MAIN OBJECTIVES FORM THE FOUNDATION OF THE COQUILLE COHO STRATEGIC ACTION PLAN	
1	Identify actions and locations of restoration priorities to align restoration efforts across stakeholder groups.
2	Enhance riparian function throughout the entire basin to maintain or lower water temperatures in order to offset climate change, buffer upland pollution loading, and restrict habitats available to invasive aquatic species.
3	Increase instream complexity in tributary, mainstem, and estuary habitats and provide lateral connectivity to associated off-channel and floodplain habitats to support juvenile Coho (i.e., fry, parr, and smolts) during summer and winter.
4	Build community awareness and support of the benefits of voluntary participation in Coho conservation and restoration.

The Coquille Coho SAP represents the culmination of a two-year planning process. The team has already achieved the first objective listed above and is now actively working to meet the rest. The Coquille Watershed Association has served as the convening organization during the development of the Coquille Coho SAP and will continue in this central role throughout the plan's implementation. The team has established a core planning team, composed of members from the full stakeholder team with significant technical knowledge of the Coquille Basin. Using extensive data, modeling, and years of professional experience, this technical team led the development of the scientifically rigorous components of this plan and was comprised of the following members:

- Bureau of Land Management
- Coquille Watershed Association
- Oregon Department of Fish and Wildlife
- NOAA Restoration Center
- Wild Salmon Center

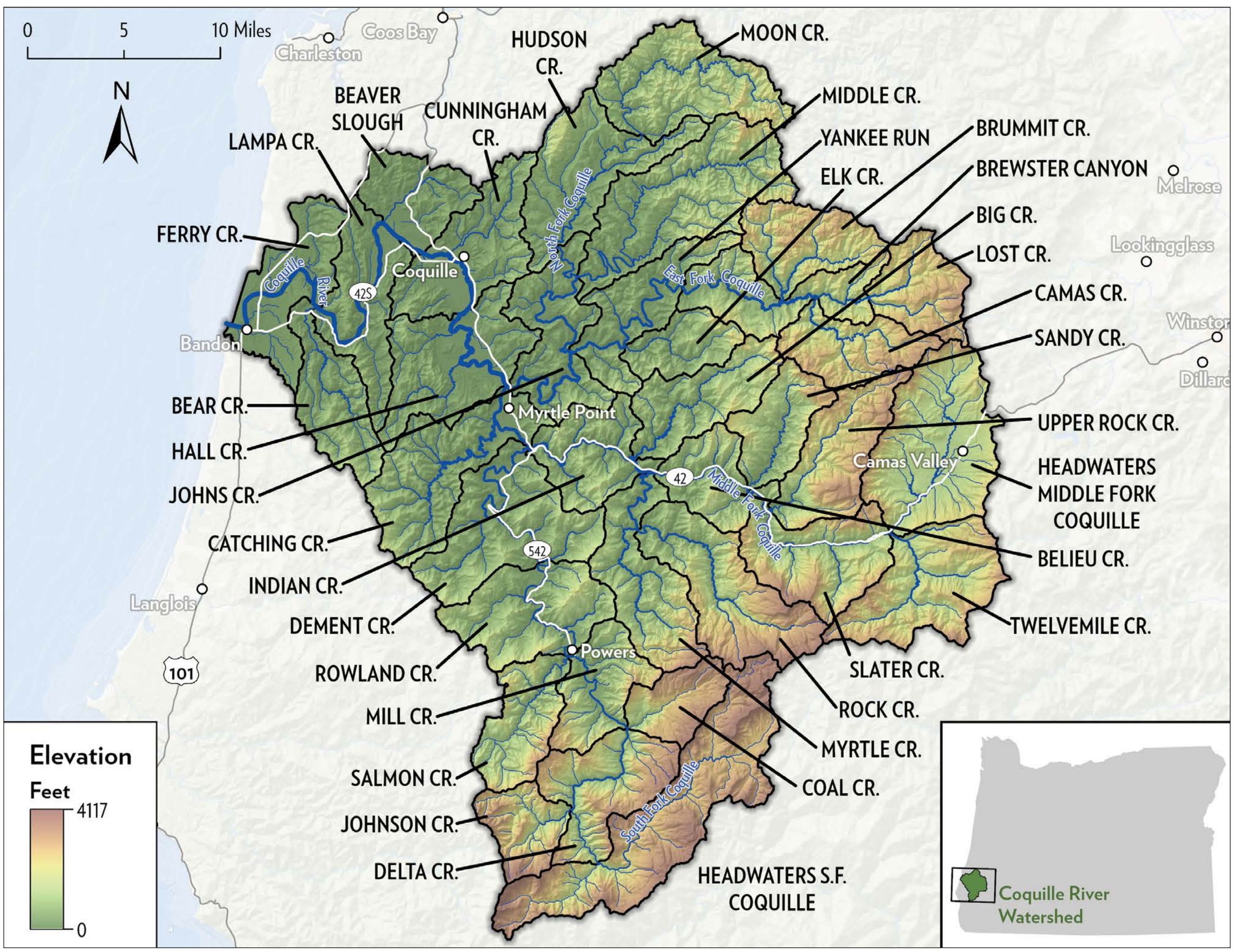
This strategic action plan is intended to be a "living document" that will help to guide restoration activities in the Coquille Basin over the next 15-20 years. The plan is meant to be dynamic and flexible but with well-articulated long-term goals. The Coquille Coho SAP team has committed to revisiting this document at five-year intervals to assess the status of project implementation and effectiveness of the identified strategies. Through lessons learned and the gathering of new data, the SAP will adapt both when and how specific projects are implemented. New information will also be sought to identify additional actions and projects that will benefit Coho and coastal communities in the Coquille Basin. Funding availability and community support will be key factors guiding how this SAP is implemented over the long term.

2.2 Scope of the Coquille Coho Strategic Action Plan

The spatial scope of the Coquille Coho SAP includes all habitat components that support the independent Coquille Coho salmon population. These components include all the tributary, mainstem, estuary, and near-shore marine habitats within OC Coho's distribution in the Coquille Basin. This population is a high priority for the recovery of the Mid-South Coast stratum of the OC Coho ESU.

The Coquille Basin is divided into five 5th field Hydrologic Unit Codes (HUCs): Lower Coquille, North Fork Coquille, East Fork Coquille, Middle Fork Coquille, and South Fork Coquille River (Figure 2.2.1). The Lower Coquille (0-0.6 river miles), South Fork (0-35.6 river miles), and North Fork (0-2.8 river miles) Coquille HUCs are tidally influenced, while the remaining 5th field HUCs are outside of tidal influence and dominated by

Figure 2.2.1. Major forks and tributaries in the Coquille Basin and 6th field HUC sub-watersheds.



Coquille River Valley. Photo: Adobe Stock.

archetypal coastal forest under various ownership and management. In general, this SAP will focus restoration efforts in sub-watersheds that support the full suite of Coho life stages, recognizing the need to protect and restore Coho "anchor habitats," areas that support Coho across multiple life stages, such as spawning and rearing.

The members and collaborators of the Coquille SAP team represent many of the major landowners, managers, and stakeholders in the Coquille Basin. While many members of this team have been working cooperatively for over 25 years, efforts have not necessarily occurred in a coordinated manner to this scale. This SAP formalizes the coordinated partnership and is largely the product of those relationships and the trust built over that time. The diverse members of the team have direct connections to each of the priority subbasins and the conservation actions described in this plan. They represent the economic, ecological, cultural, and social interests that are integral to the Coquille Basin, with its heavily resource-dependent human population, uniquely diverse and extensive ecoregional habitats, shared Tribal authority, and varied recreational opportunities. This SAP leverages these deep community and ecosystem connections into specific, directed conservation actions that formalize and reinforce the considerable success that the team has had to date.

The 20-year timeline of this SAP is an acknowledgment of the amount of work that the SAP team feels will be needed to measurably and substantially improve Coho habitats in the Coquille Basin. Focused at the subbasin scale, the SAP will expedite priority conservation actions across the Coquille Basin in a coordinated manner that maximizes the return on investment of restoration and protection activities. Additionally, 20 years is a timeframe of increased certainty within our current climate models. Beyond that time horizon, adaptation and innovation will likely necessitate an update to the SAP. The team welcomes this opportunity to leverage decades of collaborative Coho habitat restoration actions, extensive monitoring and data collection, and strong stakeholder support and engagement. It aims to build on this steadfast relationship development to tackle the greater challenge of integrating proven restoration methods with innovative economic development approaches to support and sustain Coho salmon and working coastal communities.

East Fork Falls. Photo: Dan Silvius

The Coquille team recognizes the variability and limits presented by policies governing land use and species/habitat management in the Coquille Basin. While focusing the scope of this plan on strategies to physically improve Coho habitats, the team emphasizes that implementation of this plan is entirely voluntary.

2.3 Coquille River SAP Framework

A "common framework" was used by the Coquille Coho SAP team and is based on a model developed by the Coast Coho Partnership (CCP), a broader team of public and private partners working to accelerate the recovery of Oregon Coast Coho. The CCP developed this framework to establish a consistent language that could be used within and across watersheds for the development of Coho conservation plans. The complexities of Coho salmon restoration require a specific and consistent set of terms to ensure all stakeholders are speaking the same language. Based on the unique social and ecological conditions in the Coquille Basin, the team reviewed and tailored the common framework to fit the specific local needs.

The Coquille common framework recognizes areas within the Coquille Basin that should be managed differently based on Coho biology, current and historic anthropogenic impacts, and ecological habitat types (i.e., components). The framework also identifies the "key ecological attributes" (KEAs) of each component essential to the Coquille Coho population, describes potential indicators for each KEA, and identifies the stresses and threats that may limit population viability over the long term. Terminology adopted through the framework and included in this plan are described in Section 4.5; the key terms are defined in Appendix I.

2.4 Core Values

One of the first steps in the Coquille Coho SAP process was a discussion of the core values and priorities that would guide the team and development of a long-term vision for the SAP. This discussion explored how Coho salmon conservation aligns with and balances potentially competing social, economic, and ecological priorities among local stakeholders. The result was a vision statement that guided the SAP's development and informed the long-term roles of partners within the Coquille Basin. This early discussion also resulted in principles that would guide the planning process, as well as outcome statements that clearly define the team's long-term Coho salmon recovery priorities. Actions identified throughout the plan will be implemented in a manner that is compatible and supportive of Tribal cultural resources and traditional ecological knowledge.

2.5 Partnership Vision for Coquille Coho Recovery

People have been fishing and living along the Coquille River since time immemorial. The first peoples that lived in the Coquille Basin recognized the abundance provided by the sea, the mountains, and the rivers. In more recent years, people have continued to settle throughout the Coquille Basin, attracted by the unique social, cultural, and economic lifestyle the area provides.

The members of the Coquille Coho SAP team, representing a subset of the Coquille Basin community, are committed to improving and maintaining the ecological integrity of the watershed. This team recognizes that watershed function is fundamental to community health and vitality. By managing and improving watershed function, all people living in the basin benefit from fishable and swimmable waters, clean drinking water, reduced flooding and wildfire risks, myriad recreational opportunities, and abundant salmon runs. The SAP partners are committed to providing expert technical guidance to collaboratively plan, prioritize, and implement actions that improve the quality, quantity, and diversity of ecosystem services. With a focus on protecting sources of cold water and improving riparian function throughout the basin, this team will work with voluntary landowners to achieve the long-term goals outlined in this plan.

> *The Coquille Coho SAP partners, representing the community of people who live and work in the Coquille Basin, is committed to working to improve and maintain the environmental integrity and economic stability of the watershed.*

The unique cultural, social, and economic lifestyle that draws in the people of the Coquille Basin is rooted in connection to the landscape and aquatic environment of the watershed. Photo: Dan Silvius.

Chapter 3

The Coquille River Basin

3.1 Biophysical

The Coquille River begins in the rugged terrain along the west side of the Coast Range and a small section of the Klamath Mountains. Gathering flow from 1,089 square miles of southwestern Oregon, it is the state's largest completely coastal watershed. The Pacific Ocean borders the watershed to the west, the Coos River basin to the north, the South Umpqua River basin to the east, the Rogue River basin to the south, and several smaller coastal basins, including Floras Creek and the Sixes and Elk Rivers to the southwest. Most of the watershed lies in Coos County, Oregon, with the remainder in Douglas County and a small portion in Curry County.

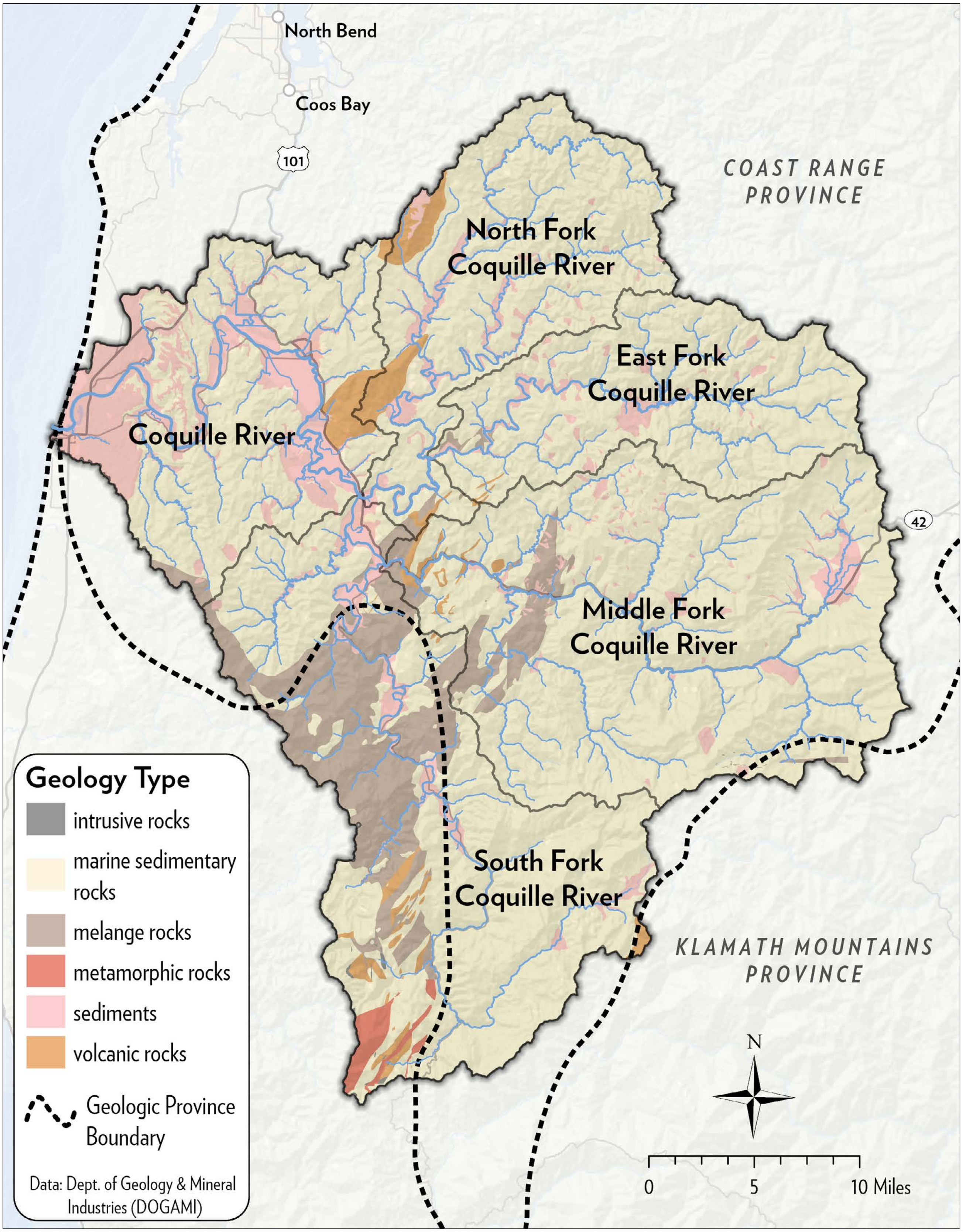
The headwaters of the Coquille's four major rivers—the North, South, Middle, and East Forks—gather flow from the basin's mountainous slopes and merge later to form the main Coquille River. Together, the Coquille River and its four major tributaries cover 226.5 miles. The South Fork Coquille River is the Coquille's longest tributary. From its beginning near Table Rock Mountain in the Rogue River-Siskiyou National Forest, the South Fork flows primarily north about 63 miles to converge with the North Fork Coquille River near the town of Myrtle Point. The 40-mile-long Middle Fork Coquille River joins the South Fork 4.7 miles above this confluence. The North Fork Coquille River is the Coquille's second-longest tributary, originating in the Coos Mountains and flowing southwest for 53 miles to the South Fork. Along its route, the North Fork picks up the 34-mile-long East Fork Coquille River, the shortest of the four forks, near the town of Gravelford. The confluence of the South and North Forks forms the mainstem Coquille River, which meanders westward for 36.3 miles to meet the Pacific Ocean near the city of Bandon.

3.2 Geology

The Coquille Basin's physical characteristics reflect the two major geologic provinces that

The mainstem Coquille River meanders westward for 36.3 miles to meet the Pacific Ocean near the city of Bandon, Oregon. Photo: Adobe Stock.

Figure 3.2.1. Major forks and tributaries in the Coquille Basin and 6th field HUC sub-watersheds.



form the watershed (Figure 3.2.1). These geologic provinces create a naturally sediment-productive basin. Its steep, thinly soiled slopes and unstable bedrock leave the drainage highly susceptible to

Eelgrass beds in Randolph Slough provide feeding, spawning, breeding, nesting, and nursery areas for terrestrial and aquatic life. Photo: ODFW.

earthflows, erosion, debris slides, and flash flooding (CWA 1997).

The Coast Range geologic province underlies 76 percent of the basin, dominating the North Fork and Middle Fork Coquille drainages. This province consists primarily of steeply sloped sandstone (Nonpoint Source Effort 1992 in CWA 1997). A central geologic formation in this area is the Tyee Formation, mostly thick layers of bedded sandstones and siltstones that are susceptible to mass movement, rapid erosion, flash flooding, and landslides (CWA 1997).

The Klamath Mountain geologic province underlies the rest of the basin, including the headwaters of the South Fork Coquille River and, to a lesser extent, the Middle Fork Coquille River. This area displays a hard rock system composed of volcanic, diorite, and serpentine rocks (CWA 1997) that is relatively unstable, resulting in earth flows, debris slides, and slumps (Coquille Indian Tribe 2007).

3.3 Geography

An often steep, variable, high-elevation terrain covers about 63 percent of the Coquille's upper watershed. Forests blanket a large portion of this higher-elevation land, with much of the forest land managed by the U.S. Forest Service, Bureau of Land Management, and private timber companies.

As the rivers drop out of the high-elevation mountain ranges, the watershed widens and flattens, with low hills, narrow alluvial valleys, and floodplain terraces. The lower Coquille River winds through a unique flat valley, with the upper reach of tidal influence extending about 40 miles from where the river meets the Pacific Ocean. Over the years, this area has been molded by fluctuating sea levels and continuous uplifting and infilling of the river channel, leaving marine and alluvial sediment deposition and terrace formation through the lower Coquille River drainage. The towns of Myrtle Point and Coquille sit on these alluvial deposits. The lowest reach of the river flows through dunes and a series of coastal marine terraces subject to erosion during high winter flows. The city of Bandon is anchored on a marine terrace near the river mouth. The Coquille River basin elevation ranges from sea level to 4,075 feet at Ophir Mountain (CWA 1997).

The Coquille River estuary covers the lower twenty miles of the watershed before joining the Pacific Ocean. The estuarine extent for the Coquille River is river mile (RM) 20.2. For low flow conditions, salinity intrusion occurs upstream to approximately RM 20 near the City of Coquille, while for higher flow conditions, less salinity intrusion occurs (Mayer 2012). Historically, the river valley contained an estimated 17,425 acres of estuarine wetlands. Around 1870, European settlers began converting wetlands and clearing tree species in the Coquille River valley for agriculture and other purposes. By 1992, only 373 acres of the valley's historic marshes remained (Scranton 2004, Scott et al. 2019).

While making up only four percent of the basin, the Coquille's floodplains and terraces historically provided highly productive spawning and rearing areas for salmon and steelhead (USDI 1994). Today, despite the diking and filling of many acres of wetlands, creek beds, and sloughs over the past century, the lower river and estuary continue to provide a rich environment supporting many fish and wildlife species. The estuary contains over 400 acres of tidelands and permanently submerged land. Eelgrass beds, wetlands, and tidal flats provide feeding, spawning, breeding, nesting, and nursery areas for terrestrial and aquatic life, including Coho and Chinook salmon.

3.4 Climate and Hydrology

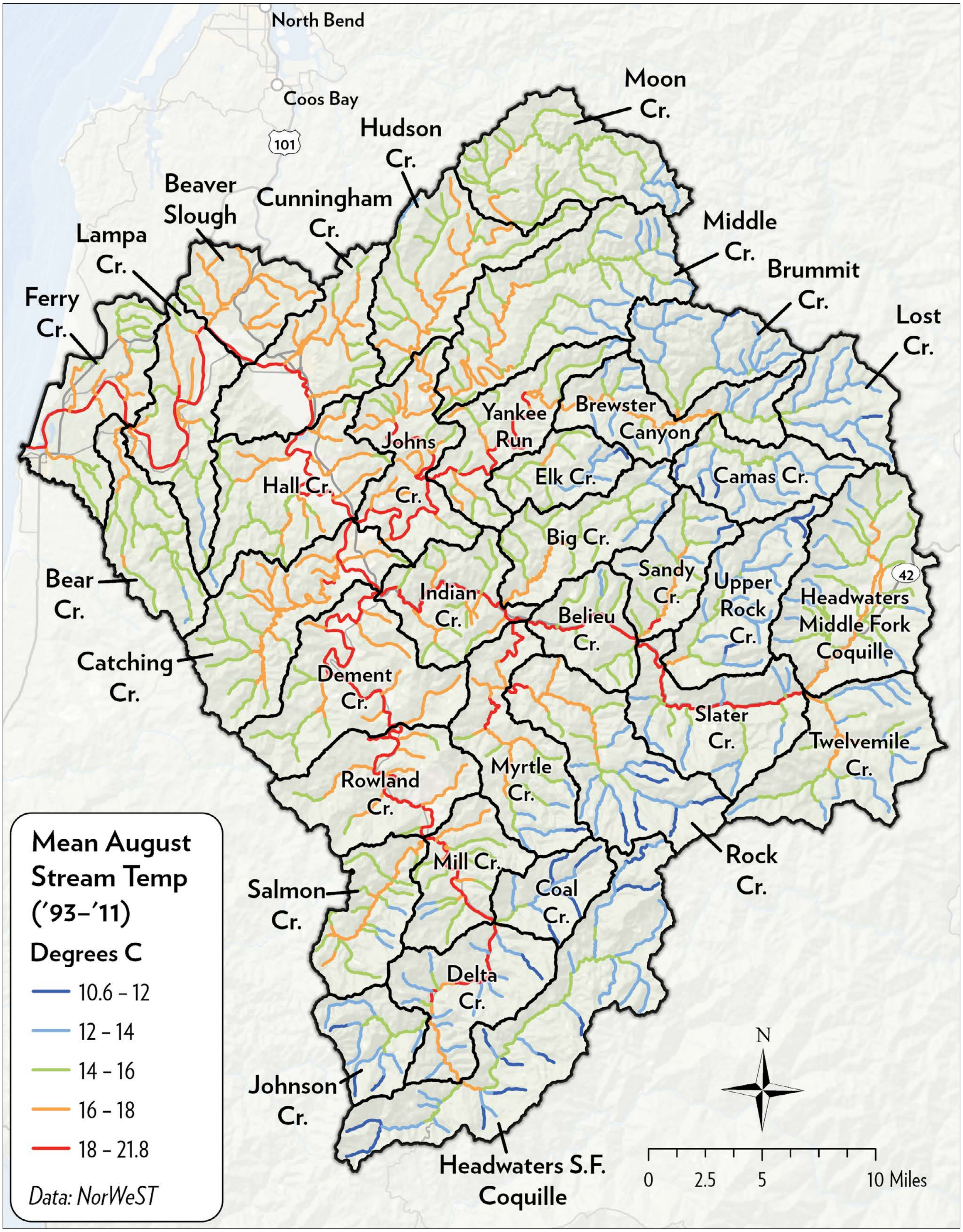
Influenced by its proximity to the Pacific Ocean, the Coquille watershed is dominated by a wet, warm marine climate. Temperatures in the area are generally mild, rarely exceeding the low 90s or falling below freezing. Precipitation falls mainly as rain, with average annual rainfall varying from a low of 45 inches at Camas Valley, in the Middle Fork Coquille drainage, to 120 inches in the upper South Fork Coquille Basin (CWA 1997, Coquille Indian Tribe 2007). Overall, the Coquille Basin averages around 70 inches of precipitation annually (Mayer 2012). Greater than 95 percent of the average annual precipitation occurs from October to June (Mayer 2012). Winter storms can bring snow, particularly at higher elevations. With the exception of the South Fork Coquille, which can have a uniquely significant snowpack that provides critical cold water into the summer months, snowpacks are typically intermittent and only last for a few weeks. Short bursts of heavy rainfall are also common during winter storms. Most precipitation, however, is of low intensity and occurs as a light mist or "drizzle" (USDI 1997).

Due to the typically southern winter storm track and the orientation of the ridges in the drainage, the East and South Forks of the Coquille River receive the most rainfall (CWA 1997, Coquille Indian Tribe 2007). Between 75 and 120 inches fall annually east of China Creek in the East Fork Coquille River drainage, in the high elevations of the South Fork Coquille River drainage, in the headwaters of Myrtle and Rock Creeks in the Middle Fork Coquille River drainage, and in the headwaters of Middle and Cherry Creeks in the North Fork Coquille River drainage. The rest of the basin receives between 50 and 75 inches per year, except for the Camas Valley area, which receives less than 50 inches (CWA 1997, Coquille Indian Tribe 2007).

The area's weather and geology heavily influence the hydrological cycles of the Coquille's four main rivers. Streamflow in the Coquille River basin follows seasonal precipitation patterns, with flows peaking in winter when heavy rainfall saturates the thin soils in the watershed's steeper, high-elevation areas. Streamflow then drops to base levels in summer when precipitation is infrequent, and groundwater contributions sustain the flows. Streamflow in the lower Coquille River is further influenced by withdrawals of surface water for municipal, domestic, and irrigation uses, and by past diking and channel straightening in low areas that speed drainage after floods (Coquille Indian Tribe 2007, Jones et al. 2012).

Stream discharge in the different forks of the Coquille River varies by orders of magnitude throughout the year and reflects seasonal precipitation patterns (Mayer 2012). For example, in 2023, the United States Geological Survey streamgage in the lower South Fork Coquille River recorded flows of 14,000 cubic feet per second (ft3/sec) in January and 12.4 ft3/sec in September (USGS). Summer baseflows in the South Fork, North Fork, and Middle Fork are generally very low, with

Figure 3.4.1. Current water temperatures in the Coquille Basin based on USFS NorWeST data.



Beaver dams add complexity to stream habitats and provide important rearing areas for juvenile salmonids. Photo: Alamy.

~99% of the total annual flows occurring between October and June. Besides the general lack of snowpack, geology is another major factor affecting the summer baseflows throughout the basin. The marine sedimentary rock formations are very permeable, which limits groundwater contributions to the Coquille River (Mayer 2012).

Water temperatures are affected by various factors, including elevation, air temperature, riparian density, channel substrate and gradient, large-wood volume, and geology (Dent et al. 2008, Mayer 2012). Mean August water temperatures (1993-2011) in the Coquille Basin ranged between < 12° in upper headwater streams to > 21.8° in lower mainstems (Figure 3.4.1).

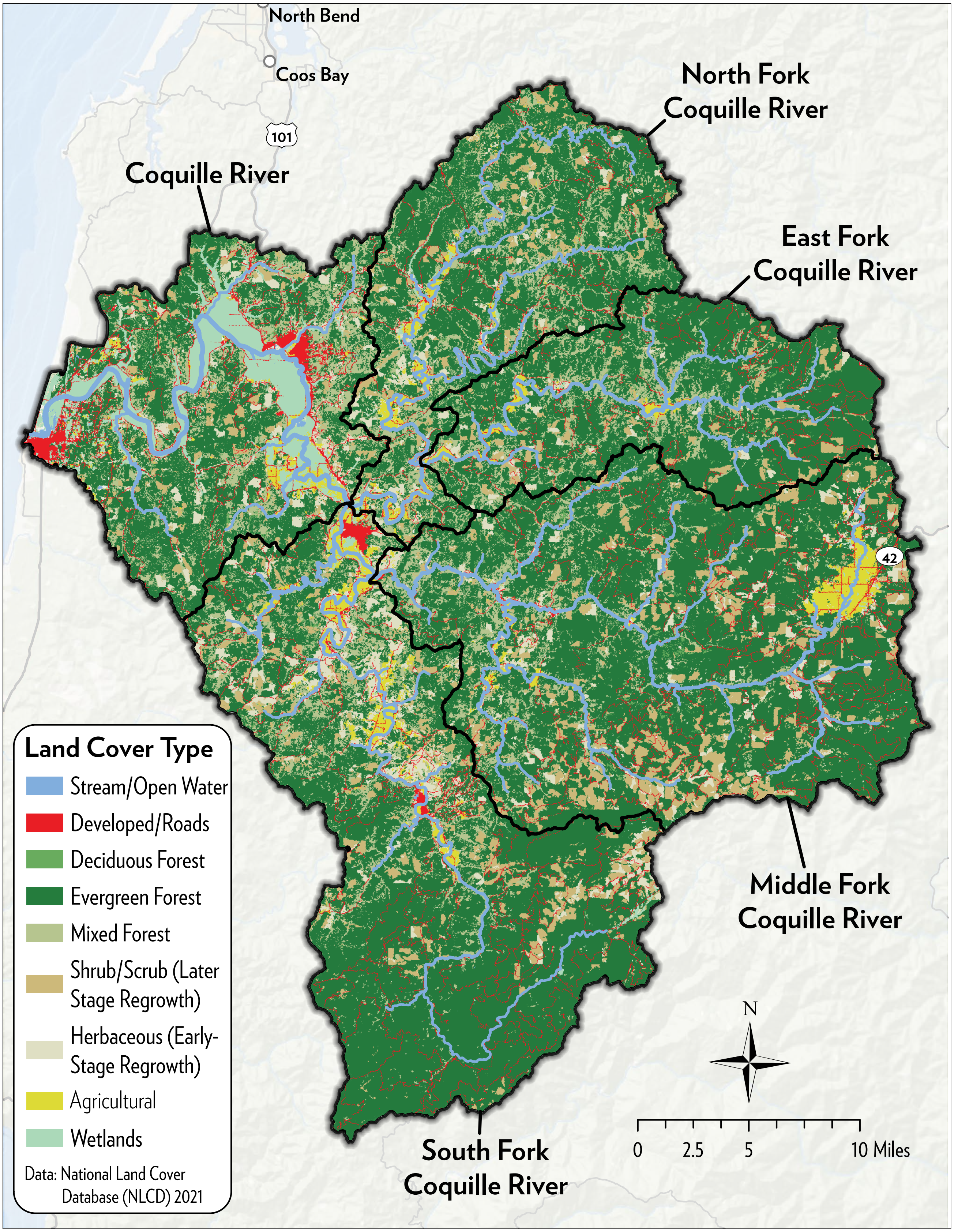
3.5 Land Cover

The Coquille Basin's vegetative cover reflects the warm, stable, temperate climate. Forests cover approximately 70 percent of the basin, with the prominent forest type a mix of Douglas fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), Sitka spruce (*Picea sitchensis*), grand fir (*Abies grandis*), and California bay (*Umbellularia californica*). Bigleaf maple (*Acer macrophyllum*), vine maple (*Acer circinatum*), and red alder (*Alnus rubra*) are primary deciduous species in and near riparian areas (Figure 3.5.1).

Most of the Coquille watershed lies within Sitka spruce and western hemlock vegetation zones, except for the Middle Fork Coquille River headwaters, which sit within the Umpqua Valley vegetation zone, and the South Fork Coquille River drainage, which is in the mixed evergreens and hardwoods zone (Lawson et al. 2004). Many of the forests in the upper watersheds are maintained to support commercial harvest activities. Most old-growth canopy has been logged, and many forests in the area are now considered second-growth forests. Some second-growth forest areas have been harvested, leaving an early seral plant community comprised of sapling trees and shrubs (Coquille Indian Tribe 2007).

Lower in the watershed, the steep slopes give way to rolling hills and low valley areas. Historically, large sections of the Coquille River valley were frequently flooded by combined seasonal rainfall, surface and subsurface runoff, and tidally influenced flows. At the time of Euro-Amer-

Figure 3.5.1. Land cover types throughout the Coquille Basin.



ican settlement in the mid-1800s, 70 percent, or 14,440 acres, of the Coquille bottomlands along the tidal portion of the channel were swampy or marshy, and most of the remaining bottomland was in floodplain areas (Benner 1991).

Running through these marshy areas, the mainstem Coquille River and its tributaries were once lined with dense riparian vegetation consisting of willow, cottonwood, myrtle, alder, and other hardwoods. Historical reports compare travel along the mainstem Coquille River to traveling through a tunnel in some reaches due to the height and overhang of the vegetation (Benner 1991). Beavers were common residents in the marshy areas along the Coquille River and its lower tributaries. An early surveyor repeatedly commented in an October 1871 report of "a vast number of beaver dams and ponds" and "much beaver and elk," or "swamp and beaver" (Benner 1991). This report also described summer boat travel on the Beaver Slough aided by beaver ponds (Benner 1991):

"*During the winter season the [Beaver] slough contains water sufficient for its easy navigation with canoes, row boats, and even small scows. But during the summer season the water is low and nearly level and is only rendered navigable by the aid of Beaver Dams which are built across at short intervals, and thus a sort of slack water navigation was found to exist in 1853…, the same Beaver Dams are used and the same system of navigation exists at this day.*"

Thus, the lower Coquille bottomlands appeared to drain slowly, aided by the work of beaver to help retain water on the land (Benner 1991). Settlers removed much of this dense vegetation for urbanization, agricultural, and timber resources. The removal of stream bank vegetation, instream boulders, and downed wood resulted in the loss of significant aquatic habitat.

3.6 Humans on the Landscape

Euro-American Settlement and Development

The earliest European visitors to the basin were likely fur trappers, traders, and explorers drawn to the flooded woodlands of the lower Coquille River valley that produced abundant beaver pelts for the fur trading industry. European settlement in the lower basin began in the mid-1850s. The population quickly increased, and the settlers expanded into fishing, forestry, agriculture, and other activities. The tidal section of the

A splash dam on the North Fork Coquille River was used to raise the water level and float logs downstream to sawmills. Photo: Emily Ronnow.

Another splash dam on the North Fork Coquille River used to transport logs downstream to sawmills. Photo: Emily Ronnow.

Coquille River was dredged and maintained for commerce and travel. By 1878, steamboats could travel to the population centers of Myrtle Point and Coquille (Benner 1997). Logging opportunities in the vast forests attracted residents and loggers to the Middle Fork Coquille River basin and other accessible forestlands. Many known historic resources on upland BLM lands are remnants of early logging and homesteading.

Logging activities began along the lower Coquille River but soon moved into the upper portion of the basin. Harvest of the upper basin forests began around 1850. Initially, stream channels were cleared of wood and boulders, and logs were floated downstream on the South Fork Coquille River below Powers, mainstem Coquille River, North Fork Coquille River, Middle Fork Coquille River, and numerous tributaries (Benner 1991, Miller 2010). Starting in about 1911, however, log transport in the mainstem and tributaries was enhanced by the use of splash dams (temporary wooden dams used to raise the water level in streams to float logs downstream to sawmills). The impacts of splash dams can still be observed on the landscape today. The logging activities, particularly the clearing of timber from the area's steep slopes and stream banks and the transport of logs downstream, led to substantial bank erosion and stream scouring and increased sediment delivery downstream (Jones et al. 2012).

3.7 Current Socioeconomic Conditions

Today, the Coquille watershed is home to around 23,000 people. Most residents live in the Bandon, Coquille, Myrtle Point, and Powers areas, with the more densely populated valley areas on floodplains adjacent to the Coquille River mainstem, its four forks, and larger-order streams.

Much of the watershed lies in Coos County, and the area has continued to experience low-level growth in recent years. In July 2022, the county's population was almost 65,000, up 0.1%

from April 2020 (U.S. Census Bureau 2022). In comparison, Coos County had 63,043 residents documented during the 2010 census. The major community centers in the Coquille watershed are Coquille (2023 population 4,052), Bandon (2023 population 3,866), Myrtle Point (2023 population 2,502), and Powers (2023 population 759) (PSU 2023). The area's demographics in 2021 were primarily white Euro-American. About 84% of Coos County residents were white, 6.9% were Hispanic, 5.35% were multiracial (non-Hispanic), 3% were American Indian and Alaska Native, 1% were Asian, and 0.45% were Black or African American (U.S. Census Bureau 2022).

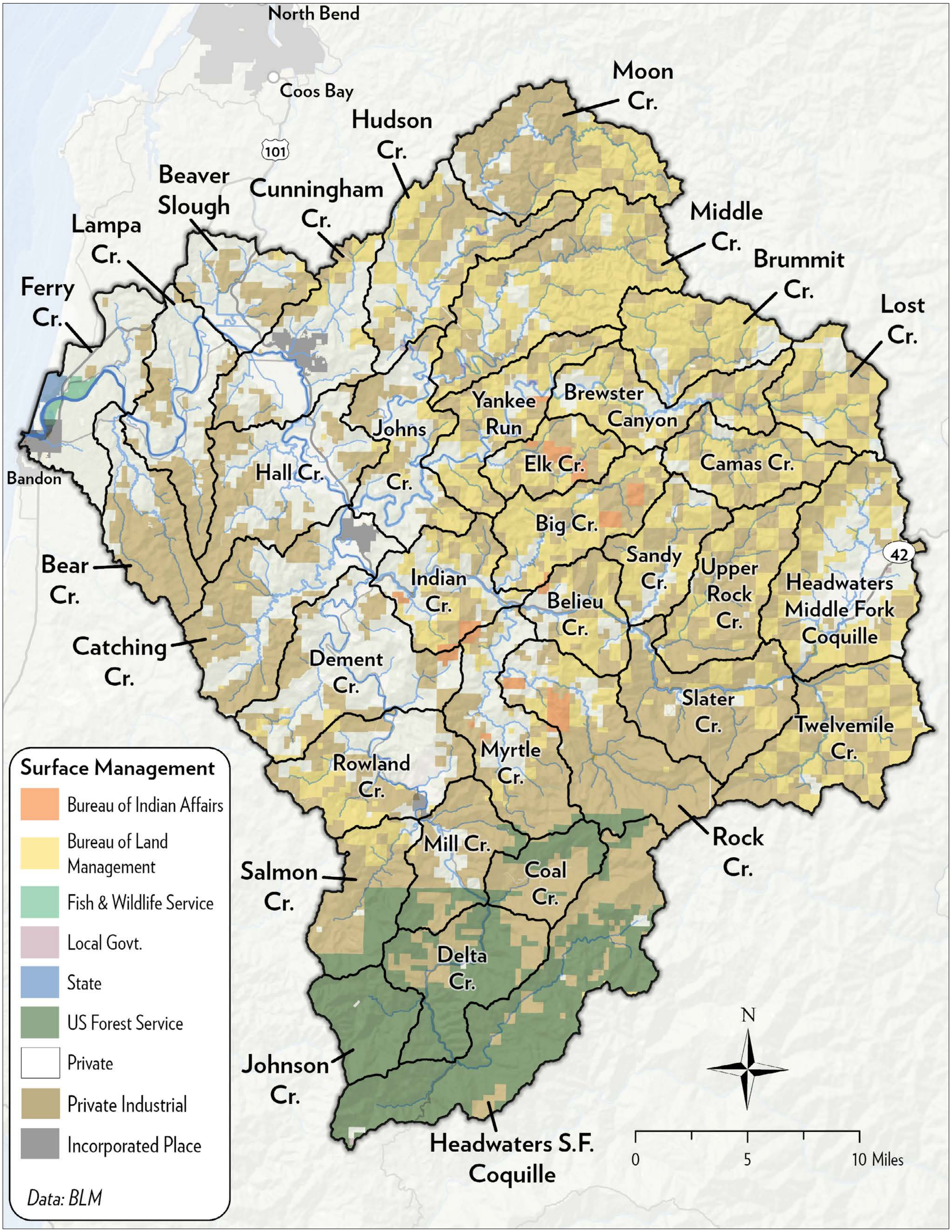
The majority of the Coquille Basin has been identified as disadvantaged, underserved communities based on the Climate and Economic Justice Screening Tool. The EPA EJ screening tool identifies Coquille Subbasin residents as, on average, older, less ethnically diverse, and living at a higher poverty rate than the state average. There is a higher percentage of non-Hispanic American Indians (3%) than the state average of 1.9%. Coquille residents also have a higher population loss rate due to fatalities and injuries resulting from natural hazards, asthma and heart disease, and -pollution from abandoned mine lands and lack of indoor plumbing. Additionally, Coquille Basin residents had higher pollutant exposure indicators for lead paint and diesel particulate matter (EPA EJ screening tool accessed June 2024).

3.8 Land Use and Ownership

The Coquille watershed supports a diverse natural resource-based economy that relies heavily on its forests, which cover 91.5% of the watershed. The vast majority of this forest land is designated for commercial harvest and is held by large private industrial owners, the Bureau of Land Management, and U.S. Forest Service (Figure 3.8.1). Approximately 40% of the watershed is private industrial forest lands. Federal, state, and county lands occupy about 30% of the watershed, with the Bureau of Land Management and U.S. Forest Service administering the largest public holdings. Another 30% of the basin is in smaller nonindustrial private holdings. Agriculture and range comprise 7% of the watershed, and Tribal ownership is 1% (Coquille Indian Tribe 2007).

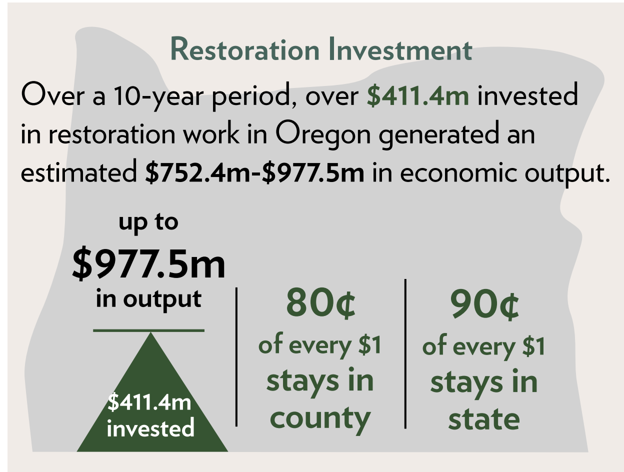
Euro-American settlers logged and milled Coquille timber to provide lumber for local buildings and mining. Photo: Emily Ronnow.

Figure 3.8.1. Map of land ownership in the Coquille Basin.



3.9 Economy

Communities within the Coquille watershed maintain an economy focused on forest products, ranching, farming, timber, fishing (commercial and recreational), and tourism. Boating, dairy farming, myrtlewood manufacturing, shipbuilding and repair, and agriculture specialty products, including cranberries, also play an important role. The upper watershed remains mostly in timber production. While the wood products industry has declined since the 1980s, it continues to employ many area residents.



Lands in the Coquille River valley generally support residential, industrial, agricultural, and commercial uses, service businesses, and gravel extraction. Pastureland extends into the hills above the floodplains in some areas. Generally, steep slopes above the valley floor remain sparsely populated, primarily supporting timber production, agriculture, and some mining activities. The upper reaches of all four forks of the river and most tidewater streams are managed as commercial forests. In the lower watershed, the area around Bandon supports a strong cranberry industry, raising 95% of Oregon's cranberries and about 5% of the national crop. Tourism has also become a growing industry, particularly along the coastline near Bandon. Tourists, as well as retirees, are attracted to the area's climate, coastal beauty, and outdoor recreation opportunities. Major recreational attractions include river and ocean fishing, surfing, golfing, and exploring area beaches. Bandon's population grew from 3,066 in 2010 to 3,866 in 2023 (PSU 2023).

Pasturelands on South Fork Coquille River. Photo: ODFW.

The Restoration Economy

Coho salmon are a key regional natural asset that has played an important part in the region's social and economic fabric for thousands of years. The strategies in this SAP aim to restore critical Coho habitats by repairing the watershed processes that generate and maintain them. Besides directly bolstering subpopulations of Coquille Coho, the projects identified in this plan will advance the local restoration economy.

A study by Ecotrust found that the restoration economy is having a big economic impact on local communities. In Oregon's rural counties, an average of 80 cents of every dollar invested in restoration stays in the county, with 90 cents of every dollar staying in the state (Kellon 2012). That means that the $411.4 million invested in 6,740 watershed restoration projects throughout the state of Oregon from 2001 to 2010 generated from $752.4 million to $977.5 million in economic output and 4,628 to 6,483 jobs (Kellon and Hesselgrave 2014). Further, the jobs created by the restoration activities were mainly in rural areas—in communities hard hit by economic downturn.

These restoration activities bring a range of employment opportunities for people in the Coquille Basin and other rural areas of Oregon, ranging from construction to engineering, natural resource sciences, and other fields. The restoration activities also generate demand for other products and services in local communities, including plant nurseries, heavy equipment companies, and rock and gravel companies. Unlike in different economic sectors, restoration jobs can't be outsourced to other locations, so the money earned through restoration work tends to stay in the local economy where the project occurs. Nielsen-Pincus and Moseley (2010) found that the multipliers that track the entire ripple effect of restoration investments through the community range from 1.7 to 2.6. In other words, up to $2.6 million in economic output was generated for every $1 million invested in restoration. These restoration investments are especially important in small, rural communities with limited job opportunities, ultimately creating between 16 and 24 jobs for every $1 million invested (Nielsen-Pincus and Moseley 2010). Such investments can translate to significant local employment. Restoration investments also continue to accrue and spread over time. Long-term improvements in habitat create enduring benefits, from enhanced recreational and fishing opportunities to the provision of critical ecosystem services (Kellon and Hesselgrave 2014).

Restoration project on Coal Creek. Photo: ODFW.

Chapter 4

Coquille Basin Coho and Habitats

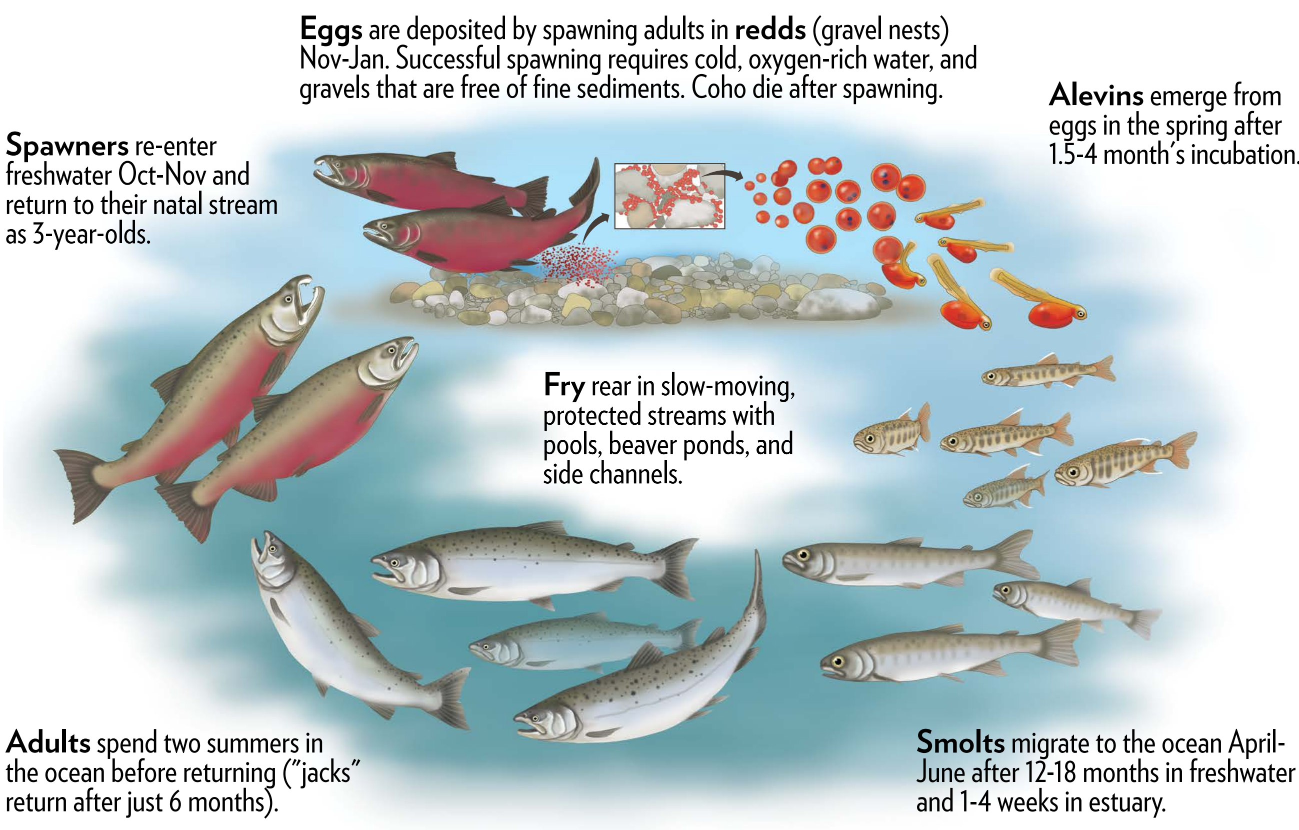
4.1 The Coquille Coho Life Cycle

Adult Coho salmon return to the Coquille Basin from the ocean between October and December and migrate to their natal streams, where they spawn sometime between November and January (Kavanaugh et al. 2005). Coho generally seek out low to moderate-gradient tributary stream reaches to spawn, but some spawning occurs in mainstem sections of rivers and headwater reaches (Kavanaugh et al. 2005, 2006). Successful spawning requires an appropriate mix of gravels and cobble substrate in riffle areas. Female Coho build redds (gravel nests) and deposit their eggs, which one or more males then fertilize. Adult Coho typically die within two weeks after spawning. After death, their carcasses provide vital nutrients that enrich both stream environment and riparian environments, helping to build a healthy food web to support the next generation of salmon. In the spring, a new generation of Coho hatch from the eggs as alevin, juveniles that rely on an attached yolk sac for nourishment while they remain in the gravels. The Coho alevin, like eggs, require a steady flow of clean, oxygen-rich water for survival. They also need gravels free from fine sediments, which can smother eggs and alevin.

Alternative Coho Salmon Life History Strategies

Coho salmon in the Coquille Basin and other Oregon watersheds exhibit a diversity of life history strategies during their freshwater residency. Species that exhibit significant life history diversity often occur in dynamic environments where exhibiting multiple life history pathways increases the stability and fitness of the population (Stearns 1992). Pacific salmon occupy watersheds throughout the North Pacific Rim, which are subject to disturbance regimes across a wide range of temporal and spatial scales that continually alter habitat suitability (e.g., thermal, hydrologic, and sediment and nutrient transport regimes, etc.) (Waples 2009). Resultantly, across juvenile and adult life stages, salmonids have evolved to exhibit significant life history diversity

Figure 4.1.1. The 'standard' Coho salmon life history strategy. Artwork by Elizabeth Morales.



The expression of multiple life history strategies within a population increases the likelihood that the population can persist following sudden or gradual variations in watershed function and the availability of high-quality habitats. This resilience is essential to the viability of Pacific salmon populations and is key to the species' success.


Photo: Eiko Jones

(Groot and Margulis 1991, Waples 2008, Quinn 2018). Salmonid life histories are often described as "pathways" that are a unique combination of the timing and location of morphological, physiological, and habitat transitions an individual undergoes from egg to death. Descriptions of juvenile salmonid life history pathways typically encompass a suite of life history traits that include developmental transitions, growth rates, habitat use, and the timing and patterns of movements between habitats prior to ocean entry (Bourret et al. 2016, Clemens & Schreck 2021).

Much has been learned about the life history of OC Coho in the last 25 years. Historically, OC Coho were thought to follow a fairly fixed life history of rearing in small, wadeable streams near natal spawning grounds. This "standard" or "conventional" life history type occurs when Coho fry rear near their natal stream for a full year before migrating to the estuary in spring (March–June) as smolts (Sandercock 1991, Nickelson 1998). During their outmigration, smolts often feed and grow in lower mainstem and estuarine habitats for days or weeks before entering the near-shore ocean environment. The period of time spent in the estuary before entry into the ocean allows them to physiologically adapt to saltwater. However, like all wild salmonids, Coho have evolved adaptations allowing them to survive and persist in the ever-changing coastal environment. Alternative life history strategies allow individuals to exploit heterogeneous and complementary freshwater and estuarine habitats and environmental conditions. Figure 4.1.1 illustrates the "standard" Coho salmon life cycle. The expression of different life history pathways provides resilience at both the population and the ESU level, increasing the likelihood that local and meta populations will persist in the face of sudden or gradual variations in watershed function and the availability of high-quality habitats at various spatial scales.

Coho expressing alternative life history strategies often move within and between freshwater and estuarine habitats prior to outmigration, seeking productive river or estuarine habitats much earlier during their first year of life. Habitats used by juvenile salmonids over a range of temporal scales include natal and non-natal tributary streams, intermittent streams, mainstem rivers, lakes, freshwater off-channel wetlands, and brackish estuaries. A primary driver of life history diversity is hypothesized to be the effect of proximate cues (e.g., environmental or ecological conditions experienced by the individual) on key life history decisions such as migration and growth rate. Environmental conditions have a significant impact on physiological status and bioenergetic costs; therefore, the interactions between environment and physiology are a major driver of life history decisions. The early migration of these individuals, called "nomads," was reported as early as the 1960s (Chapman 1962). This early migration was originally believed to be caused by density-dependent competition (e.g., a natural population dynamic in which juveniles respond to competition for limited resources) for rearing space, and displaced individuals were believed to have lower survival rates than the "standard" life history. Subsequent research into Coho, and other Pacific salmon species, indicates that these migrations are not indicatively driven by density dependence, high flows, or other sources of displacement; instead, they represent a viable alternative life history strategy (Bottom et al. 2005, Koski 2009, NMFS 2016). Coho parr also show varied migratory rearing patterns based on fluvial and tidal cycles (Miller and Sadro 2003). NMFS's Biological Review Team (BRT) reported at least three discrete

life history strategies involving Coho fry and pre-smolt migrations into lower river habitats: (1) late fall migration into side-channel habitats connected to lower mainstem reaches from mainstem summer rearing habitats, (2) lower mainstem and estuarine summer rearing followed by upstream migration for overwintering, and (3) lower mainstem and estuarine rearing followed by sub-yearling outmigration to the ocean (Stout et al. 2012).

Research in the Coquille Basin has detected several life history strategies for the Coquille Basin Coho (C. Claire - ODFW communications - February 2024). Bourret et al. (2016) describe four discrete life history strategies.

LIFE HISTORY STRATEGIES FOR COQUILLE BASIN COHO	
1	Natal site rearing, yearling smolt, with ocean entry at 12+ months. Historically called the 'Standard' life history.
2	Fry migrants, estuary rearing, yearling smolt, with ocean entry at 12+ months. Often called 'Nomads.'
3	Parr migrants, mainstem river rearing, yearling smolt, with ocean entry at 12+ months.
4	Parr migrants, mainstem river rearing, sub-yearling smolt, with ocean entry at 12 months.

The proportion of the Coquille Coho population expressing alternative life histories is unknown at this time.

Alternative life history strategies have evolved to sustain populations within dynamic environments (Stearns 1992). In any given year on the Oregon Coast, the environmental conditions that Coho encounter are unknown (e.g., early seasonal snowmelt, early increases in water temperature, low spring flows, etc.), and a single life history strategy is insufficient to account for this environmental variability. Overall, population fitness increases when proportions of the population utilize different strategies, spreading out the risks of mortality and increasing population carrying capacity through niche partitioning. There are annual trade-offs in the survival of different life histories allowing some to thrive under certain conditions, while others suffer higher mortality. Over time, this type of "bet-hedging" conveys stability to populations by spreading mortality risks and ensuring that at least one life history strategy is adapted to the current environmental conditions.

The Coquille team recognizes the importance of life history variation for Coho within the basin. Restoring and conserving juvenile life history diversity is a critical strategy to advance Coho recovery in the Coquille Basin and the larger OC Coho ESU. Expanding life history diversity can increase population abundance, promote stability, and foster resilience to future disturbances and climate change (Bisson et al. 2009, Bottom et al. 2005, Craig et al. 2014, Jones et al. 2021, Waples et al. 2009). Historically, juveniles likely used a broader range of habitats in the river system than is currently observed due to habitat loss and degradation. Nonetheless, through phenotypic plasticity, populations are likely to retain the potential to exploit a diversity of habitats in a watershed if they are made accessible and restored to sufficient quality (Waples et al. 2009). Recent studies have demonstrated that habitat conservation activities that increase the diversity of macrohabitat types available to juveniles can support life history pathways that depart from natal stream reaches and rear in alternative habitats prior to outmigration (Anthony et al. 2022, Hoem Neher et al. 2013, Jones et al. 2021, Koski 2009, Sethi et al. 2021, Waples et al. 2009). In short, restoring a diversity of habitats can increase the diversity of life histories expressed.

During the SAP development process, the Coquille technical team considered strategies to promote Coho life history diversity within the watershed. The team considered the following questions when thinking about how to promote life history diversity in the Coquille Basin:

- *What are the current and potential habitat types that juvenile Coho can utilize in the watershed (i.e., mainstem, tributary, estuarine, floodplains, beaver ponds, etc.)?*
- *Are the available habitats complementary and diverse?*
- *Are habitats of sufficient complexity?*
- *Is there sufficient connectivity between complementary, diverse habitat sites for juvenile rearing?*

After Coho leave the Coquille Basin, they generally spend 16 to 20 months rearing in the ocean and growing to maturity before returning to their natal streams as three-year-old adults. However, a small proportion of male Coho reach early sexual maturity and return to freshwater as two-year-old "jacks" after only six months to a year in the ocean or near-shore environment. Jacks represent a life history variation within Coho populations associated with high juvenile growth rates of smolts (linked to productive rearing habitats such as the freshwater tidal habitats). Jacks provide population resiliency by increasing the genetic exchange between different cohorts of spawning Coho and increasing fertilization rates during years of low adult abundance.

4.2 Wild Coho Distribution, Abundance, and Production

Wild Coho Distribution in the Coquille Basin

Coquille Coho utilize all connected freshwater lotic habitats between the Pacific Ocean and the coast range (Figure 4.2.1). Additionally, when connected, Coho utilize lentic off-channel ponds and sloughs. Both anthropogenic and natural fish passage barriers limit access to habitat throughout the basin. Of particular note are barriers limiting access to historical floodplain habitats in low-elevation agricultural lands. Levees, dikes, and tide gates, which are used to drain floodplains for agricultural use, are the primary anthropogenic fish passage barriers in the Coquille Basin. Several natural barriers exist in the upper reaches of the basin that currently and historically limit Coho access.

As with other mid-coast watersheds largely defined by sandstone geology, Coho distribution extends far into the Coquille Basin through a network of perennial streams. Due to the predominately low-gradient stream system in the basin, Coho distribution is generally not segmented by natural barriers on the perennial stream network, except in the vicinity of Brewster Gorge, which isolates the upper East Fork Coquille River from Coho habitation, and Middle Fork Falls, which isolates the upper Middle Fork Coquille River. In the upper extent of freshwater habitat, log jams and debris flows may have isolated sections of habitat from Coho usage for periods of time. As the jams moved and re-formed, or as debris flows worked down through a stream system, Coho were able to re-colonize those stream reaches.

Wild Coho Abundance and Productivity

In an analysis of historical wild Coho adult abundance along the Oregon Coast (ESU scale), NOAA estimated the aggregated peak abundance to range between 2.8 million and 3.3 million prior to European settlement (Lawson et al. 2007). Between 1951 and 1980, the estimated average number of Coho salmon (pre-harvest) for the ESU declined to 373,531, due to overharvest and the negative effects of habitat loss and hatchery influences (Table 4.2.1). During this time, harvest rates averaged 68%, leaving an estimated average ESU spawning population of 119,348 (Table 4.2.1). Between 1980 and 1998, the estimated average number of Coho salmon (pre-harvest) in the ESU further declined to 93,994, with an average spawning abundance around 55,514 (Table 4.2.1). The OC Coho ESU continued to decline to an estimated low of 23,661 spawners in 1997 (Table 4.2.1). These declines led to the species' listing as "Threatened" under the federal Endangered Species Act in 1998 (NFMS 2016).

Figure 4.2.1. Coquille Coho spawning and rearing distribution.

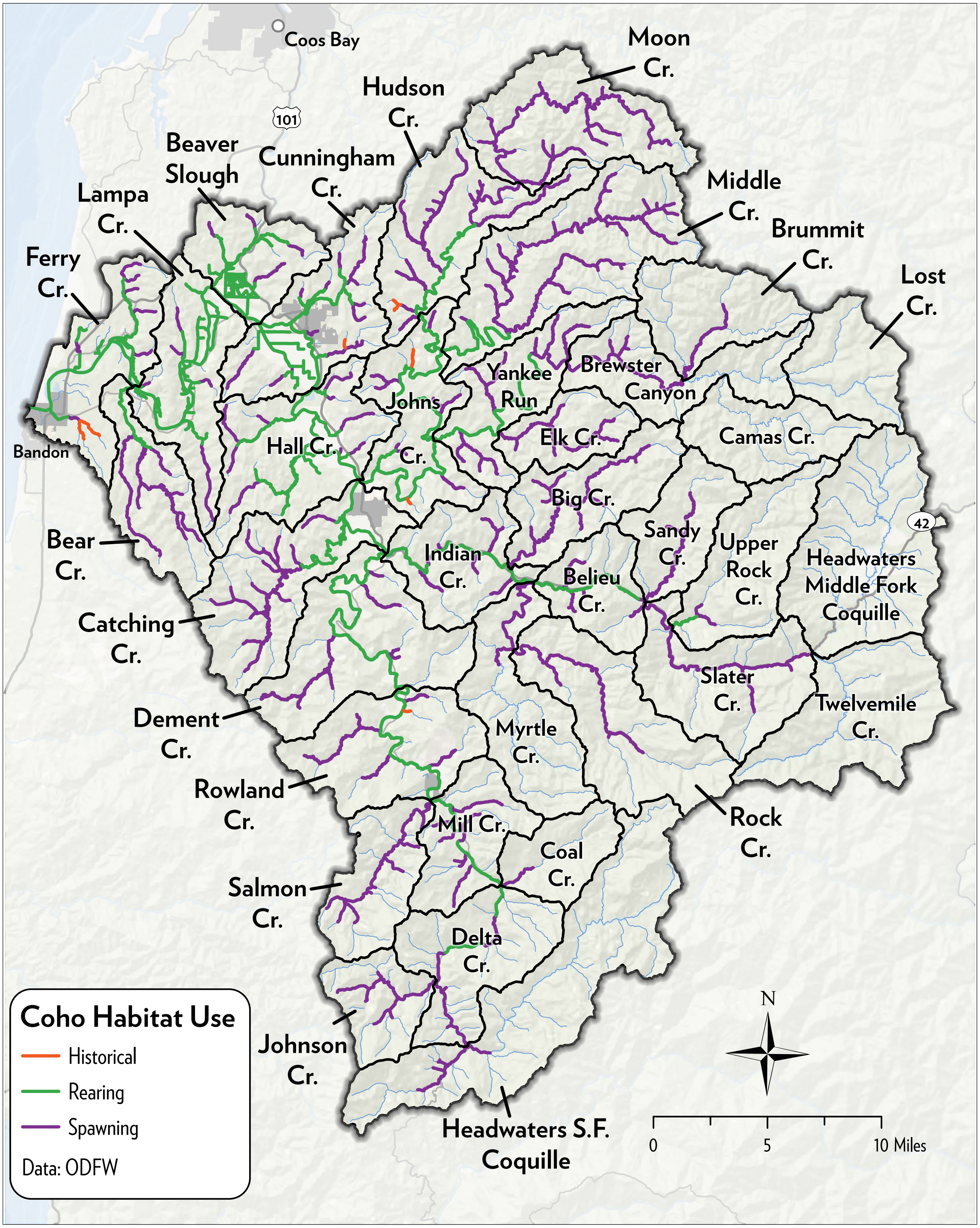


Table 4.2.1. Estimated ESU scale abundance of Coho salmon pre-harvest and post-harvest and estimated harvest rates. *Harvest rates dropped <12% between 1993 and 1998. **OC Coho ESU declined to a low of 23,661 in 1997.

Years	Pre-harvest	Post-harvest	Average Harvest Rate
1951-1960	409,562	156,612	0.62
1961-1970	378,727	131,623	0.65
1971-1980	332,306	69,809	0.78
1981-1990	124,430	62,325	0.53
1991-1998	63,558	48,704**	0.21*
1999-2009	174,872	157,097	0.09
2010-2020	172,851	154,220	0.12
2021-2023	220,261	188,398	0.15

This table summarizes information provided by ODFW for the Oregon Coast ESU. It contains information from several sources, including spawning ground surveys, Winchester Dam counts, and ODFW management reports. Further information is available in NOAA's Technical Memorandum NMFS-NWFSC-91 and the Oregon Coast Coho Conservation Plan (Appendix 2).

Between 1951 and 1980, the estimated average number of Coquille Coho salmon (pre-harvest) was 26,454 (Table 4.2.2). During this time, harvest rates averaged 68%, leaving an estimated average Coquille Coho spawning population of 9,387 (Table 4.2.2). Between 1980 and 1998, the estimated average number of Coquille Coho (pre-harvest) declined to 8,361, with average spawning abundance around 4,975 (Table 4.2.2). The Coquille Coho population continued to decline to a low of 2,622 spawners in 1998 (Table 4.2.2).

Table 4.2.2. Estimated abundance of Coquille Coho salmon pre-harvest and post-harvest and estimated harvest rates. *Harvest rates dropped to <12% between 1993 and 1998. **Coquille Coho spawning abundance declined to 2,622 in 1998. *Data Source: NOAA Technical Memorandum NMFS-NWFSC-91 and the Oregon Coast Coho Conservation Plan (Appendix 2).*

Years	Pre-harvest	Post-harvest	Average Harvest Rate
1958-1960	27,935	11,270	0.61
1961-1970	27,178	9,560	0.65
1971-1980	24,251	7,332	0.78
1981-1990	9,614	4,300	0.53
1991-1998	7,109	5,651**	0.21*
1999-2009	16,273	14,606	0.09
2010-2020	19,390	17,361	0.12
2021-2023	18,050	15,546	0.15

Following ESA listing, recent actions to improve Coho habitats, as well as reductions in hatchery production and harvest management, are having positive impacts. Since 2000, OC Coho abundance has increased, resulting from habitat improvements driven by both direct restoration and regulatory protections (e.g., wetland rules, forest practices rules). The OC Coho ESU is estimated to have averaged 155,597 adults between 1999 and 2020, while the Coquille Coho population estimates increased to an average of 15,983 over the same time period (Table 4.2.1 and 4.2.2).

However, while the habitat restoration and management changes have helped stabilize the ESU, climate change effects on freshwater habitats, ocean productivity, and marine survival continue to affect Coquille Coho and other OC Coho populations. Coho remain highly vulnerable to changing freshwater habitat conditions related to climate change (Crozier et al. 2019), with the juvenile freshwater stage being especially susceptible due to prolonged freshwater rearing before entering the ocean. The OC Coho improvements are reflected in NMFS's 2022 five-year status review, which found that the ESU has improved somewhat since the previous status review in 2016 but needs further progress to be viable over the long term (NMFS 2022).

4.3 Hatchery Production and Releases in the Coquille Basin

Before OC Coho salmon were ESA listed, high hatchery releases in some rivers in the ESU allowed hatchery fish to dominate the naturally spawning Coho populations, decreasing their productivity. After ESA listing, the State of Oregon made an unprecedented effort to reduce hatchery influence on wild Coho populations by greatly reducing the production of hatchery Coho along the coast. This reduction in hatchery production included eliminating the Coquille Coho hatchery smolt program following the 2006 release.

As a result, the Coquille Coho population has been an entirely wild run since 2006. Prior to the ESA listing, between 1983 and 2006, ODFW's Bandon Fish Hatchery, located in the Ferry Creek sub-watershed, produced and released 100,000 Coho salmon smolts annually. Between 2000 and 2004, the percentage of hatchery fish spawning with wild fish ranged between 0 and 17% (ODFW 2005). Coho hatchery production was stopped at the Bandon Fish Hatchery in 2006, when ODFW shifted hatchery production to producing an equivalent poundage of Fall Chinook.

Several studies show that reductions in the release of hatchery salmon have increased the abundance and productivity of OC Coho across the ESU (Jones et al. 2018, NMFS 2018, NMFS 2022). According to the NMFS (2018) evaluation

of ODFW's hatchery and genetic management plans for their operation of ten Oregon Coast hatchery facilities, 260,000 hatchery Coho are annually released throughout the ESU. The reduction of hatchery fish from tens of millions released annually before ESA listing to the present level of 260,000 hatchery fish has substantially reduced hatchery-related genetic and ecological risks (NMFS 2018). As a result, the genetic risk of hatchery fish interbreeding with natural fish for the ESU is considered low (NMFS 2022).

The hatchery programs for Chinook salmon and steelhead, including the program for Chinook smolt production in the Coquille, have been shown not to jeopardize the viability of the OC Coho ESU (NMFS 2022). As mentioned above, the Coquille's hatchery program for Chinook salmon replaced the former hatchery program for Coho, and aims to meet the State's Chinook salmon harvest and smolt-to-adult survival objectives. The State manages its hatchery programs to reduce ecological interactions with juvenile and adult wild Coho, especially those risks posed by releases of hatchery Chinook salmon and steelhead smolts into areas where young-of-the-year (age-0) Coho salmon are also present. The hatchery programs operate under hatchery and genetic management plans and implement best management practices to minimize impacts on natural populations consistent with the goals of Oregon's Coastal Multi-Species Conservation and Management Plan (ODFW 2014).

4.4 Harvest Management

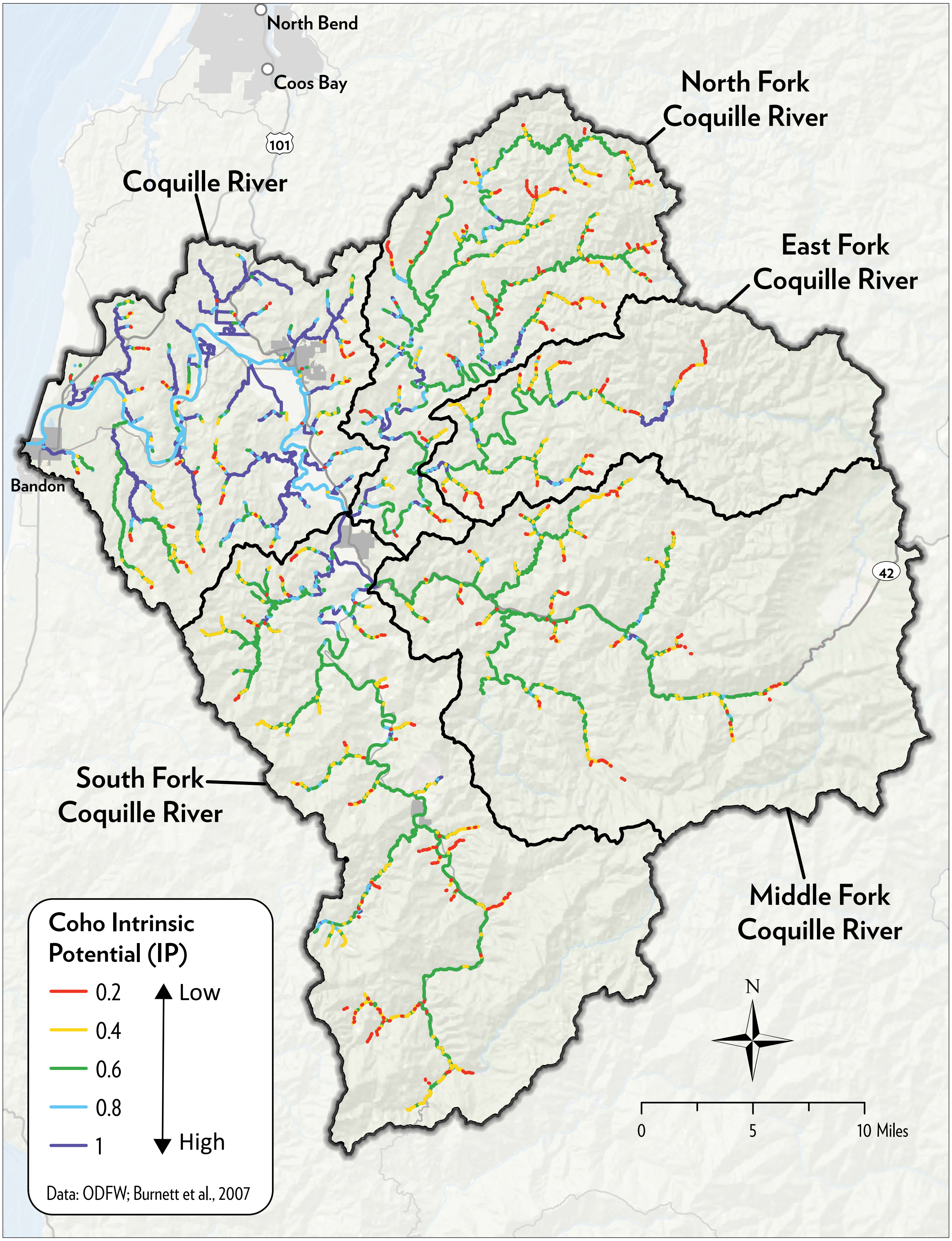
Historic harvest rates of Coquille Coho and other OC Coho populations contributed to their decline. Between 1950 and 1990, estimated harvest rates averaged 65% across the ESU (Table 4.2.1). Harvest rates on the Coquille Coho population peaked in the 1970s with an estimated average harvest of 78% (Table 4.2.2). After the Coho population's subsequent decline, ODFW increased the annual hatchery production up to 100,000 smolts. This hatchery production accounted for approximately 70% of Oregon's ocean sport and commercial catch after the 1970s (ODFW 2005). Unfortunately, the hatchery production inadvertently encouraged the overharvest of wild stocks.

Today, fishing for wild Coho in the Coquille and elsewhere in the ESU depends on the abundance of adult returns, with harvest rates (<15%) set to meet specific harvest metrics and criteria (Tables 4.2.1 and 4.2.2). Under this management, fisheries occur only in select years when Coho adult returns are near or exceed the full capacity of the freshwater habitat (NMFS 2022). Until recently, adult Coho returns had fallen below this level, and no fisheries on wild Coho occurred in those years on OC Coho salmon ESU rivers.

4.5 Coho Habitat Needs and Watershed Component Types

Coho salmon require diverse, complex, and highly connected habitats in freshwater and estuarine ecosystems. Coho seek out these different habitat types during their various life stages. For juvenile Coho, the temporal and spatial use of these habitats varies according to their individual life history strategy. During their freshwater residency, juvenile Coho seek out and prefer slow-moving water (ideally flows of less than two cubic feet per second [cfs]) with a complex instream and riparian structure capable of generating and maintaining pools, off-channel rearing areas, and channel-floodplain interaction. Among other important attributes, these conditions provide aquatic and terrestrial forage, shelter from predators, refuge from high water temperatures in summer, and low-velocity resting areas during fall/winter high flows. Juvenile Coho are, however, capable of occupying, and in low densities rearing in, stream reaches that are moderately steep gradient (generally thought of as being steelhead or trout habitat) if there are sufficient pools, large woody debris, and sufficient water quality. Coho habitat intrinsic potential (IP) is a modeling approach that uses geomorphic and hydrologic conditions to determine the quality

Figure 4.5.1. Intrinsic potential (IP) for Coho salmon in the Coquille Basin. IP is a modeling approach used to rank the quality of fish habitats based on geomorphic and hydrological conditions. Higher IP indicates a more suitable habitat.



Common Framework Terminology

Habitat Components: Components are the types of habitats that are essential to support the (non-marine) life cycle of Coho salmon.

Key Ecological Attribute: Key ecological attributes (KEAs) are characteristics of watersheds and specific habitats that must function in order for Coho salmon to persist. KEAs are essentially proxies for aspects of ecosystem function. If KEAs like habitat connectivity, instream complexity, water quality, and riparian function are in good condition, then watershed processes are likely functioning sufficiently to generate and maintain the habitats required to sustain viable Coho populations.

of habitat. In the Coquille Basin, Coho habitats range from degraded (IP <0.2) to high-functioning (IP >0.8; Figure 4.5.1).

The lack of instream and off-channel complex habitats, especially insufficient winter rearing habitat, is the primary factor limiting the Coquille Coho population. According to the Oregon Coast Coho Conservation Plan, "high-quality over-wintering habitat for juvenile Coho is usually recognizable by one or more of the following features: large wood, pools, connected off-channel areas, alcoves, beaver ponds, lakes, connected floodplains, and wetlands" (ODFW 2007).

The specific habitats that Coho require are generated and maintained within a complex, interconnected system of watershed "components" that are essential to support the freshwater life stages of Coho salmon. The "Common Framework for Coho Recovery Planning," which the Coast Coho Partnership developed in 2015, standardizes how coast Coho habitats are defined, classified, and evaluated in plans like this one.

The Coquille team used this common framework in developing this SAP. This approach helps link federal, state, and local planning efforts by consistently describing the habitats that Coho rely on and the ecosystem processes that generate and maintain these habitats.

The following watershed components are used throughout this SAP:

Tributary Creek near South Fork Coquille River. Photo: George Osterta / Alamy

- **Mainstem river:** Typically, mainstems are 4th-order streams, downstream of Coho spawning distribution and are non-wadeable. Mainstem designations include portions of rivers above the head of tide, the farthest point upstream where a river is affected by tidal fluctuations. The mainstem river component includes associated riparian and floodplain habitats. Mainstem areas support upstream migration for adults, downstream migration for juveniles, and provide summer and winter juvenile rearing habitat.
- **Tributaries** include all 1st- to 3rd-order streams with drainage areas greater than 0.6 km2. The tributary component includes fish-bearing and non-fish-bearing, perennial and intermittent streams—the full aquatic network, with headwater areas, riparian and floodplain habitats. Tributaries support spawning, incubation and larval development, fry emergence, and juvenile rearing.

Mainstem Coquille River. Photo: Barbara Grant

Winter Lake off-channel habitat. Photo: Coquille Watershed Association

- **Off-channel areas** include locations other than the primary channel of mainstem or tributary habitats that provide velocity and temperature refuge for Coho. Off-channel habitats include alcoves, side channels, oxbows, and other habitats connected to the mainstem or tributary. These off-channel habitats are essential to the survival of juvenile Coho, providing refuge from high flows in winter and high water temperatures in summer.
- **Freshwater non-tidal wetlands** include areas inundated or saturated by surface or groundwater at a frequency and duration sufficient to support vegetation typically adapted for life in saturated soil conditions. These wetlands are hydrologically connected to Coho streams. They provide unique functions, including retention, cooling, and filtering of overland flows before they enter surface waters, nutrient cycling, and productive aquatic and terrestrial habitats. They are essential to capturing sediment and other contaminants before they enter surface waters, and maintaining and regulating cold water flows.
- **The euryhaline tidal estuary and floodplain** includes that portion of the basin where salt and freshwater mix. The tidally influenced lower reaches of rivers extend upstream to the head of tide and seaward to the mouth of the estuary. For the Coquille, the estuary extends upstream to river mile 14. It includes tributary streams and connected salt marshes, coastal and intertidal areas, sloughs, bays, harbors, lagoons, and inshore waters. Habitats include salt and emergent marshes, open water, subtidal, intertidal, backwater areas, tidal swamps, and deep channels. The estuary provides essential feeding and rearing habitats for juvenile Coho, especially for the estuary overwintering life strategy.
- **Freshwater tidal estuary and floodplain** includes the Coquille River and adjacent floodplain from RM 14 upstream to head of tidal influence at RM 41 at Myrtle Point. This reach of the river is bounded by large floodplain pasturelands that historically were forested landscapes with highly complex dendritic channel networks and large quantities of large wood. The elevations are sufficiently low for tidal influences onto pastures up to RM 27, with floodwater entry onto the floodplain

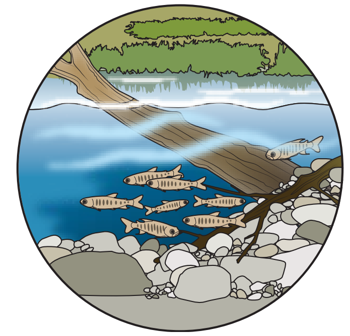
from RM 0.0 to 41.0. Salinity is not present above RM 14 in the Coquille River estuary. Habitats include mainstem river pools/eddies/shoreline, tidal channels, sloughs/backwaters, high water channels, and pasture swales.

- **Uplands** include all lands at a higher elevation than adjacent wetlands, water bodies, and alluvial plains. They include all lands from where the floodplain/riparian zones terminate, and the terrain begins to slope upward, forming a hillside, mountainside, cliff face, or other non-floodplain surface.
- **Near-shore marine environment:** The Coquille SAP technical team decided to add the near-shore marine environment to the list of habitat components to consider in this plan. Upon ocean entry, Coho salmon adapt to and utilize the near-shore marine environment before embarking on further marine migrations. This period of the Coho life cycle has been identified as a critical period that affects marine survival and subsequent adult run size. ODFW's Near-shore Marine Ecoregion (2006) definitions describe this habitat as the area that extends from the coastal high-tide mark to a depth of 30 fathoms (180 ft or 55 m). Ecological factors change along the transition from shallow to deep water, including light penetration, wave force, and vegetation composition (ODFW 2006). Of particular concern for the technical team is the spatial distribution of eelgrass (*Zostera* sp.) and kelp habitats (*Nereocystis luetkeana* and others) within the near-shore environment. Eelgrass and kelp habitats are known to provide critical resources and protection to a myriad of marine species (Kenedy 2016), including OC Coho.


Upland old-growth stand in North Fork Coquille headwaters. Photo: Dan Silvius


Beaver Hill Wetland. Photo: Wild Salmon Center

Figure 4.5.2. Components of a watershed. The map below is a conceptual illustration (not a map of the Coquille Basin) intended to show: 1) the major "habitat components" of a coastal watershed; and 2) selected "key ecological attributes" (KEAs) that are critical to the health of these components. This is not intended to provide an in-depth explanation of the habitat needs of coast Coho, but simply highlight several KEAs that this plan is focused on restoring.

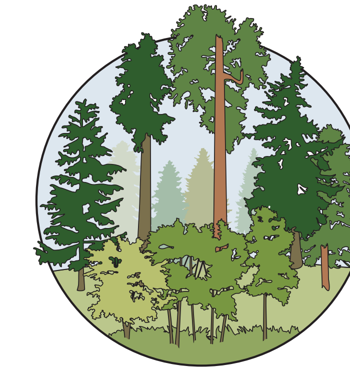


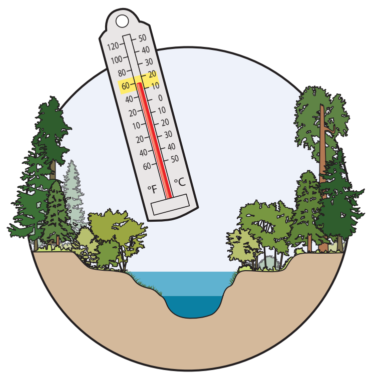
Instream Complexity

Lack of instream complexity is the primary factor limiting Coquille Coho (and many other coast Coho populations). The loss of features that provide instream complexity like large wood, pools, connected off-channels, alcoves, and beaver ponds–limit the survival of juvenile Coho in both summer and, especially, winter.

Structural Diversity

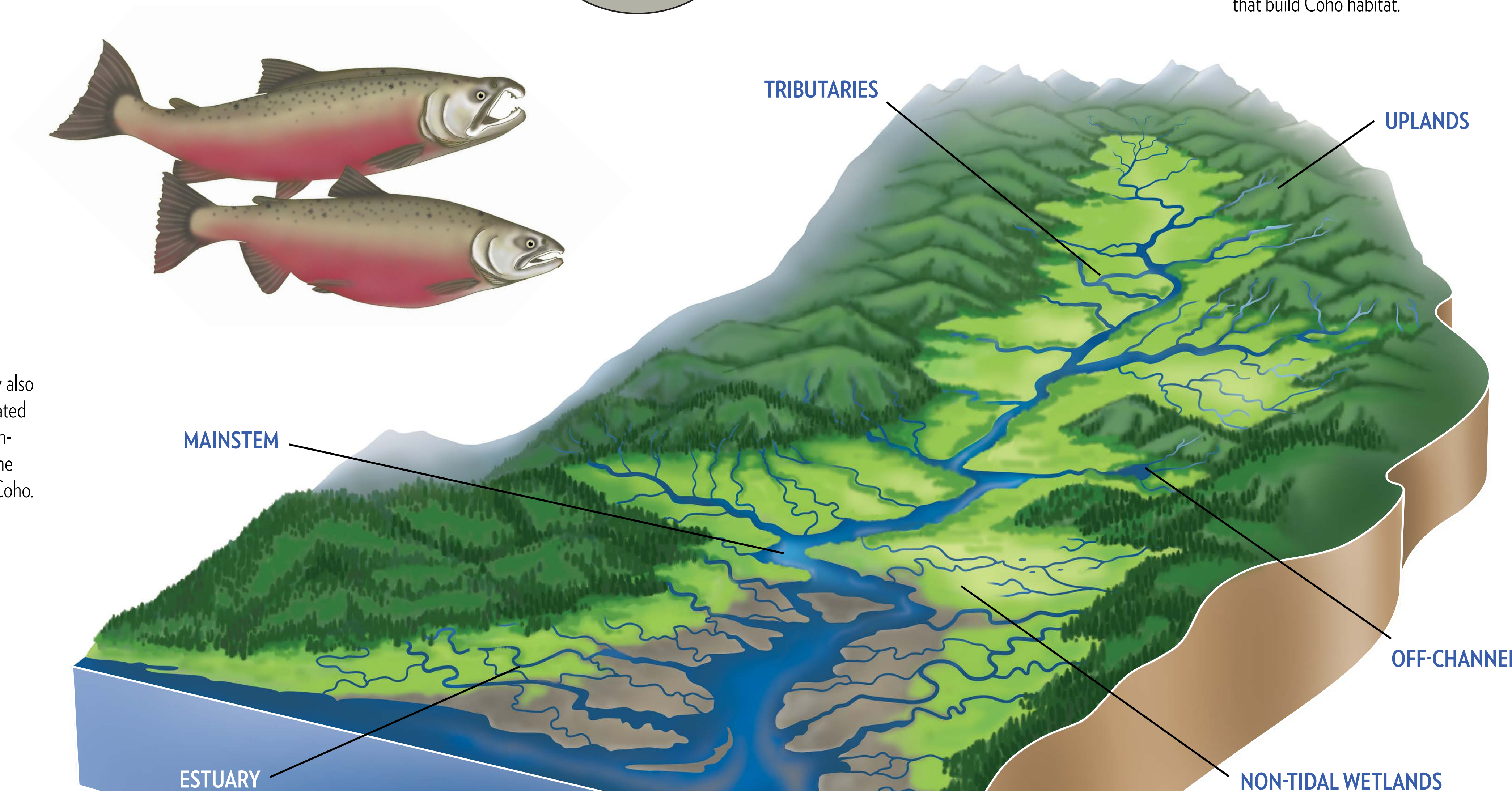
Healthy upland forests contribute large wood, gravel, and other inputs to streams, which enhances the channel's biological and structural complexity. The range and distribution of forest stand size, type, age, and composition determines the extent to which forests can provide the inputs to streams that build Coho habitat.

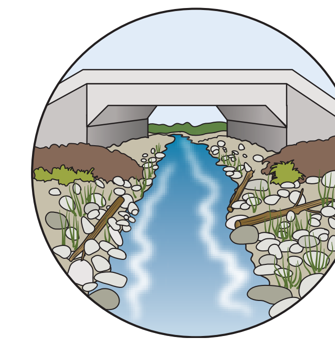




Water Quality

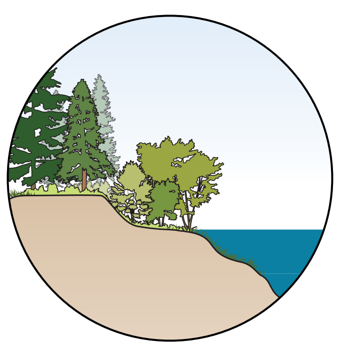
In tributary, mainstem, off-channel, and estuarine habitats, degraded water quality also limits the Coquille Coho population. Elevated water temperatures (especially in the main-stem Coquille Basin) and sediments are the primary water quality issues confronting Coho.





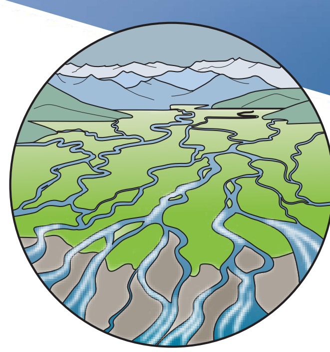
Longitudinal Connectivity

Inadequate culverts in tributaries and tidegates in estuaries often restrict access for both adult and juvenile Coho to prime spawning and rearing areas. Longitudinal connectivity refers to the degree to which coho are able to migrate unimpeded up and down stream channels and sloughs.

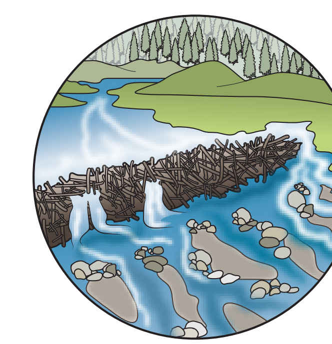


Riparian Function

Streamside vegetation along tributaries, off-channel areas, wetlands, and mainstem channels creates shade, provides food and cover for juveniles, filters out pollutants, and provides large wood to the channel. Riparian function in the Coquille Basin is heavily degraded contributing to elevated water temperatures, reduced instream complexity, and reduced lateral connectivity.



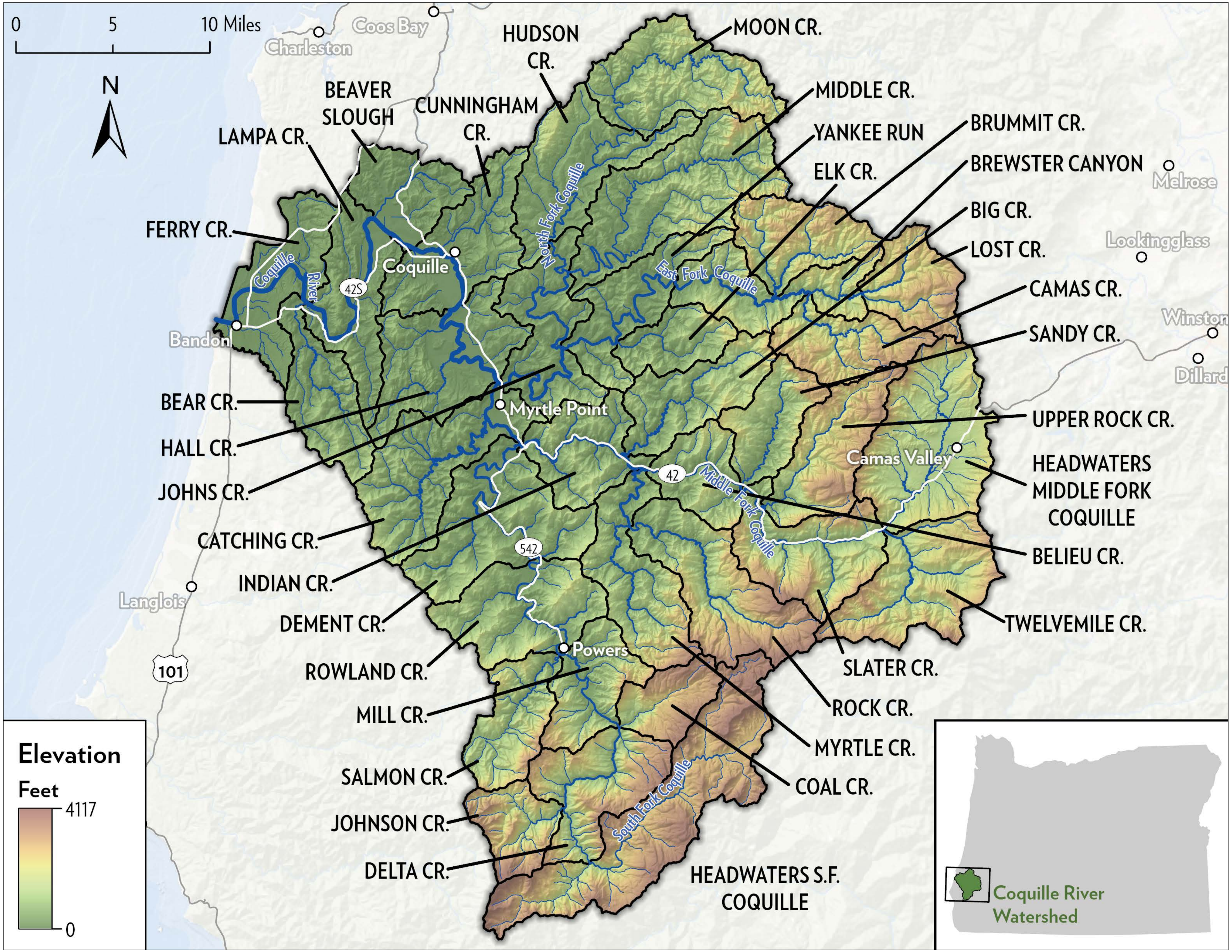
Artwork by Elizabeth Morales



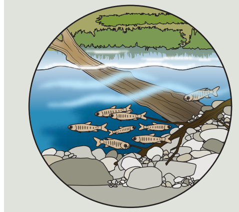
Beaver Ponds

Beaver ponds are a critical attribute of healthy coho watersheds. Impounded water behind beaver dams provides juvenile Coho refuge from both high flows in winter and elevated water temperatures in summer. The number of beavers has declined substantially in the Coquille Basin, significantly reducing available off-channel habitats.

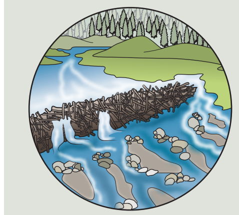
Figure 4.5.3. The Coquille Basin watershed.



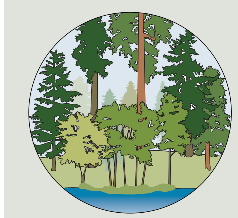
By 2030, the partnership will achieve the following restoration objectives.



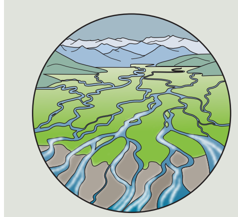
Instream Restoration
Improve water quality within 11.3 miles of tributaries and mainstems.



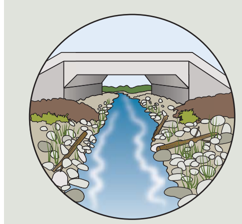
Instream Complexity
Increase instream complexity on 29.9 acres of tributaries and mainstems.



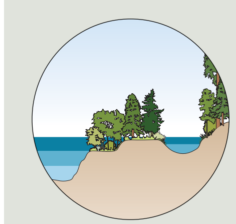
Riparian Enhancement
Enhance a minimum of 116.5 acres of riparian areas.



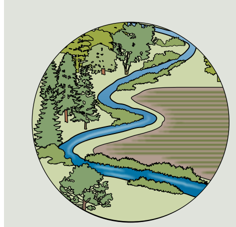
Longitudinal Complexity
Increase longitudinal connectivity on 16.4 miles of tributaries and mainstems.



Reconnection
Remove or upgrade 11 fish passage barriers.



Lateral Connectivity
Increase lateral connectivity on 2,036.8 acres of tidal and fresh-water floodplains.



Assessment
Perform sub-watershed assessment in 11 high-priority, focal basins.

Artwork by Elizabeth Morales

4.6 Climate Change Impacts to Coquille Coho

It is well established that the global climate system is changing (IPCC 2014). Since the 1950s, ocean warming and acidification have occurred at a rate of change that is unprecedented (IPCC 2014). There is overwhelming scientific evidence that this 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 released into our atmosphere (IPCC 2014). Ocean acidification is expected to continue through the end of the century under most greenhouse gas emission scenarios and has the potential to accelerate as the ocean's buffering capacity diminishes (Jiang et al. 2019).

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 changes occurring during summer months (Dalton and Fleishman 2021). Seasonal changes in precipitation patterns and increased drought frequency are also expected (Dalton and Fleishman 2021), with important ramifications for stream flow volume and flow timing. In the absence of counteracting management actions, summer stream temperatures are expected to increase due to rising air temperatures and decreased base flows (Figures 4.6.1, 4.6.2, 4.6.3, 4.6.4). These changes could affect Coho salmon growth and survival through numerous pathways during their life cycle (Wainwright and Weitkamp 2013). High stream temperatures have been linked to reduced Coho salmon parr abundance (Ebersole et al. 2009), higher susceptibility to disease (Cairns et al. 2005), and lower freshwater production (Lawson et al. 2004) in the OC Coho ESU.

Climate change will exacerbate the factors limiting the recovery of this species. Poor water quality, which includes high summer water temperatures and excess fine sediment, is currently a secondary limiting factor for most OC Coho populations, including the Coquille population. If increases in summer stream temperatures outpace actions that increase shade and reduce water temperatures, water quality may become the primary limiting factor (ODFW 2021). Therefore, there is a

Figure 4.6.1. Modeled change in August stream temperatures between historical conditions and conditions expected in 2040 and sub-watersheds expected to have the greatest changes over the given time horizon.

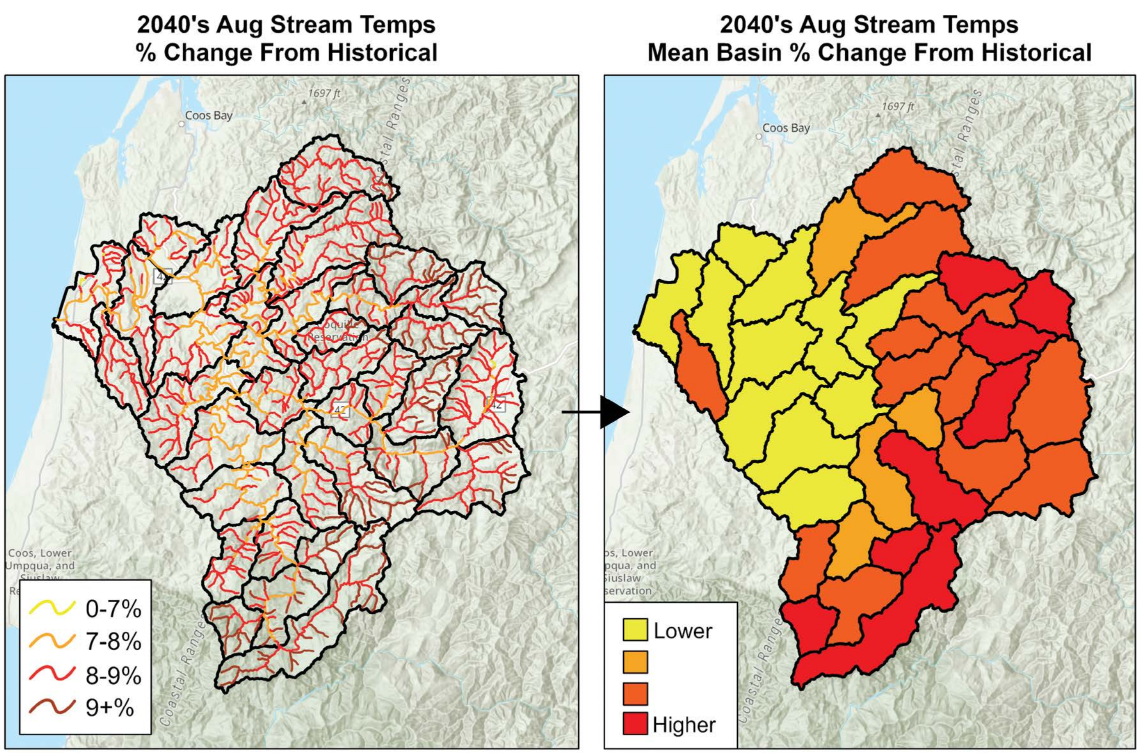


Figure 4.6.2. Modeled change in August stream temperatures between historical conditions and conditions expected in 2080 and sub-watersheds expected to have the greatest changes over the given time horizon.

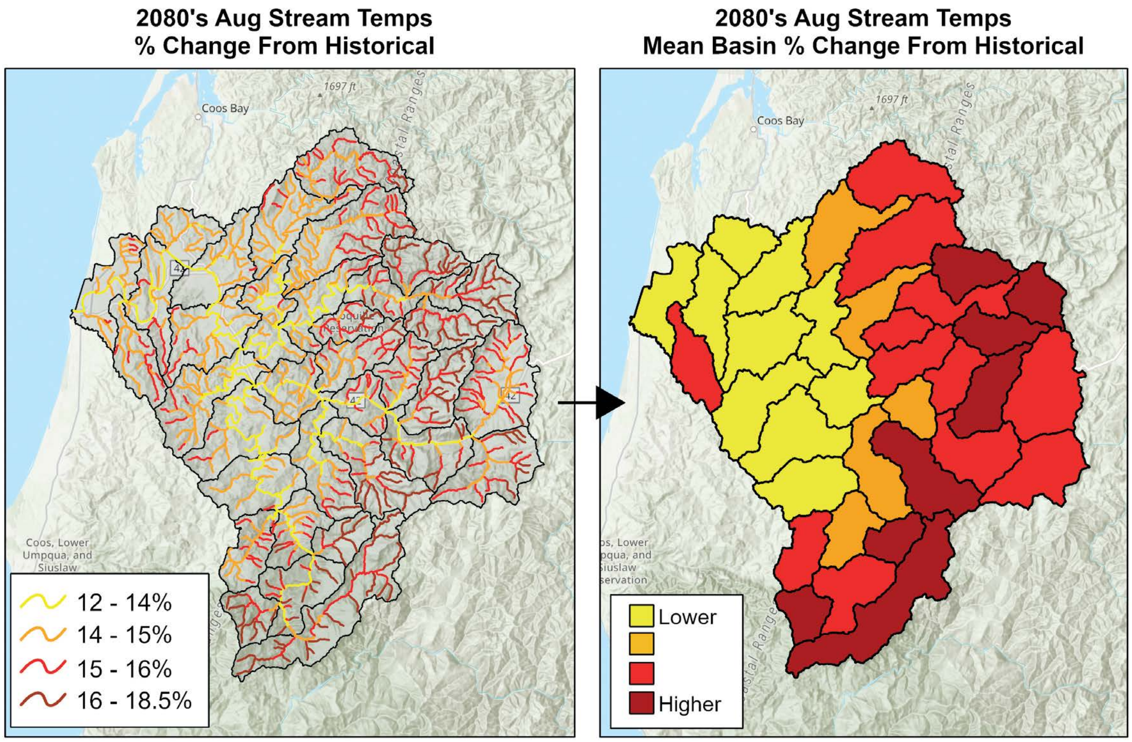


Figure 4.6.3. Modeled change in summer stream flows between historical conditions and conditions expected in 2040 and sub-watersheds expected to have the greatest changes over the given time horizon.

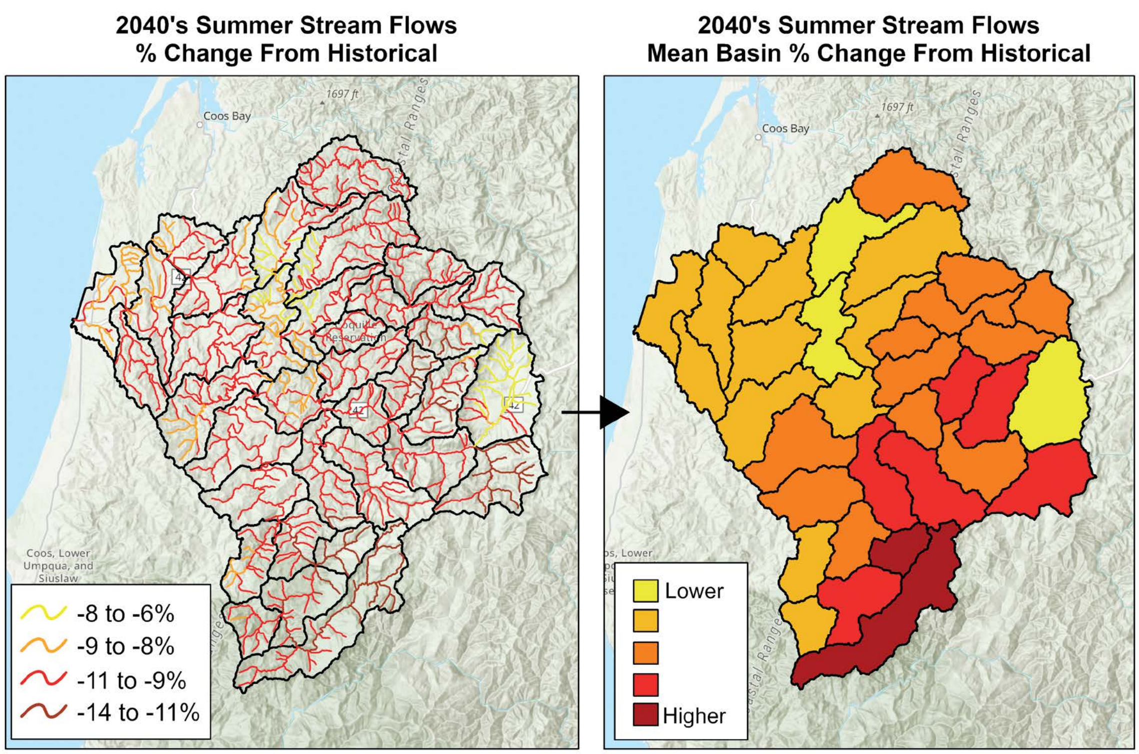
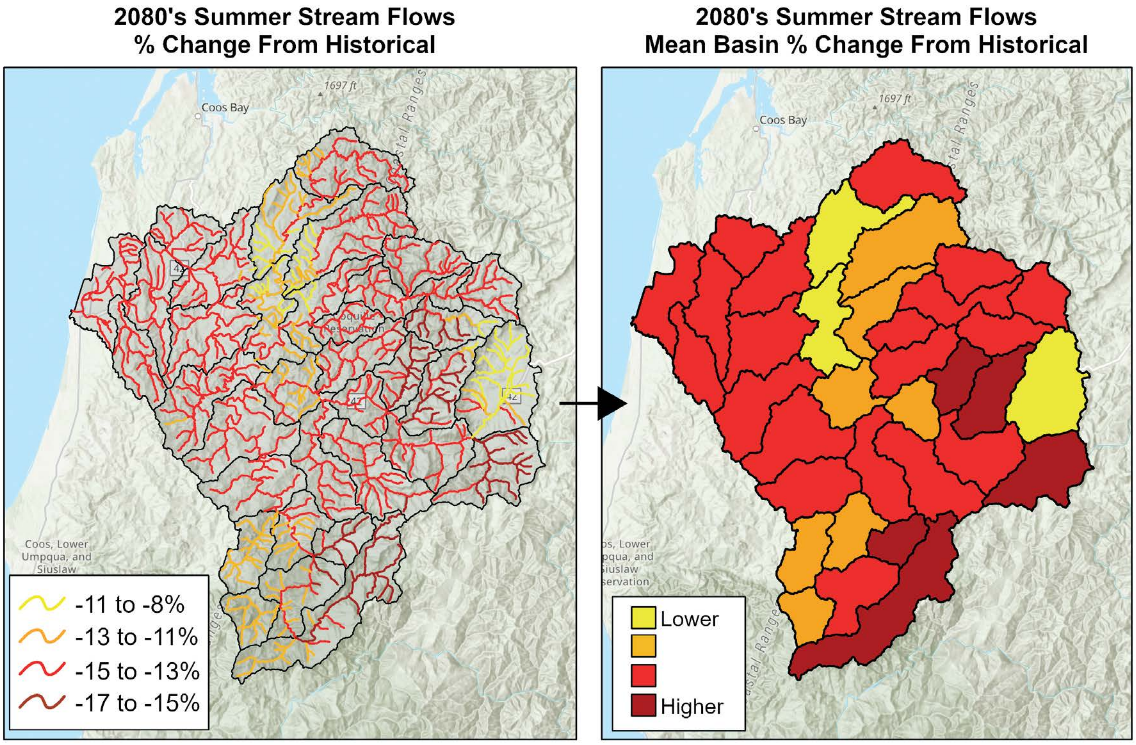


Figure 4.6.4. Modeled change in summer stream flows between historical conditions and conditions expected in 2080 and sub-watersheds expected to have the greatest changes over the given time horizon.



need to continue work to restore stream complexity, while also implementing actions to mitigate expected changes in summer temperature and flow.

In most OC Coho populations, low overwinter survival of Coho parr due to a lack of stream complexity will continue to limit smolt production in the near term. However, increasing water temperatures and decreasing base flows in the future could eventually lead to an even more severe reduction in productive summer habitat (ODFW 2021). Additionally, 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.

The effects of increasing summer water temperature on juvenile Coho abundance and smolt 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, and the quality and quantity of overwinter habitat available to juvenile fish that survive the summer period (ODFW 2021). Local climate, geomorphology, and the ecological consequences for Coho salmon will vary across the ESU; however, no Coho population will be unaffected.

Vulnerability, as described by the IPCC (2007), is 1) a function of the *sensitivity* of a particular species or system to climate changes, 2) its *exposure* to those changes, and 3) its *capacity to adapt* to those changes. Crozier et al. (2019) completed a formal vulnerability assessment of ESA-listed Pacific salmon and steelhead ESUs based on these three components of vulnerability. They concluded that OC Coho are highly vulnerable to climate change due to increased exposure and sensitivity. The assessment concluded that the OC Coho ESU had moderate adaptive capacity, meaning that life history diversity may offset some of the negative effects of exposure and sensitivity to climate change. These findings highlight the importance of implementing actions to restore ecosystem resiliency for these populations.

Projected changes in the ocean environment (e.g., sea-level rise, increasing sea surface temperature, increased ocean acidification) are largely outside of local management control. Therefore, the primary management strategy to minimize the long-term impacts of climate and ocean change on OC Coho 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 during cycles of poor ocean productivity, which may become more extreme and unfavorable in the future. Many of the changes in the freshwater habitat that are expected to occur due to climate change are lower in magnitude than those observed following the alteration of habitat for human uses, so there is clear potential to mitigate against climate effects with actions to restore or enhance habitat.

Coho in the Coquille Basin will be exposed to these projected climate conditions; their sensitivity, at each life stage, and their adaptive capacity will determine their vulnerability to these changes. In the face of such uncertainty, an extra degree of caution must be taken when managing species with complex anadromous life cycles.

Photo: Amanda Loman Cochran / Lens for Change

Stresses: Stresses are impaired attributes of an ecosystem and are equivalent to altered or degraded KEAs. They are not threats (defined below), but rather degraded conditions or "symptoms" that result from threats. In the common framework, stresses represent the physical challenges to Coho recovery, such as decreased low flows or reduced extent of off-channel habitats.

***Threats*:** Threats are the human activities that have caused, are causing, or may cause the stresses that destroy, degrade, and/or impair components. The common framework includes a list of threats with definitions and commonly associated stresses. This list is based on threats listed (sometimes using different terms) in existing Coho recovery plans. The definitions are based on previous classifications (Salafsky et al. 2008) with minor modifications reflecting the work of the Coast Coho Partnership.

Chapter 5

Impaired Watershed Processes and Resulting Stresses on Coho Habitats

Like many Oregon coastal watersheds, the conservation and restoration efforts needed in the Coos Basin revolve around ameliorating the effects of current and legacy land use practices. The Recovery Plan for OC Coho identified habitat degradation, water diversions, adult harvest, and artificial hatchery production as the major anthropogenic activities leading to the listing of this ESU under the ESA (NMFS 2016).

Since NMFS listed OC Coho in 1998, the effects on Coos Coho from adult harvest and hatchery production have been largely addressed through regulation and reduction. Harvest rates along the Oregon Coast, between 1960 and 1980, took 60-90% of adult OC Coho annually. These high harvest rates, combined with naturally occurring poor ocean conditions in the 1970s and 1990s, led to extremely low abundances of spawning adult Coho. Abundance reached an all-time low of 21,000 spawning OC Coho in 1990, estimated to be 1-2% of the historical run size (NMFS 2016; ODFW 2016).

Artificial propagation, which began in the early 1900s to offset the declining numbers of wild OC Coho and bolster commercial and recreational fisheries, has also declined (ODFW 1990). In 1981, at the peak of hatchery production, 35 million smolt were released into 17 independent OC Coho populations (NMFS 2016). Due to increased competition, predation, and reduced genetic diversity of hatchery-origin Coho, ODFW began reducing and/or eliminating hatchery production in the mid-1990s (NMFS 2016). As of 2016, Oregon has only three hatcheries that continue to produce OC Coho smolts, with a combined total of 260,000 fish produced from the Cow Creek (South Umpqua River), North Fork of the Nehalem, and Trask (Tillamook River) programs. The Cow Creek program is now included in the OC Coho ESU because of its practice of integrating wild-origin fish in its broodstock (NMFS 2016).

Today, while population-level improvements have been made through regulating fisheries har-

Figure 5.1.1. North Fork Coquille River splash dam. Photo: Emily Ronnow.

vest and eliminating hatchery programs, reduced and degraded freshwater habitat conditions remain the major ongoing threat to OC Coho recovery. Since the late 1990s, annual OC Coho abundance has generally increased but continues to fluctuate substantially based on variable ocean conditions, highlighting the ongoing challenges and synergy of reduced habitat quantity and quality in the context of dynamic ocean conditions. This dynamic is illustrated well by the disparity between estimated total population sizes in 2014 and 2015. The estimated total population of OC Coho in 2014 was 420,000 (the largest since the 1950s) followed by a mere 71,000 in 2015 (ODFW 2016).

5.1 Ongoing and Anticipated Threats to OC Coho

A substantial body of research, conducted by state and federal agencies, has identified the threats (i.e., human activities or natural events) and limiting factors (i.e., biological and physical conditions, including ecological processes, that limit a species' viability) that hinder the ability of OC Coho to be self-sustaining, especially during periods of poor ocean conditions (ODFW 1990; Stout 2012; NMFS 2016).

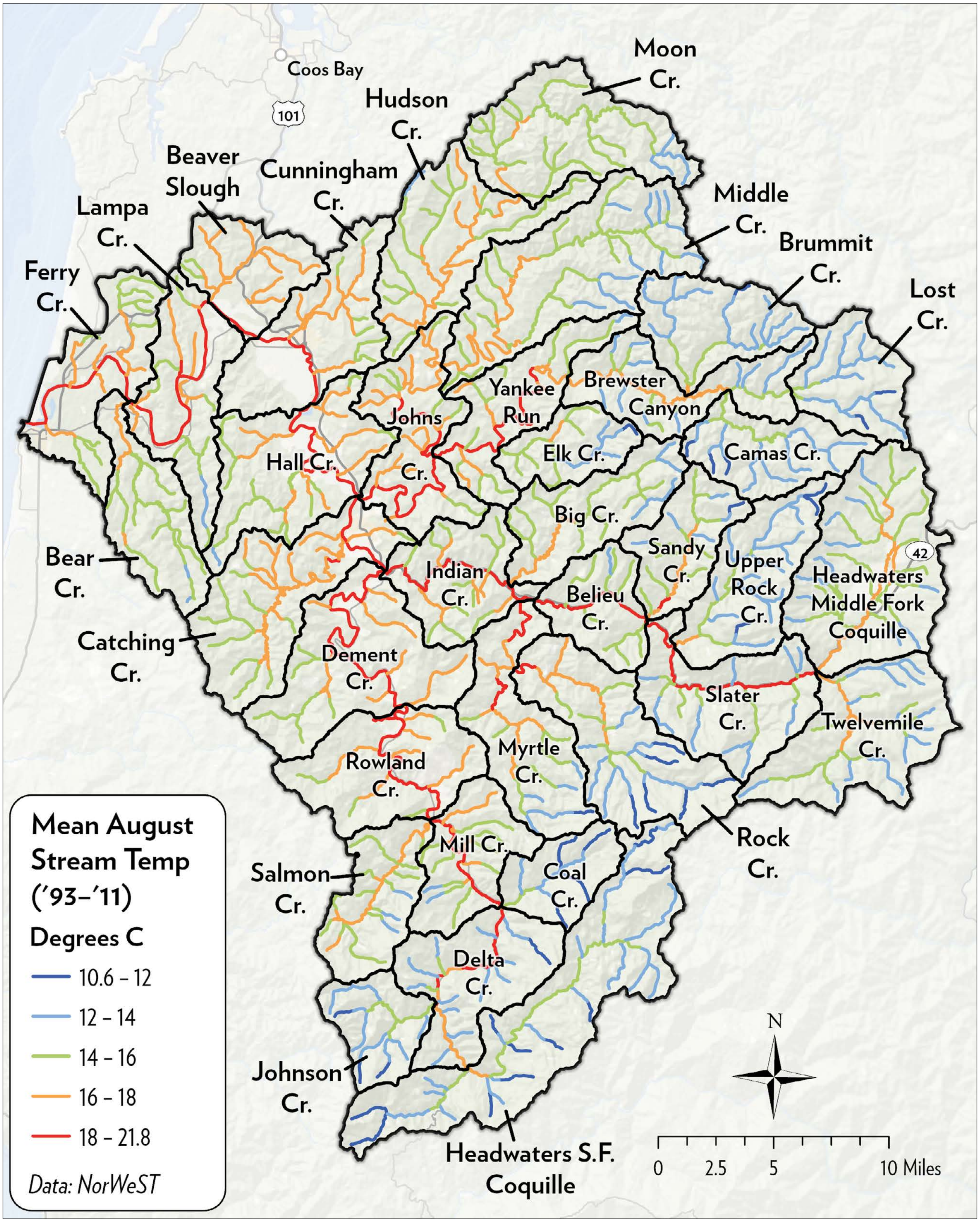
In general, the ongoing and anticipated threats to OC Coho are ubiquitous across the range of the ESU. The largest threats are 1) land use activities (past, current, and future) that affect watershed functions that support Coho and their habitat, 2) ineffective regulatory mechanisms, and 3) dynamic ocean conditions (including human-driven climate change [NMFS 2016]).

The primary limiting factors are:

- Blocked and/or hindered fish passage
- Loss of stream complexity
- Degraded water quality
- Inadequate long-term habitat protection
- Reduced Coho fitness that affects abundance and productivity

Figure 5.1.2. Smallmouth bass predation of a juvenile salmonid. Photo: Coos District ODFW.

Figure 5.1.3. Mean August water temperatures in the Coquille Basin between 1993 and 2011.



Ongoing and anticipated threats in the Coquille watershed result from past and current land use practices and resource extractions that have reduced the quantity of available habitat and degraded the quality of habitat that remains accessible (CoqWA 2014). In the upper Coquille Basin, timber harvests (ongoing threat) and splash damming (legacy threat) reduced or removed riparian vegetation, eliminated large-wood inputs, simplified stream channels (straightened and reduced side channels), reduced aquatic complexity, and scoured away sediment and spawning gravels. In the lower Coquille Basin, the conversion of historic estuary and wetlands into agricultural and commercial/residential lands through diking, draining, and filling resulted in the extensive loss of estuarine-rearing habitats. Further habitat loss resulted from the removal of beaver and beaver dams.

The loss of riparian habitat due to land use conversion and timber practices has led to warmer stream temperatures and reduced the amount of large-wood inputs, resulting in longitudinal thermal barriers, reduced stream complexity and biodiversity, increased sedimentation, expanding aquatic invasive species, and disconnected floodplains. The loss of riparian function was identified by the Coquille technical team as a major factor limiting OC Coho in much of the basin. Largely due to agricultural practices that removed or altered riparian vegetation, the Oregon Department of Environmental Quality (DEQ) has issued two Total Maximum Daily Load (TMDLs) exceedances for parts of the Coquille River basin for dissolved oxygen, nutrients, and temperature (NMFS 2016). See Appendix III for examples of temperature exceedances in the Lower Coquille, South Fork Coquille, Middle Fork Coquille, and North Fork Coquille. The combination of climate-related warming and loss of riparian function has created an ecological cascade of effects that are negatively impacting Coquille Coho and other cold water fishes. These effects include increased predation of salmonids by non-native fish such as smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmonides*), and striped bass (*Morone saxatilis*), which are causing serious negative impacts on salmonid populations in the Coquille Basin.

Figure 5.1.4. Livestock directly in the Lower Coquille River. Photo: Coos-Coquille-Tenmile District ODFW.

Figure 5.1.5. Livestock with direct access to the Lower Coquille River. Photo: Coos-Coquille-Tenmile District ODFW.

Figure 5.1.6. Striped bass caught near Riverton, OR. Photo: Mike Gray / ODFW.

5.2 Coquille Sub-watershed Stress Assessment

The Final Recovery Plan for OC Coho Salmon (NOAA 2016) identified a lack of stream complexity and degraded water quality as the primary limiting factors for the independent Coquille Coho population. While this assessment is especially valuable for comparing differences and limiting factors between independent populations, the large spatial scale at which the assessment was conducted does not shed light on habitat nuances and specific restoration needs at the sub-watershed scale. To gain insight regarding sub-watershed habitat variation, we conducted an expert opinion assessment of the stresses (i.e., symptoms that a component is degraded) and threats (i.e., human activities that stress and degrade the health of components) at the sub-watershed scale.

During the SAP development process, a team that included local experts from CoqWA, ODFW, CIT, BLM, and NRCS was asked to assess the stresses and threats to each of the components within the 6th field HUCs throughout the Coquille Basin. The resulting stress table informed the long-term strategies identified to improve habitat conditions (Table 5.2.1). One vital piece identified in the federal recovery plan, and strongly reaffirmed during the stress assessment, was the recognition that enhancing riparian function throughout the basin is essential for the long-term viability of Coquille Coho. The importance of riparian enhancement was adopted as a key element throughout the entire SAP process.

Figure 5.1.7. Channelization and altered riparian function along the Lower Coquille River. Photo: Holden Films.

Table 5.2.1. Coquille Basin stress assessment. Table shows the ecological stresses at the 5th Field HUC level, the overall goals for each 6th Field HUC, and the primary stressors to each habitat component within the sub-watersheds.

Watershed Scales		Habitat Component Stressors				
5th Field HUCs	**6th Field HUCs**	**Mainstem**	**Tributary**	**Non-Tidal Wetlands**	**Upland**	**Estuary**
Lower Coquille **5th Field HUC Stresses:** • Reduced floodplain and tidal (lateral) connectivity • Impaired riparian function • Loss of forested wetlands • Increased invasive species • Elevated stream temperature • Reduced stream complexity	**Cunningham Creek** **Subbasin Goals:** • Reduce nutrient loading from ag lands • Enhance riparian function • Increase educational outreach opportunities • Protect Coquille drinking water	• Decreased water quality (increased water temps) • Altered flows (reduced flows) • Decreased water quality (increased water nutrients) • Decreased lateral connectivity (decreased beaver ponds) • Decreased riparian function	• Decreased longitudinal connectivity (perched culverts) • Decreased water quality (increased fine sediments) • Decreased riparian function (invasive plants) • Decreased lateral connectivity (decreased beaver ponds)		• Decreased water quality (increased fine sediments) • Species and resource management (altered forest compositions)	N/A
	Ferry Creek **Subbasin Goals:** • Enhance riparian function • Increase floodplain connectivity	• Decreased riparian function (invasive plants) • Decreased longitudinal connectivity • Altered flows (reduced flows) • Reduced instream complexity (reduced extent of habitat • Decreased water quality (increased toxins)	• Decreased riparian function (invasive plants) • Decreased water quality (reduced flow)	N/A	• Species and resource management (invasive plants)	N/A
	Beaver Slough **Subbasin Goals:** • Protect cold water refugia • Enhance riparian function • Increase floodplain connectivity	• Decreased water quality (increased water temps) • Decreased riparian function	• Altered flows (increased flashy flows) • Decreased water quality (increased sediment/turbidity) • Altered riparian function (decreased riparian inputs) • Decreased lateral connectivity (decreased beaver ponds)	N/A	• Species and resource management (invasive plants-gorse)	• Species and resource management (reduced wetland eelgrass) • Reduced riparian function (wood inputs) • Reduced lateral connectivity (tidal connectivity)

Table 5.2.1. Coquille Basin stress assessment. Table shows the ecological stresses at the 5th Field HUC level, the overall goals for each 6th Field HUC, and the primary stressors to each habitat component within the sub-watersheds *cont*.

Watershed Scales		Habitat Component Stressors				
5th Field HUCs	**6th Field HUCs**	**Mainstem**	**Tributary**	**Non-Tidal Wetlands**	**Upland**	**Estuary**
Lower Coquille **5th Field HUC Stresses:** • Reduced floodplain and tidal (lateral) connectivity • Impaired riparian function • Loss of forested wetlands • Increased invasive species • Elevated stream temperature • Reduced stream complexity	**Lampa Creek** **Subbasin Goals:** • Improve water quality in the lower basin • Increase floodplain connectivity • Enhance riparian function	• Decreased water quality (temperature and sediment) • Decreased lateral connectivity (floodplain-adjacent areas need reconnection)	• Altered flows (increased flashy flows) • Decreased water quality (increased sediment/turbidity) • Decreased riparian function (decreased riparian inputs) • Decreased lateral connectivity (decreased beaver ponds)			N/A
	Hall Creek **Subbasin Goals:** • Increase riparian function • Improve water quality • Increase beaver influence	• Decreased water quantity • Decreased water quality (specifically bacteria)	• Decreased lateral connectivity (decreased beaver ponds)			
	Bear Creek **Subbasin Goals:** • Increase riparian function • Improve water quality • Increase beaver influence	• Decreased water quantity • Decreased water quality (specifically bacteria)	• Decreased lateral connectivity (decreased beaver ponds)			

Table 5.2.1. Coquille Basin stress assessment. Table shows the ecological stresses at the 5th Field HUC level, the overall goals for each 6th Field HUC, and the primary stressors to each habitat component within the sub-watersheds *cont*.

Watershed Scales		Habitat Component Stressors			
5th Field HUCs	6th Field HUCs	Mainstem	Tributary	Non-Tidal Wet-lands	Upland
North Fork Coquille **5th Field HUC Stresses:** • Impaired riparian function • Decreased water quality (temperature and sediment) • Reduced stream complexity	**Moon Creek** **Subbasin Goals:** • Increase instream complexity (lacking pools) • Improve water quality (sediment loading is an issue)	• Decreased instream complexity (lacking pools) • Decreased water quality (sediment)	• Decreased riparian function (stream buffering)		• Species and resource management (upland forestry practices)
	Hudson Creek **Subbasin Goals:** • Improve water quality (heavy OHV use and sediment issues)	• Decreased riparian function (invasive species) • Decreased water quality (sediment) • Decreased longitudinal connectivity (fish passage)	• Decreased instream complexity		
	Middle Creek **Subbasin Goals:** • Increase instream complexity • Protect upland stands • Improve water quality (decrease sediment inputs) • *Road assessment to identify the sediment inputs	• Altered riparian function • Decreased water quality (increased sedimentation) • Decreased instream complexity • Decreased longitudinal connectivity			
	Johns Creek **Subbasin Goals:** • Enhance riparian function • Improve water quality	• Decreased riparian function • Decreased water quality (increased sedimentation) • Decreased water quality • Decreased instream complexity • Decreased lateral connectivity	• Decreased riparian function • Decreased water quality (increased sedimentation)		

Table 5.2.1. Coquille Basin stress assessment. Table shows the ecological stresses at the 5th Field HUC level, the overall goals for each 6th Field HUC, and the primary stressors to each habitat component within the sub-watersheds *cont*.

Watershed Scales		Habitat Component Stressors			
5th Field HUCs	6th Field HUCs	Mainstem	Tributary	Non-Tidal Wetlands	Upland
East Fork Coquille **5th Field HUC Stresses:** • Impaired riparian function • Decreased flows and water quality • Reduced stream complexity • *Road assessment is needed within the whole 5th field	**Lost Creek (above Coho anadromy)** **Subbasin Goals:** • Increase longitudinal connectivity (culverts) • Improve water quality (reduce road networks and sediment loads) • Enhance riparian function • *Road assessment in the whole 6th field				
	Yankee Run **Subbasin Goals:** • Enhance riparian function • Improve water quality (reduce road networks and sediment loads) • *Road assessment in the whole 6th field	• Decreased riparian function (lack of wood inputs) • Reduced instream complexity • Decreased riparian function (invasive species are a major issue)	• Reduced instream complexity • Reduced riparian function		
	Brummit Creek **Subbasin Goals:** • Enhance riparian function • Improve water quality (reduce road networks and sediment loads) • *Road assessment in the whole 6th field	• Reduced riparian function • Reduced instream complexity			
	Elk Creek **Subbasin Goals:** • Enhance riparian function • Improve water quality (reduce turbidity/ sediment) • Increase instream complexity • Increase longitudinal connectivity	• Decreased instream complexity			

Table 5.2.1. Coquille Basin stress assessment. Table shows the ecological stresses at the 5th Field HUC level, the overall goals for each 6th Field HUC, and the primary stressors to each habitat component within the sub-watersheds *cont*.

Watershed Scales		Habitat Component Stressors			
5th Field HUCs	**6th Field HUCs**	**Mainstem**	**Tributary**	**Non-Tidal Wetlands**	**Upland**
East Fork Coquille **5th Field HUC Stresses:** • Impaired riparian function • Decreased flows and water quality • Reduced stream complexity • *Road assessment is needed within the whole 5th field	**Brewster Canyon** **Subbasin Goals:** • Increase riparian function • Improve water quality (reduce turbidity/ sediment)	• Reduced riparian function • Reduced instream complexity • Decreased riparian function (invasive species)			
	Camas Creek **Subbasin Goals:** • Enhance riparian function • Improve water quality (reduce turbidity/ sediment) • *Road assessment in the whole 6th field				
South Fork Coquille **5th Field HUC Stresses:** • Decreased water quality (temperature and sediment) • Decreased lateral connectivity to floodplain • Reduced stream complexity	**Salmon Creek** **Subbasin Goals:** • Enhance riparian function • Increase instream complexity • Increase floodplain connectivity • *Needs road assessment	• Decreased instream complexity (lack of wood) • Decreased water quality (sediment delivery)			
	Delta Creek **Subbasin Goals:** • Improve water quality	• Decreased water quality • Altered riparian function (increased buffer is needed)			

Table 5.2.1. Coquille Basin stress assessment. Table shows the ecological stresses at the 5th Field HUC level, the overall goals for each 6th Field HUC, and the primary stressors to each habitat component within the sub-watersheds *cont*.

Watershed Scales		Habitat Component Stressors			
5th Field HUCs	6th Field HUCs	Mainstem	Tributary	Non-Tidal Wetlands	Upland
South Fork Coquille **5th Field HUC Stresses:** • Decreased water quality (temperature and sediment) • Decreased lateral connectivity to floodplain • Reduced stream complexity	**Catching Creek** **Subbasin Goals:** • Enhance riparian function • Increase instream complexity (specifically pools) • Road assessments needed	• Lack of instream complexity (pools) • Decreased riparian function (livestock fencing is needed along the mainstem) • Decreased instream complexity (lack of beaver) • Decreased water quality • Decreased lateral connectivity	• Decreased instream complexity (lack of beaver)		
	Coal Creek **Subbasin Goals:** • Improve water quality (turbidity issues throughout) • Enhance riparian function • Protect cold water (keep Coal Creek contributing cold water)	• Decreased instream complexity • Decreased water quality (issues from sediment and road failures)			
	Headwaters South Fork **Subbasin Goals:** • Enhance riparian function • Increase instream complexity • Improve water quality (reduce sediment delivery from legacy logging roads) • *Needs road assessment	• Decreased instream complexity (needs large wood) • Decreased water quality (turbidity) • Decreased riparian function (lack of large-wood inputs)			
	Rowland Creek **Subbasin Goals:** • Increase instream complexity • Road assessment needed	• Decreased instream complexity • Decreased water quality (pH issues from the Powers Wastewater Treatment Plant) • This section of Rowland used to be a core Fall Chinook spawning area	• Decreased riparian function (there is bedrock close to the surface preventing hyporheic flow) • Decreased instream complexity (large wood) • Beaver and Baker Creek are release sites for hatchery winter steelhead		

Table 5.2.1. Coquille Basin stress assessment. Table shows the ecological stresses at the 5th Field HUC level, the overall goals for each 6th Field HUC, and the primary stressors to each habitat component within the sub-watersheds *cont*.

Watershed Scales		Habitat Component Stressors			
5th Field HUCs	6th Field HUCs	Mainstem	Tributary	Non-Tidal Wetlands	Upland
South Fork Coquille **5th Field HUC Stresses:** • Decreased water quality (temperature and sediment) • Decreased lateral connectivity to floodplain • Reduced stream complexity	**Johnson Creek** **Subbasin Goals:** • Enhance riparian function • Increase instream complexity	• Decreased water quality (sediment from the China Flat Road) • Reduced instream complexity	• Reduced instream complexity		
	Mill Creek **Subbasin Goals:** • Improve water quality (specifically temperatures) • Enhance riparian function • *Needs road assessment	• Altered riparian function • Decreased water quality (sediment delivery) • Decreased water quality (temperature)	• Decreased water quality (sediment delivery from logging roads) • Decreased instream complexity (Hayes Creek)		
	Dement Creek **Subbasin Goals:** • Enhance riparian function • Increase instream complexity • Road assessment has been done	• Decreased riparian function • Decreased instream complexity • Decreased water quality (sediment delivery)	• Decreased water quality (sediment delivery)		
Middle Fork Coquille **5th Field HUC Stresses:** • Decreased water quality (temperature and sediment) • Reduced longitudinal connectivity • Road assessment is needed within the whole 5th field.	**Slater Creek** **Subbasin Goals:** • Improve flows and water quality (reduce flashy flows) • Improve water quality (decrease sediment inputs) • Enhance riparian function	• Reduced instream complexity • Reduced riparian function • Reduced water quality			

Table 5.2.1. Coquille Basin stress assessment. Table shows the ecological stresses at the 5th Field HUC level, the overall goals for each 6th Field HUC, and the primary stressors to each habitat component within the sub-watersheds *cont*.

Watershed Scales		Habitat Component Stressors			
5th Field HUCs	**6th Field HUCs**	**Mainstem**	**Tributary**	**Non-Tidal Wet-lands**	**Upland**
Middle Fork Coquille **5th Field HUC Stresses:** • Decreased water quality (temperature and sediment) • Reduced longitudinal connectivity • Road assessment is needed within the whole 5th field.	**Indian Creek** **Subbasin Goals:** • Improve flows and water quality (reduce flashy flows) • Improve water quality (decrease sediment inputs) • Enhance riparian function	• Reduced riparian function (cows) • Reduced longitudinal connectivity • Reduced water quality (nutrient loading from cows)	• Reduced riparian function • Reduced longitudinal connectivity		
	Twelvemile Creek **Subbasin Goals:** • Increase instream complexity • Improve water quality • *Road assessment has been done	• Decreased riparian function • Reduced instream complexity			
	Big Creek **Subbasin Goals:** • Increase instream complexity • *Road assessment needed	• Reduced riparian function • Reduced instream complexity • Reduced water quality (increased sedimentation)			
	Upper Rock Creek **Subbasin Goals:** • Increase instream complexity • Road assessment needed	• Reduced riparian function • Reduced instream complexity • Reduced water quality (specifically increase sediment)			
	Sandy Creek **Subbasin Goals:** • Increase instream complexity • Enhance riparian function • *Road assessment has been done	• Reduced water quality (specifically increase sediment) • Decreased lateral connectivity	• Reduced instream complexity • Degraded flow and water quality		

Table 5.2.1. Coquille Basin stress assessment. Table shows the ecological stresses at the 5th Field HUC level, the overall goals for each 6th Field HUC, and the primary stressors to each habitat component within the sub-watersheds *cont*.

Watershed Scales		Habitat Component Stressors			
5th Field HUCs	**6th Field HUCs**	**Mainstem**	**Tributary**	**Non-Tidal Wet-lands**	**Upland**
Middle Fork Coquille **5th Field HUC Stresses:** • Decreased water quality (temperature and sediment) • Reduced longitudinal connectivity • Road assessment is needed within the whole 5th field.	**Headwaters Middle Fork Coquille River** **Subbasin Goals:** • Enhance riparian function • Improve flows and water quality • *Road assessments needed	• Reduced riparian function • Reduced flow and water quality	• Reduced riparian function		
	Rock Creek **Subbasin Goals:** • Improve flows and water quality • *Road assessments needed	• Decreased water quality (specifically turbidity) • Reduced riparian function • Reduced instream complexity • Reduced lateral connectivity			
	Myrtle Creek **Subbasin Goals:** • Improve flow and water quality • Enhance riparian function • *Road assessments needed	• Decreased lateral connectivity (decreased beaver ponds) • Reduced riparian function			
	Belieu Creek **Subbasin Goals:** • Improve flows and water quality • Enhance riparian function • Increase longitudinal connectivity • *Needs road assessment	• Reduced riparian function	• Reduced instream complexity		

Chapter 6

Methods for Developing the Coquille Coho Strategic Action Plan

6.1 Ecological Priorities for OC Coho Recovery in the Coquille Basin

We followed a multi-step process to identify the principal strategies to guide habitat restoration for recovering Coho in the Coquille Basin. We used the federal recovery plan strategies as a starting point, and then refined these strategies by integrating the sub-watershed-specific stresses identified in the Coquille subbasin stress assessment. We then shared the results of this assessment with the technical team and gained their feedback to best define the restoration strategies specific for the Coquille Basin. The primary strategies that emerged in the Coquille watershed are 1) enhancing riparian function throughout the entire basin, 2) protecting and enhancing sources of cold water, and 3) increasing the quantity and quality in rearing habitat, especially floodplain rearing habitat.

1) Enhance riparian function

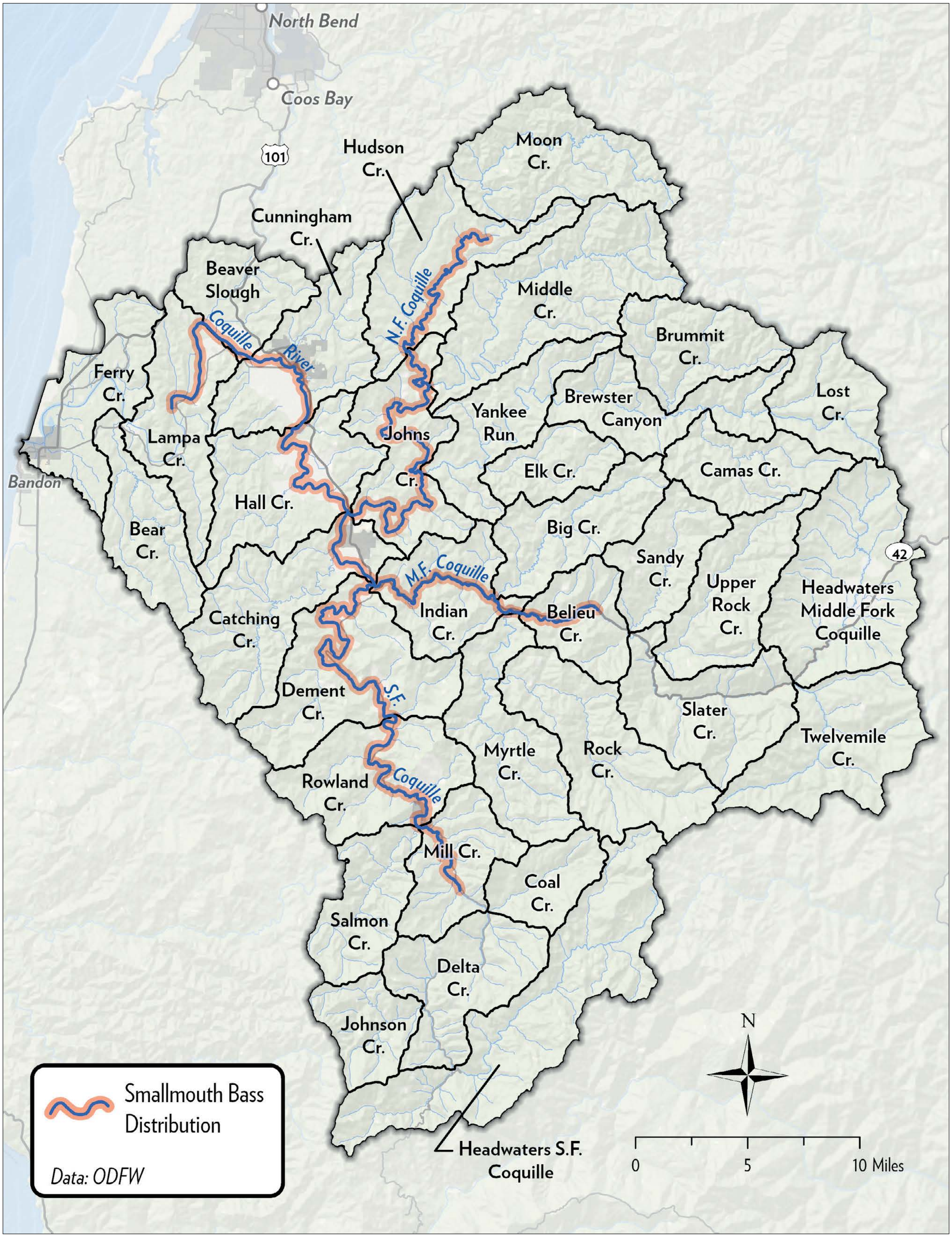
The current and historic loss of riparian function, paired with the localized effects of climate change, have elevated stream temperatures, reduced stream complexity, altered allochthonous food web inputs (material that is imported, instead of produced, in the aquatic system: e.g., arboreal insects, leaves, branches that provide resources to aquatic organisms), increased the presence and persistence of aquatic invasive species, and reduced habitat resilience to flooding throughout the Coquille Basin. Both primary and secondary effects arise from degraded riparian function (Seavy et al 2009). The primary effects are those that directly alter ecological processes, such as increased water temperatures and reduced dissolved oxygen levels that negatively affect aquatic organisms, reduced large-wood inputs that create and maintain instream complexity, increased bank erosion that results in loss of property and increased sediments loads, and fewer allochthonous inputs that can support aquatic food webs. The secondary effects of a degraded riparian function are those that arise due to the altered ecological function. An example of the secondary impacts of altered riparian function is the spread of invasive fish, especially smallmouth bass and striped bass (*Morone saxatilis*), due to warmer water in the lower basin. It is believed that smallmouth bass were illegally introduced into the Coquille Basin around 2010 from a neighboring watershed.

2) Protect and improve sources of cold water

Due to the combined effects of altered riparian function, agricultural water withdrawals and climate change, water temperatures in the Coquille Basin are substantially elevated above historic levels. Coho salmon require cold, clean water during each of their freshwater life stages. In a meta-analysis of water temperature effects on various salmonids, Richter and Kolmes (2005) identified the following temperature requirements for different Coho salmon life stages: Coho eggs require water temperatures between 36.5 and 43.7° F (2.5-6.5° C). Alevin and fry survival is highest at temperatures between 39.2 and 46.4° F (4-8° C). Optimum temperatures for rearing Coho juveniles range between 53.6 and 59° F (12-15° C; constant or seven-day average). Smoltification in Coho salmon can be impaired by water temperatures above 59° F. Migrating adult Coho require water temperatures between 44.9 and 60.1° F (7.2-15.6° C). Constant exposure to water temperatures above 71.6 -73.4° F (22-23° C) can be lethal to juvenile Coho. DEQ has been monitoring water temperatures in the Coquille Basin since 1980 and has records of summertime temperatures from several different locations within the basin. See Appendix III for DEQ's Ambient Water Quality Monitoring System (AWQMS) stations and boxplots of monthly temperature exceedances.

ODFW performed a climate change analysis that demonstrates that water temperatures are expected to continue to increase over time (see section 4.6 for more detail). This analysis shows that 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 changes occurring during summer months.

Figure 6.1.1. Distribution of smallmouth bass in the Coquille Basin.



3) Increase the quantity and quality of rearing habitat by restoring watershed and estuarine processes.

High-quality salmon habitat is created and maintained through naturally occurring physical and biological processes operating at multiple scales (i.e., watershed-scale processes and reach-scale processes; Table 6.1.1). For Coquille Coho, high-quality rearing habitat is associated with low stream gradients with connected floodplains that provide velocity refuges for juveniles during powerful winter flow events (Figure 6.1.1). These types of habitats generally have laterally connected floodplains and wetlands (tidal and freshwater), off-channel alcoves, beaver dams, and structurally complex sinuous channels with large woody debris and deep pools. These elements of high-quality habitat allow juveniles to avoid high water velocities in the winter, provide cool water refuge during the hot summer months, and support escapement from predation year-round. Suitable summer rearing habitat (i.e., structurally complex and productive cold water areas) is increasingly understood to play a vital role for Coquille Coho juveniles.

Between 1870 and 1970, an estimated 70% of tidal wetlands in Oregon's largest estuaries were converted to arable lands for agriculture and residential lands by constructing dikes, levees, and tide gates (Good 2000, Bass 2010). In the agricultural lowlands of the Coquille Basin, tide gates are a prominent landscape feature that allows pasture land (historic estuary, floodplain, and/or tidal wetlands) to drain freshwater, while preventing brackish tidal inundation (e.g., one-way hydro-

Figure 6.1.2. Coquille Coho spawning and rearing habitat.

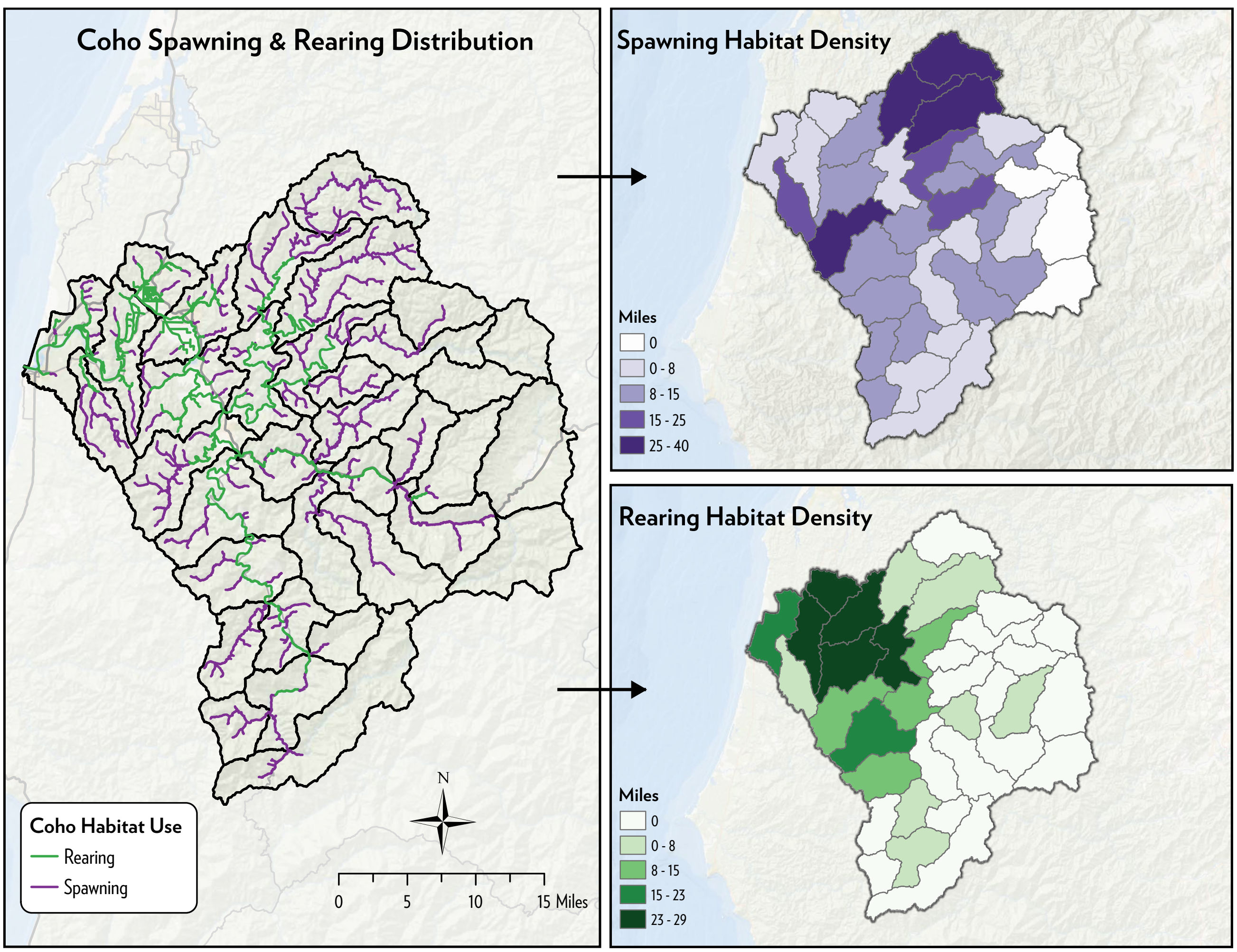


Table 6.1.1. Common restoration techniques and their effect, modified from Beechie et al. (2012). Green circles indicate a positive effect on temperature, flow, and resilience. Open circles indicate no effect, and orange circles indicate a context-dependent effect.

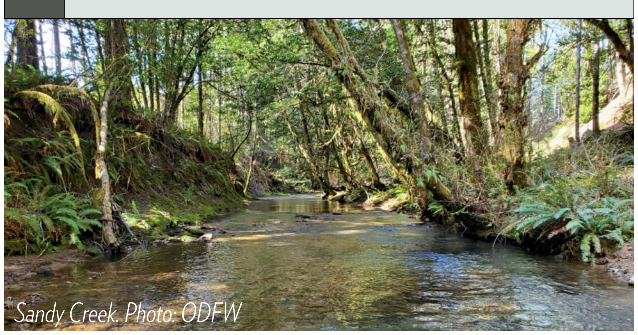
Restoration Action Type	Common Techniques	Ameliorates Temperature Increase	Ameliorates Base Flow Decrease	Ameliorates Peak Flow Increase	Increases Salmon Resilience
Longitudinal Connectivity (barrier removal)	Dam removal	● green	● green	○	● green
	Culvert removal or replacement	○	○	○	● green
Lateral Connectivity (floodplain reconnection)	Levee removal	● green	○	● green	● green
	Floodplain reconnection	● green	○	● green	● green
	Tide gate upgrade/removal	○	○	○	○
Vertical Connectivity (incised channel restoration)	Reintroduce beaver	● green	● green	● green	● green
	Remove livestock	● green	● green	● green	○
	Install grade control	● green	● green	● green	○
Stream Flow Regimes	Restoration of natural flood regime	● green	● green	○	● orange
	Reduce water withdrawals (restore summer base flows)	● orange	● green	○	○
	Reduce upland grazing	○	● orange	● orange	○
	Disconnect road drainage from streams	○	○	● green	○
	Natural drainage systems, retention ponds, urban stormwater techniques	○	● orange	● green	○
Erosion and Sediment Delivery	Road resurfacing	○	○	○	○
	Landslide hazard reduction	○	○	○	○
	Reduce cropland erosion	○	○	○	○
	Reduce grazing	● orange	○	○	○
Instream Complexity	Re-meander streams	● orange	○	○	● orange
	Large-wood structures	● orange	○	○	○
	Boulders weirs	○	○	○	○
	Brush bundles	○	○	○	○
	Gravel addition	○	○	○	○
Riparian Function	Grazing removal, fencing	● green	○	○	○
	Planting native vegetation	● green	○	○	○
	Thinning or removal of understory	○	○	○	○
	Remove non-native plants	● orange	● orange	○	○

logic flow). Tide gates inherently cause changes in the connectivity between the river environment and the estuary/floodplain, resulting in undesirable physical, chemical, and biological conditions for Coho (Souder et al. 2018). The ecological effects of the most common and oldest top-hinged style tide gates have been shown to reduce or eliminate tidal inundation, block or delay fish passage, reduce water quality (e.g., increased temperature, low dissolved oxygen and high salinity), as well as altering upstream plant communities (Souder et al. 2018). Traditional tide gate designs restrict fish passage by increasing water velocity and only periodically opening to allow fish passage during ebb tides when the hydraulic head upstream is greater than downstream (Bass 2010, Souder et al. 2018).

6.2 Ecological Goals

The Coos Basin Coho Partnership identified several long-term ecological goals it plans to achieve by 2045.

LONG-TERM ECOLOGICAL GOALS TO ACHIEVE BY 2045	
1	By 2045, the wild Coquille Coho population provides annually stable returns that can sustain commercial, recreational, and traditional harvest needs.
2	By 2045, restoration efforts (i.e., riparian enhancement and protection of cold water sources) in mainstems and tributaries have maintained, or lowered, summer stream temperatures at DEQ AWQMS sites to 2024 levels (compare four-year averages to averaged temperature between 2020 and 2024).
3	By 2045, instream habitats in mainstems, tributaries, and the estuary have sufficient complexity to provide year-round rearing for all juvenile Coho (i.e., fry, parr, and smolts) produced in the Coquille Basin.


Sandy Creek. Photo: ODFW

6.3 Restoration Strategies in the Coquille Basin

After identifying the major stressors in each of the sub-watersheds, the Coquille Coho SAP technical team (consisting of CoqWA, CIT, ODFW, NOAA, BLM, and NRCS) conducted a multi-step process to determine where specific protection restoration actions should occur. The first step was an expert opinion process, during which maps and aerial images of each 6th field HUC were projected. Team members who are uniquely familiar with each sub-watershed virtually "walked" each perennial tributary, mainstem, and estuary reach, and discussed the protection and restoration priorities. This "watershed walk" evaluated the current conditions of essential habitat components in each of the 35 6th field sub-watersheds. Using ArcGIS, the team identified reaches where stresses and/or threats compromise the ecological function of each component. The maps created from this exercise are called "strategy maps" and define all the locations where specific restoration actions should be conducted, in the long term, to ameliorate the stresses and threats. For example, the mainstem component of Big Creek (6th field sub-watershed) was identified as having reduced instream complexity. The restoration actions that can improve those conditions include constructing large-wood structures, developing side channels and/or alcoves, introducing beavers or constructing beaver dam analogs (BDAs), and conserving and/or enhancing riparian reserves that will deliver large wood into the future.

It is important to note that the "watershed walk" process did not consider whether or not a project was socially feasible or had the support of landowners. Instead, the intent was to identify locations where the factors limiting Coho salmon (e.g., reduced instream complexity, degraded riparian function, etc.) should be addressed through a protection or restoration project (e.g., placement of large-wood structures). All actions identified throughout this plan will require voluntary, willing landowners. Additionally, all actions will be implemented in a manner compatible with and supportive of Tribal cultural resources and traditional ecological knowledge.

6.4 Theory of Change

The Coquille SAP team developed a "theory of change" that describes the factors currently limiting the Coquille Coho population, the strategies identified to ameliorate the limiting factors, the ecological outcomes, and the long-term ecological goals. In practice, the theory of change is the road map for all the restoration partners, identifying the current ecological state of the watershed and articulating where the team intends it to be in 2045.

Several statements define the theory of change for Coquille Coho.

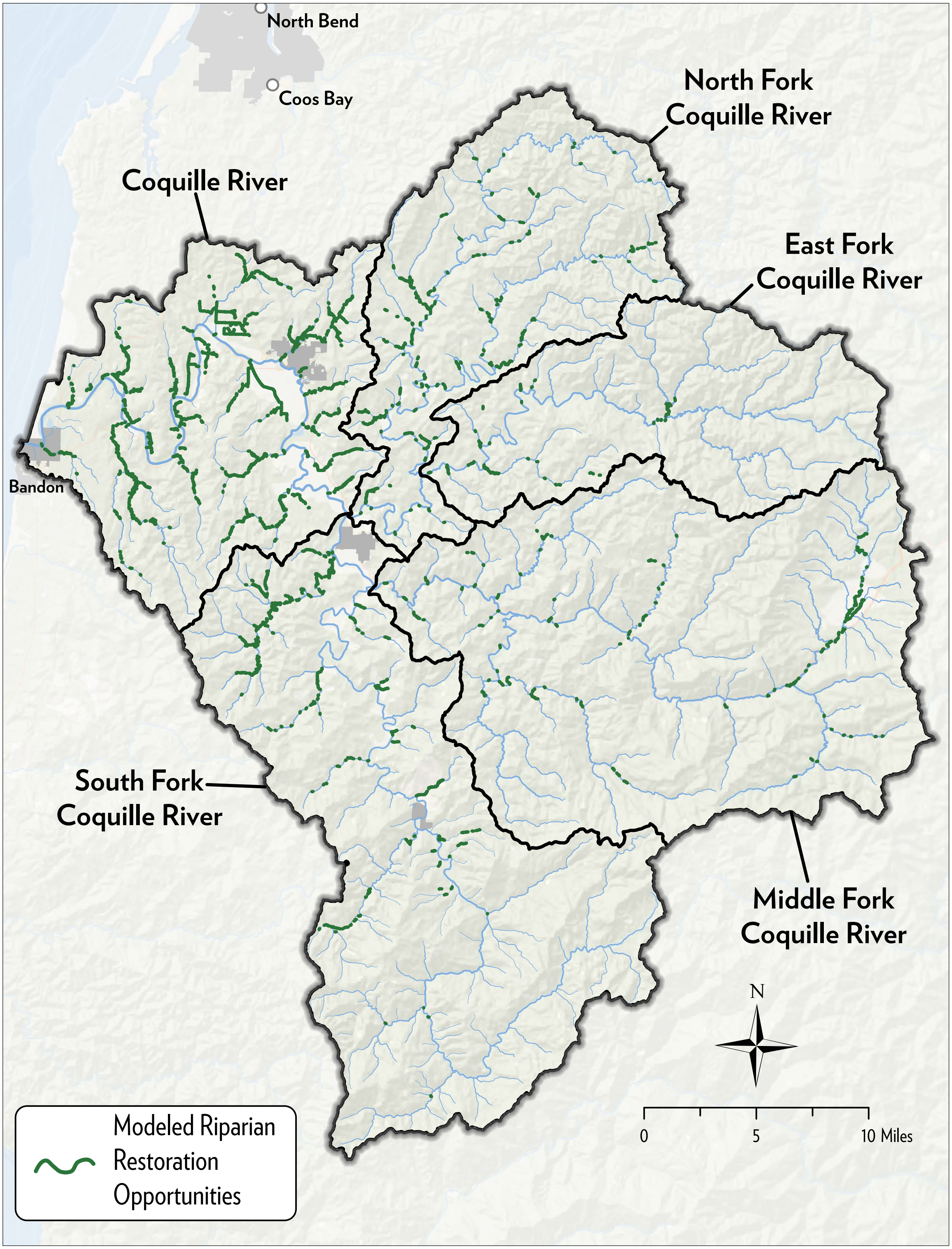
- Reduced instream complexity, decreased lateral connectivity, degraded water quality, and altered riparian function are the primary factors limiting the abundance and productivity of the Coquille Coho population. The historic loss of these key ecological attributes (KEAs) limits the availability of high-quality rearing habitats for juvenile Coho.
- Restoration practitioners in the Coquille Basin have worked cooperatively for decades to improve the KEAs. Prior restoration actions, as well as improvements in land use policy and resource management, have increased the likelihood that current and future restoration actions can generate a net benefit in ecological function and overall watershed health. Actions to increase ecological function have and will continue to infuse money into the local economy (aka, the restoration economy).
- However, the loss and/or degradation of spawning and rearing habitats continues to limit the survival of juvenile Coho, especially in tributary habitats. Rates of restoration actions must be accelerated to offset the effects of climate change. Climate change will further exacerbate the negative effects that Coho salmon face. More robust and focused habitat restoration efforts are needed.
- Coquille Coho productivity and abundance can be increased by strategically restoring the ecological function of mainstem, tributary, and estuary habitats. Increasing riparian function, enhancing and protecting cold water sources, reducing excessive consumptive water use, and increasing the quality and quantity of juvenile rearing habitats (e.g., instream complexity and lateral connectivity) in focal subbasins will alleviate the freshwater bottlenecks for juvenile Coho in the Coquille.
- Improving these habitat characteristics will increase Coquille Coho's productivity and resilience to future watershed alterations resulting from land use practices and climate change, thus ensuring the population's long-term viability.
- By improving these population and habitat characteristics, we will increase the Coos Coho's productivity, diversity, and resilience to future watershed alterations resulting from climate change, thus ensuring the population's long-term viability.


Twelvemile Creek Falls. Photo: ODFW

Figure 6.3.1. Summary of major stressors identified by the Coquille Coho SAP technical team in each habitat component.

Habitat Component	Major Stressors
Mainstems	Decreased water quality (temperature, organic matter) Decreased riparian function Reduced instream complexity Species and resource management (Bass)
Tributaries	Decreased riparian function Decreased water quality (temperature) Reduced instream complexity Species and resource management (Bass)
Non-tidal and Tidal Wetlands	Reduced instream complexity (lack of beaver)
Uplands	Species and resource management (invasive species)
Estuary	Species and resource management (invasive species) Decreased riparian fun Decreased lateral connectivity

Figure 6.5.1. Netmap output for Coho anchor habitats that provide essential habitat to all life stages of OC Coho.



6.5 Netmap as a Tool to Test and Refine Project Locations

TerrainWorks was commissioned by ODFW and NOAA to develop the Coquille Basin Netmap to help inform and analyze optimal locations for restoration strategies. Netmap creates a "virtual watershed" using LiDAR-generated digital elevation models and enumerating aspects of the watershed structure and processes over a range of scales (Barquin et al. 2015, Benda et al. 2015). Netmap's virtual watershed features multiple analytical capabilities that facilitate optimization analyses including 1) delineating watershed-scale synthetic river networks, 2) connecting river networks and terrestrial environments, 3) routing watershed information downstream (e.g., sediment transport) or upstream (e.g., adult Coho), 4) subdividing landscapes and land uses into smaller areas to identify interactions and effects, 5) characterizing landforms, and 6) attributing river segments with key stream and watershed information. Figure 6.5.1 provides an example of areas that Netmap identified as providing essential habitat conditions for all Coho life stages.

The use of Netmap had three primary goals. The first goal was to conduct an independent and objective evaluation that provides a robust baseline from which the Coquille Coho SAP technical team could prioritize restoration strategies. In cases where the Netmap model did not agree with the best professional recommendations, the technical team identified the causes for inconsistencies and either redefined or adjusted the model inputs. In other cases, the Netmap model was recalibrated based on local knowledge and/or additional data that better reflected the actual site conditions in the Coquille Basin.

The second goal of incorporating Netmap was to provide the team with modeled sites in cases where information or local expertise was limited. In general, however, extensive long-term local knowledge and data were available, and field verifications to ground truth the model were deemed unnecessary.

The third goal of Netmap was to provide a long-term tool and data layers to assist in future prioritization efforts. The Netmap watershed model will provide a strong platform for integration of other models, such as Tide Gate Optimization Tools and Tide Gate Pipe Sizing Tool in the Coquille and basins coast-wide. CoqWA retains a license to use the Netmap model and associated data.

Coho jack. Photo: Seth Mead

6.6 Ranking and Prioritization of Sub-watersheds

The Coquille Coho SAP team performed a sub-watershed ranking and prioritization process to objectively select sub-watersheds within the Coquille Basin where restoration efforts should be focused in the long term (Figure 6.6.1). This selection approach is consistent with the Coho Business Plan efforts, which arose from a recognition, by restoration practitioners and funders, of the challenges associated with quantifying the benefits of terrestrial and aquatic habitat restoration beyond the project scale. In large part, these challenges are due to the fact that historically, practitioners have performed restoration work opportunistically, dispersed over large geographic areas, and lacked the capacity and/or funding to implement projects at the rate necessary to yield measurable impacts at the watershed scale. The CCP decided to address this challenge by prioritizing project implementation within a subset of "high-ranked" focal sub-watersheds (Figure 6.6.2).

The criteria for scoring and ranking used in the selection of priority sub-watersheds are described in detail in Appendix II. Briefly, the prioritization process was guided by a "stronghold" approach, based on two main assumptions. The first assumption was that, over the long term, protecting habitats that are in good or excellent condition is the most cost-effective and ecologically efficient restoration strategy. This assumption is grounded in the idea that it takes more time and resources to bring highly degraded systems up to basic levels of functionality than to enhance and protect areas that are already providing relatively high ecological function. The second assumption is that expanding the areas of high ecological function is more likely to provide the desired results and show a quicker return on investment than starting in highly degraded systems.

This approach recognizes that the stresses on highly anthropogenically altered systems are either too numerous or take too long to substantively reverse. Restoration actions in highly degraded watersheds can often be unsuccessful at ameliorating the myriad of stresses or take years, or decades, to accomplish the restoration goals at the watershed scale. Accordingly, the team decided to prioritize sub-watersheds that are relatively intact and demonstrate greater ecosystem function over more degraded sub-watersheds.

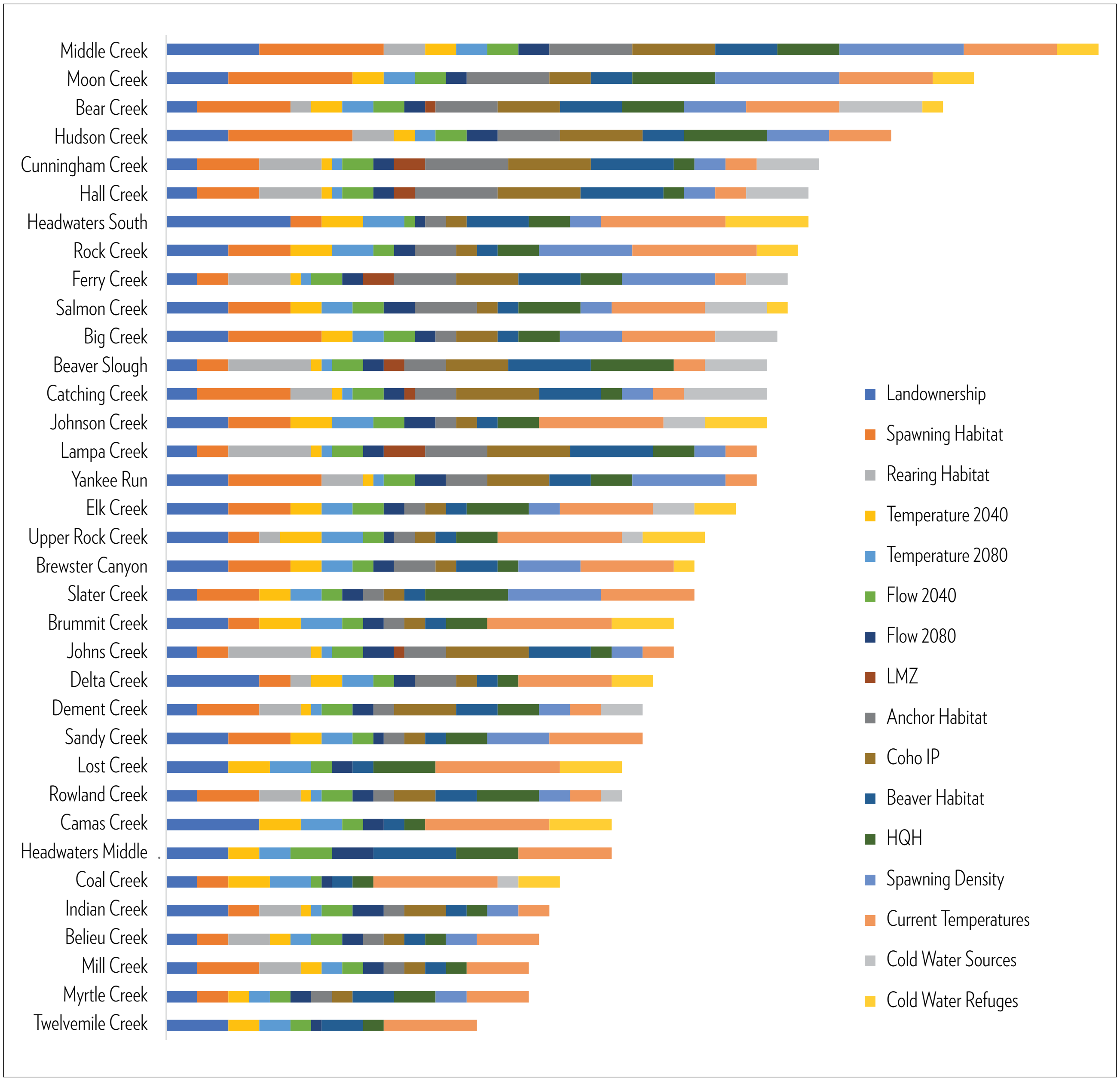
Wild Coho Abundance and Productivity

The technical team spent an extensive amount of time developing and reviewing the criteria by which the sub-watersheds were evaluated. The team chose to evaluate the Coquille Basin at the 6th field HUC scale due to the similarity of habitat components and the size of the overall watershed.

Figure 6.6.1. Sub-watershed evaluation parameters and ranking score weights for each parameter. Ranking score weights increase (e.g., ranking score multiplied by a factor of 1.5) or decrease (e.g., ranking scores multiplied by 0.5) the effect size of a given parameter. Parameters without a weighting factor were unchanged.

FISH	HABITAT	CLIMATE CHANGE
• Spawning Habitat (ranking score weighted by 1.5) • Rearing Habitat • Oasis Spawning Surveys (ranking score weighted by 1.5) • Current Temperature (C°) (ranking score weighted by 1.5)	• High-quality Habitat • Coho Intrinsic Potential • Land Ownership (ranking score weighted by 1.5) • Anchor Habitat • Beaver Habitat • Cold Water Sources • Cold Water Refugia	• Mean August Flow (% change) in 2040 (ranking score weighted by 0.5) • Mean August Flow (% change) in 2080 (ranking score weighted by 0.5) • Temperature (C°) in 2040 (ranking score weighted by 0.5) • Temperature (C°) in 2080 (ranking score weighted by 0.5) • Landward Migration Zones (ranking score weighted by 0.5)

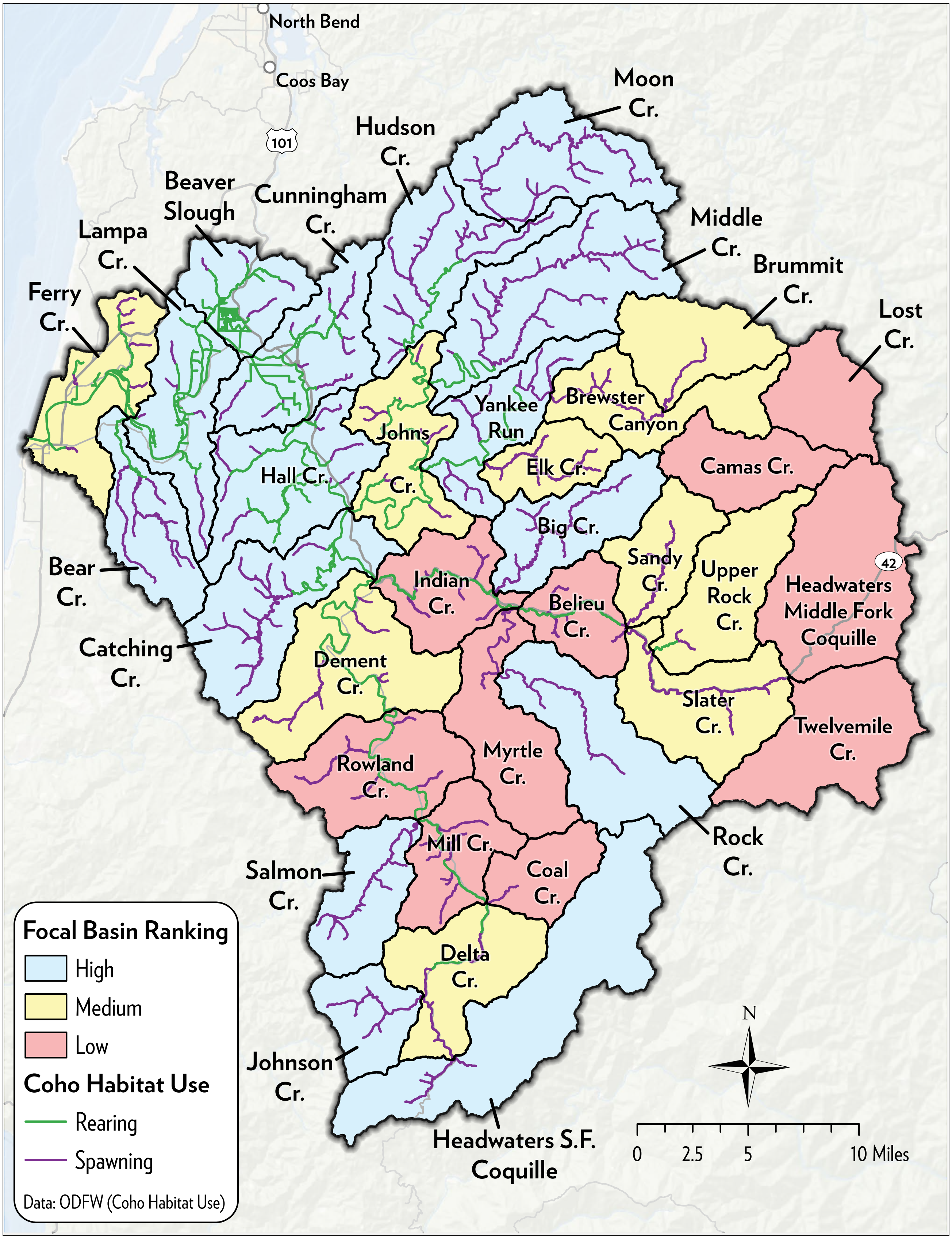
Figure 6.6.1. Coquille sub-watershed ranking by criteria.



The thirty-five sub-watersheds were initially evaluated based on the following criteria:

- Total quantity of spawning habitat
- Total quantity of rearing habitat
- Spawning surveys
- Current water temperatures
- Quantity of high-quality habitat (HQH)
- Coho intrinsic potential (Coho IP)
- Land ownership
- Anchor habitat
- Beaver habitat (Beaver IP)
- Cold water sources
- Cold water refugia
- Percent change in August stream flow (2040 and 2080)
- Percent change in August temperature (2040 and 2080)
- Landward migration zones (LMZ)

Figure 6.6.2. Sub-watershed ranking in the Coquille Basin.



Chapter 7

Focal Areas for Coho in the Coquille Basin

7.1 Lower Coquille Subbasin Focal Areas

This section describes the 15 high-priority sub-watersheds (HUC 6) the team identified as the focal areas for Coho habitat restoration and protection in the Coquille Basin (Figure 7.1.1).

Overview of Land Use and Conditions in the Lower Coquille Subbasin

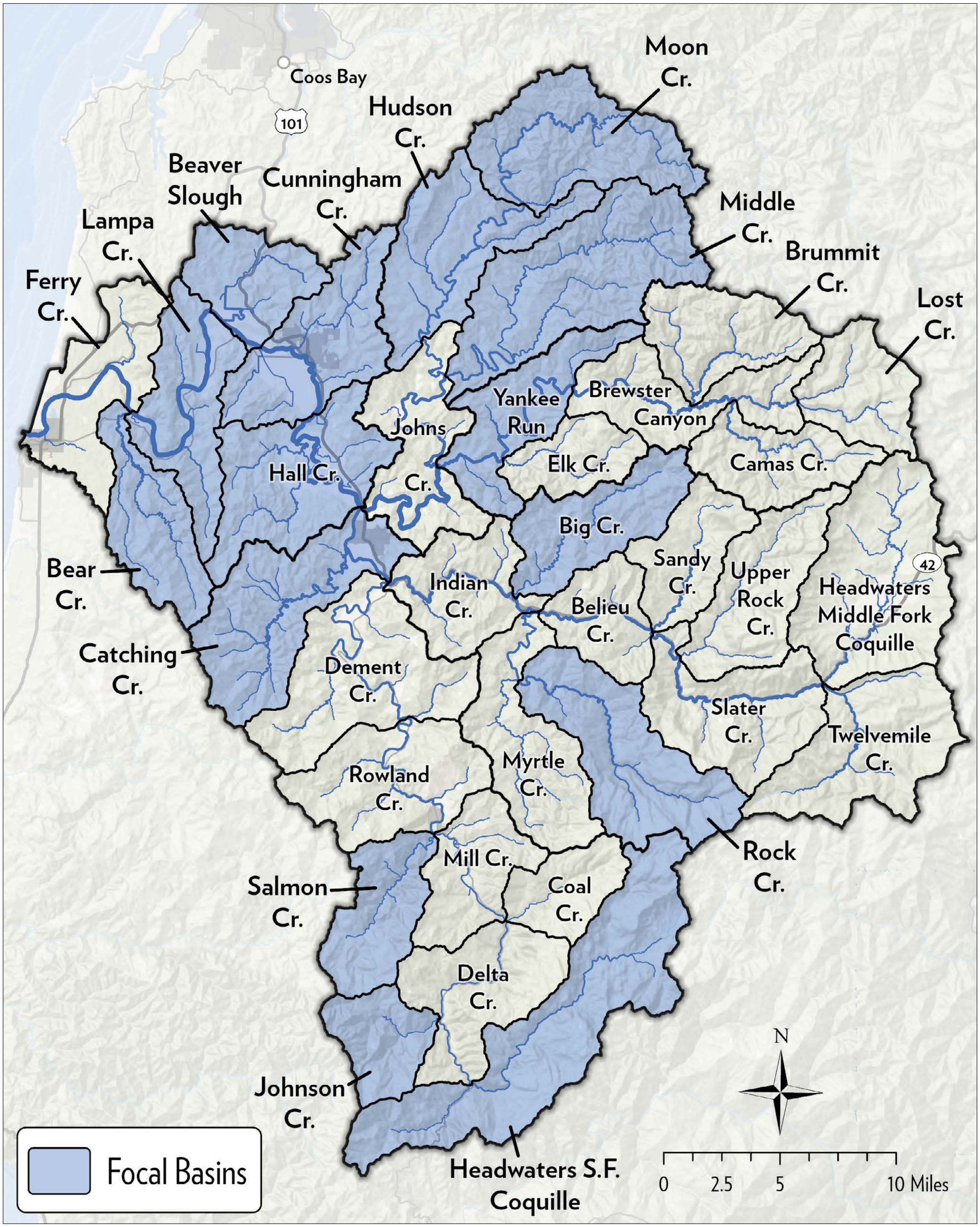
The lower Coquille subbasin displays the geologic effects of fluctuating sea levels and the continued uplifting and deposition of coastal sandstone sediments in the floodplain of the lower 40 miles of the river. These conditions resulted in marine and alluvial sediment deposition and terrace formation through the lower Coquille River drainage. The unconsolidated to semi-consolidated sand and gravel deposits that form these terraces are highly erodible during high winter flows. Before the construction of the jetties, the lower two miles of the Coquille River channel regularly changed its entry course into the ocean.

Since time immemorial, Native Americans have lived, fished, and hunted along the lower Coquille River. At one such location, the Osprey fishing site, located on the lower Coquille River estuary, western archeologists have dated use from before 1100 A.D. to the mid-1800s. European settlers began moving into the watershed in the mid-1800s, cutting timber in forests, clearing riparian areas, and converting floodplains and wetlands into pasture land for agricultural and other purposes. Starting in the late 1800s, the U.S. Army Corps of Engineers and Port of Coquille dredged, removed snags, and maintained the lower river for navigation from Bandon to Myrtle Point. Dredge material was used to build dikes and levees, disconnecting the river from its floodplain and concentrating flow into a narrower river channel. Settlers placed tide gates in the dikes and levees to drain floodplains for agricultural production, restricting fish passage to off-channel areas, reducing instream habitat complexity, and affecting water quality. Upstream of RM 8.0, the valley floor was historically largely forested with Oregon ash (*Fraxinus latifolia*). Road building in riparian areas removed trees, destabilized stream banks, restricted stream movement, and increased the volume and rate of runoff.

Today, impaired access to floodplain and tidal floodplain habitats and human-induced simplification (e.g., removal of large wood (LWD), channelization) remain the primary factors

Coho smolts. Photo: Brian Kelley

Figure 7.1.1. High-priority focal sub-watersheds in the Coquille Basin.



limiting Coho production in the Lower Coquille. Restoration efforts focus on restoring ecological processes and connectivity, especially to increase the occurrence of and access to slow-water habitats that provide refugia for winter parr.

Subbasin-level Goals:

- Increase lateral connectivity (floodplain and tidal reconnection).
- Increase riparian function, including plant species diversity.
- Decrease invasive species.
- Reduce water temperatures with the intent to meet DEQ water quality standards; secure cold water sites.
- Increase instream complexity.

Focal Areas in the Lower Coquille Subbasin

Based on the technical team's subbasin prioritization process (see Appendix 2), five focal sub-watersheds (HUC 6) were identified for Coho restoration in the Lower Coquille subbasin: Bear Creek, Beaver Slough, Cunningham Creek, Hall Creek, and Lampa Creek.

Bear Creek Focal Area

The Bear Creek focal area provides spawning and rearing habitat for Coho and Chinook salmon, anadromous and resident coastal cutthroat trout, and Pacific lamprey. The primary spawning streams for Coho within this focal area are Bear Creek, Little Bear Creek, Bills Creek, and Mack Creek. Rearing of Coho occurs in these streams, floodplain habitats, and several other smaller tributaries. The segment of the mainstem Coquille River in this focal area only serves for overwinter rearing due to high summer temperatures.

The hydrology and habitat of the Bear Creek watershed have been severely degraded through historic log drives, channel ditching, and draining of wetlands. Riparian forests, composed primarily of willow (*Salix spp.*) and Oregon ash, were historically cleared in bottomlands to develop pasture grazing. The above-noted factors have resulted in impaired water quality and aquatic habitat complexity, and reduced late summer flows. Today, the sub-watershed is almost entirely in private ownership, and agriculture and forestry are the dominant land uses.

Stressors for Coho in mainstem Bear Creek include decreased water quantity and water quality. In tributary reaches, the primary stressor is decreased lateral connectivity (including loss of beaver ponds). Monitoring by the Coos SWCD shows that summer water temperatures and E. coli pollution levels in Bear Creek exceed the limits set by Oregon DEQ water quality standards.

Removing invasive smallmouth bass. Photo: Holden Films

Focal area goals:

- Increase riparian function.
- Improve water quality, especially by reducing bacteria during high and peak flows.
- Increase riparian function by building livestock exclusion fencing.
- Increase beaver activity and influence.

Previous restoration and protection accomplishments:

The Coos SWCD, Oregon Department of Agriculture (ODA), and others continue to work to create high-quality habitats for Coho and improve the overall health of the Bear Creek watershed. Besides being a focal area for Coquille Coho restoration, Bear Creek is part of the ODA Lower Coquille Strategic Implementation Area (SIA). The SIA aims to improve water quality and aquatic habitat on agricultural lands through restoration and monitoring. The SWCD's monitoring data illustrate strong restoration potential, such as a 1-mile section of Bear Creek with intact riparian vegetation that runs through agricultural land and has lower summer water temperatures than upstream and downstream sites. The SWCD is working to replicate these conditions on more agricultural properties on Bear Creek.

Current habitat restoration priorities to increase Coho viability:

- Increase instream habitat complexity through wood placement.
- Increase riparian function along the mainstem through riparian planting and fencing.
- Promote beaver use in tributaries to restore in-stream complexity and floodplain connectivity.

The restoration efforts proposed in the SAP build on previous efforts by building riparian fencing, planting native trees and shrubs, treating for invasive weeds, increasing lateral connectivity, and improving off-channel wetlands. Along with related improvements in land use policy and resource management, actions in this focal area will strategically enhance freshwater habitats and boost Coho abundance and productivity.

Beaver Slough Focal Area

Beaver Slough contains 18.7 miles of slow-water reaches with the potential to provide high-quality overwintering habitat for juvenile Coquille Coho. The main spawning streams within this sub-watershed are Beaver Creek and China Camp Creek. No spawning occurs in the mainstem river due to high turbidity during high winter flows. Overall, spawning habitat is limited within this focal area, and the primary role of the Beaver Creek focal area is overwinter rearing for juvenile Coho produced in upriver locations. Large numbers of upriver parr and pre-smolts move down from as far as the South Fork and North Fork Coquille headwaters in late November through March and attempt to enter floodplain tidal wetlands. Historically, the valley floor exhibited a flooded wetland forest with off-channel areas that allowed juvenile Coho and other fish to escape high, turbid flows and shelter in slow-water refugia with food, cover, and protection from predators. Since 1880, the mid and lower reaches of Beaver Creek and floodplain portions of its tributaries have lost most of their riparian forest to the creation of pasturelands; however, the sub-watershed retains a moderately robust component of tidal channels. The lack of riparian forest and lateral connectivity are the main factors restricting Coho production in this sub-watershed. Uplands in the HUC have been managed intensively for timber production, with historical removal of stream-adjacent riparian forests that limit the potential for future large-wood additions and shading. More recent buffer criteria under the Oregon Department of Forestry (ODF) are resulting in increased retention of upland tributary shading.


Tide gate on the Lower Coquille. Photo: ODFW

Primary stressors in the Beaver Slough mainstem include decreased water quality (specifically increased temperatures) and decreased riparian function. Water temperatures currently climb above 16° C (60.8° F) and are expected to rise above 18° C (64.4° F) by 2040 and above 19° C (66.2° F) by 2080 without substantive riparian restoration. Stream flows will likely become more variable as the climate changes in the coming years, with summer flows expected to decline by over 9% by 2040 and by almost 14% by 2080, with more flood-level flows in the winter months. Stressors in tributaries include altered flows (increased flashy flows), decreased water quality (sediment and turbidity), altered riparian function (decreased riparian inputs), and decreased lateral connectivity (decreased beaver ponds). Stressors in the estuary include resource management (reduced wetlands), reduced riparian function (wood inputs), and reduced lateral connectivity (tidal connectivity). This HUC has some of the largest floodplain/tidal areas within the Coquille Basin.

Ducks swimming in Winter Lake. Photo: ODFW

Focal area goals:

- Protect cold water refugia.
- Increase riparian function to create a cold water corridor between the river and cold water sources.
- Increase floodplain connectivity.

Previous restoration and protection accomplishments:

The Coquille Watershed Association, The Nature Conservancy, ODFW, Beaver Slough Drainage District, and other restoration practitioners in the Beaver Slough sub-watershed have worked for several decades, most strongly since 2010, to improve habitat conditions and restore overall watershed health. Several wetlands in the Beaver Slough HUC have been reconnected/enhanced through combined restoration efforts and improved natural processes. Past efforts include replacing tide gates and culverts, improving stream connectivity, fencing riparian areas, and planting native vegetation. One prime example is the Winter Lake Phase I and II projects (implemented in 2017 and 2018, respectively) that have constructed 6.3 miles of large tidal channels and reconnected another 1.8 miles of existing tidal swales to new tide gate infrastructure on 409 acres. These projects were designed to provide juvenile salmonid access to overwintering habitats and improve water management for landowners. Upland forest riparian areas on tributary streams are considered to be on an upward functional trend due to ODF administration of stream-adjacent harvest protections.

Current habitat restoration priorities to increase Coho viability:

- Increase water quality and riparian function along lower Beaver Slough.
- Increase instream habitat complexity, water quality, and riparian function in Beaver Creek.
- Increase riparian function along mainstem and select tributary reaches through riparian planting and fencing.
- Increase longitudinal connectivity at strategic points along Beaver Slough and tributaries.
- Promote beaver use in tributaries to restore instream complexity and floodplain connectivity.

The actions proposed in the SAP build on past actions to restore Coho habitat and improve watershed health in Beaver Slough. They will protect good-quality tidal habitat, restore additional riparian areas, increase floodplain connectivity, and increase the resiliency of transportation infrastructure.

Cunningham Creek Focal Area

Cunningham Creek provides key overwintering habitat for Coho in the Lower Coquille subbasin, with over 23 miles of rearing habitat in the mainstem and 15 miles of anchor habitat. The main Coho spawning streams are Cunningham, Calloway, and Coffee Creeks, with some activity in smaller tributaries. There is suitable rearing within those tributaries; however, over 2,600 acres of tidal and non-tidal floodplain habitat is no longer accessible for overwintering juvenile fish. The mainstem does not support spawning due to sandy substrates and high turbidity during winter high flows. While the mainstem Coquille River water quality currently prohibits summer rearing (i.e., high water temperatures), the reach is heavily used as a corridor during fall/winter/spring for parr and presmolts seeking off-channel habitat. Moderate-density mainstem rearing also occurs in slower pool edge habitats. Habitat in this focal area has been degraded by historical land use practices that led to eroding stream banks, restricted floodplain connectivity, and elimination of riparian vegetation. There has been systematic riparian forest clearing along the mainstem river and floodplain forests, yielding high solar input into the mainstem.

Stressors for Coho production in the Cunningham Creek focal area include decreased water quality (high water temperatures, increased nutrient loading, E. coli and fecal coliform), altered flows (reduced flows), loss of lateral connectivity to floodplains, decreased beaver ponds, and decreased riparian function. Summer water temperatures in Cunningham Creek currently reach or exceed 17° C (62.6° F) and, if current conditions persist, are expected to rise to 18.5° C (65.3° F) by 2040 and to 19.5° C (67.1° F) by 2080 as air temperatures increase and stream flows decline. Stressors in tributaries include decreased longitudinal connectivity (perched culverts), decreased water quality (increased fine sediments), decreased riparian function (invasive plants), and decreased lateral connectivity (decreased beaver ponds).

Focal area goals:

- Reduce nutrient loading from agricultural lands.
- Increase riparian species diversity to increase shade and cool stream temperatures.
- Increase educational outreach opportunities, especially at high school and middle school levels.
- Protect water quality to provide high-quality drinking water to the city of Coquille.

Coho smolts. Photo: Ray Aspelund

Previous restoration and protection accomplishments:

The Coquille Watershed Association, SWCD, Wild Rivers Coast Alliance, and other restoration partners have been increasing efforts to restore riparian areas and instream complexity, and improve fish passage in sections of Cunningham Creek and tributaries.

Current habitat restoration priorities to increase Coho viability:

- Increase instream habitat complexity through wood placement.
- Increase riparian function along mainstem through riparian planting and fencing.
- Promote beaver use in tributaries to restore instream complexity and floodplain connectivity.

The proposed actions in the SAP build on previous efforts. Along with related improvements in land use policy and resource management, the proposed actions for Cunningham Creek include removing invasive species, stabilizing streambanks, and planting riparian areas to improve riparian function.

Hall Creek Focal Area

Hall Creek flows primarily through private lands and enters the mainstem Coquille River from the south near Arago at RM 32.8 in the lower Coquille watershed. The sub-watershed provides 11.6 miles of spawning habitat and 24.4 miles of rearing habitat for Coquille Coho. Hall, Rich, Fish Trap, Gray's, and Rock Robinson Creeks are the sub-watershed's larger spawning and rearing tributaries. The mainstem river substrates are sandy and overwinter turbidity exceeds tolerance for spawning Coho. The valley floodplain along the Coquille River within the focal area is elevated just above tidal influence. Parr and presmolts rear from late fall through late spring in the mainstem river prior to smoltification. Habitat quality in the Hall Creek HUC has been affected by habitat degradation and flow modifications.

The primary stressors for Coho in the mainstem Hall Creek include decreased lateral connectivity (all floodplain-adjacent areas need reconnection) and decreased riparian function. In the tributaries, the main stressors are decreased water quality and altered flows (increased flashy flows).

Focal area goals:

- Increase floodplain connectivity.
- Increase riparian function.

Tide gate on the Lower Coquille. Photo: ODFW

Previous restoration and protection accomplishments:

The SWCD, ODFW, and other restoration practitioners continue to work to improve the key ecological attributes that create high-quality habitats for Coho and to restore the overall health of the Hall Creek sub-watershed. These previous actions—and related improvements in land use policy and resource management—increase the likelihood that the actions proposed for this focal area can strategically enhance the freshwater habitats that continue to restrict Coho abundance and productivity.

Current habitat restoration priorities to increase Coho viability:

- Increase water quality on the mainstem Coquille River upstream of Arago and both up and downstream of Norway.
- Increase riparian function along Hall Creek and the mainstem Coquille River through riparian planting and fencing.

Proposed actions in the SAP will help stabilize stream banks and improve riparian function on Hall Creek through invasive species removal, native plantings, and increased instream structure.

Lampa Creek Focal Area

Lampa Creek provides important rearing habitat for Coho in the Lower Coquille watershed, and also serves as the primary spawning stream within the HUC. Similar to Beaver Creek, large opportunities for tidal floodplain overwintering habitat restoration exist within the north portion of the HUC, which encompasses Iowa and Hatchet sloughs. Conditions are unsuitable (i.e., lack of gravels/poor water quality) for mainstem spawning in this segment. This HUC largely serves as a surrogate rearing production site to upstream spawned fish. Most of the creek flows through private lands, and some reaches show degraded riparian areas with limited native vegetation. Lampa Creek generally maintains relatively good water quality, but problem areas remain that have been affected by habitat and flow modifications.

The primary stressor for Coho in the mainstem Lampa Creek is decreased water quality due to high summer water temperatures and sediment levels. In the tributaries, the main stressors are altered flows (increased flashy flows), decreased water quality (sediment and turbidity), decreased riparian function (decreased riparian inputs), and reduced lateral connectivity (decreased beaver activity). There is substantive potential in the lower three miles of Lampa Creek to push stream hydrology onto floodplain areas with riparian and beaver restoration. Many reaches of the mainstem Coquille River and Hatchet Slough within this HUC are highly in need of riparian restoration.

Measuring juvenille coho. Photo: Amanda Loman / Lens for Change

Focal area goals:

- Improve water quality in the lower basin.
- Increase floodplain connectivity and off-channel refugia in the lower basin.
- Enhance riparian function and provide healthy riparian buffers on all tributaries.

Previous restoration and protection accomplishments:

Past projects by the Coos SWCD and others have included riparian area fencing and improvements, blackberry removal, and tree planting. These efforts have helped to stabilize stream banks and reduce water temperatures. The efforts have also improved livestock grazing management, a win-win for landowners and fish. These previous actions and related improvements in land use policy and resource management increase the likelihood that the actions proposed for this focal area can strategically enhance the freshwater habitats that continue to restrict Coho abundance and productivity.

Current habitat restoration priorities to increase Coho viability:

- Increase water quality in Lampa Creek.
- Increase riparian function in upper Lampa Creek.
- Increase riparian function and water quality in Lower Coquille reaches above and below Riverton.

Actions proposed for Lampa Creek in this SAP will provide fencing and planting in riparian areas and upgrade irrigation systems to increase watering efficiency.

7.2 North Fork Coquille Subbasin Focal Areas

The North Fork Coquille River runs 53 miles from its headwaters on the west slope of the Coast Range, draining 154 square miles and joining the mainstem Coquille River near Myrtle Point (Figure 7.2.1). The North Fork watershed is the Coquille's most productive subbasin in terms of Coho spawning and summer rearing. It produces the highest number of summer-rearing Coho juveniles in the Coquille Basin.

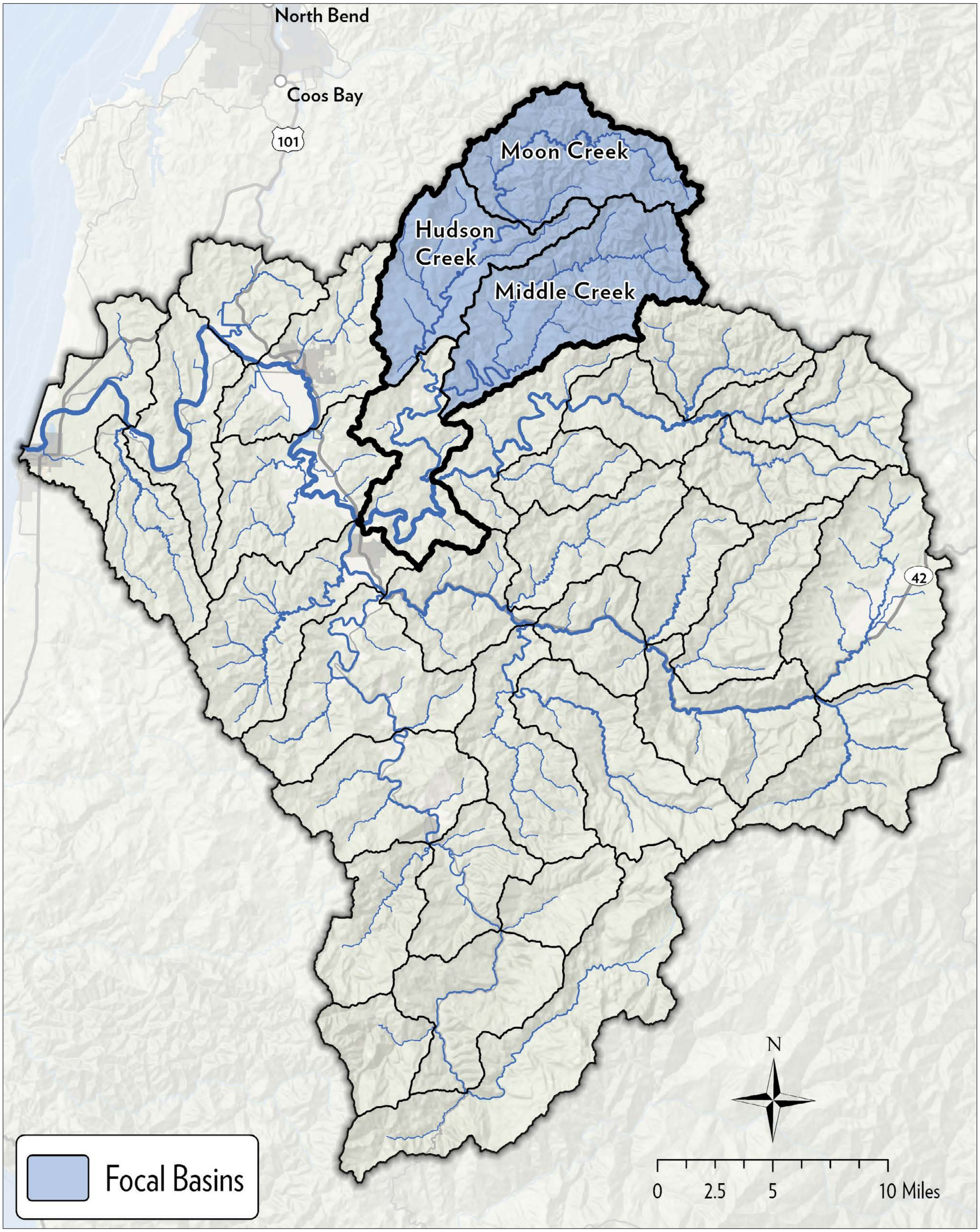
Overview of Land Use and Conditions in the North Fork Coquille Subbasin

Timber production remains the primary land use in the North Fork Coquille subbasin. Past timber harvest practices, including the operation of eight splash dams on the North Fork and even more on tributary reaches, down-cut stream channels, and removed riparian conifers and other vegetation along stream corridors. Other areas were cleared and drained for agricultural and other uses, resulting in streambank erosion, high sediment input, and the loss and simplification of complex habitats. Between 1880 and 1960, there was heavy use of all tributaries with a bank-full width greater than ~15 ft for floating of individual logs on high flows, or in combination with splash damming, which necessitated the removal of large wood. Large-wood structures are critical for development of salmon, steelhead, and lamprey habitats, including pools, spawning gravel aggradation, and hiding cover. Directed stream cleaning occurred on the remaining tributaries in the 1950-1975 period, removing any large wood that remained.

Today, the river system lacks habitat complexity, with a limited supply of large wood in riparian areas and low pool frequency and depth. Hillslopes or terraces naturally constrain many reaches in the North Fork system, and the river in these reaches contains limited floodplain land area, wetlands, and off-channel areas. Other degraded reaches along the North Fork disconnect the stream from riparian areas. Instream flows in the lower half of the North Fork Coquille River provide notable salmonid habitat, but with sediment and temperature perturbations in winter and summer, respectively. Mainstem habitats exhibit only a limited quantity of slow-water refugia during important overwintering months for juvenile fish. Floodplain valley form becomes present downstream of Fairview along the mainstem North Fork and presents substantive potential for improving overwinter rearing of juvenile Coho. Several forks and tributaries restricted by the road network in the North Fork watershed are 303(d) listed by ODEQ as water quality limited for temperature and bacteria. The watershed


North Fork Coquille Steelhead Falls. Photo: ODFW

Figure 7.2.1. High-priority focal sub-watersheds in the North Fork Coquille.



has the greatest potential for improving water temperature in the Coquille Basin, with nearly 21 miles of stream showing promise for riparian shade restoration, which, if implemented, would pose strong resistance to climate change increases in ambient air temperature.

Subbasin-level goals:

- Restore riparian function.
- Improve water quality and geomorphic characteristics.
- Increase instream complexity.

Focal Areas in the North Fork Coquille Subbasin

The team identified three focal areas with the best potential for Coho restoration in the North Fork Coquille watershed: Hudson Creek, Middle Creek, and Moon Creek.

Hudson Creek Focal Area

The Hudson Creek HUC 6 includes a mix of public and private lands, with 34% of the sub-watershed in public ownership. The primary land uses are timber production and recreation. There are several small and medium-size Coho spawning/rearing streams within the HUC, including Hudson Creek, for which the focal area HUC is named, Woodward, Steinnon, and Steele Creeks, with spawning also in a few others. Some spawning occurs in the mainstem from Moon Creek downstream to Fairview. These tributaries provide important rearing habitat for summer and overwintering juvenile Coho. The mainstem has especially high-density Coho rearing during late summer through early winter. Notable segments of tributaries within the Hudson Creek HUC 6 are low-to-mid gradient, single-thread channel streams constrained by hillsides with limited off-channel areas, and limited instream structure due to the historical removal of LWD and historical removal of potential recruitment wood from riparian forests. Woodward Creek within the HUC is less channel-confined and represents a strong opportunity for floodplain connectivity. The section of the mainstem North Fork Coquille River in the HUC has some notable segments that are in need of riparian habitat improvement.

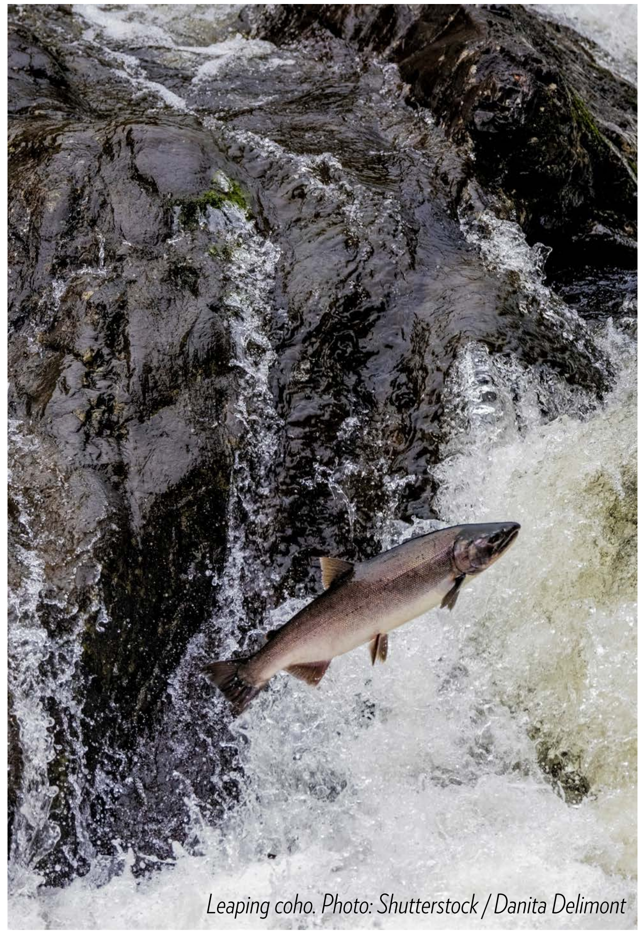
The primary stressor for Coho in the mainstem Hudson Creek is decreased riparian function (i.e., invasive species).

Focal area goals:

- Reduce illegal OHV use throughout the sub-watershed.
- Improve water quality.

Previous restoration and protection accomplishments:

The CoqWA, BLM, industrial timber partners, and Coos County have worked in the Hudson Creek HUC 12 for several years on a wide variety of projects aimed at reducing illegal use and water quality improvement projects. Much of the recent work has been centered on Woodward Creek: in stream wood placements, culvert removals and replacements, sediment-reducing road upgrades, invasive species removal, and blocking unauthorized access points.



Leaping coho. Photo: Shutterstock / Danita Delimont

Current habitat restoration priorities to increase Coho viability:

- Increase riparian function through riparian planting and fencing.
- Increase habitat complexity in the lower reach.

The proposed actions in this SAP call for a "Basin Assessment" to refine restoration needs. Actions will also enhance riparian habitat, instream complexity, and habitat connectivity, and reduce sediment loads within the HUC for the mainstem North Fork Coquille River, reaches of tributaries including lower Hudson Creek, and other locations as defined following the Basin Assessment. Proposed actions will also upgrade culvert structures where appropriate to improve fish passage and enhance riparian areas.

Middle Creek Focal Area

Middle Creek HUC 6 is one of the highest-producing Coho streams in the North Fork watershed, with 60% of the sub-watershed in public lands. Primary spawning/rearing streams within the HUC include Middle, Park, Honcho, Vaughan's Park, and Alder Creeks. Some spawning/rearing also occurs in several other smaller tributaries. Much of the sub-watershed is forested, and the primary land use is timber production. The above-noted creeks are important spawning/rearing habitat for Coquille Coho, with almost 40 miles of productive spawning habitat. These streams also contain good habitat for summer-rearing and moderately productive overwintering for juveniles. Still, habitat quality in the Middle Creek HUC has been affected by habitat degradation and flow modifications. Large riparian conifers are limited, restricting LWD levels in some reaches. Still, conifers of 30-55 years of age are present most densely in the first 20 feet adjacent to the streams in riparian communities.

The mainstem Middle Creek was heavily used for timber transport from 1880 to the early 1900s. Splash damming occurred with multiple transport events, resulting in a glacial-like grinding of the channel spawning gravels and immediately adjacent riparian forest. All LWD was removed. This LWD was critical for developing and maintaining salmon, steelhead, and lamprey habitats, including pools, spawning gravel aggradation, and hiding cover. Directed stream cleaning occurred on the remaining tributaries from 1950 to 1975, though some LWD remained.


Headwaters North Fork old growth. Photo: Dan Silvius

The primary stressors for Coho in mainstem Middle Creek are altered riparian function and decreased water quality (temperature and increased sediment).

Focal area goals:

- Increase instream complexity.
- Protect upland forest stands.
- Decrease sediment inputs.
- Conduct a road assessment to identify sediment inputs.

Previous restoration and protection accomplishments:

The Coquille Watershed Association, BLM, ODFW, and others have implemented some restoration efforts in the Middle Creek HUC to improve instream complexity. Restoration efforts include the construction of numerous boulder-weir structures in the 1990s and early 2000s, and then LWD since 2010 in the upper-mid-reaches of Middle Creek to increase instream complexity.

Current habitat restoration priorities to increase Coho viability:

- Increase water quality in the lower river.
- Increase habitat complexity in the lower river.
- Increase riparian function along the lower river.

The proposed actions in this SAP continue this habitat restoration in the Middle Creek sub-watershed. They will improve instream complexity for Coho use in degraded reaches by adding large-wood structures and boulders, and reducing erosion and sediment loads from upland roads.

Moon Creek Focal Area

The Moon Creek HUC is an important spawning and rearing area for Coquille Coho, with over 31 miles of spawning habitat. The primary spawning/rearing tributary streams within the focal area are the mainstem North Fork Coquille River and Little Fruin, Giles, Moon, and Freely Creeks. Due to its relatively good water quality,


North Fork Coquille Road erosion in Myrtle Point. Photo: ODFW

a large amount of spawning occurs in the mainstem North Fork Coquille River within this HUC. There is also heavy mainstem North Fork Coquille rearing yearlong in the reach. Much of the sub-watershed is forested and managed to support timber production. However, stands of young timber dominate the area, indicative of historical harvest to stream edge, with limited large riparian conifers for LWD that resist stream hydrology forces in the mainstem North Fork Coquille River. Instream habitat quality in various tributary and mainstem reaches is limited by high percentages of fine sediment, reduced gravel, and low levels of pools. Pool habitat development is primarily restricted by a lack of oversize LWD and other structure to provide instream complexity.

Habitat quality in the Moon Creek sub-watershed has been affected by habitat and flow modifications. Hydrology modifications are related to road network capture of hillslope precipitation rerouting and alterations to the watershed rainfall evapotranspiration yields relating to removal of timber canopy.

The primary stressors for Coho in the mainstem Moon Creek include decreased instream complexity (lack of pools) and decreased water quality (sediment). The main stressor in the tributaries is decreased riparian function (stream buffering).

Focal area goals:

- Increase instream complexity and pool habitat.
- Reduce sediment loading.
- Conduct a road assessment to identify sediment inputs.

Previous restoration and protection accomplishments:

The BLM, ODFW, Coquille Watershed Association, and others have implemented restoration efforts in the Moon Creek sub-watershed to improve instream complexity.

Current habitat restoration priorities to increase Coho viability:

- Increase instream habitat complexity in mainstem Moon Creek.
- Improve riparian function along mainstem Moon Creek.

Proposed actions in this SAP continue habitat restoration on Moon Creek. They will improve instream complexity for Coho use in degraded reaches by adding large-wood structures and boulders, and reducing erosion and sediment loads from upland roads.

7.3 East Fork Coquille Subbasin Focal Areas

Overview of Land Use and Conditions in the East Fork Coquille Subbasin

The East Fork Coquille River is the shortest and steepest fork of the Coquille River. The East Fork runs west for just under 34 miles and drops about 70 feet per mile from its headwaters to its mouth east of Sitkum, joining the North Fork Coquille at Gravelford (Figure 7.3.1). The East Fork drainage is small, only 135 square miles in size, but consistently produces large runs of Coho. While the mainstem East Fork has little spawning gravel, several major tributaries contain adequate spawning gravel to support the fish.

The East Fork subbasin continues to display the effects of past logging, road building, and beaver removal, which began after European settlers began moving into the area in the early-to-mid 1800s, with changes from land use practices continuing through much of the 1900s. Early logging and land clearing for agriculture and other purposes removed large timber near the river, including from riparian areas. Splash dams operating in the sub-watershed, including four dams on the East Fork, caused large-scale decreases in channel complexity. Operation of the splash dams damaged riparian vegetation and flushed stream sediment and large wood downstream, scouring bedrock and disconnecting streams from floodplains, wetlands, and off-channel areas that had historically provided overwintering habitat for Coho and other juvenile fish. Today, timber harvest and agricultural production remain the primary economic drivers in the sub-watershed.


Road failure in the Coquille River basin. Photo: Coquille Watershed Association

Several habitat conditions continue to restrict Coho production in the East Fork Coquille sub-watershed. Analyses of aquatic habitat conditions by ODFW between 1994 and 2002 showed that the lack of large riparian conifers was the primary factor limiting Coho habitat in the drainage, with surveys suggesting that 22 of 23 streams lacked sufficient riparian conifers (Coquille Indian Tribe 2007). The reduction of this long-term source of large wood restricts pool development, structural complexity, and gravel retention. It also contributes to a lack of shade and subsequent high summer water temperatures. The East Fork Coquille is considered water quality limited due to high summer water temperatures from the mouth to headwaters. The stream temperatures also reflect summer withdrawals of streamflow to meet irrigation needs. Insufficient summer instream flow in rearing tributaries affects Coho production. The mainstem East Fork has very low summer flows and high water temperatures that restrict Coho fry and juvenile fish from entering the main river, which is the main migratory route to move between habitat locations. While land use practices in the area are changing for the betterment of fish, the area continues to recover from past land use degradation. Currently, three primary factors restrict Coho production: lack of habitat complexity, especially for overwintering juveniles, high summer water temperatures, and turbidity during winter months, which inhibits macroinvertebrate production, causes siltation of redds, and inhibits the ability of salmonids to feed as they are primarily sight feeders (Burns 1970, Hall and Lanz 1969, Suttle et al. 2004, Tripp and Poulin 1992, Waters 1995). These combined factors limit overwinter parr survival.

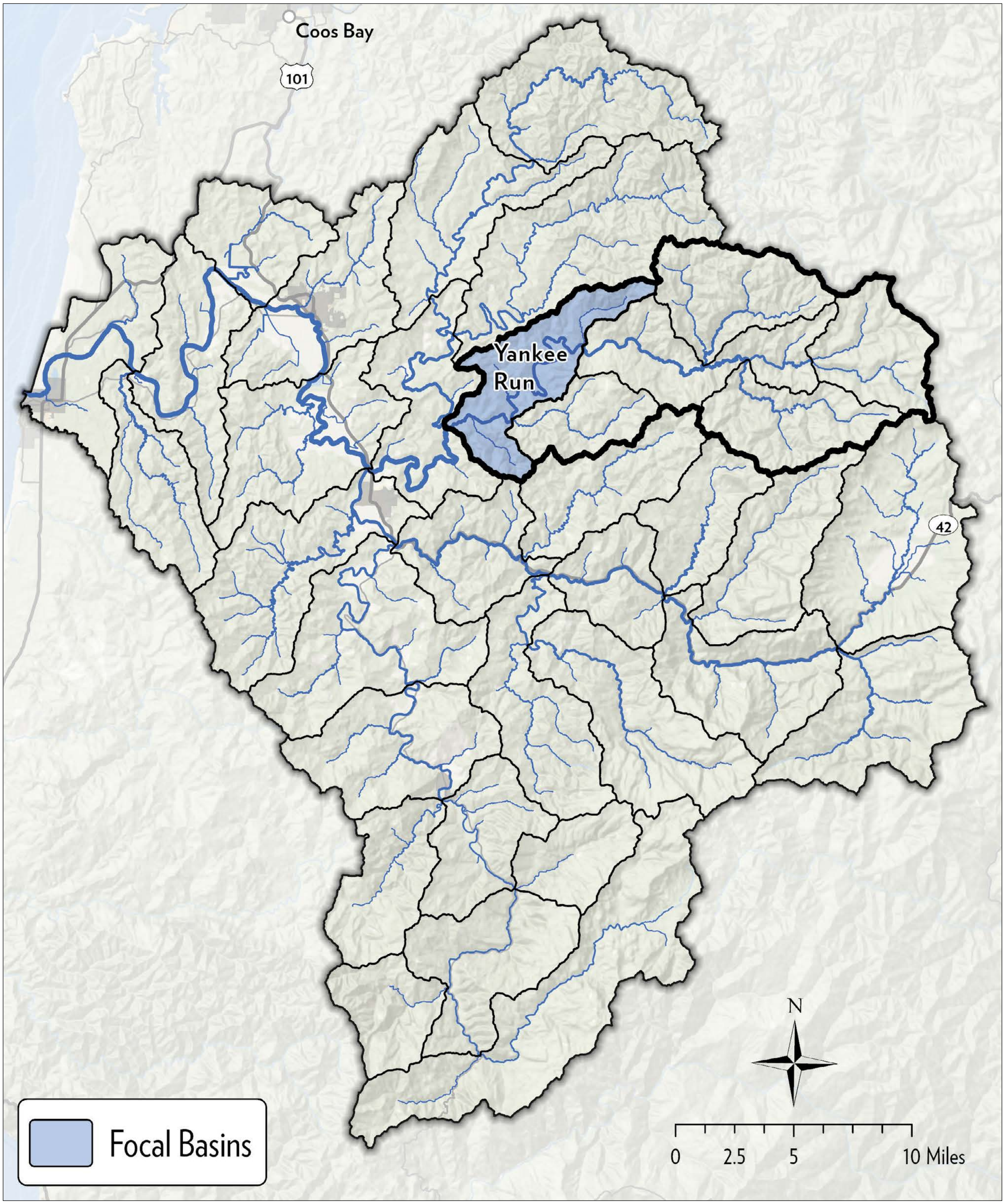
Subbasin-level goals:

- Increase riparian function.
- Restore flows.
- Restore water quality.
- Enhance instream complexity.
- Conduct a road assessment to identify areas to improve the road network and reduce sediment.

Focal Areas in the East Fork Coquille Subbasin

The team identified one focal area with the best potential for Coho restoration in the East Fork Coquille watershed: Yankee Run.

Figure 7.3.1. High-priority focal sub-watersheds in the East Fork Coquille.



Yankee Run Focal Area

Much of the Yankee Run HUC is forested and managed for the primary land use, timber production. Notable Coho rearing/spawning streams include Yankee Run, Steel, Hanz, and Weekly Creeks. Although there is strong use of the mainstem in fall/winter/spring, high temperatures prohibit summer rearing other than in thermal refugia. Only limited spawning occurs in the mainstem due to overwinter high turbidity levels. Habitat quality in the sub-watershed has been affected by past activities, including stream cleaning, road construction, and past logging practices that have led to poor conditions for fish habitat and water quality. Agricultural pasture grazing dominates much of the floodplain from Dora downstream, at a distance of over 10.6 miles. This zone was historically dense forest comprised of hardwoods with interspersed conifers. Stream temperature controls in the mainstem East Fork Coquille River, similar to in the North Fork, were encompassed in the effects of this overstory forest. Most of this forest has been removed, and the river is now widely exposed to solar input, with degenerating eroded streambank effects accelerating in recent years. Opportunities exist to improve overwintering habitat for Coho in the Yankee Run sub-watershed in tributaries and in floodplain pastures where juvenile Coho enter during high water events. Recent sampling of fish during Coquille monitoring efforts has noted several thousand juvenile Coho within these types of habitats.

The primary stressors for Coho in the mainstem Yankee Run are decreased riparian function (invasive species and lack of wood inputs) and reduced instream complexity (lack of pools). The main stressors in the tributaries are reduced instream complexity and decreased riparian function.

Focal area goals:

- Increase riparian function.
- Conduct a road assessment to implement identified actions to reduce road network and sediment loads.

Previous restoration and protection accomplishments:

The Coquille Watershed Association, BLM, and others have implemented projects adding large-wood debris to Yankee Run and enhancing riparian areas through fencing and planting. The log jams improve channel complexity, pool depth, and pool cover, providing habitat for adult spawners, juvenile Coho, and resident trout.

Current habitat restoration priorities to increase Coho viability:

- Increase instream habitat complexity in mainstem Yankee Run and other tributaries.
- Improve riparian function along mainstem East Fork Coquille from Dora to the mouth.

Proposed actions in this SAP continue habitat restoration efforts in the Yankee Run sub-watershed.

7.4 South Fork Coquille Subbasin Focal Areas

The South Fork, the Coquille River's longest fork, runs 63 miles from its headwaters to where it joins the Middle and North Fork Coquille Rivers near Myrtle Point (Figure 7.4.1). The South Fork once produced a vibrant subpopulation of Coho but now provides less habitat for summer-rearing juveniles and overwintering juveniles than the other Coquille subbasins.

Overview of Land Use and Conditions in the South Fork Coquille Subbasin

The subbasin's healthy stream conditions began unraveling in the early 1850s when miners, loggers, and other settlers moved into the area. The activities continued into the early 1900s and included building settlements near the current town of Powers to support logging activity. In 1915, a railroad began operating between Powers and Myrtle Point to serve the growing logging industry, which expanded east from the Salmon and Land Creek drainage to Eden Ridge. Access to timber lands increased with the construction of roads extending up the South Fork Coquille and into Eden Valley. Extensive logging and road building began in the South Fork Coquille headwaters in the 1950s. These activities changed hydrology and sediment transport conditions in the watershed, affecting salmonid fish production. Logging and land clearing for agriculture and other purposes removed large swatches of forest, including from riparian areas. The lower 13.6 miles from Myrtle Point to Dement Creek was historically a floodplain forest dominated by black cottonwood (*Populus trichocarpa*) overstory forest with ash, willow, and Oregon Myrtle composition. Most sections currently reflect a thin strip of riparian forest. Heavy streambank calving related to pasture grazing effects and historical gravel mining from the channel are highly visible in the Broadbent reach. Splash dams damaged riparian vegetation and flushed stream sediment and large wood downstream, scouring bedrock and disconnecting streams from floodplains and wetlands. Moderate levels of mining activities also occurred, with gravel extraction and placer mines in the South Fork and tributaries, including Johnson, Salmon, and Rock Creeks. Forest fires and flooding further degraded habitat in the watershed, including the 1889 forest fire, followed by a flood in 1890 that triggered a large landslide and debris flow on

Salmon Creek that raised river levels 10 to 25 feet and swept down the South Fork to Coquille City.

Today, habitat conditions in the South Fork Coquille subbasin continue to recover from past and current land use degradation. Two primary factors continue to restrict Coho production: lack of habitat complexity, especially for overwintering juveniles, and high summer water temperatures, which limit parr survival. The Coquille TMDL (2025) and the 2015 South Fork Coquille Watershed Action Plan identify geomorphological changes needed to achieve the greatest reduction in stream temperatures along with site potential vegetation restoration in riparian areas. Instream complexity and floodplain connectivity, along with robust riparian restoration, will achieve these water quality goals.

Subbasin-level goals:

- Improve connectivity between mainstem and tributary reaches, especially to cold water refugia.
- Reduce water temperatures to meet DEQ targets; improve geomorphic changes to the SF mainstem channel and enhance riparian conditions.
- Where feasible, provide lateral connection to floodplains.
- Reduce the thermal inertia in the tributaries.
- Increase instream complexity.

Focal Areas in the South Fork Coquille Subbasin

The team identified four focal areas with the best potential for Coho restoration in the South Fork Coquille: Catching Creek, the Headwaters of the South Fork, Johnson Creek, and Salmon Creek.

Catching Creek Focal Area

The Catching Creek focal area provides spawning and overwintering habitat for Coho in the South Fork Coquille subbasin. Primary spawning tributaries within the HUC include Upper Mainstem Catching, the South and Middle Forks, and Ward, Knootz, Roberts, Getty's, and Beaverdam Branch Creeks. The mainstem South Fork Coquille does not support spawning in the reach due to high turbidity levels and unstable gravels during the winter. Efforts continue to address habitat degradation from historical land use practices that caused stream bank erosion, high sediment inputs, and lack of riparian vegetation.

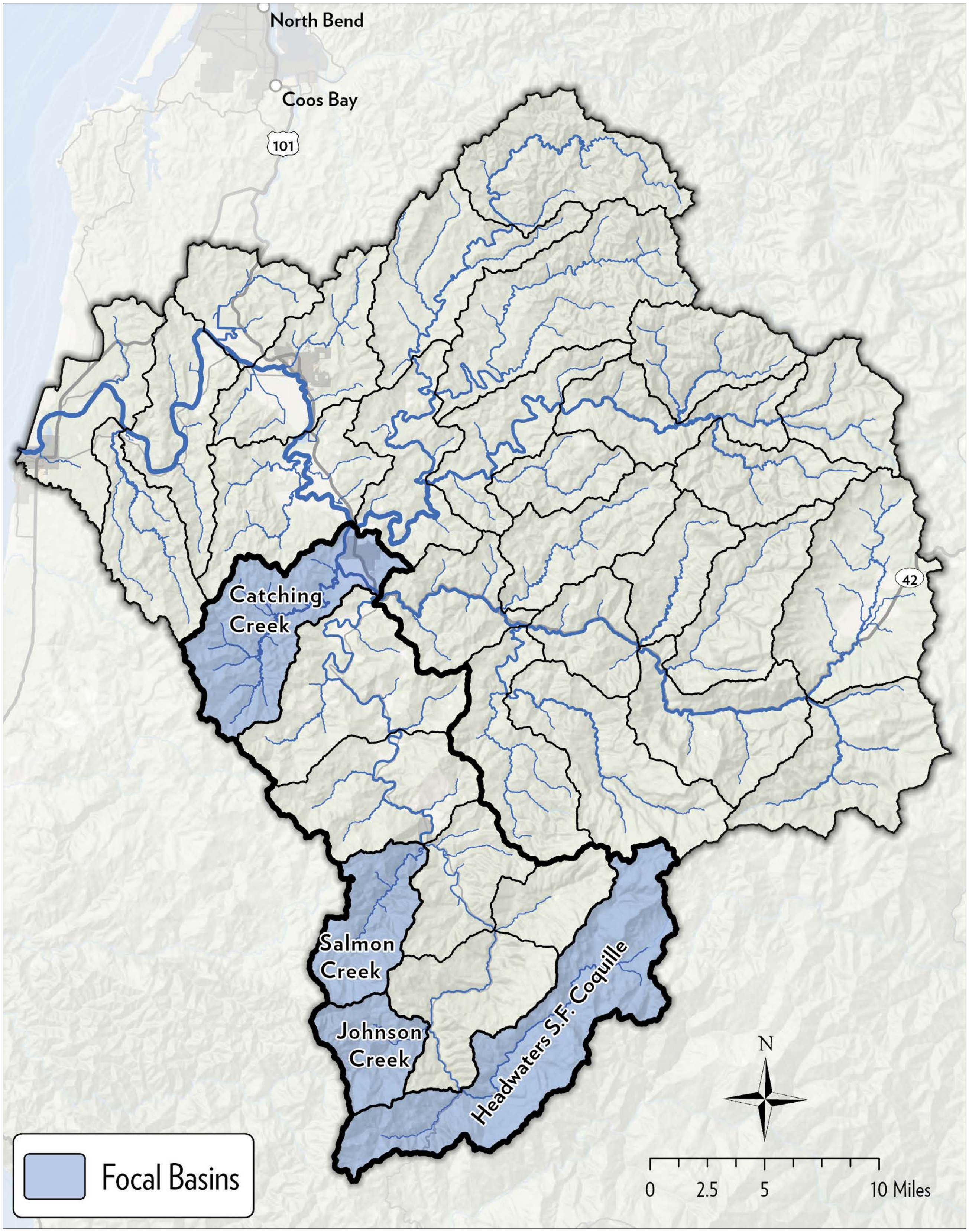
Primary stressors in the mainstem Catching Creek HUC include lack of instream complexity (loss of pools and beaver), decreased riparian function due to livestock grazing, and decreased water quality. Reduced instream complexity due to lack of beaver is the primary stressor in the tributaries.

Focal area Goals:

- Enhance riparian function.
- Increase instream complexity (specifically pools).
- Conduct road assessments to identify opportunities to improve water quality.

South Fork Coquille. Photo: George Ostertag / Alamy

Figure 7.4.1. High-priority focal sub-watersheds in the South Fork Coquille.



Previous restoration and protection accomplishments:

Riparian restoration has been a key restoration tactic in the Catching Creek sub-watershed in recent years. Actions under previous projects have fenced 0.7 miles of stream, planted 1.9 acres of riparian vegetation, pulled back 350 feet of stream bank for stream stability, cleared 0.52 acres of invasive species, and improved two existing livestock crossings and provided another. The Coquille Watershed Association, ODFW, and others continue to build on these efforts, working with landowners to fence additional stream reaches from livestock use, plant riparian vegetation, pull back banks, and address stream crossings. The CoqWA has also installed several bridges and updated culverts to improve fish passage. Ongoing coordination between private landowners and the Coos County Road Department is needed to continue addressing water quality elements on agricultural land on mainstem Catching Creek and within the HUC in general between the mouth and RM 11.2.

Current habitat restoration priorities to increase Coho viability:

- Increase instream habitat complexity in the tributaries through wood placement.
- Increase riparian function along the mainstem through riparian planting and fencing.
- Promote beaver use in tributaries to restore instream complexity and floodplain connectivity.

Actions proposed in the SAP build on these efforts to improve Coho viability in the Catching Creek focal area. They include fencing and planting riparian areas, stabilizing streambanks, and reducing erosion and sediment from upland roads.

Headwaters of South Fork Coquille Focal Area

The Upper South Fork Coquille sub-watershed (above the mouth of Rock Creek) is primarily forested and is mainly public land managed by the U.S. Forest Service. Past land uses, especially timber harvest and mining activities, have affected habitat conditions in the upper South Fork Coquille sub-watershed. Past logging activities included splash damming, removal of riparian conifers, and building roads along streams.

Today, the sub-watershed continues to display the effects of these activities. Stressors reduce the production of juvenile Coho in the upper South Fork Coquille mainstem, including decreased instream complexity (large wood), reduced water quality (turbidity), and loss of riparian function. The lack of large-wood inputs also affects conditions downstream, including stream temperature.

Focal area goals:

- Improve riparian function and reduce stream temperatures.
- Increase instream complexity.
- Reduce sediment delivery from legacy logging and other public-use roads.
- Conduct road assessments to identify opportunities to improve water quality.

Previous restoration and protection accomplishments:

The U.S. Forest Service, ODFW, and others have implemented a few projects to improve water quality in the upper South Fork Coquille sub-watershed. While South Fork Falls, a waterfall just upstream from Rock Creek on the mainstem South Fork, restricts Coho movement, water quality in the upper watershed is highly relevant for Coho production and abundance downstream of the falls.

Current habitat restoration priorities to increase Coho viability:

- Increase instream habitat complexity in the South Fork headwaters by improving beaver habitat.
- Decrease water quality in the South Fork headwaters.

The actions proposed in the SAP will build on previous efforts to improve Coho habitat in the South Fork headwaters. Although the Upper South Fork Coquille sub-watershed is without anadromous fish access due to South Fork Falls, actions to improve instream habitat complexity and water quality by the placement of large wood to provide pools, reduce sediment loads, and increase cold water retention will yield dividends for fish downstream. Strong enhancement of beaver habitat and expansion of beaver dam activity is anticipated to increase summer water volume during low flows. Some hyporheic reentry of water from beaver complexes may also reduce summer temperatures.

Johnson Creek Focal Area

The Johnson Creek focal area offers some of the largest potential for Coho production in the South Fork Coquille watershed. Coho spawning primarily occurs within mainstem Johnson, Nickel, and Sucker Creeks within the HUC. The focal area does not include the mainstem South Fork Coquille River. Much of mainstem Johnson Creek displays a moderate gradient constrained by hillslopes, except for a small reach of the lower mainstem with available side channel habitat. The sub-watershed contains cold water refugia that could safeguard juvenile Coho in future years when water temperatures increase in the South Fork Coquille subbasin.

Past mining for gold and other minerals, timber harvest, and other land uses have affected habitat conditions in the Johnson Creek watershed. As with other streams, historical logging and stream cleaning have removed much of the LWD component.

The primary stressors in mainstem Johnson Creek are decreased water quality (sediment from China Flat road) and reduced instream complexity. Reduced instream complexity is also the primary stressor in the tributaries.

Focal area goals:

- Enhance riparian function to increase large-wood inputs.
- Decrease stream temperatures (year-round).

Previous restoration and protection accomplishments:

Little, if any, substantive fish restoration work has been conducted to date in the Johnson Creek sub-watershed. This has been mainly due to the limited road access along the creek, although ridge roads are present in moderately high density. Increasing instream complexity (large wood and pools) in Johnson Creek and tributaries and improving water quality have been identified as the best means to alleviate the freshwater bottlenecks for juvenile Coho abundance and productivity in Johnson Creek. Managing road-generated sediments remains a priority for increasing Coho and other anadromous fish production in the sub-watershed.

South Fork Coquille Falls. Photo: ODFW / Alan Ritchey

Current habitat restoration priorities to increase Coho viability:

- Increase instream habitat complexity in mainstem Johnson Creek and tributaries.
- Increase water quality in Johnson Creek mainstem and tributaries.

Salmon Creek Focal Area

Salmon Creek is the largest tributary to the South Fork Coquille and is considered a key watershed for salmon recovery in the Coquille River system. Most Coho spawning within the focal area is within mainstem Salmon Creek; however, some use also occurs in Pyburn, Flannigan, and Dude Creeks. This HUC does not include any reach of the mainstem South Fork Coquille River. Summer and overwinter rearing occurs primarily within the mainstem Salmon Creek, with many fish considered to migrate in late fall downstream to mainstem South Fork Coquille reaches and floodplain habitats downstream of Myrtle Point.

Past mining for gold and other minerals, and later for gravel, as well as timber harvest and other land uses, have affected habitat conditions in the Salmon Creek watershed. Clearcutting activities and road construction on sensitive soils eroded banks, leading to landslides and debris flows that delivered sediment to downstream areas. The upper Salmon Creek watershed has had homestead-era pasture grazing on wetland meadows since the 1800s, resulting in highly degraded riparian habitats, lack of beaver food abundance, and high solar input to several tributaries. Splash damming may or may not have been implemented within the main Salmon Creek; however, single log transport on high flows likely occurred. Stream cleaning implemented historically removed LWD and greatly reduced hydrology forces that form fish habitats.

Primary stressors in the mainstem Salmon Creek include decreased instream complexity (lack of wood) and decreased water quality due to sediment. Salmon Creek is also listed as water quality limited for temperature (RM 0 to 9.2).

Focal area goals:

- Enhance riparian function.
- Increase large-wood inputs.
- Increase access to off-channel habitats.
- Conduct road assessments to identify opportunities to improve water quality.

Road erosion in South Fork Coquille near Salmon Creek. Photo: ODFW

Previous restoration and protection accomplishments:

A moderate number of rock weirs were installed in the 2000 to 2010 era in the very lower reaches of Salmon Creek. These provided spawning gravel accumulation for fall Chinook. Most Coho spawning occurs upstream of that reach.

Current habitat restoration priorities to increase Coho viability:

- Increase instream habitat complexity, including wood, in the mainstem Salmon Creek.
- Improve riparian function along the mainstem Salmon Creek.

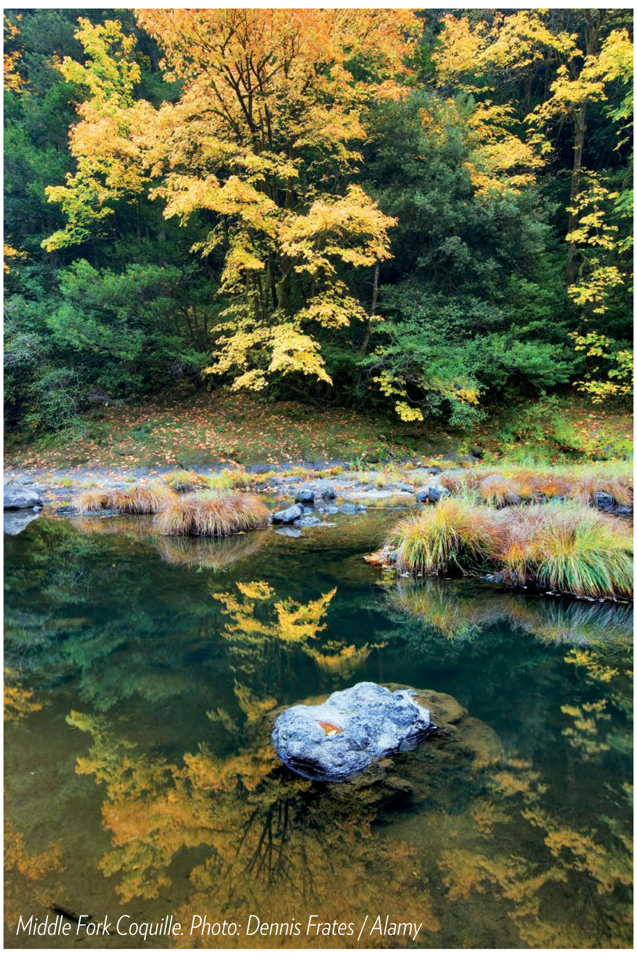
The Coquille Watershed Association and ODFW have proposed actions in the SAP to further improve habitat conditions for Coho in Salmon Creek. These actions will increase instream diversity and complexity through large wood and boulder placements. They will also improve riparian functions through fencing and planting riparian vegetation, stabilize banks, and improve upland roads to reduce erosion and sediment.

7.5 Middle Fork Coquille Subbasin Focal Areas

The Middle Fork Coquille River is a tributary to the South Fork Coquille River, joining the South Fork just southeast of Myrtle Point. The river extends 40 miles from its mouth to the headwaters in Camas Valley in the Coast Range (Figure 7.5.1). Draining 310 square miles, it is the largest of the Coquille River subbasins. Many tributaries to the Middle Fork are moderate to high-gradient, single-channel systems constrained by hillslopes or terraces.

Overview of Land Use and Conditions in the Middle Fork Coquille Subbasin

Primary land uses in the Middle Fork Coquille watershed include timber production, agriculture, and livestock grazing. The BLM manages 5,400 acres of forest lands in the Middle Fork watershed. Historical logging and splash damming, with three splash dams on the Middle Fork, radically altered stream channels, floodplains, and species composition of riparian communities. Splash damming flushed riparian vegetation, sediments, and large-wood debris downstream, scouring channels to bedrock and reducing connectivity to floodplains. Today, riparian areas along many creeks in the Middle Fork watershed are dominated by red alder and other hardwood species with a distinct lack of conifers. The low amount of riparian conifers has led to a deficiency of large-wood debris, limiting instream structural complexity, pool habitat, and gravel retention. These instream conditions limit juvenile rearing and refuge habitat. Many reaches also contain undesirable levels of fine sediment.


Middle Fork Coquille. Photo: Dennis Frates / Alamy

Coho production in the Middle Fork watershed is limited by reduced water quality, including temperatures and sediment (Burns 1970, Hall and Lanz 1969, Weiser and Wright 1988, Suttle et al. 2004, Tripp and Poulin 1992, Waters 1995); reduced connectivity to floodplains, wetlands, and off-channel areas; and decreased instream habitat complexity, with a limited supply of large coniferous wood in riparian areas and low pool frequency and depth. A road assessment is needed throughout the watershed to identify areas where erosion and sediment input can be reduced.

Subbasin-level goals:

- Improve water quality (reduce water temperature, sediment input, and bacterial loading).
- Increase longitudinal connectivity.
- Increase instream complexity.
- Conduct road assessment in this watershed.

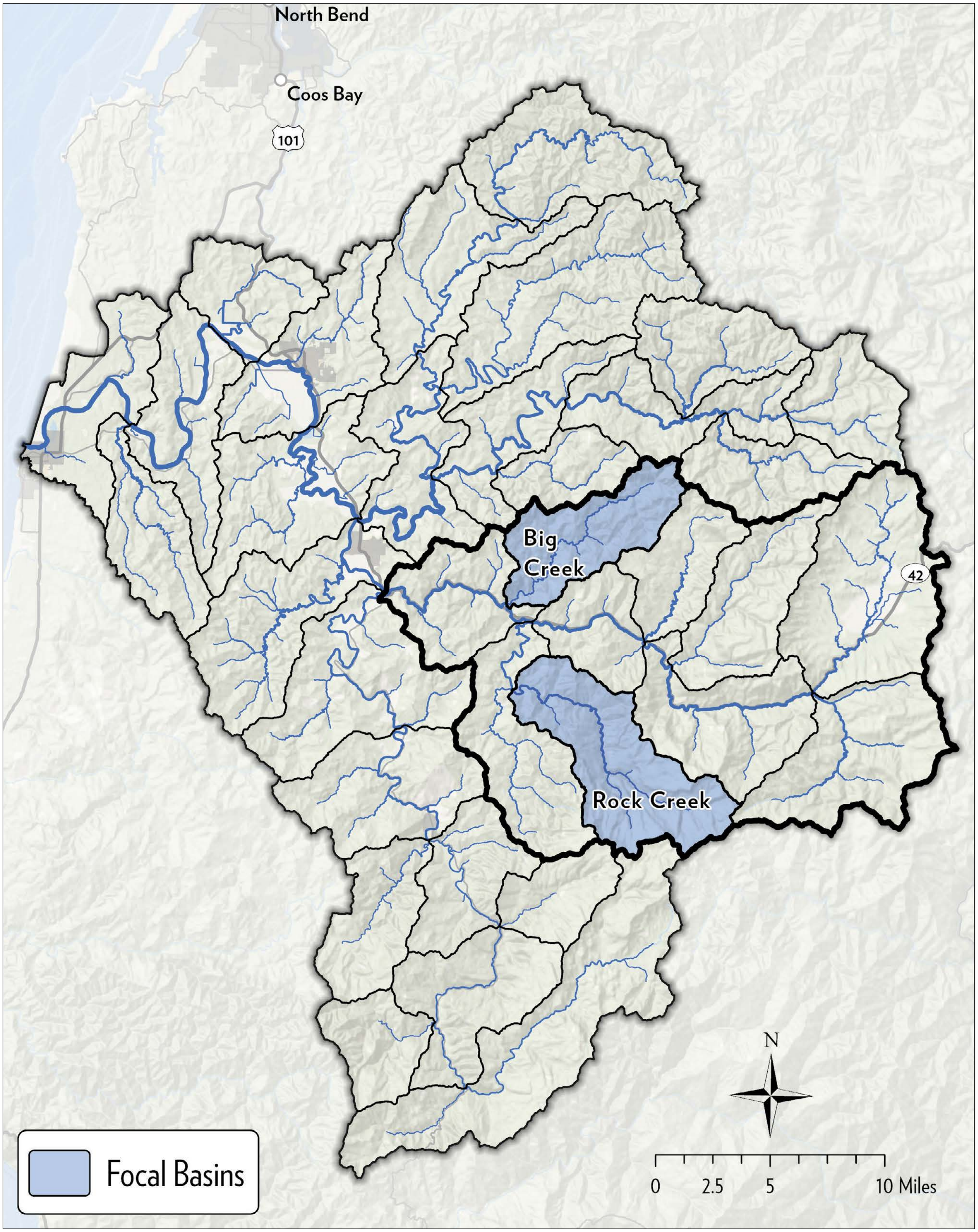
Focal Areas in the Middle Fork Coquille Subbasin

The team identified two focal areas with the best potential for Coho restoration in the Middle Fork Coquille watershed: Big Creek and Rock Creek.

Big Creek Focal Area

Big Creek enters the mainstem Middle Fork Coquille from the north, at Bridge, Oregon. Coho spawning and rearing within the Big Creek HUC is primarily in the mainstem, with some use of Brownson, Bear Pen, Axe, and Fall Creeks. The focal area HUC does not include any segments of the mainstem Middle Fork Coquille River. Excess summer parr likely migrate to the mainstem Middle Fork Coquille to overwinter, or to floodplain habitats downstream of Myrtle Point. Primary land use along Big Creek is timber production. The sub-watershed provides overwintering habitat for Coho, but the quality of

Figure 7.5.1. High-priority focal sub-watersheds in the Middle Fork Coquille.




Culvert failure on Middle Fork Coquille. Photo: ODFW

the rearing habitat is limited due to past land use activities that removed conifer trees from riparian areas, reducing levels of large-wood debris in streams. The remaining deciduous trees provide shade along many reaches. Habitat quality in the Big Creek sub-watershed has been affected by timber harvest alterations to hydrology, sediment inputs from road networks, and a loss of instream complexity through stream cleaning and reduction of riparian forest age/density.

The primary stressors for Coho in the Big Creek focal area are reduced riparian function (primarily lack of LWD recruitment), decreased instream complexity, and reduced water quality (increased sediment).

Focal area goals:

- Increase instream complexity.
- Conduct a road assessment to identify sediment inputs.
- Increase riparian function.


Road failure in Coquille River basin. Photo: Coquille Watershed Association

Previous restoration and protection accomplishments:

The Coquille Watershed Association, BLM, ODFW, timber companies, and others have completed a number of restoration projects in Big Creek and its tributaries to restore instream complexity for Coho and other anadromous and resident fish species. Projects include placing 459 trees/logs at 89 sites over 4.5 miles of stream over the past 25 years. Still, many of the structures can be further enhanced through additional wood augmentation to improve effectiveness, and a number of additional reaches still need to be restored.

Current habitat restoration priorities to increase Coho viability:

- Increase instream habitat complexity in lower Big Creek.
- Increase riparian function along lower Big Creek.

Actions proposed in this SAP for the Big Creek sub-watershed will build on previous efforts by enhancing large-wood debris and boulder structures as needed in the previously treated 4.5 miles, and installing structures on an estimated additional 4.0 miles of stream. These structures will greatly enhance gravel collection and sorting in addition to developing the hydrology necessary for the creation of summer and winter rearing pools with in-water structure for hiding cover. The projects will also stabilize stream banks and fence and plant riparian areas to improve riparian health as needed.

Rock Creek Focal Area

Rock Creek enters the Middle Fork Coquille River from the south at Bridge. Spawning and rearing within the focal area is predominantly within mainstem Rock Creek, with some use of Rasler Creek. The HUC does not include any segments of the Middle Fork Coquille River. This watershed likely has the highest overall density of forest road network within the Coquille Basin. The steep slopes associated with these roads result in large mass wasting events and subsequent high sediment delivery to Rock Creek. Although not fully investigated, Rock Creek is likely the greatest contributor of sediment to the Middle Fork Coquille River, other than the upper Middle Fork Camas Valley HUC. Habitat quality in the Rock Creek sub-watershed has also been reduced by timber harvest effects on stream hydrology and the reduction of large conifers in riparian areas. Large wood quantity, pool frequency, and stream complexity in Rock Creek are also well below targets.

The primary stressors for Coho in Rock Creek are decreased water quality (specifically turbidity), reduced riparian function, decreased instream complexity, and reduced lateral connectivity.

Focal area goals:

- Improve water quality, especially sediment.
- Increase riparian function.
- Increase stream complexity.
- Conduct a road assessment to identify high-risk areas contributing excess sediments.

Previous restoration and protection accomplishments:

The Coquille Watershed Association, ODFW, and other partners have completed several projects in the Rock Creek sub-watershed to restore stream complexity and riparian health, and enhance Coho habitat. Efforts have aimed to restore the natural processes in sections of Rock Creek by adding large wood and boulders, planting riparian areas, and creating a side channel to provide an area of refuge for juvenile Coho.

Current habitat restoration priorities to increase Coho viability:

- Improve water quality in lower Rock Creek.
- Increase habitat complexity in Rock Creek.
- Increase riparian function along Rock Creek.

Actions proposed in this SAP will build on previous efforts by placing large-wood debris and boulders along 8 miles to provide stream structure and complexity, and to increase cold water retention. The projects will also stabilize streambanks, improve upland roads to reduce sediment, and fence and plant riparian areas to improve riparian health.

Middle Fork Coquille Falls. Photo: ODFW

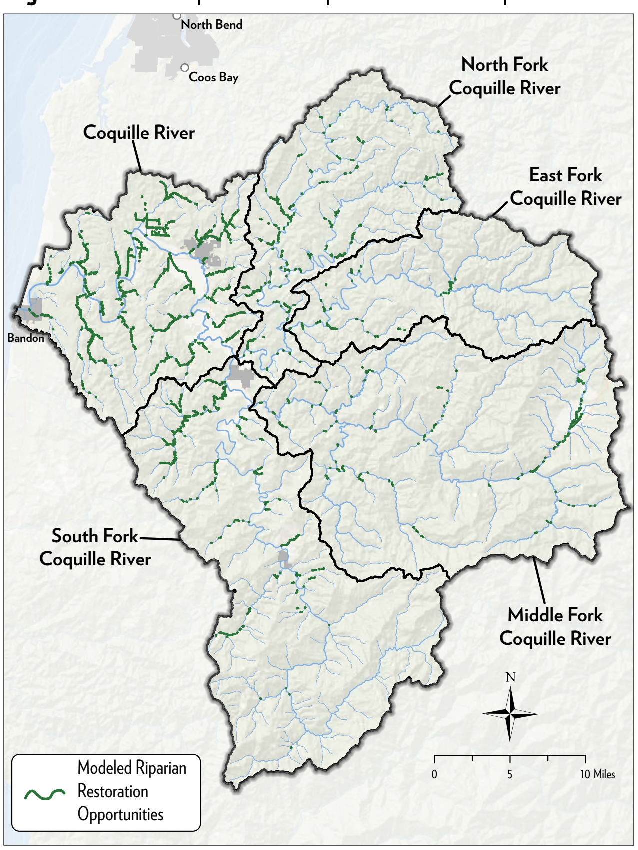
Chapter 8

Long-term Strategies, Outcomes, and Short-term Work Plan

8.1 Long-term Strategies, Outcomes, and Actions

The Coquille Coho SAP contains a prioritized list of habitat protection and restoration strategies developed to support the viability of the independent Coquille population of OC Coho (Figure 8.1). The Coquille Coho SAP takes a long-term (2024-2045) outlook on the strategies needed to ameliorate the stresses and threats, and provides a short-term work plan (2024-2030) to begin implementing projects in the highest-priority focal sub-watersheds that advance the long-term objectives described below.

Figure 8.1. Net-map identified riparian restoration priorities.



Strategy 1. Enhance riparian function along Coquille mainstem and tributaries

Outcome #1: By 2045, 40% of low- to moderate-functioning riparian habitat in focal sub-watersheds is enhanced to protect or sustain cold water inputs and ensure sustainable recruitment of large wood.

Actions to enhance riparian function

- Native planting to reduce thermal loading/ thermal barriers
- Fencing and riparian setbacks, establishing of riparian buffers and livestock exclusions
- Invasive vegetation management, treatment, and reduction
- A steady funding source for fencing maintenance and riparian management
- Conservation easements for long-term protection of riparian function

Strategy 2. Protect flows and water quality in headwaters and enhance water quality in mainstems

Outcome #2: By 2045, restoration actions have reduced or maintained water temperatures on >120 miles of juvenile summer rearing habitat (5.5 miles/year).

Outcome #3: By 2045, aquatic invasive species (specifically smallmouth bass) distribution in tributaries has been reduced by 50% through improved water quality, water quantity, and riparian management.

Actions to enhance water quality and quantity

- Instream water rights acquisitions
- Cold water source/refugia identification and protection
- Forest stand management
- Agricultural land management improvements (increased efficiency, updated irrigation systems, pasture/crop management, ODA SIA areas, conservation easements/acquisition)
- Livestock management strategies to improve water quality (i.e., bacteria, sediment, bio-solids, and fencing)
- Improved management of storm runoff and road decommissioning
- Increased/promoted beaver-initiated pond storage

Figure 8.1.1 Long-term strategies identified in Coquille Basin focal watersheds.

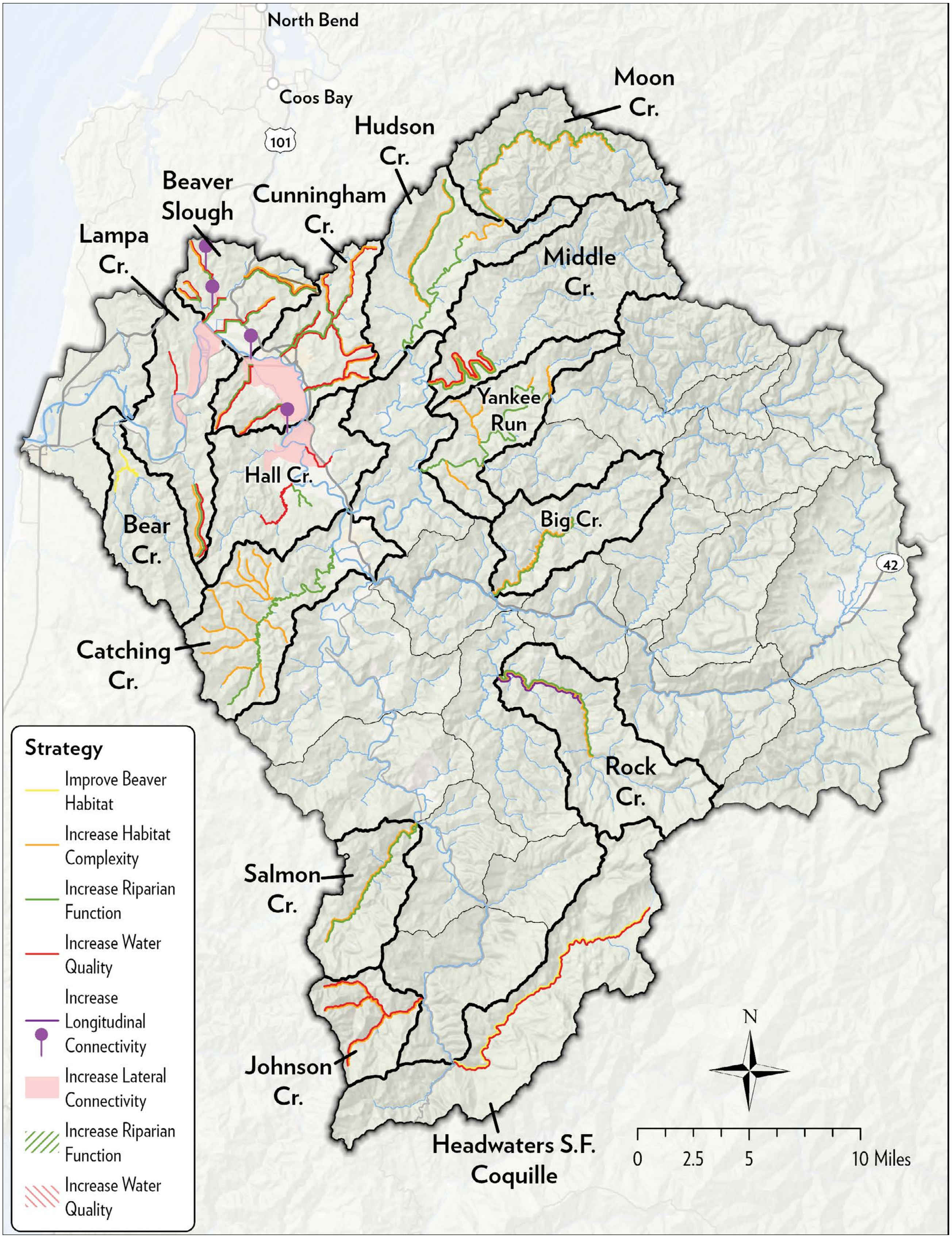
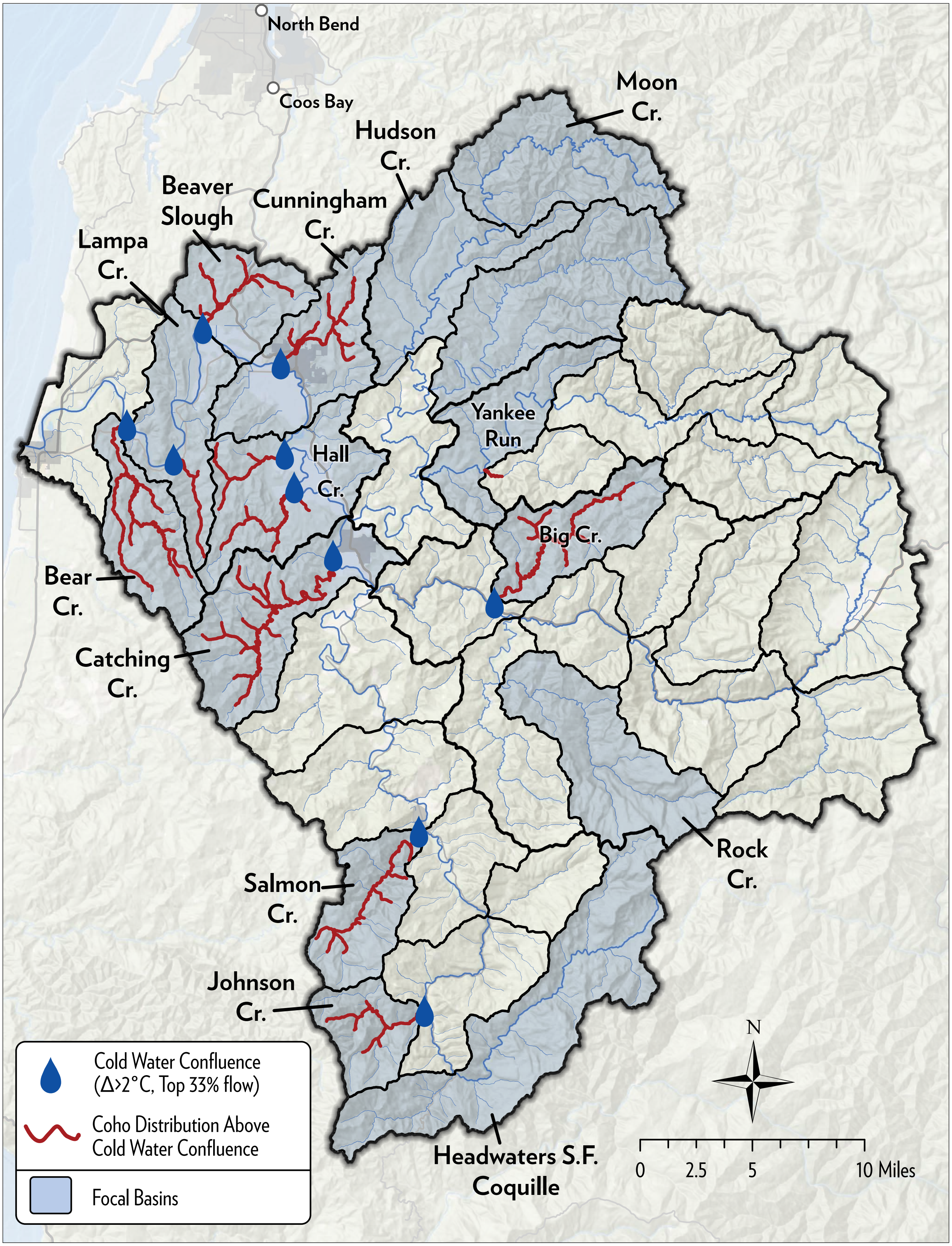


Figure 8.1.2. Cold water sources in focal sub-watersheds.



Strategy 3. Increase instream complexity and lateral connectivity in Coquille mainstem and tributaries

Outcome #4: By 2045, restoration actions have increased year-round rearing capacity to such an extent that freshwater habitats are not limiting juvenile productivity in focal sub-watersheds.

Outcome #5: By 2045, restoration actions have restored connection to 400 acres of full tidal wetlands, off-channel or floodplain areas (18.1 acres/year).

Outcome #6: By 2045, restoration actions have restored connection to 1,000 acres of managed tidal wetlands, off-channel or floodplain areas (45.5 acres/year).

Actions to increase complexity and laterally connect

- LWD/boulder placement in tributaries and mainstems (2nd–6th order)
- Beaver reestablishment and beaver dam analogues (BDAs) in 2nd- and 3rd-order streams
- Process-based restoration, re-meander streams, floodplain connectivity
- Management for late successional tree and shrub species in riparian zones and upslope of tributary anchor habitats

Strategy 4. Increase public outreach regarding climate change, habitat needs and restoration strategies

Outcome #7: By 2030, contact has been initiated, with the intent to engage all public and private landowners in focal sub-watersheds containing habitats identified for protection or restoration.

Actions for outreach

- Engage private agricultural landowners
- Engage private timber landowners
- Engage rural residential landowners
- Engage city, county, state, and Tribal governments
- Increase education to local schools
- Engage social media, recreational user groups, conservation groups

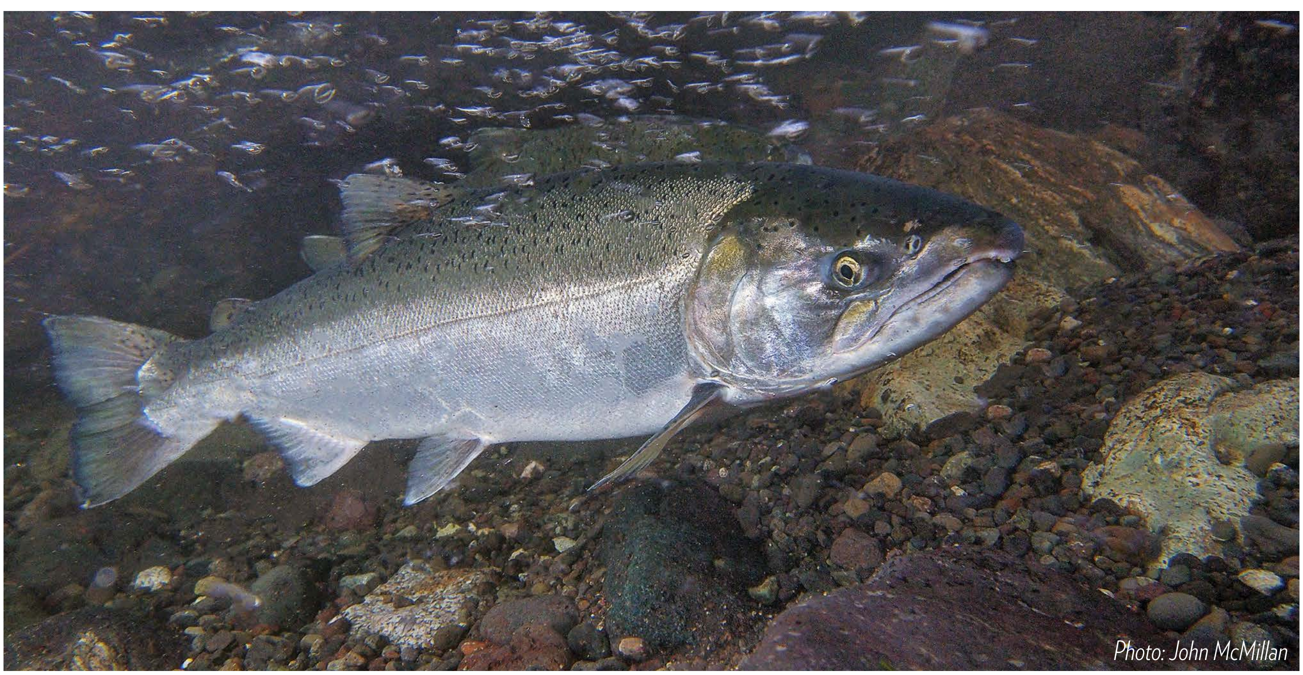


Photo: John McMillan

Figure 8.1.4. Long-term strategies and focal areas identified in the Lower Coquille.

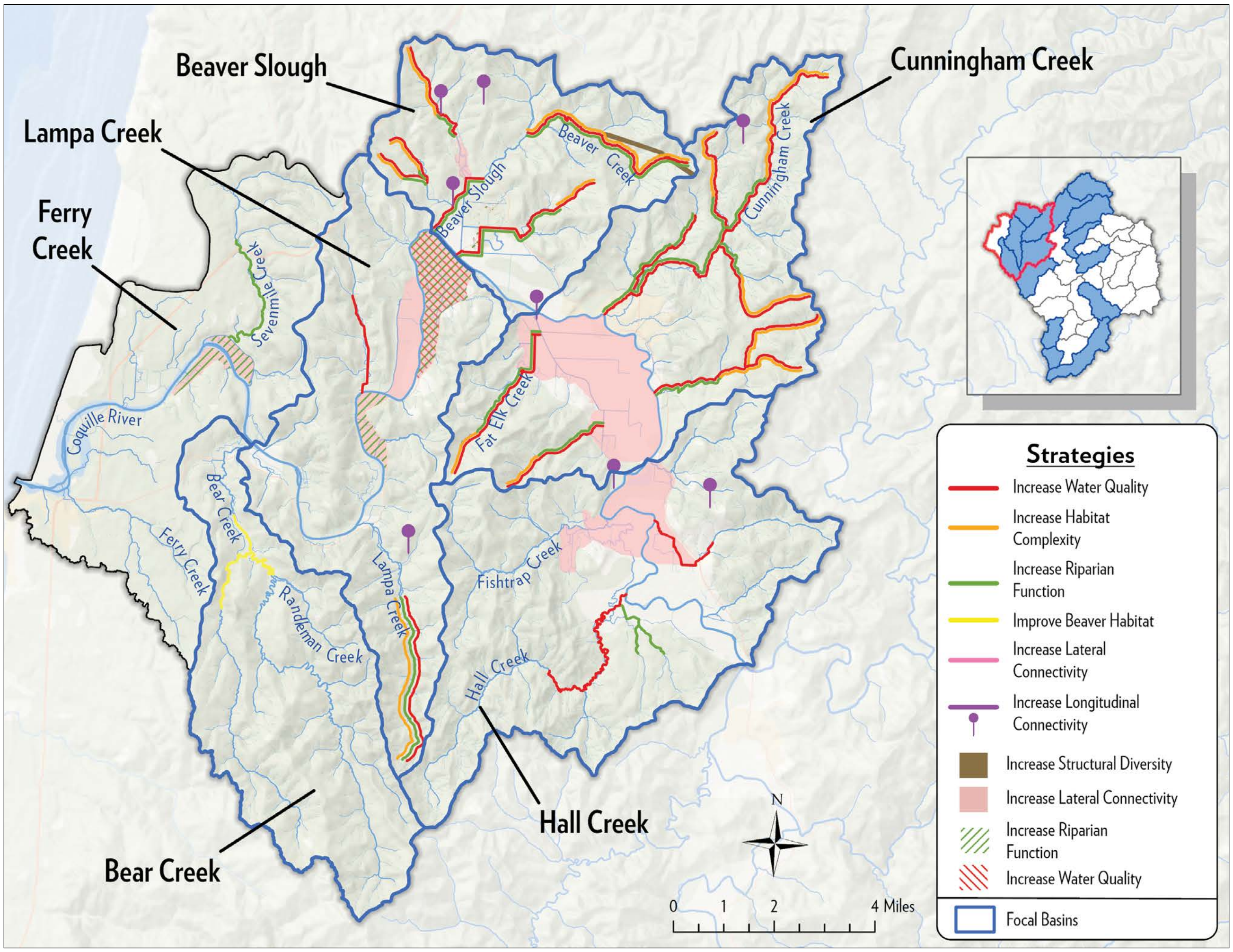


Figure 8.1.5. Long-term strategies and focal areas identified in the North Fork Coquille.

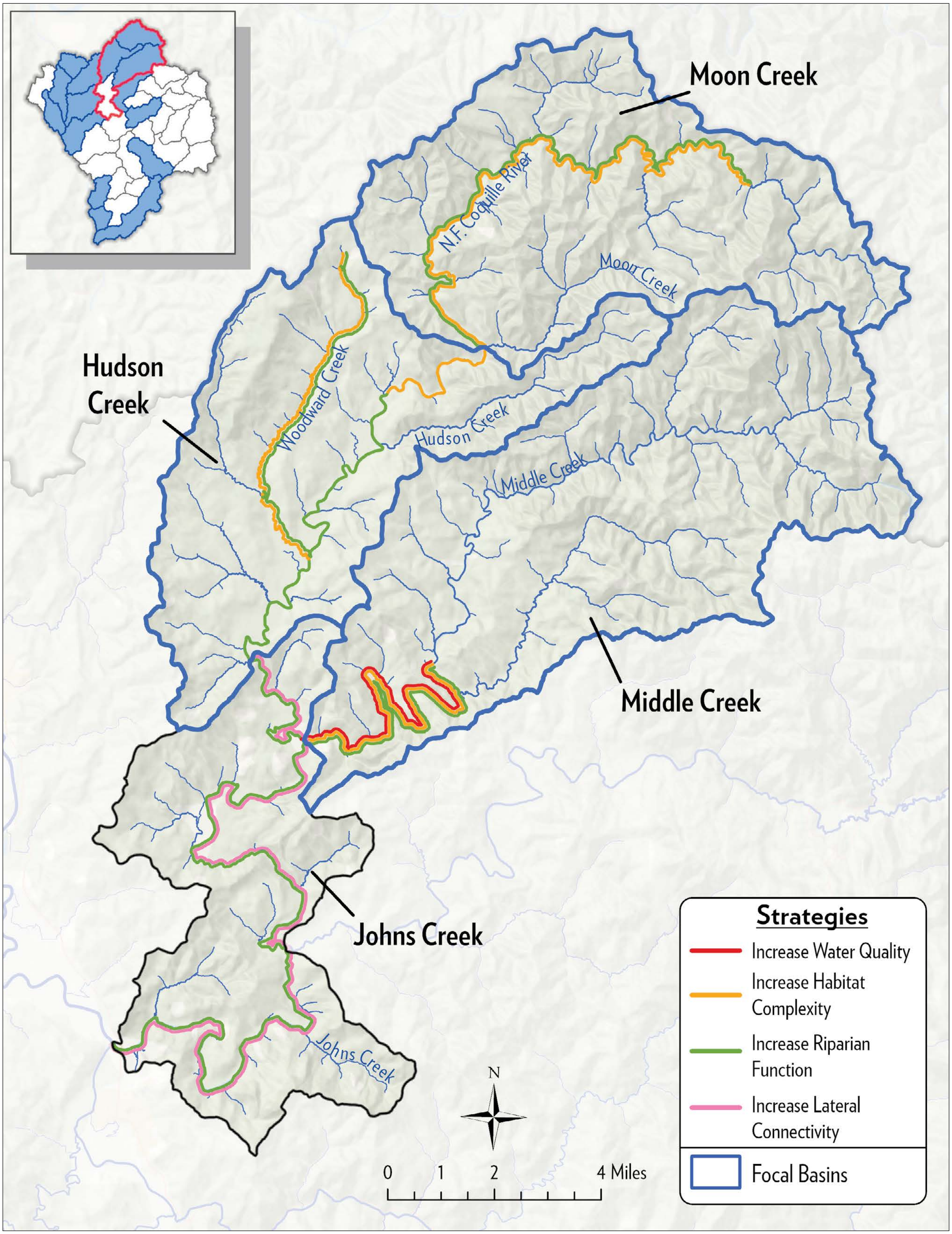


Figure 8.1.6. Long-term strategies and focal areas identified in the East Fork Coquille.

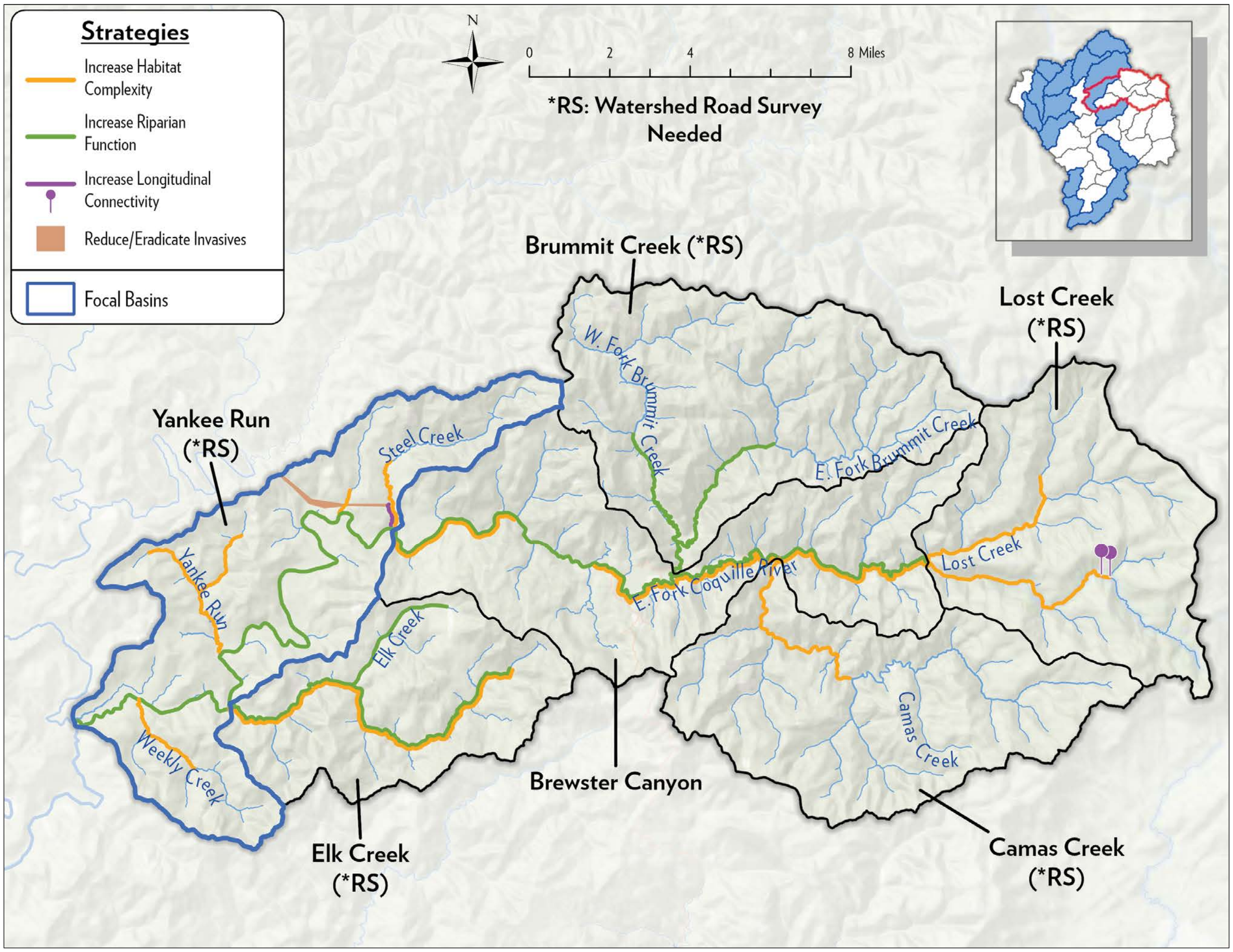


Figure 8.1.7. Long-term strategies and focal areas identified in the Middle Fork Coquille.

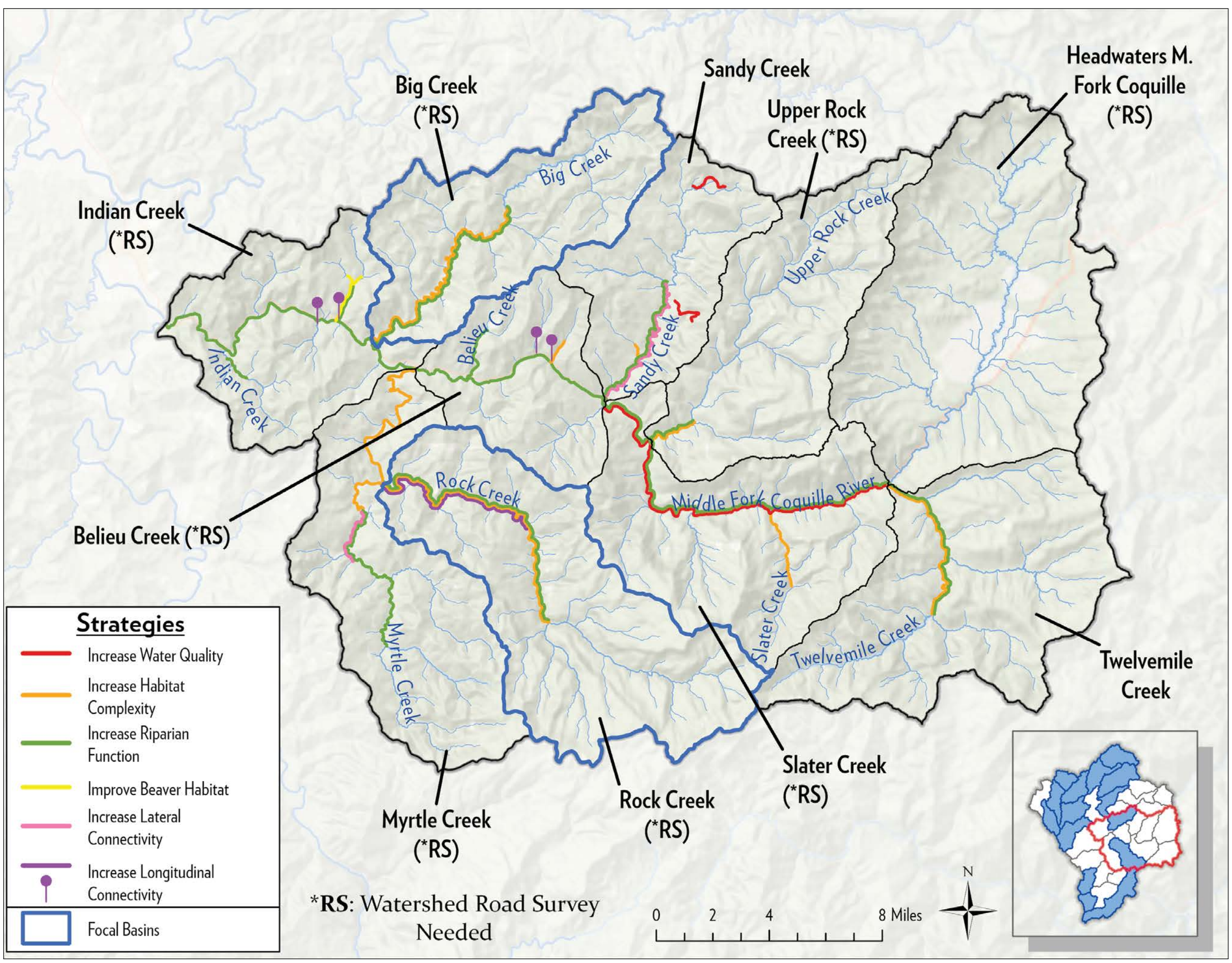


Figure 8.1.8. Long-term strategies and focal areas identified in the South Fork Coquille.

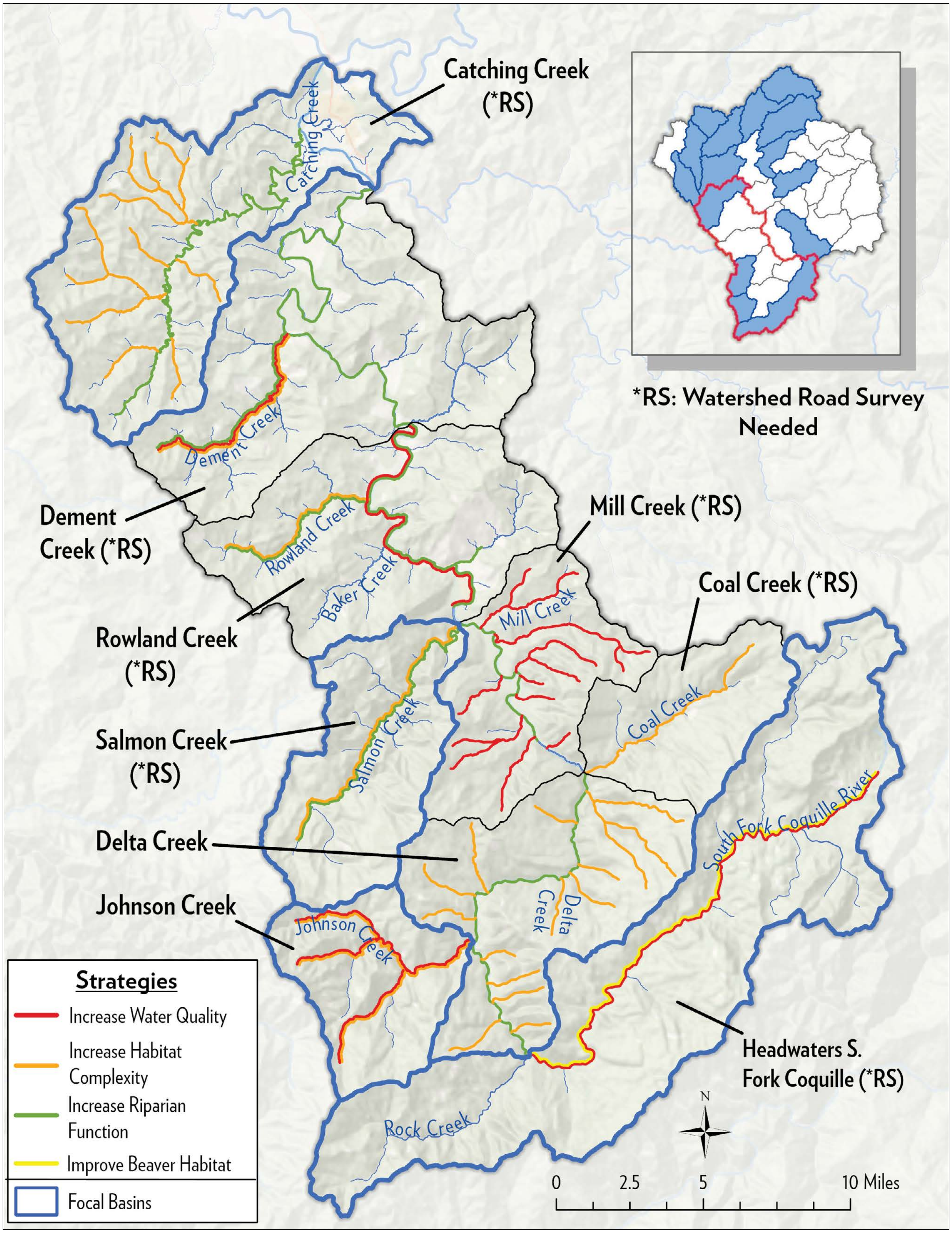
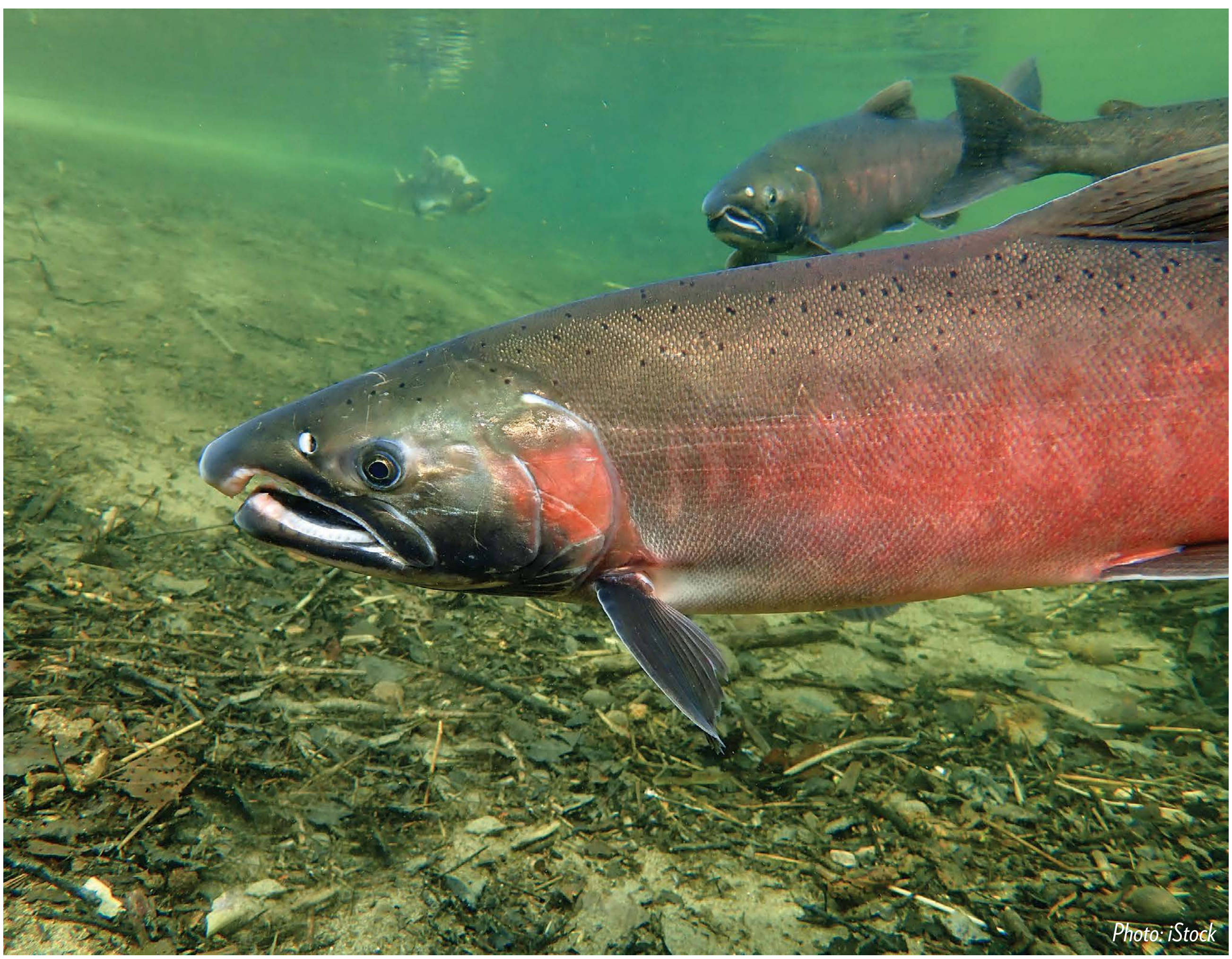


Table 8.1.1. Summary of the long-term outcomes (2024-2045), by strategy, in high-priority focal sub-watersheds.

KEAS RESTORED OR ENHANCED (2024-2045)	Lower Coquille	North Fork Coquille	East Fork Coquille	Middle Fork Coquille	South Fork Coquille	Strategy Totals in Focal Areas
Improved Water Quality (miles)	62	9	0	14	67.3	**152**
Increased Instream Complexity (acres)	30	138	160	153	201.3	**683**
Enhanced Riparian Function (acres)	2,862	873	739	1,044	1,256.5	**6,775**
Increased Longitudinal Connectivity (miles)	1	0	1	6	0	**8**
Fish Passage Barriers Removed/Upgraded	11	0	2	4	0	**17**
Increased Lateral Connectivity (acres)	7,297	253	0	84	0	**7,634**



8.2 Short-term Implementation

The short-term work plan (2024 to 2045) includes projects and actions in focal areas that align with the long-term strategies and set a path to meet the long-term outcomes.

Table 8.2.1. Short-term projects identified in high-priority focal areas. Project name, lead agency or organization, and implementation year.

Project Number	Project Name	Project Lead	2024-2026	2026-2028	2028-2029
1	Moon Creek Basin Assessment	CoqWA	X		
2	Middle Creek Basin Assessment	CoqWA	X		
3	Hudson Creek Basin Assessment	CoqWA	X		
4	Catching Creek Basin Assessment	CoqWA	X		
5	Big Creek Basin Assessment	CoqWA	X		
6	Rock Creek Basin Assessment	CoqWA	X		
7	Salmon Creek Basin Assessment	CoqWA		X	
8	South Fork Headwaters Basin Assessment	CoqWA		X	
9	Woodward Creek Basin Assessment	CoqWA	X		
10	Woodward Creek Road Realignment	CoqWA/BLM	X		
11	Woodward Creek Tributary Fish Passage	CoqWA/BLM	X		
12	Cunningham Creek Riparian Enhancements	CoqWA/SWCD	X	X	
13	Coaledo Tide Gate Replacement & Beaver Slough Fish Passage Project	CoqWA	X		
14	Bear Creek Riparian Enhancements	SWCD	X	X	X
15	Wooden Rock Creek	USFS/CoqWA	X	X	
16	Albertson Creek (Lower Coquille unnamed trib) Tide gate Replacement	SWCD	X	X	
17	Gatov Creek (Lower Coquille unnamed trib) Tide gate Replacement	SWCD	X	X	
18	Winter Lake Phase III Floodplain Enhancement	SWCD	X	X	
19	SFCR Off-Channel Refugia	CoqWA/ODFW	X		
20	Honcho Creek Fish Passage Culvert	BLM	X		
21	Beaver Hill Wetland Reserve Restoration & NBL Fish Passage Upgrades	CoqWA/USFWS	X		
22	Culbertson Off-Channel Refugia and Riparian Restoration	SWCD/ODFW		X	X
23	Cherry Cr to Mouth of Middle Cr	CoqWA/BLM		X	X

Figure 8.2.1. Short-term projects identified in the Lower Coquille.

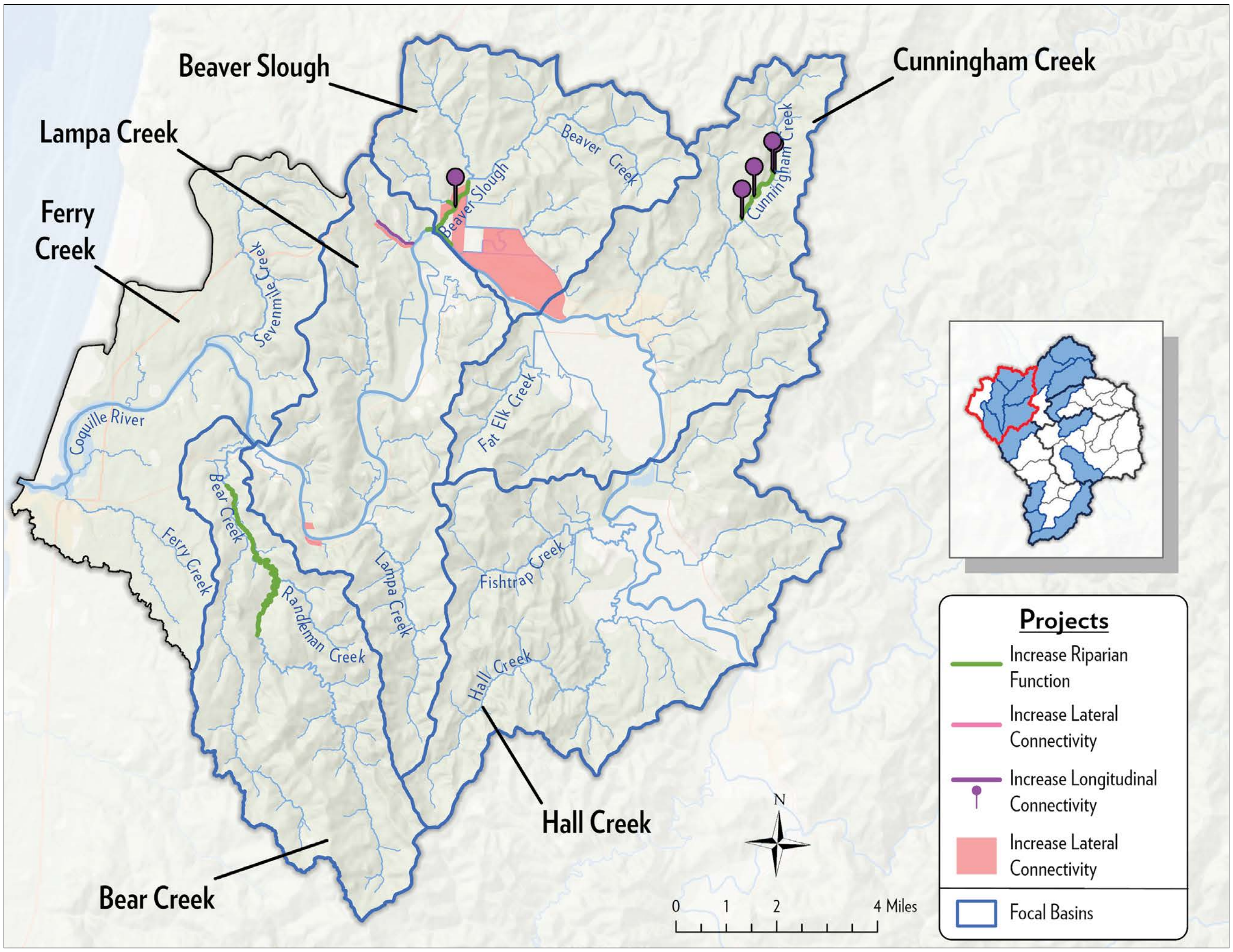


Figure 8.2.2. Red star indicatesshort-term projects identified in the North Fork Coquille. Red stars indicate that a whole sub-watershed assessment is needed. Sub-watershed assessments will identify the next round of projects to be implemented (2030-2036).

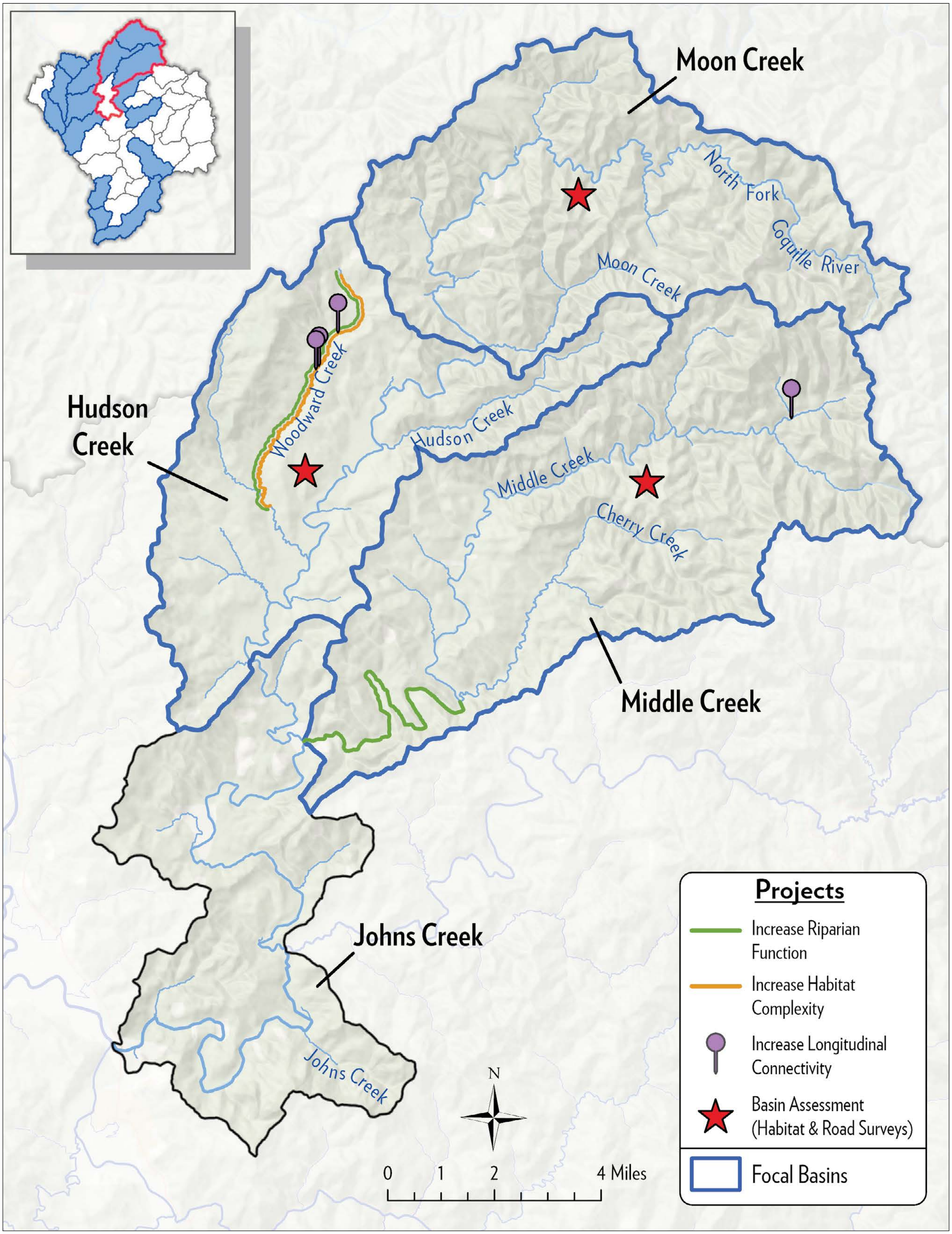


Figure 8.2.3. Red star indicates short-term projects identified in the East Fork Coquille.

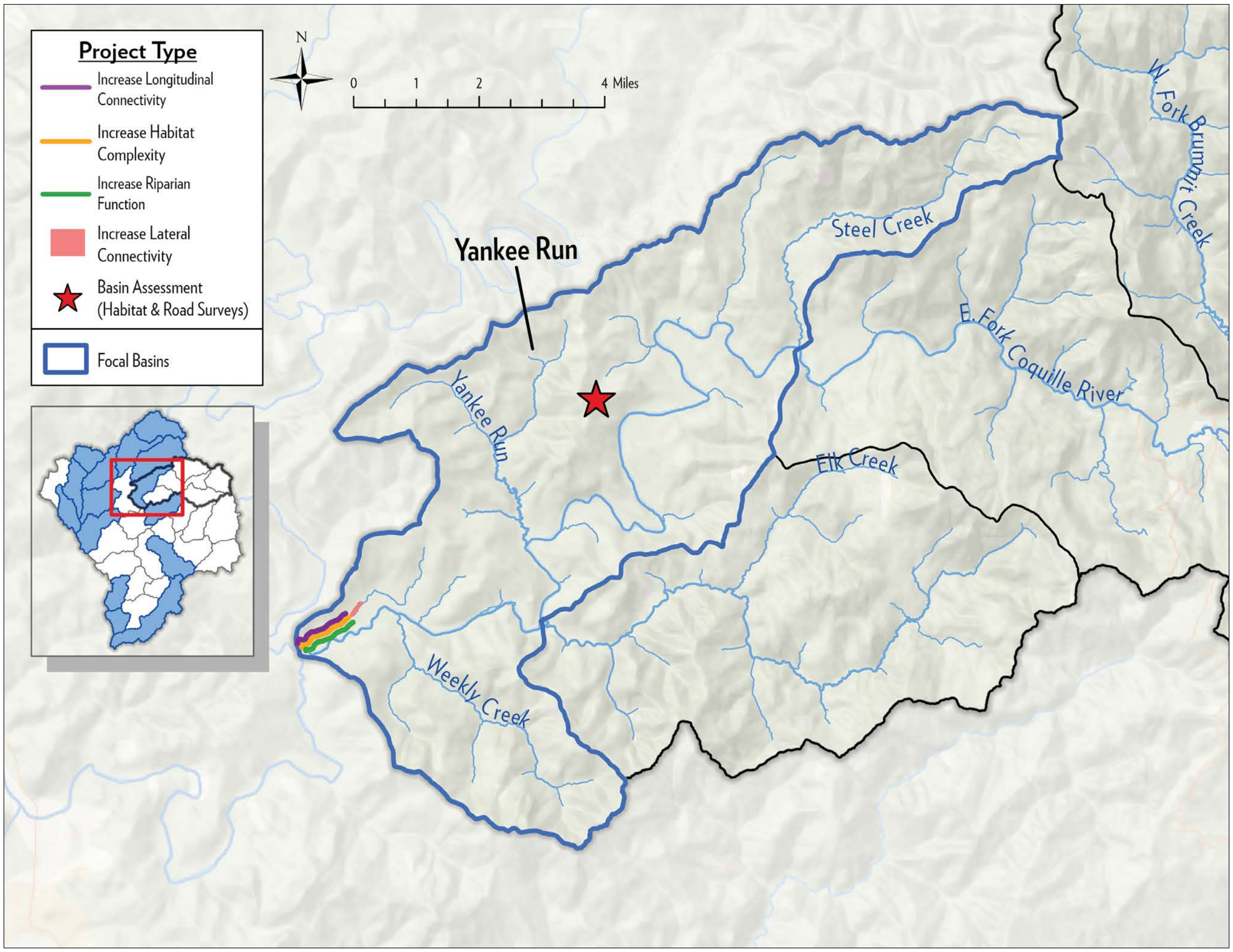


Figure 8.2.4. Red star indicates short-term projects identified in the Middle Fork Coquille. Red stars indicate that a whole sub-watershed assessment is needed. Sub-watershed assessments will identify the next round of projects to be implemented (2030-2036).

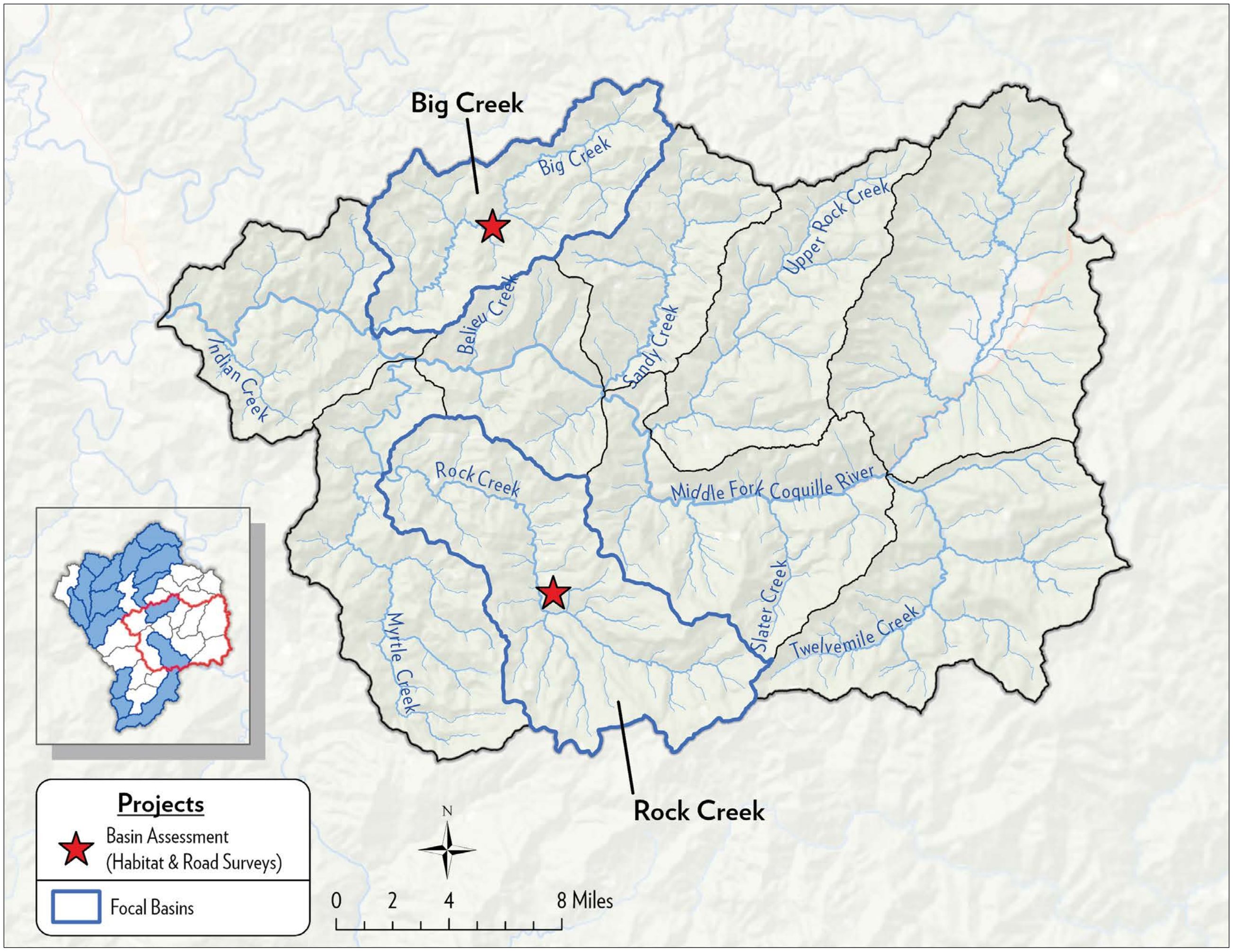


Figure 8.2.5. Red star indicates short-term projects identified in the South Fork Coquille. Red stars indicate that a whole sub-watershed assessment is needed. Sub-watershed assessments will identify the next round of projects to be implemented (2030-2036).

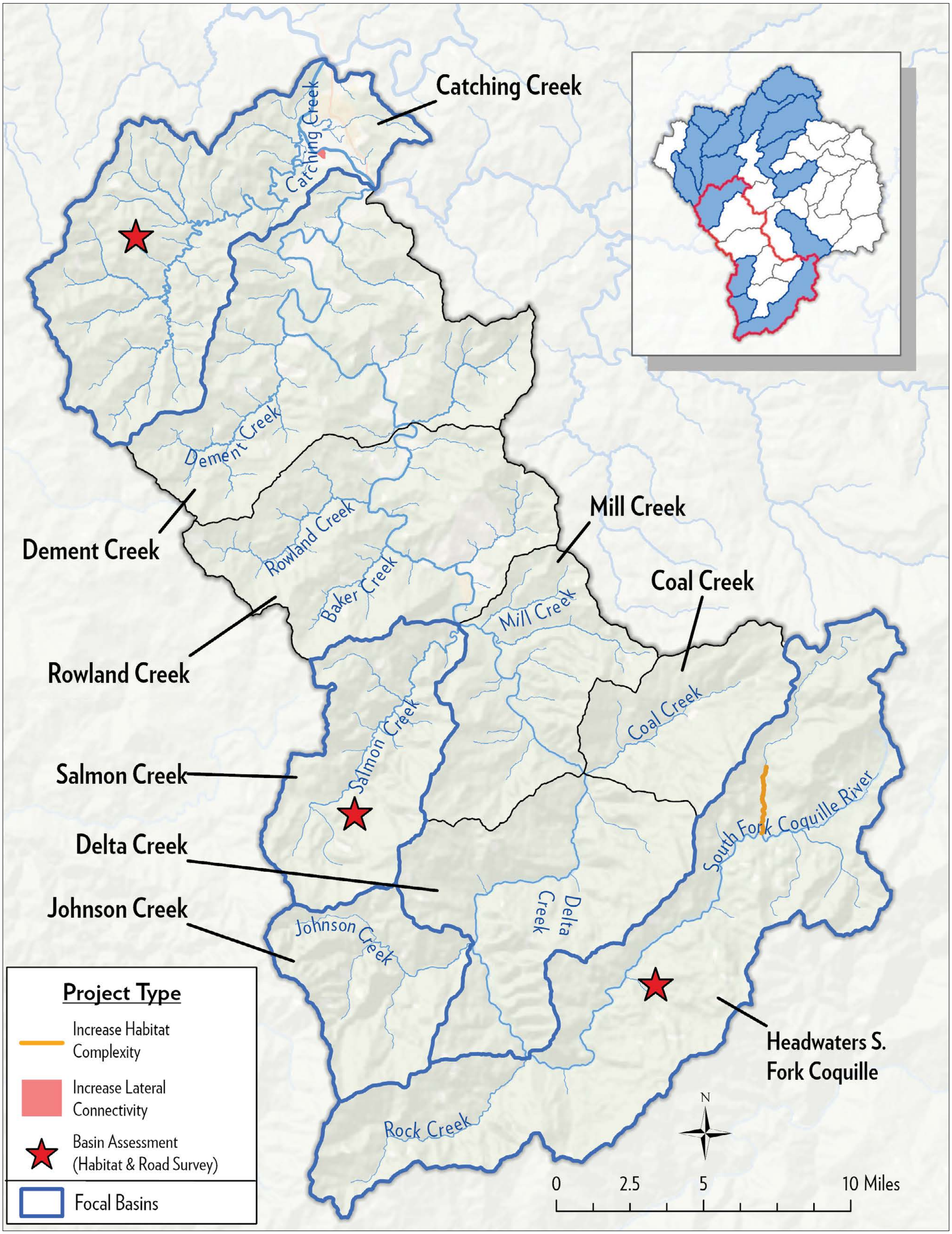


Table 8.3. Short-term outcomes by strategy in high-priority focal sub-watersheds (2024-2045). Project outcomes aggregated into 5th field HUCs.

KEAS RESTORED OR ENHANCED (2024-2030)	Lower Coquille	North Fork Coquille	East Fork Coquille	Middle Fork Coquille	South Fork Coquille	Strategy Totals in Focal Areas
Improved Water Quality (miles)	9.2	0	2.1	0	0	**11.3**
Increased Instream Complexity (acres)	15.8	0.4	1.4	12.3	0	**29.9**
Enhanced Riparian Function (acres)	72.3	36.7	7.5	0	0	**116.5**
Improved Longitudinal Connectivity (miles)	13	2.2	1.2	0	0	**16.4**
Fish Passage Barriers Removed/Upgraded	11	0	0	0	0	**11**
Increased Lateral Connectivity (acres)	2,011	0	7.5	18.3	0	**2,036.8**
Watershed Assessments	0	4	0	3	2	**9**

Brummit Waterfall. Photo: Dan Silvius

Chapter 9

Funding Needs: Estimated Costs

This chapter provides cost estimates for implementing the short-term work plan outlined in Chapter 8. The following table contains the estimated costs required to design and/or implement all the projects identified in the focal sub-watersheds (Table 9.1).

The estimated costs are summarized by focal area, project name, project lead, and project type. The table also identifies the long-term strategy the project addresses. The costs were estimated by the lead agency/organization and reviewed by the technical team. In several cases, projects were far enough along in the planning and development process to have verified cost estimates. In other cases, project-specific costs were not available, so broad estimates were made based on the project type and extent. For floodplain reconnection and off-channel projects, restoration cost estimates, with a similar level of complexity, were scaled to the proposed project's size. For instream complexity projects, estimates were generated by multiplying mileage by an average cost per mile. For riparian enhancement projects, acreage was either calculated using GIS software or, by calculating the number of stream miles proposed for treatment and multiplying by 50 feet. This 50-foot width approximates the average riparian buffer treated over the last decade. The riparian acreage was then multiplied by a mid-range cost per acre.

It should be noted that in 2021, pandemic-era inflation caused a sharp rise in material and labor costs across sectors, including habitat restoration. As of 2024, the costs for goods and services remain high. The cost estimates in Table 9.1 should be re-examined annually to reflect current inflation rates.

Table 9.1. Focal areas, project names, project lead, project type, long-term strategy, and cost.

Focal Area	Project Name	Project Lead	Project Type	Long-term Strategy	Cost
Moon Creek	Moon Creek Basin Assessment	CoqWA	Whole basin assessment	Filling data gap	$125,000
Middle Creek	Middle Creek Basin Assessment	CoqWA	Whole basin assessment	Filling data gap	$150,000
Hudson Creek	Hudson Creek Basin Assessment	CoqWA	Whole basin assessment	Filling data gap	$70,000
Catching Creek	Catching Creek Basin Assessment	CoqWA	Whole basin assessment	Filling data gap	$70,000
Big Creek	Big Creek Basin Assessment	CoqWA	Whole basin assessment	Filling data gap	$125,000
Rock Creek	Rock Creek Basin Assessment	CoqWA	Whole basin assessment	Filling data gap	$125,000
Salmon Creek	Salmon Creek Basin Assessment	CoqWA	Whole basin assessment	Filling data gap	$70,000
South Fork Headwaters	South Fork Headwaters Basin Assessment	CoqWA	Whole basin assessment	Filling data gap	$125,000
Yankee Run	Yankee Run Basin Assessment	CoqWA	Whole basin assessment	Filling data gap	$40,000
Hudson Creek	Woodward Creek Road Realignment	CoqWA/BLM	Habitat connectivity; instream complexity, riparian enhancement	Strategy 1 Strategy 3	$300,000
Hudson Creek	Woodward Creek Tributary Fish Passage	CoqWA/BLM	Habitat connectivity; instream complexity, riparian enhancement	Strategy 1 Strategy 3	$500,000

Table 9.1. Focal areas, project names, project lead, project type, long-term strategy, and cost *cont.*

Focal Area	Project Name	Project Lead	Project Type	Long-term Strategy	Cost
Headwaters South Fork Coquille	Wooden Rock Creek	USFS/CoqWA	LWD placement for sediment and cold water retention, beaver habitat enhancement, upland road sediment abatement	Strategy 2 Strategy 3	$349,964
Lampa Creek	Albertson Creek Tide gate Replacement	SWCD	Stream complexity, tide gate replacement/ fish passage, riparian plantings, off-channel water, longitudinal, and lateral connectivity	Strategy 1 Strategy 2 Strategy 3	$900,000
Lampa Creek	Gatov Creek Tide gate Replacement	SWCD	Stream complexity, tide gate replacement/ fish passage, riparian plantings, off-channel water, longitudinal and lateral connectivity	Strategy 1 Strategy 3	$450,000
Cunningham Creek & Beaver Slough	Winter Lake Phase III Floodplain Enhancement	SWCD	Lateral connectivity, floodplain habitat enhancement, riparian planting and fencing	Strategy 1 Strategy 2 Strategy 3	$5,000,000
Catching Creek	SFCR Off-Channel Refugia	CoqWA/ ODFW	Floodplain reconnection, off-channel rearing	Strategy 3	$900,000
Middle Creek	Honcho Creek Fish Passage Culvert	BLM	Longitudinal connectivity	Strategy 3	$600,000
Lampa Creek	Beaver Hill Wetland Reserve Restoration & NBL Fish Passage Upgrades	CoqWA/ USFWS	Floodplain reconnection, off-channel rearing, valley floor reset, fish passage, LWD placement, spruce cribs, riparian planting	Strategy 1 Strategy 2 Strategy 3	$3,300,000
Yankee Run	Culbertson Off-Channel Refugia and Riparian Restoration	CoosSWCD/ ODFW	Connection of floodplain off-channel overwinter ponds (floodplain/ nontidal) with channel reconstruction, installation of LWD, riparian fencing/ planting	Strategy 1 Strategy 2 Strategy 3	$948,042
Middle Creek	Cherry Cr to Mouth of Middle Cr	CoqWA/BLM	Blackberry removal, riparian planting, bank stabilization	Strategy 1 Strategy 2	$700,000
Total of 23 projects to be implemented between 2024 and 2030			**Total budget of $20,763,006**		

Chapter 10

Adaptive Management

The Coquille Coho Strategic Action Plan is, in essence, the initiation of an adaptive management plan. Chapter 8 describes the strategic objectives, actions, and outcomes the Coquille Coho SAP team will monitor over the short and long term, and identifies those potential projects in the high-priority focal areas. Appendix II describes the rigorous analyses that identified the high-priority sub-watersheds. These pieces are the lens through which the monitoring framework outlined in the tables below are considered and will be applied to a fully developed monitoring plan.

The Coquille Coho SAP monitoring framework is built around quantifiable key ecological attributes (KEAs) and indicators to evaluate implementation outcomes based on specific objectives and targets. The KEAs and indicators presented in the table below were derived from the larger common framework and represent the factors identified by the SAP technical team as the priorities most likely to reflect changes in watershed conditions for Coho. The evaluated indicators are derived from established ecological paradigms that were assessed through this process with robust modeling and validated with survey data.

The technical team acknowledges, however, that knowledge gaps exist in the complex ecology of OC Coho populations and that paradigms and historical relationships can, and have, shifted over a relatively short time period. As we gain a better understanding of Coho's adaptive capacity and successful life history strategies, adjustments to the monitoring framework are inevitable. Similarly, as we gather new information regarding project outcomes, this new information will either confirm that the restoration strategies are working or provide new direction for Coho management and restoration. In summary, the Coquille Coho SAP team has the expertise and capacity to directly investigate uncertainties and identify new indicators of significance as they arise.

The framework below is the basis for the development of a full monitoring plan that will require significant resources. The Coquille Coho SAP team is familiar with the financial and capacity requirements of effectiveness monitoring, and will focus the development and acquisition of monitoring resources toward methods and study designs that address the KEAs listed below. The collective experience and expertise of the partners impart a practical perspective on the task of identifying causal relations between the restoration actions described in this plan and subbasin-level habitat and fish population response.

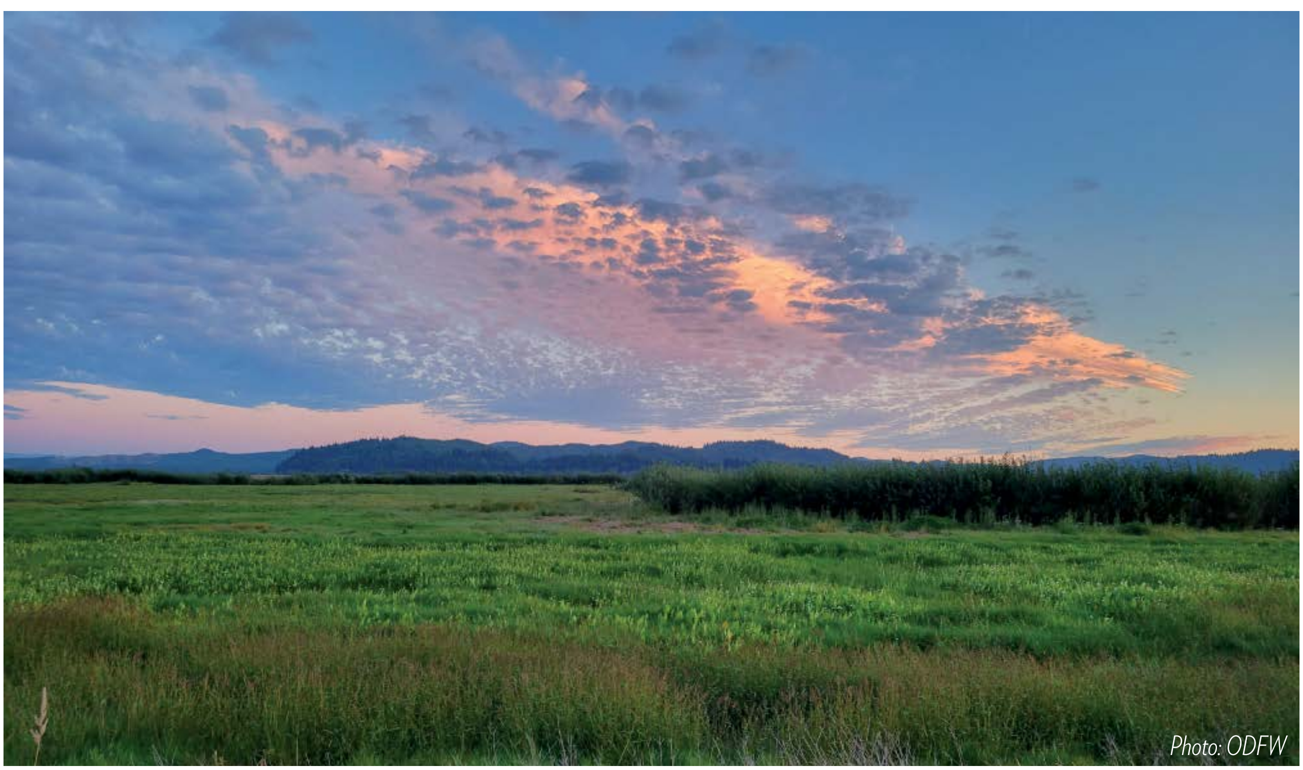


Photo: ODFW

Table 10.1.1. Implementation and effectiveness monitoring table for the Coquille SAP long-term outcomes #1 and #2.

SAP Monitoring Framework				
Implementation Monitoring – *Are the SAPs being implemented?*		**Effectiveness Monitoring –** *Is SAP implementation having the intended effects? Are we moving toward our goals?*		
Metrics to Measure Outputs	***SAP LONG-TERM OUTCOMES***	**Component & Key Ecological Attributes**	**Indicators to Evaluate Change**	**Locations to Monitor & Notes**
• Riparian function enhancement projects completed • Acres of invasive species removed • Acres of native vegetation planted • Miles of surface waters fenced • Post riparian plant survival • Cold water sources protected	**Outcome #1** *By 2045, 40% of low to moderate functioning riparian habitat in focal sub-watersheds is enhanced to protect or sustain cold water inputs and ensure sustainable recruitment of large wood.*	**Mainstem & Tributaries** • Water quality: Temperature • Instream complexity • Riparian function	• Total # of days where monitoring locations exceed temperature standards (DEQ 7-day running max) • Number of consecutive days exceeding 18°C average temperature • Presence of a thermal barrier in the mainstem that prevents migration of fish during warm periods • Plant mortality • Conversion of riparian plantings to LWD	• GIS analysis of riparian restoration • Summer temperature gradients • Riparian planting growth and survival at multiple time scales
• Riparian function enhancement projects completed • Acres of invasive species removed • Acres of native vegetation planted • Post riparian plant survival • Cold water sources protected • Geomorphic characteristics	**Outcome #2** *By 2045, restoration actions have reduced or maintained water temperatures on >120 miles of juvenile summer rearing habitat (5.5 miles/year).*	**Mainstem & Tributaries** •Water quality: Temperature • Instream complexity • Riparian function	• Total # of days where monitoring locations exceed temperature standards (DEQ 7-day running max) • Number of consecutive days exceeding 18°C average temperature • Presence of a thermal barrier in the mainstem that prevents migration of fish during warm periods • Plant mortality • Conversion of riparian plantings to LWD • Channel depth-to-width ratios	• DEQ AWQMS: Coquille River: Station Number 10596 SF Coquille River: Station Number 11486 MF Coquille River: Station Number 33922 NF Coquille River: Station Number 10393 • Summer temperature gradients • Water temperature monitoring in focal areas

Table 10.1.3. Implementation and effectiveness monitoring table for the Coquille SAP long-term outcomes #3 and #4.

SAP Monitoring Framework				
Implementation Monitoring – *Are the SAPs being implemented?*		**Effectiveness Monitoring –** *Is SAP implementation having the intended effects? Are we moving toward our goals?*		
Metrics to Measure Outputs	***SAP LONG-TERM OUTCOMES***	**Component & Key Ecological Attributes**	**Indicators to Evaluate Change**	**Locations to Monitor & Notes**
• Riparian function enhancement projects completed • Acres of invasive species removed • Acres of native vegetation planted • Post riparian plant survival • Cold water sources protected	**Outcome #3** *By 2045, reduce aquatic invasive species (specifically smallmouth bass) distribution in tributaries by 50% through improved water quality, water quantity, and riparian management.*	**Mainstem & Tributaries** • Water quality: Temperature • Instream complexity • Riparian function	• Total # of days where monitoring locations exceed temperature standards (DEQ 7-day running max) • Number of consecutive days exceeding 18°C average temperature • Presence of a thermal barrier in the mainstem that prevents migration of fish during warm periods • Plant mortality • Conversion of riparian plantings to LWD	• GIS analysis to document bass presence/absence in tributaries • Summer temperature gradients • Reduced temperatures at DEQ AWQMS
• Instream and off-channel projects completed (number) • Structures per mile (number) • Lineal distance treated with LWD (miles, percent of whole tributary)	**Outcome #4** *By 2045, restoration actions have increased year-round rearing capacity to such an extent that freshwater habitats are not limiting juvenile productivity in focal sub-watersheds.*	**Mainstem & Tributaries** • Instream complexity • Off-channel/floodplain habitat • Estuary	• Amount of large wood remaining that is effectively increasing complexity and HQ habitat • Substrate accumulation and retention • Increasing juvenile productivity and survival in focal basins	• ODFW juvenile monitoring in focal areas • Number of LWD placements and riparian plantings in focal basins • Off-channel access and pool area and volume increase • Decrease in water temperatures leading to increased summer rearing in focal basins

Table 10.1.5. Implementation and effectiveness monitoring table for the Coquille SAP long-term outcomes #5 and #6.

SAP Monitoring Framework				
Implementation Monitoring – *Are the SAPs being implemented?*		**Effectiveness Monitoring –** *Is SAP implementation having the intended effects? Are we moving toward our goals?*		
Metrics to Measure Outputs	***SAP LONG-TERM OUTCOMES***	**Component & Key Ecological Attributes**	**Indicators to Evaluate Change**	**Locations to Monitor & Notes**
• Number of tide gates removed • Miles of levees removed or relocated • Miles of tidal channel constructed or re-meandered	**Outcome #5** *By 2045, restoration actions have restored connection to 400 acres of full tidal wetlands, off-channel or floodplain areas (18.1 acres/year).*	**Mainstem & Tributaries** • Off-channel/floodplain habitat • Estuary	• Acres of tidal wetland permanently reconnected • Miles of slough habitat reconnected • Acres of floodplain reconnected	• GIS analysis to document projects resulting in full tidal reconnection • Areas and volume of restored tidal inundation at season time scales • Fish use of reconnected floodplains in focal basins
• Number of tide gates removed • Miles of levees breached • Miles of tidal channel constructed or re-meandered	**Outcome #6** *By 2045, restoration actions have restored partial connection to 1,000 acres of managed tidal wetlands, off-channel or floodplain areas (45.5 acres/year).*	**Mainstem & Tributaries** • Off-channel/floodplain habitat • Estuary	• Acres of tidal wetland partially reconnected • Miles of slough habitat partially reconnected • Acres of floodplain partially reconnected	• GIS analysis to document projects resulting in full tidal reconnection • Water management plans that articulate seasonal inundation and/or connection to floodplains and ponds • Areas and volume of restored tidal inundation at season time scales • Fish use of reconnected floodplains in focal basins

Table 10.1.7. Implementation and effectiveness monitoring table for the Coquille SAP long-term outcome #7.

SAP Monitoring Framework				
Implementation Monitoring – *Are the SAPs being implemented?*		**Effectiveness Monitoring –** *Is SAP implementation having the intended effects? Are we moving toward our goals?*		
Metrics to Measure Outputs	***SAP LONG-TERM OUTCOMES***	**Component & Key Ecological Attributes**	**Indicators to Evaluate Change**	**Locations to Monitor & Notes**
• Number of private landowners contacted • Number of public landowners contacted	**Outcome #7** *By 2030, contact, with the intent to engage, all public and private landowners in focal sub-watersheds containing habitats identified for protection or restoration.*	**Mainstem & Tributaries** • Off-channel/floodplain habitat • Estuary	• Landowner agreements in place • Grant funding secured to support restoration projects	• All high-priority focal watersheds

Coquille River Falls. Photo: Alamy

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Appendices

The following appendices are available at coastcoho.org/watershed-plans/

1. Appendix I - Glossary of Terms and Definitions
2. Appendix II - Description and Rationale for Criteria Used to Prioritize Sub-watersheds
3. Appendix III - Water Temperature Exeedances in the Coquille Basin

Appendix I. Glossary of Terms and Definitions

Abundance	The number of fish in a population. See also **population.**
Adaptive Management	Adaptive management in salmon recovery planning is a method of decision making in the face of uncertainty. It is a process for adjusting actions and/or direction based on new information. A plan for monitoring, evaluation, and feedback is incorporated into an overall implementation plan so that the results of actions can become feedback on design and implementation of future actions.
Anadromous Fish	Species that are hatched in freshwater, migrate to and mature in salt water, and return to freshwater to spawn.
Anchor Habitat	A stream reach that provides all the essential habitat features necessary to support the complete Coho freshwater life history. An anchor site supports all of the seasonal habitat needs of Coho salmon from egg to smolt outmigration, including optimal gradient, potential for floodplain interaction, and accumulation of spawning gravels.
Artificial Propagation	Hatchery spawning and rearing of salmon, usually to the smolt stage.
Barrier	A blockage such as a waterfall, culvert, or rapid that impedes the movement of fish in a stream system.
Beaver Dam Analogues	Human-made, channel-spanning structures that mimic or reinforce beaver dams (Pollock et al. 2015).
Critical Habitat	Critical habitat includes: (1) specific areas within the geographical area occupied by the species at the time of listing, on which are found those physical or biological features that are essential to the conservation of the listed species and that may require special management considerations or protection, and (2) specific areas outside the geographical area occupied by the species at the time of listing that are essential for the conservation of a listed species. If a species is listed or critical habitat is designated, ESA section 7(a) (2) requires federal agencies to ensure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of such a species or to destroy or adversely modify its critical habitat (NMFS 2008).
Dependent Populations	Populations that rely on immigration from surrounding populations to persist. Without these inputs, dependent populations would have a lower likelihood of persisting over 100 years.
Diversity	All the genetic and phenotypic (life history, behavioral, and morphological) variation within a population. Variations could include anadromy vs. lifelong residence in freshwater, fecundity, run timing, spawn timing, juvenile behavior, age at smolting, age at maturity, egg size, developmental rate, ocean distribution patterns, male and female spawning behavior, physiology, molecular genetic characteristics, etc.
Ecoregion	An integration of physical and biological factors such as geologic history, climate, and vegetation.
Ecosystem	A complex system, or group, of interconnected elements and processes and functions, formed by the interaction of a community of organisms with their environment.
Endangered Species	A species in danger of extinction throughout all or a significant portion of its range. See also **ESA and threatened species**.
Endangered Species Act	Passed by Congress in 1973, its purposes include providing a means to conserve the ecosystems on which endangered species and threatened species depend. See also **endangered species** and **threatened species**.
Escapement	Adult fish that escape from fisheries and natural mortality to reach the spawning grounds.
Estuarine Habitat	Areas available for feeding, rearing, and smolting in tidally influenced lower reaches of rivers. These include marshes, sloughs and other backwater areas, tidal swamps, and tide channels.

Evolutionarily Significant Unit	An evolutionarily significant unit (ESU) represents a distinct population segment of Pacific salmon that (1) is substantially reproductively isolated from conspecific populations and (2) represents an important component of the evolutionary legacy of the species. Equivalent to a distinct population segment (DPS) and treated as a species under the Endangered Species Act.
Flashy	A term that describes a river that is prone to reach high peak discharge in a short time frame and be more likely to flood.
Floodplain	A nearly flat plain along the course of a stream or river that is naturally subject to flooding, or using geological terms, a depositional landform in alluvial basins.
Freshwater Habitat	Areas available for spawning, feeding, and rearing in freshwater.
Fry	Young salmon that have emerged from the gravel and no longer have a yolk sac.
Full Seeding	In general, full seeding refers to having enough spawners to fully occupy available juvenile habitat with offspring. As applied in fisheries management for Oregon Coast Coho salmon, it refers to habitat quality sufficient for spawners to replace themselves when marine survival is 3% and is based on early models of juvenile rearing capacity.
Gradient	The slope of a stream segment.
Habitat Quality	The suitability of physical and biological features of an aquatic system to support salmon in the freshwater and estuarine system.
Hatchery	A facility where artificial propagation of fish takes place.
Historical Abundance	The number of fish produced before the influence of European settlement.
Hydrologic Units	Hydrologic units are areas of land that contribute surface water runoff to a specific point on a stream, such as its mouth or outlet. They are also known as drainage areas. HU boundaries are defined by following the highest elevation of land that divides the direction of surface water flow, known as the ridge line, from the outlet point back to itself. In the U.S. Geological Survey, hydrologic units have been divided at different scales.
Hydrology	The distribution and flow of water in an aquatic system.
Independent Population	A collection of one or more local breeding units whose population's dynamics or extinction risk over a 100-year period is not substantially altered by exchanges of individuals with other populations (migration). **Functionally independent populations** are net donor populations that may provide migrants for other types of populations. This category is analogous to the independent populations of McElhany et al. (2000).
Intrinsic Potential	The estimated relative suitability of a habitat for spawning and rearing of anadromous salmonid species under historical conditions inferred from stream characteristics including channel size, gradient, valley constraint, and mean annual discharge of water. Intrinsic potential in this report refers to a measure of potential Coho salmon habitat quality. This index of potential habitat does not indicate current actual habitat quality.
Jack	A male Coho salmon that matures at age 2 and returns from the ocean to spawn a year earlier than normal.
Juvenile	A fish that has not matured sexually.
Keystone Species	A species that plays a pivotal role in establishing and maintaining the structure of an ecological community. The impact of a keystone species on the ecological community is more important than would be expected based on its biomass or relative abundance.
Limiting Factors	Impaired physical, biological, or chemical features (e.g., inadequate spawning habitat, high water temperature, insufficient prey resources) that result in reductions in viable salmonid population (VSP) parameters (abundance, productivity, spatial structure, and diversity).

Lowland Habitat	Low-gradient stream habitat with slow currents, pools, and backwaters used by fish. This habitat is often converted to agricultural or urban use.
Marine Survival Rate	The proportion of smolts entering the ocean that survive to adulthood. May be harvested or return as escapement.
Metrics	Something that quantifies a characteristic of a situation or process; for example, the number of natural-origin salmon returning to spawn to a specific location is a metric for population abundance.
Migration	Movement of fish from one population to another.
Objectives	We use the term objectives to refer to formal statements of the outcomes (or intermediate results) and desired changes that we have identified as necessary to attain the goals. Objectives specify the desired changes in the factors (direct and indirect threats and opportunities) that we would like to achieve in the short and medium term. "A good objective meets the criteria of being *results oriented, measurable, time limited specific, and practical.*[1]"
Parr	The life stage of salmonids that occurs after fry and prior to smoltification (or smolting). Generally recognizable by dark vertical bars (parr marks) on the sides of the fish.
Population	A group of fish of the same species that spawns in a particular locality at a particular season and does not interbreed substantially with fish from any other group. See also **abundance.**
Population Dynamics	Changes in the number, age, and sex of individuals in a population over time, and the factors that influence those changes. Five components of populations that are the basis of population dynamics are birth, death, sex ratio, age structure, and dispersal.
Population Structure	Includes measures of age, density, and growth of fish populations.
Production	The number of fish produced by a population in a year.
Productivity	The rate at which a population is able to produce fish, such as the average number of surviving offspring per parent. Productivity is used as an indicator of a population's ability to sustain itself or its ability to rebound from low numbers. The terms "population growth rate" and "population productivity" are interchangeable when referring to measures of population production over an entire life cycle. Can be expressed as the number of recruits (adults) per spawner or the number of smolts per spawner.
Recovery	The reestablishment of a threatened or endangered species to a self-sustaining level in its natural ecosystem (i.e., to the point where the protective measures of the ESA are no longer necessary).
Recovery Plan	A document identifying actions needed to make populations of naturally produced fish comprising the OCCS ESU sufficiently abundant, productive, and diverse so that the ESU as a whole will be self-sustaining and will provide environmental, cultural, and economic benefits. A recovery plan also includes goals and criteria by which to measure the ESU's achievement of recovery, site-specific management actions as may be necessary to achieve the plan's goal, and an estimate of the time and cost required to carry out the actions.
Redd	A nest constructed by female salmonids in streambed gravels where eggs are deposited, fertilized by males, and buried in gravel.
Resilience	A measure of the ability of a population or ESU to rebound from short-term environmental or anthropogenic perturbations.
Run Timing	The time of year (usually identified by week) when spawning salmon return to the spawning beds.
Salmonid	Fish belonging to, or characteristic of, the family Salmonidae, which includes salmon, steelhead, trout, char, and whitefish. These are typically cold water groups of species.
Smolt	A life stage of juvenile salmon that occurs just before the fish leaves freshwater. Smolting is the physiological process that allows salmon to make the transition from freshwater to saltwater.

Spawner	Adult fish on the spawning grounds.
Spawner Survey	Effort to estimate the number of adult fish on spawning grounds. It uses counts of redds and fish carcasses to estimate escapement and identify habitat. Annual surveys can be used to compare the relative magnitude of spawning activity between years.
Species	Biological definition: A group of organisms formally recognized by the scientific community as distinct from other groups. Legal definition: Refers to joint policy of the USFWS and NMFS that considers a species as defined by the ESA to include biological species, subspecies, and DPSs. In this Plan, "the species" refers to the Oregon Coast Coho salmon ESU.
Stakeholders	Agencies, groups, or private citizens with an interest in recovery planning, or those who will be affected by recovery planning and actions.
Threatened Species	A species not presently in danger of extinction, but likely to become so in the foreseeable future. See also **endangered species** and **ESA**.
Threats	Human activities or natural events (e.g., road building, floodplain development, fish harvest, hatchery influences, and volcanoes) that cause or contribute to limiting factors. Threats may exist in the present or be likely to occur in the future.
Valley Constraint	The valley width available for a stream or river to move between valley slopes.
Viable, Viability	The likelihood that a population will sustain itself over a 100-year time frame. As used in this plan, viable and viability are the same, or nearly the same, as sustainable and sustainability.
Viable Salmonid Population	A viable salmonid population (VSP) is an independent population of any Pacific salmonid (genus Oncorhynchus) that has a negligible risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes (random or directional) over a 100-year time frame.
Wild Fish	Fish whose ancestors have always lived in natural habitats, that is, those with no hatchery heritage. See also **naturally produced fish**, for comparison.

Appendix II

Description and Rationale for Criteria Used to Prioritize Sub-watersheds

The federal Recovery Plan for Oregon Coast Coho Salmon (2016), Oregon Coast Coho Conservation Plan for the State of Oregon (2007), Coquille River Subbasin Plan (2007), and the Coquille Coho SAP technical team (2023) identified lack of stream complexity and degraded water quality (i.e., elevated summer temperatures) as the two primary limiting factors for OC Coho in the Coquille Basin. The Coquille Coho SAP team chose to identify high-priority focal areas within the Coquille Basin using a composite score ranking model informed by the factors limiting Coho salmon. The Coquille Coho SAP technical team spent approximately seven months identifying 16 parameters with which to evaluate, rank, and prioritize sub-watersheds. The following text describes the process and parameters used in the ranking model.

Coquille Basin Sub-Watershed Ranking and Prioritization

Through the strategic action planning process, a model was developed to help identify and prioritize where restoration efforts should be focused within the Coquille Basin. The technical team weighed the merits of this evaluation at different sub-watershed scales and agreed that prioritization should happen at the 6th Field HUC scale. This scale produced a manageable number of sub-watersheds to evaluate (n = 35) and, while tidal influence is a consideration in the lower Coquille, the major current and historic anthropogenic perturbations (timber harvest, agricultural practices, floodplain disconnection, road building, etc.) occur ubiquitously throughout the rest of the basin.

Our model used sixteen parameters recognized during full and technical team meetings as important to the recovery of OC Coho in the Coquille Basin. The overall ranking of sub-watersheds is the result of a composite score from the ranking parameters, and led to the “high”, “medium” and “low” sub-watershed priority designations. The fifteen sub-watersheds that received the “high priority” designation became the Coquille SAP Focal Areas. It should be noted that due to the homogeneity of ecological disturbances that have occurred throughout the basin and the widespread effects of climate change, there was only a thin line between the scores of sub-watersheds at the bottom of the high-priority and top of the medium priority classifications (i.e., 0.5 ranking score difference). As restoration actions in the high-priority sub-watersheds are addressed over time, the sub-watersheds at the top of the medium priority classification should be considered for restoration actions.

The resulting ranking is based on the best available data. It uses a scientific approach to identify where the most good can be accomplished for the most fish, based on our knowledge of the biological, ecological, and physical parameters influencing the Coquille Coho salmon population. This analysis is intended to be used as a decision support tool for short- and long-term planning. This ranking does not account for the complex social and political pressures that often influence where and when restoration work gets done.

Ranking Parameters

The following ranking parameters were selected based on the biological needs of Coho salmon, their physical habitat needs and modeling that indicates what future habitat in the Coquille Basin will look like under conditions expected from climate change. We recognize that many of the parameters could be categorized in several classification bins (e.g., current temperatures could be classified as a “fish parameter” or a “habitat parameter”).

Fish Parameters

- Coho spawning habitat
- Coho rearing habitat
- ODFW spawning surveys
- Current temperature

Habitat Parameters

- High-quality Coho habitat
- Coho intrinsic potential
- Land ownership
- Coho anchor habitat
- Beaver habitat
- Cold water sources
- Cold water refugia

Climate Change Parameters

- Predicted flow (% change) in 2040
- Predicted flow (% change) in 2080
- Predicted temperature (°C) in 2040
- Predicted temperature (°C) in 2080
- Landward migration zones

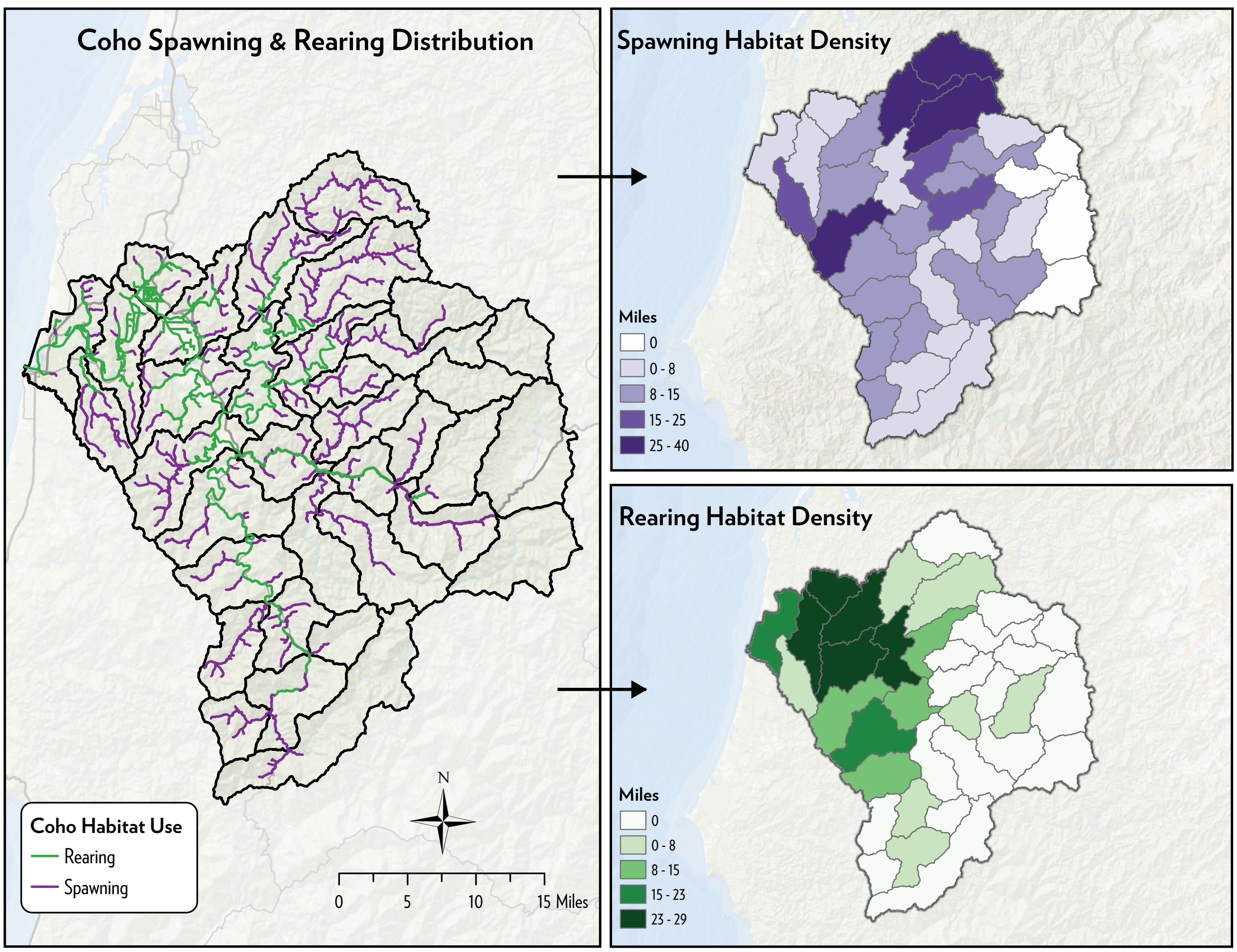
Fish Parameters

Coho Spawning and Rearing Habitat

This parameter utilized ODFW's current (2023) Coho spawning and rearing distribution GIS layer to calculate the total amount of spawning and rearing miles contained within each sub-watershed. The highest-ranking scores were given to sub-watersheds that contain > 24 miles of Coho rearing habitat. Sub-watersheds with no spawning or rearing habitat received a score of 0.

ODFW Spawning Surveys

This parameter used ODFW's Oregon Adult Salmon Inventory and Sampling (OASIS) data from the Coquille Basin between 1989 and 2021. ODFW uses a generalized random tessellation stratified survey design to select sites to survey on a rotating 1-, 3-, 9-, and 27-year interval (Stevens 2002). The data set for the Coquille Basin contains robust spatial and temporal coverage. However, there were circumstances where data was unavailable due to random non-selection or barriers. There are several reaches above natural or artificial barriers in the upper portion of the Coquille Basin that have not been surveyed as Coho are not present. The highest-ranking scores were given to sub-watersheds that contain > 25.5 miles of Coho spawning habitat.



Current temperature

Due to the size of the Coquille Basin and current lack of basin-wide temperature monitoring, we utilized the NorWeST Stream Temperature data from the U.S. Forest Service Rocky Mountain Research Station. These data utilize observed August stream temperatures and use spatial statistical network models to estimate current and future stream temperatures where empirical data is not available. This evaluation considered mean August temperatures that are at or below the thermal tolerance of Coho salmon (< 18 °C) between 2002 and 2011. The highest-ranking scores for current temperature were given to sub-watersheds that had the coldest mean August temperatures (i.e., < 14 °C).

Habitat Parameters

High-quality Coho habitat

These data are based on ODFW's Aquatic Inventory (AQI) project and contains quantitative information on the habitat condition for streams in the Coquille Basin. During these aquatic surveys, stream characteristics (e.g., frequency of pools, riffles, and glides) are recorded. Those data are then fed into a Habitat Limiting Factor Model (HLFM) that estimates the habitat carrying capacity for juvenile Coho within those stream reaches. We considered habitat to be of "high quality" if it was estimated to support at least 959 juvenile Coho. The highest-ranking scores were given to sub-watersheds estimated to have > 959 juvenile Coho/km.

Coho intrinsic potential

Intrinsic potential (IP) refers to high-quality rearing habitat based on stream flow, valley constraint, and stream gradient. These three landscape characteristics can affect stream habitats and thus can affect Coho salmon populations (Burnett et al., 2007). We used the Netmap Coho IP model to determine stream reaches that have high intrinsic potential (e.g., IP score > 0.6). We summed the number of stream miles with high IP within each sub-watershed. The highest-ranking scores were given to sub-watersheds that had > 23 miles of high Coho IP.

Land ownership

The technical team discussed the effects of land ownership on Coho salmon and their habitats a great deal. Due to the differences in land use practices and management regimes (timber stand ages, timber harvest intervals, riparian buffer widths, access, etc.) between private lands and public and Tribal lands, the technical team decided to include this parameter in the ranking process. For each sub-watershed, the total amount of state, federal, and Tribal lands were summed. Sub-watersheds with > 79 sq km received the highest-ranking scores.

Coho anchor habitat

Anchor habitats are those that can support multiple life stages of Coho salmon including eggs, alevin, fry, parr, and adults. This parameter is calculated from geomorphic characteristics including channel width, valley constraint, and gradient. Sub-watersheds that received the highest-ranking scores contained > 9 miles of Coho anchor habitat.

Beaver habitat

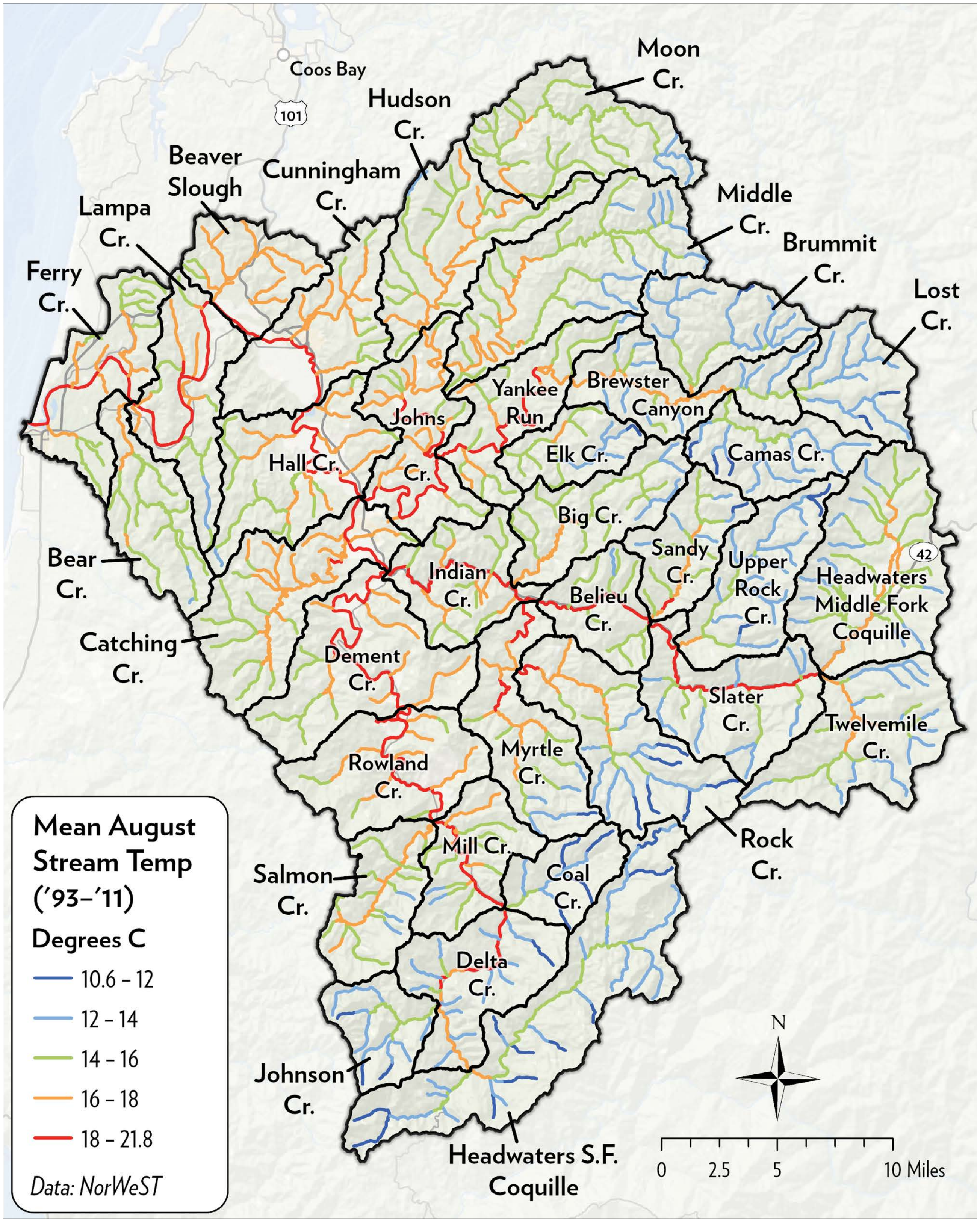
We used the beaver habitat model identified in the Dittbrenner et al. (2018) paper to identify areas within each sub-watershed that can support beaver reestablishment. This model uses stream gradient, stream width, and valley width to identify locations that have habitat suitable for beaver establishment. The highest-ranking scores were given to sub-watersheds that contain > 36 miles of potential beaver habitat.

Cold water refugia

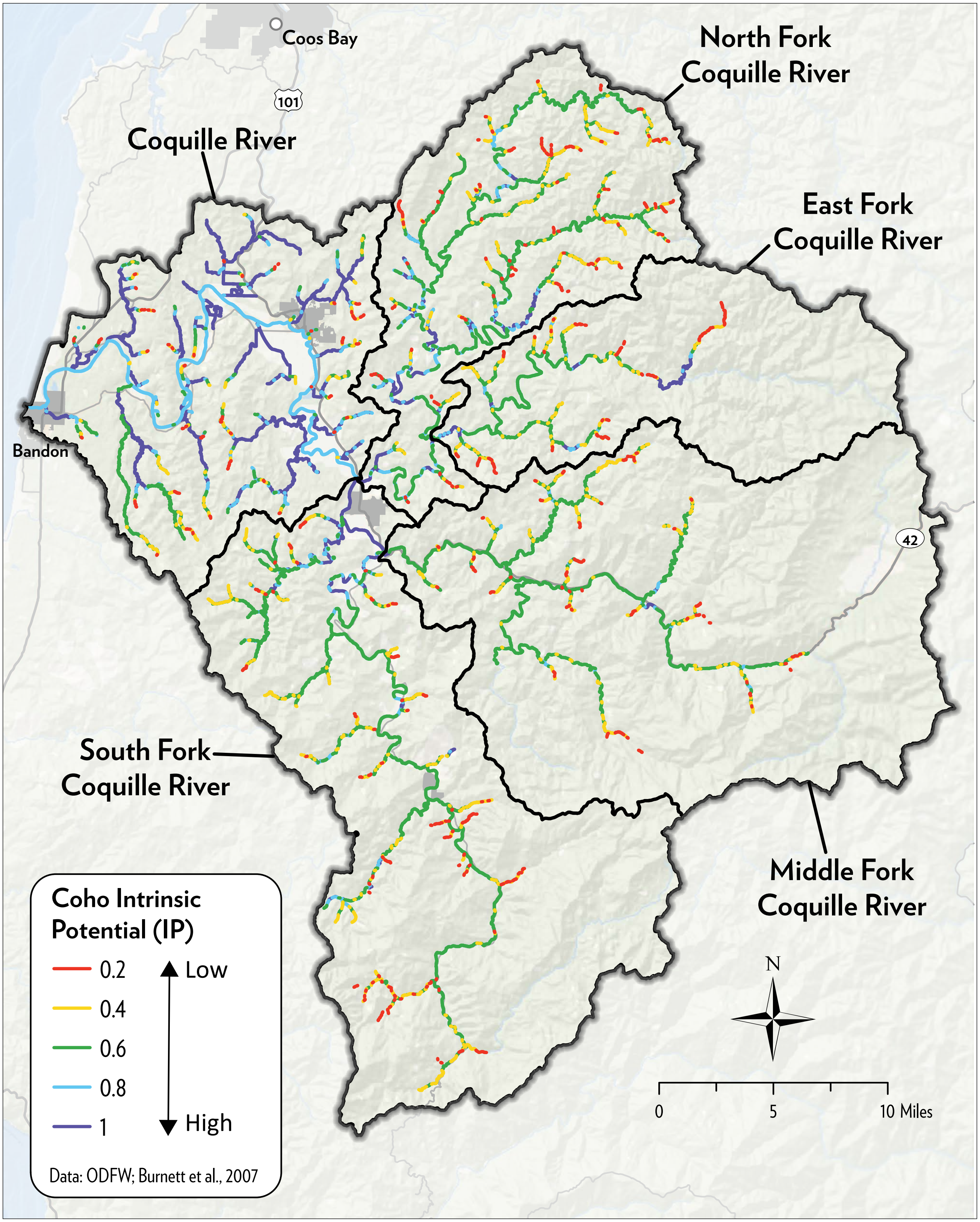
The cold water refugia model was adapted from an ODFW model that assesses and identifies streams contributing cold water to larger receiving streams. The model identifies tributaries that have a 2 °C Δ between contributing and receiving streams AND are within the top 33% of Coquille Basin flows in August. All the reaches identified as cold water refugia (> 2 degrees cooler than the receiving stream) are at or below the thermal requirements for Coho salmon (i.e., < 18 °C). Overall, this parameter was developed to identify cold water refugia that could be utilized by rearing juveniles during the hot summer months. The highest-ranking scores were given to sub-watersheds that had > 20 miles of Coho habitat within the cold water reaches.

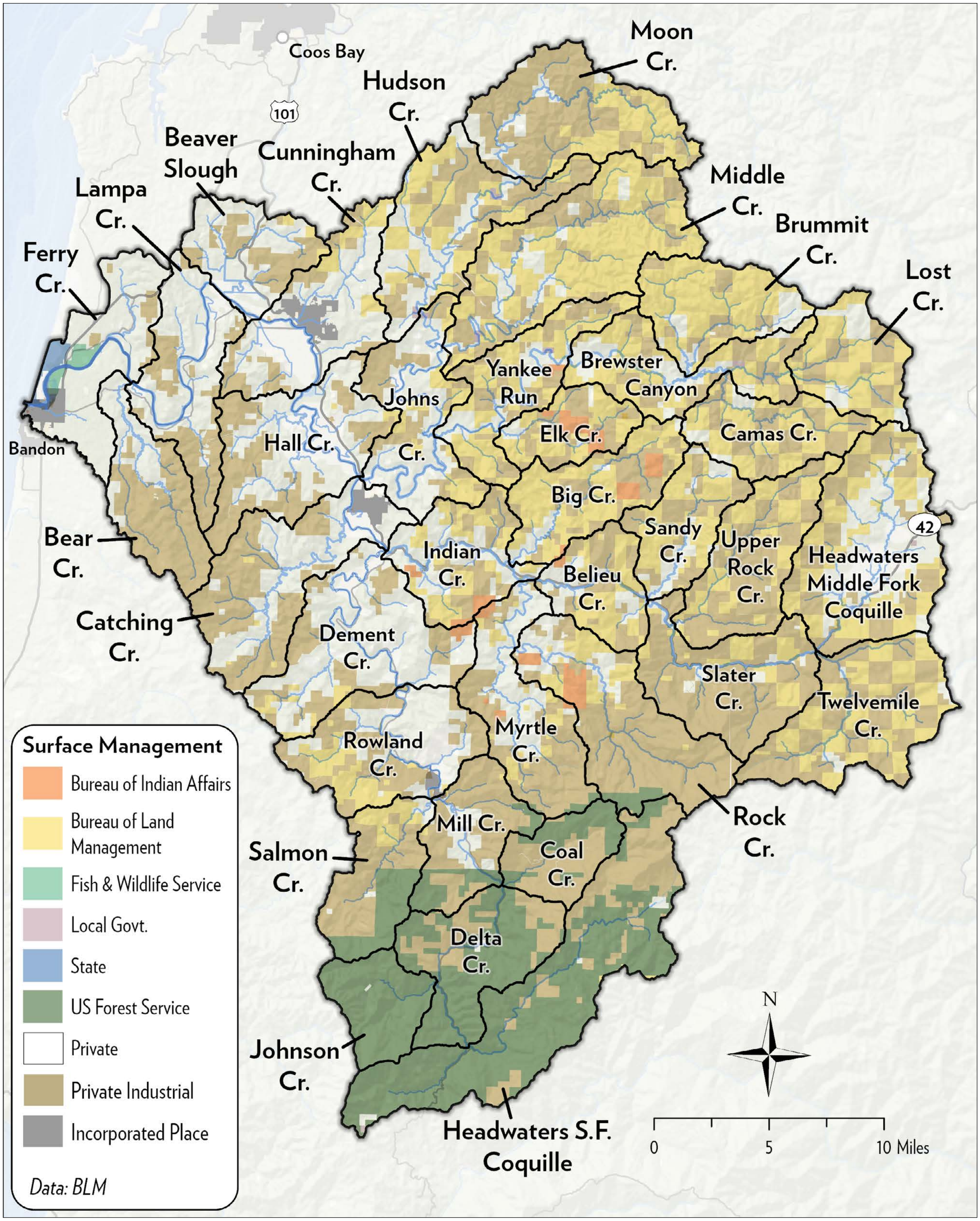
Cold water sources

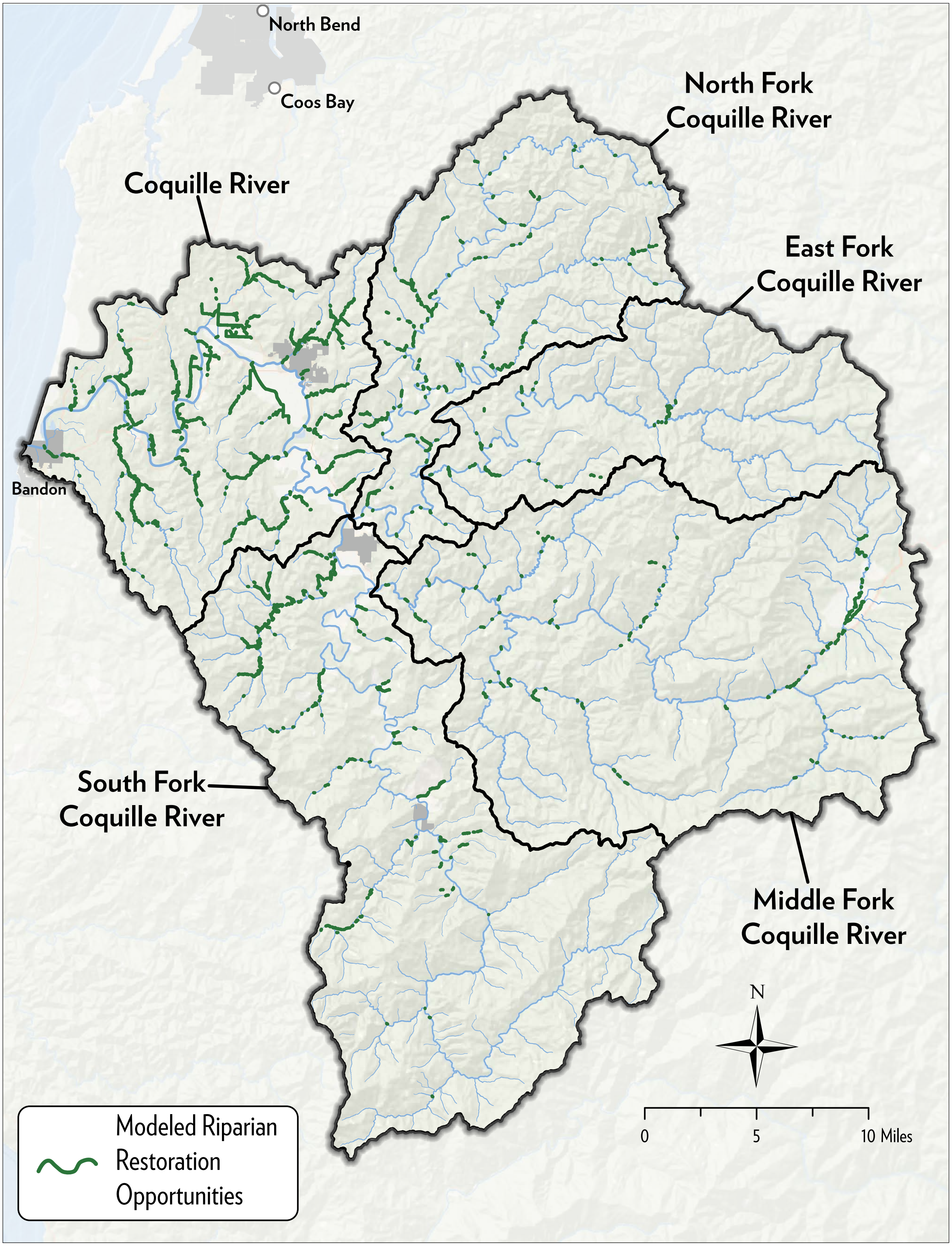
The cold water sources model uses current (1993-2011) August stream temperature data from NorWeST and identifies the top 33% of cold water reaches from within the entire Coquille Basin. From this subset, the model selects the cold water reaches that also rank within

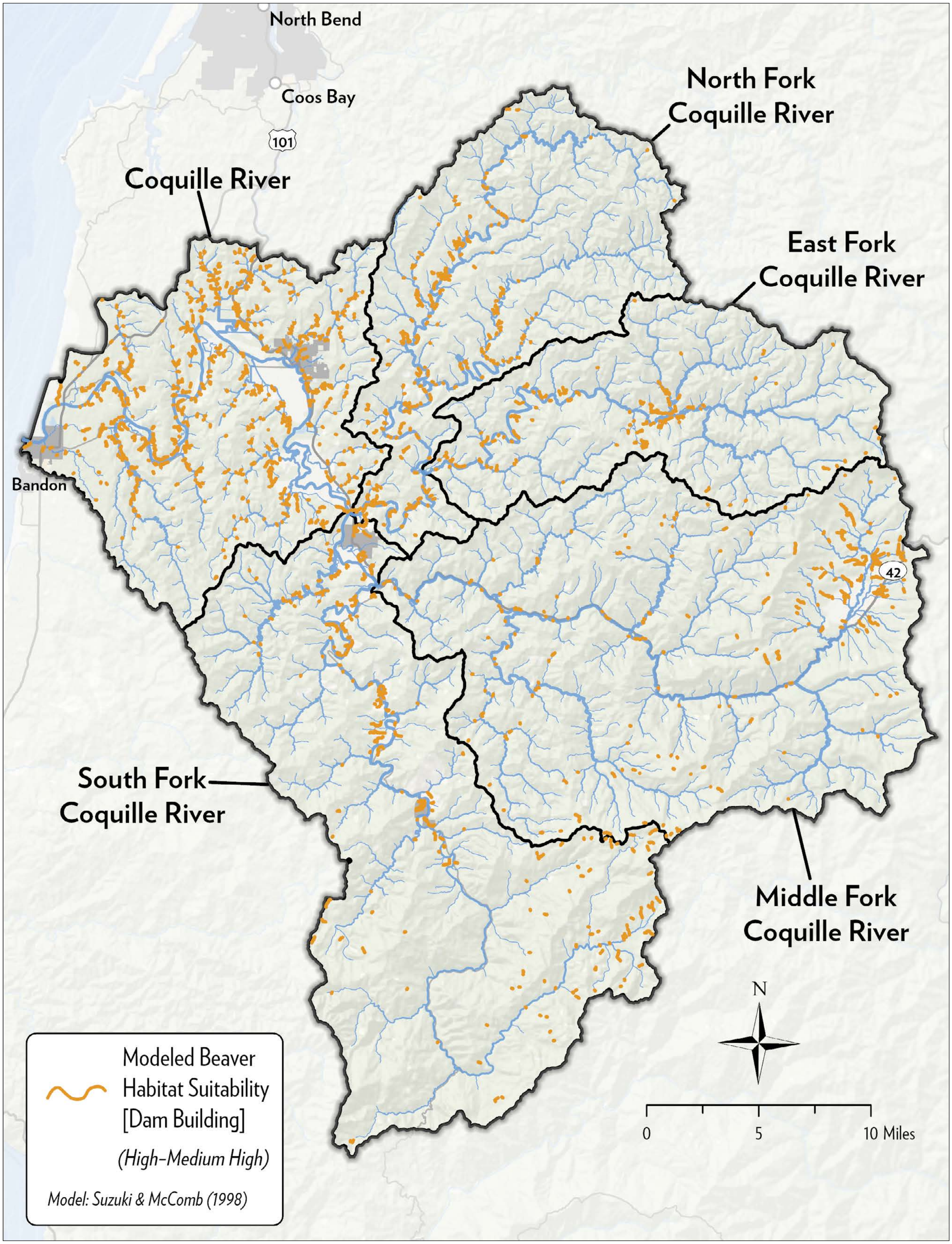


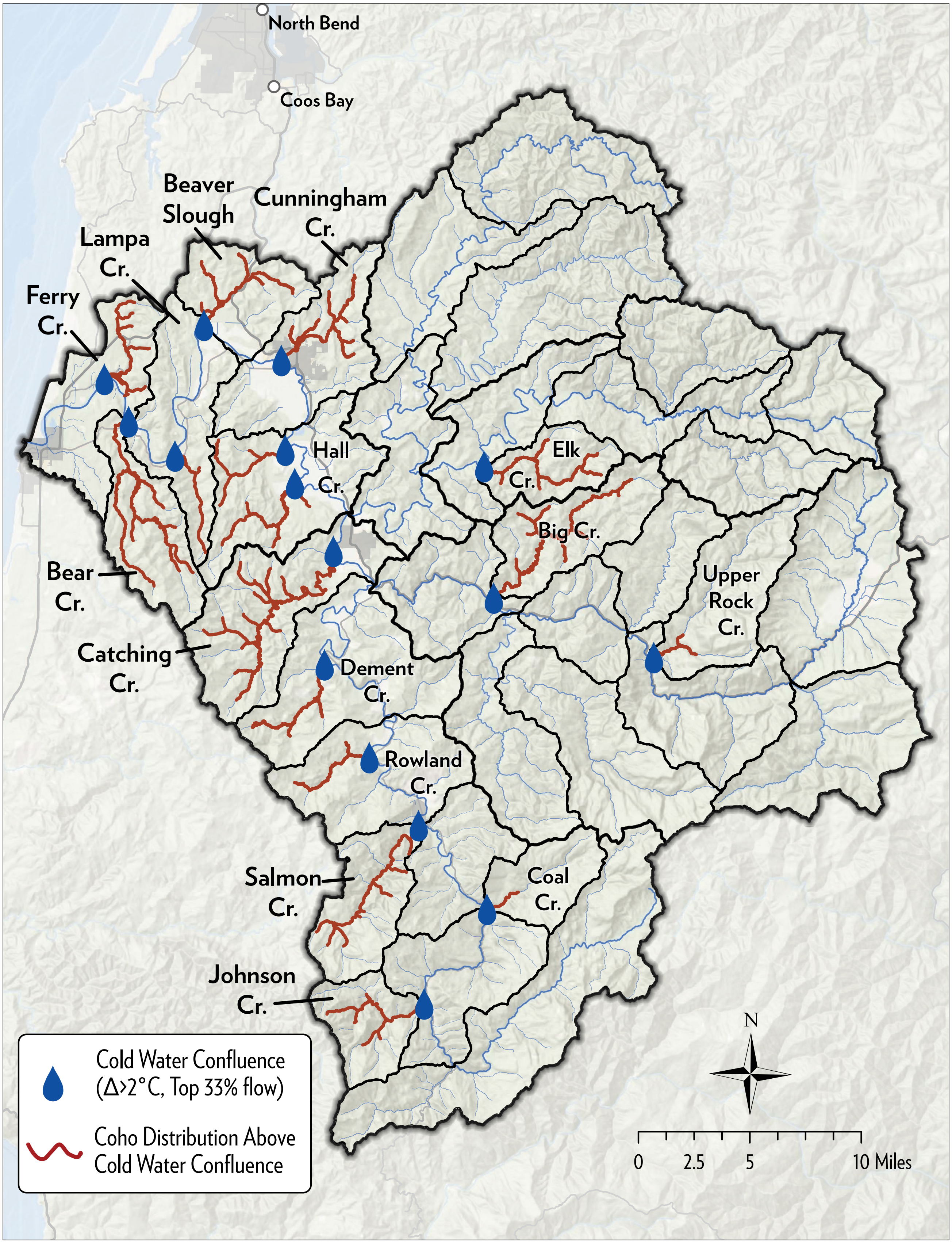
the top 33% of August stream flow (cfs) for the basin. The outputs are locations that contain the coldest water with the most summertime flows. We quantified the number of stream miles in each sub-watershed that has these cold water sources. This parameter was developed to identify where the most cold water is being produced, with the intent that these areas should be protected. The highest-ranking scores were given to sub-watersheds that have > 8 miles of cold water sources.

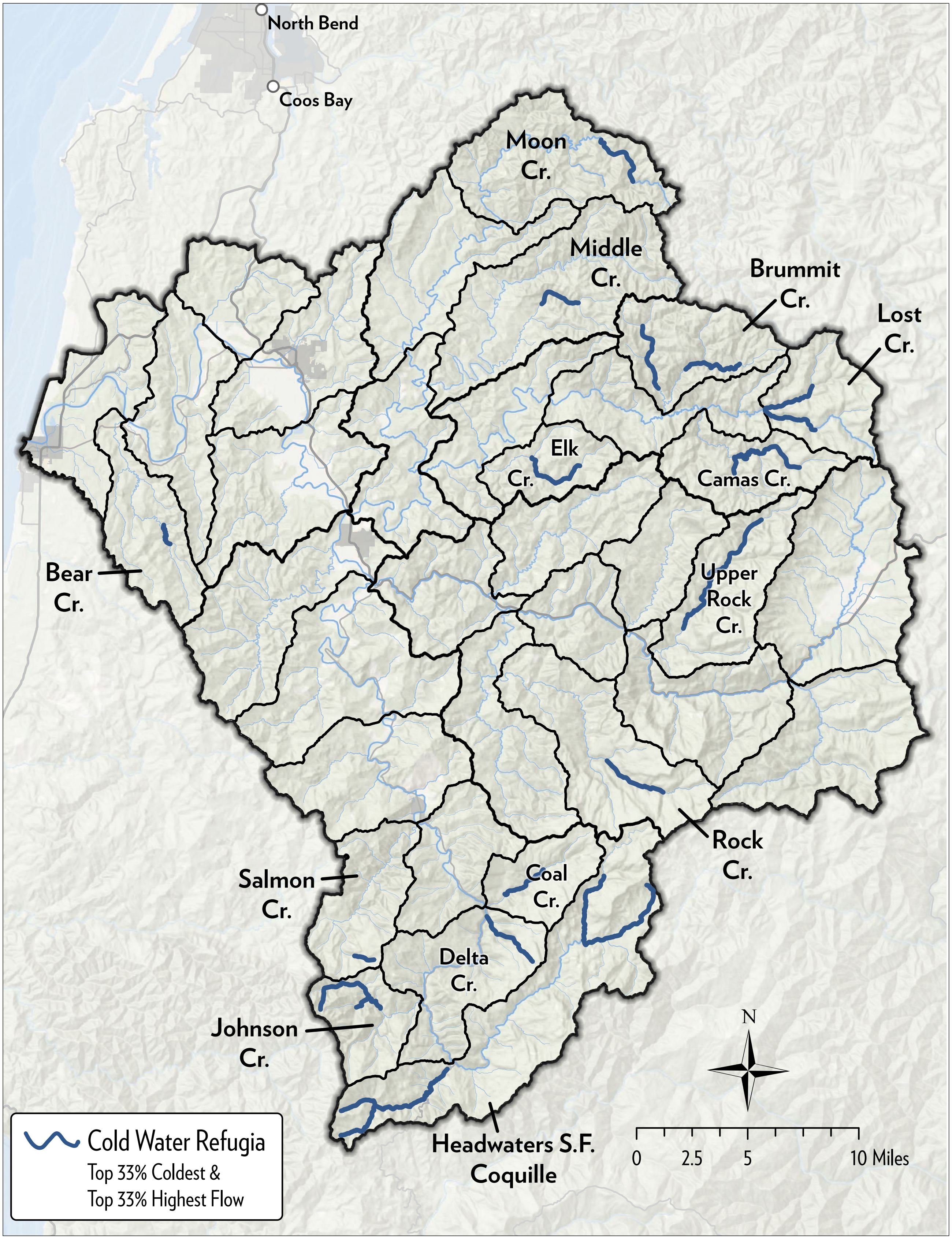

Coos Bay
101
North Fork
Coquille River
Coquille River
East Fork
Coquille River
Bandon
42
South Fork
Coquille River
Middle Fork
Coquille River
Coho Intrinsic
Potential (IP)
0.2
0.4
0.6
0.8
1
Low
High
Data: ODFW; Burnett et al., 2007
N
0
5
10 Miles


Coos Bay
101
Moon Cr.
Hudson Cr.
Cunningham Cr.
Beaver Slough
Lampa Cr.
Ferry Cr.
Middle Cr.
Brummit Cr.
Lost Cr.
Bandon
Yankee Run
Brewster Canyon
Johns Cr.
Hall Cr.
Elk Cr.
Camas Cr.
Big Cr.
42
Bear Cr.
Sandy Cr.
Upper Rock Cr.
Headwaters Middle Fork Coquille
Indian Cr.
Belieu Cr.
Catching Cr.
Dement Cr.
Slater Cr.
Twelvemile Cr.
Myrtle Cr.
Rowland Cr.
Mill Cr.
Rock Cr.
Salmon Cr.
Coal Cr.
Delta Cr.
Johnson Cr.
Headwaters S.F. Coquille
N
0
5
10 Miles
Surface Management
Bureau of Indian Affairs
Bureau of Land Management
Fish & Wildlife Service
Local Govt.
State
US Forest Service
Private
Private Industrial
Incorporated Place
Data: BLM


North Bend
Coos Bay
North Fork
Coquille River
Coquille River
East Fork
Coquille River
Bandon
South Fork
Coquille River
Middle Fork
Coquille River
N
0
5
10 Miles
Modeled Riparian
Restoration
Opportunities


North Bend
Coos Bay
101
North Fork
Coquille River
Coquille River
East Fork
Coquille River
Bandon
42
South Fork
Coquille River
Middle Fork
Coquille River
N
0
5
10 Miles
Modeled Beaver
Habitat Suitability
[Dam Building]
(High-Medium High)
Model: Suzuki & McComb (1998)


North Bend
Coos Bay
Beaver Slough
Cunningham Cr.
Lampa Cr.
Ferry Cr.
Hall Cr.
Elk Cr.
Big Cr.
Upper Rock Cr.
Bear Cr.
Catching Cr.
Dement Cr.
Rowland Cr.
Salmon Cr.
Coal Cr.
Johnson Cr.
Cold Water Confluence (Δ>2°C, Top 33% flow)
Coho Distribution Above Cold Water Confluence
N
0
2.5
5
10 Miles


North Bend
Coos Bay
Moon Cr.
Middle Cr.
Brummit Cr.
Lost Cr.
Elk Cr.
Camas Cr.
Bear Cr.
Upper Rock Cr.
Rock Cr.
Salmon Cr.
Coal Cr.
Delta Cr.
Johnson Cr.
Headwaters S.F. Coquille
N
0
2.5
5
10 Miles
Cold Water Refugia
Top 33% Coldest &
Top 33% Highest Flow

Climate Change Parameters

Predicted flow in 2040

Based on ODFW climate change exposure analysis for the Coquille Basin. We calculated the percent change in mean summer flows between historic and predicted flows in 2040. The highest-ranking scores were given to sub-watersheds that have the smallest change in flows (i.e., < 7.3 % reduction) over the next 17 years.

Predicted flow in 2080

Based on ODFW climate change exposure analysis for the Coquille Basin. We calculated the percent change in mean summer flows between historic and predicted flows in 2080. The highest-ranking scores were given to sub-watersheds that have the smallest change in flows (i.e., < 9.8 % reduction) over the next 57 years.

Predicted temperatures in 2040

Based on ODFW climate change exposure analysis for the Coquille Basin. We calculated the predicted August water temperatures (°C) in 2040. The highest-ranking scores were given to sub-watersheds predicted to remain the coldest (i.e., < 15.3 °C) over the next 17 years.

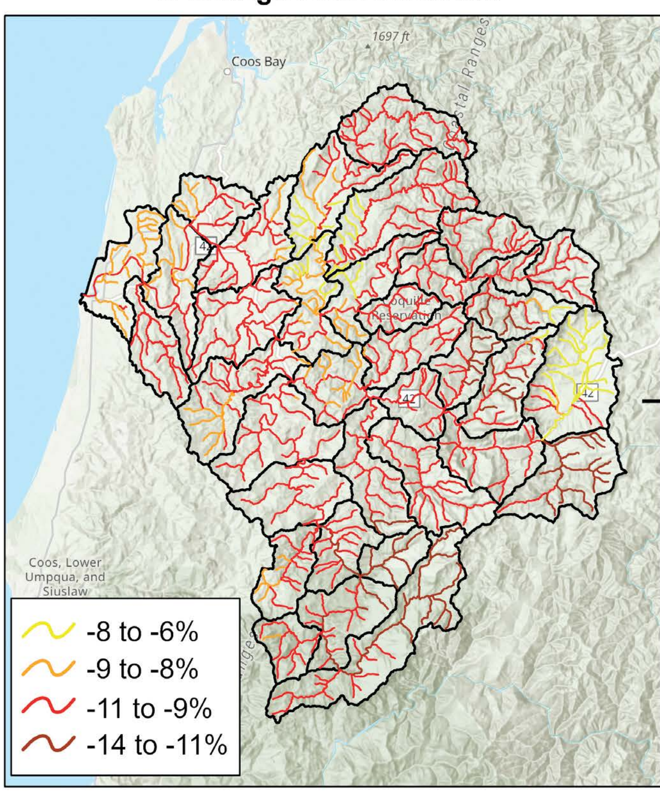
Predicted temperatures in 2080

Based on ODFW climate change exposure analysis for the Coquille Basin. We calculated the predicted August water temperatures in 2080. The highest-ranking scores were given to sub-watersheds predicted to remain the coldest (i.e., < 16.3 °C) over the next 57 years.

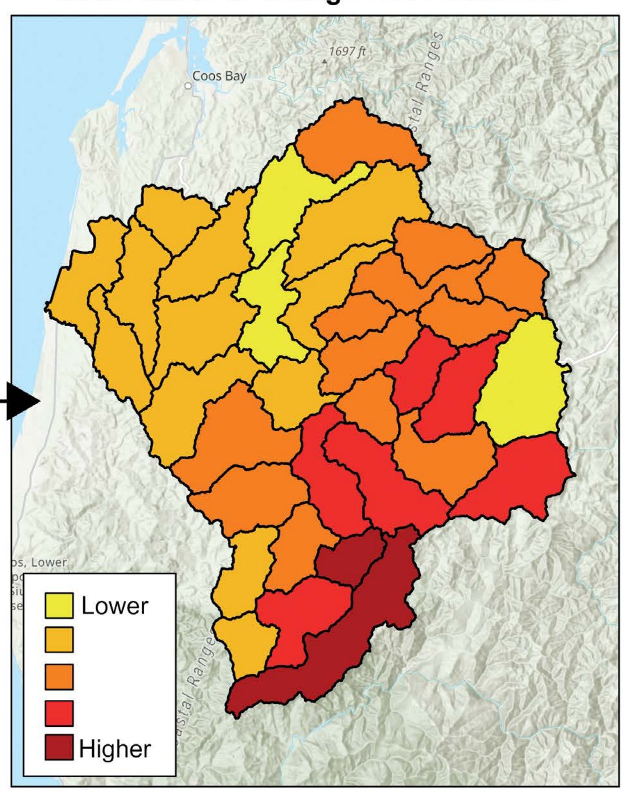
Landward migration zones

We used the Brophy and Ewald (2017) Landward Migration Zone (LMZ) GIS layer to calculate terrestrial habitats that are predicted to be tidally inundated by 2080 (current sea level + 1.6 feet). The highest-ranking scores were given to sub-watersheds predicted to have the largest conversion of terrestrial habitat into estuarine habitat over the next 57 years.

2040's Summer Stream Flows
% Change From Historical

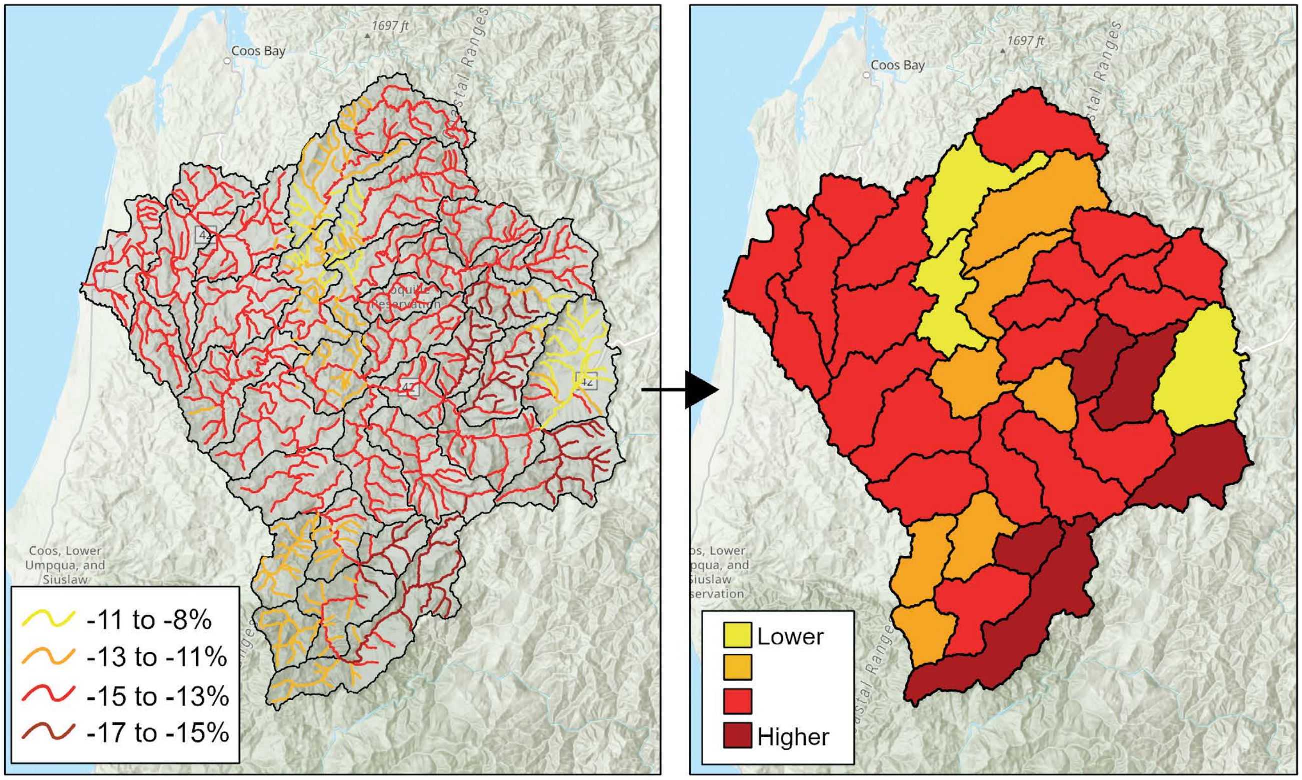


2040's Summer Stream Flows
Mean Basin % Change From Historical



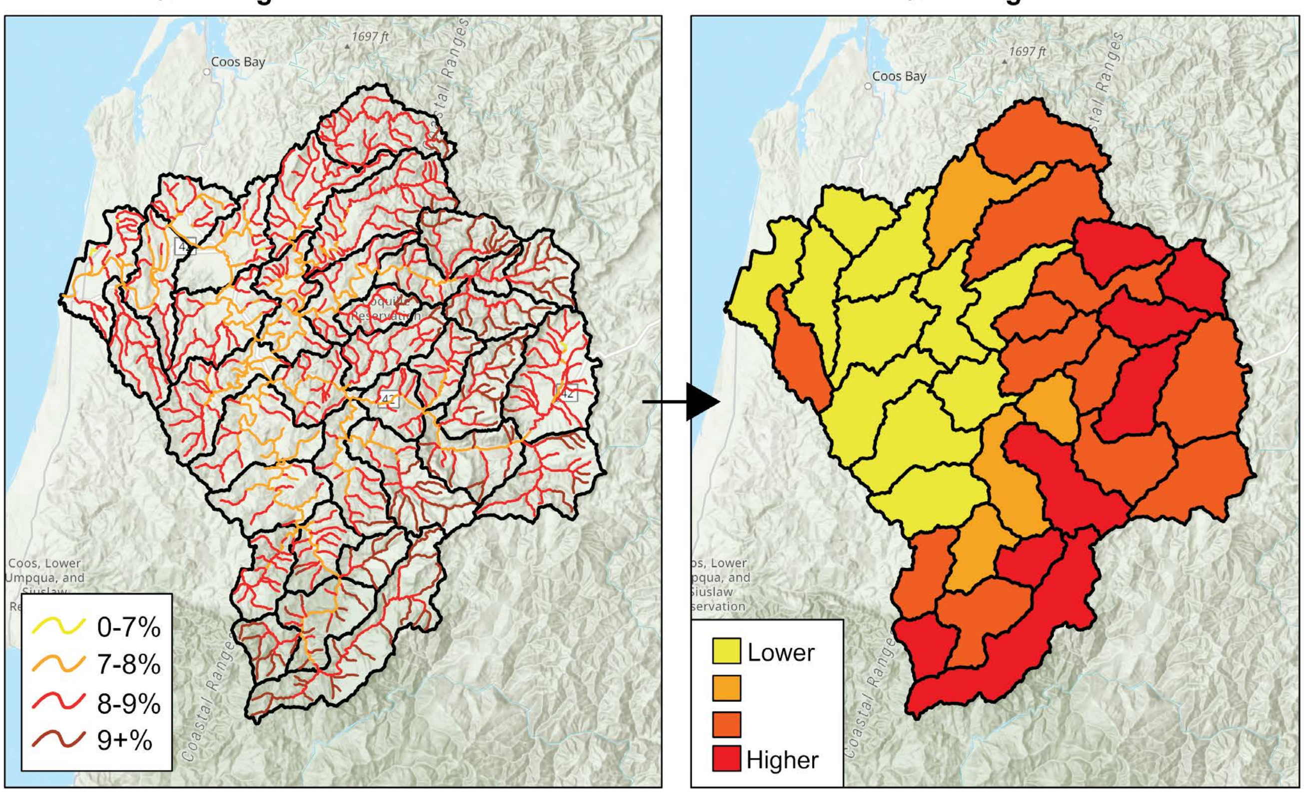
2080's Summer Stream Flows % Change From Historical

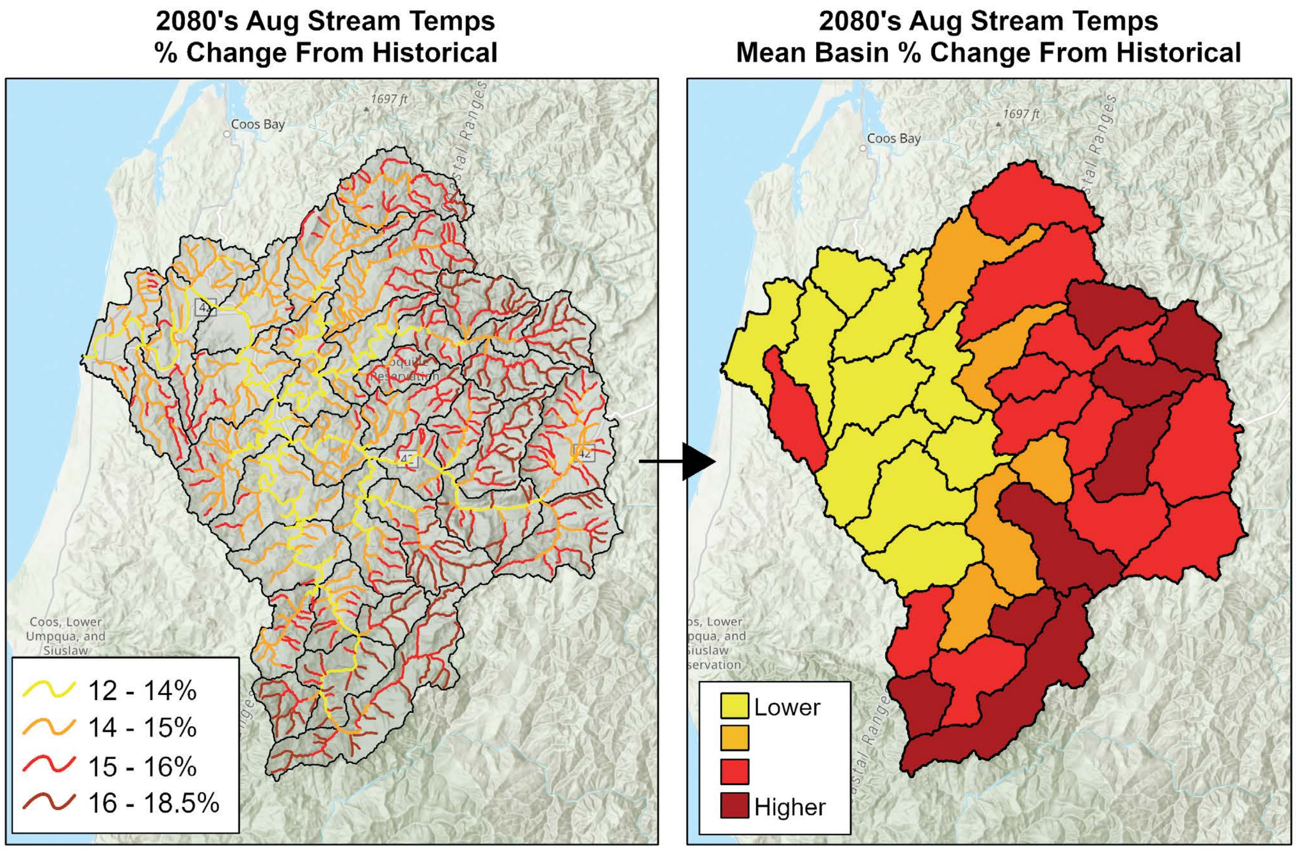
2080's Summer Stream Flows Mean Basin % Change From Historical

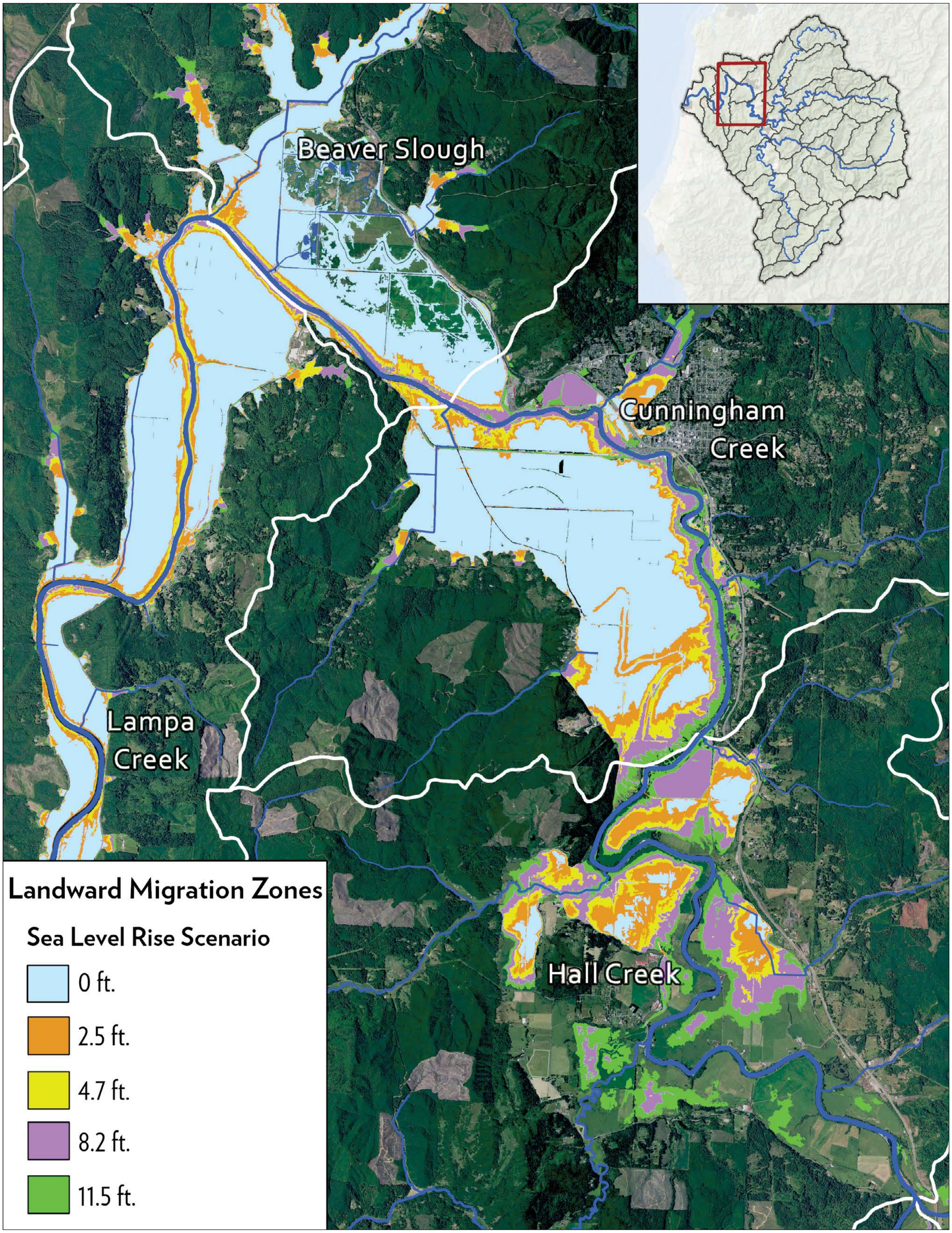


2040's Aug Stream Temps % Change From Historical

2040's Aug Stream Temps Mean Basin % Change From Historical




2080's Aug Stream Temps
% Change From Historical
Coos Bay
1697 ft
Coos, Lower Umpqua, and Siuslaw
12 - 14%
14 - 15%
15 - 16%
16 - 18.5%
2080's Aug Stream Temps
Mean Basin % Change From Historical
Lower
Higher


Beaver Slough
Cunningham Creek
Lampa Creek
Hall Creek
Landward Migration Zones
Sea Level Rise Scenario
0 ft.
2.5 ft.
4.7 ft.
8.2 ft.
11.5 ft.

Ranking Model Development

For each ranking parameter, we used the Jenk's Natural Breaks Classification Method to sort the sub-watershed parameter data into one of four classes and assigned a ranking score (i.e., 1, 2, 3, 4). The Jenk's Natural Breaks Classification Method uses a statistical algorithm to find natural break points between bin classes that maximize the variance between classes and minimizes the variance within bin classes. Higher ranking scores were assigned to sub-watersheds that positively affect Coho salmon or their habitat (e.g., more spawning habitat, more rearing habitat, highest juvenile carrying capacity, etc.). Sub-watersheds that did not have a parameter value were given a ranking score of zero.

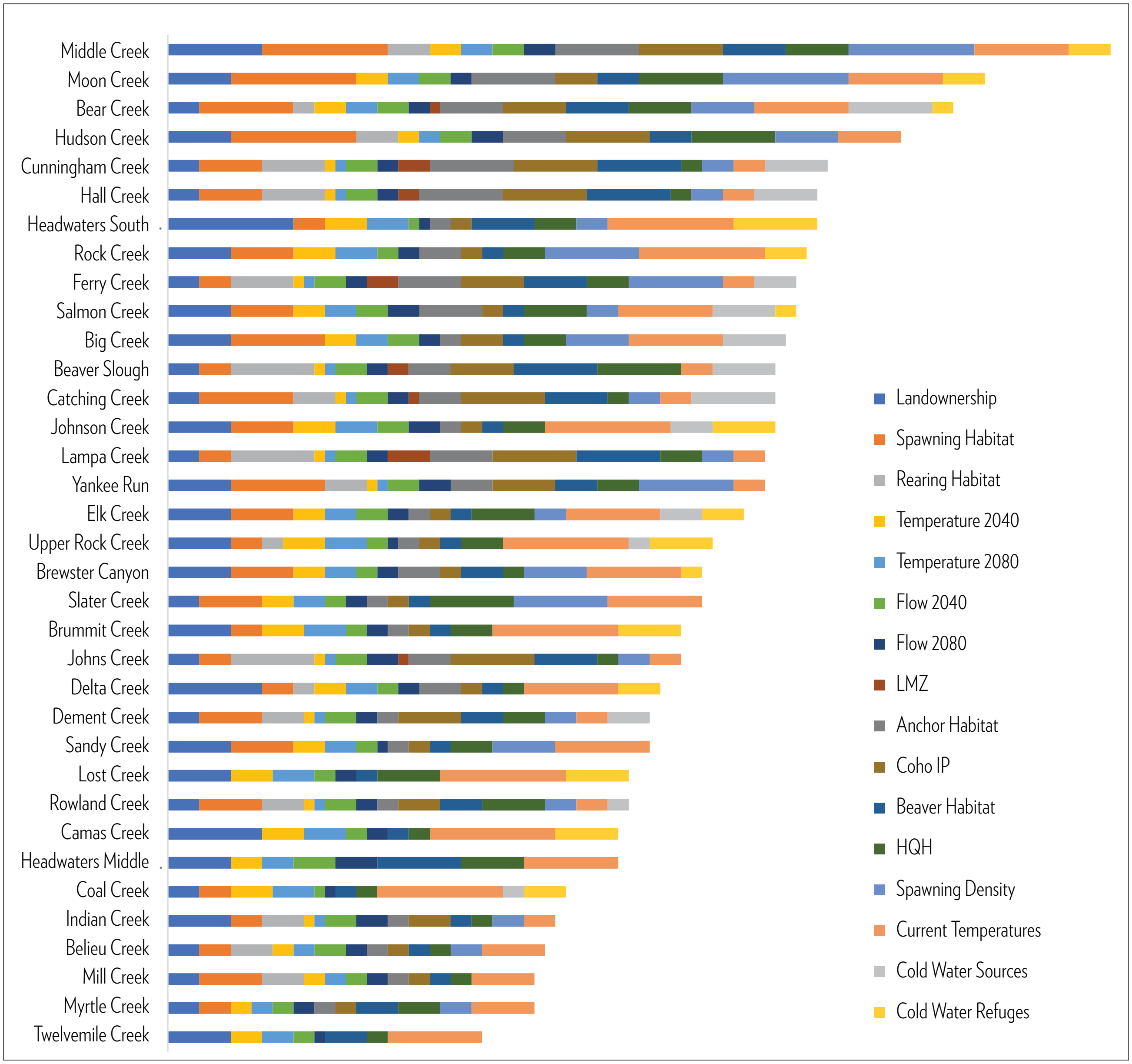
Once all the ranking scores were calculated, the technical team discussed the importance of each parameter in terms of its effect on Coho salmon, their habitats, and the team's confidence level in the data. Based on that discussion, the team decided to decrease, retain, or increase the ranking score of each parameter by applying a weighting factor of 0.5, 0, or 1.5.

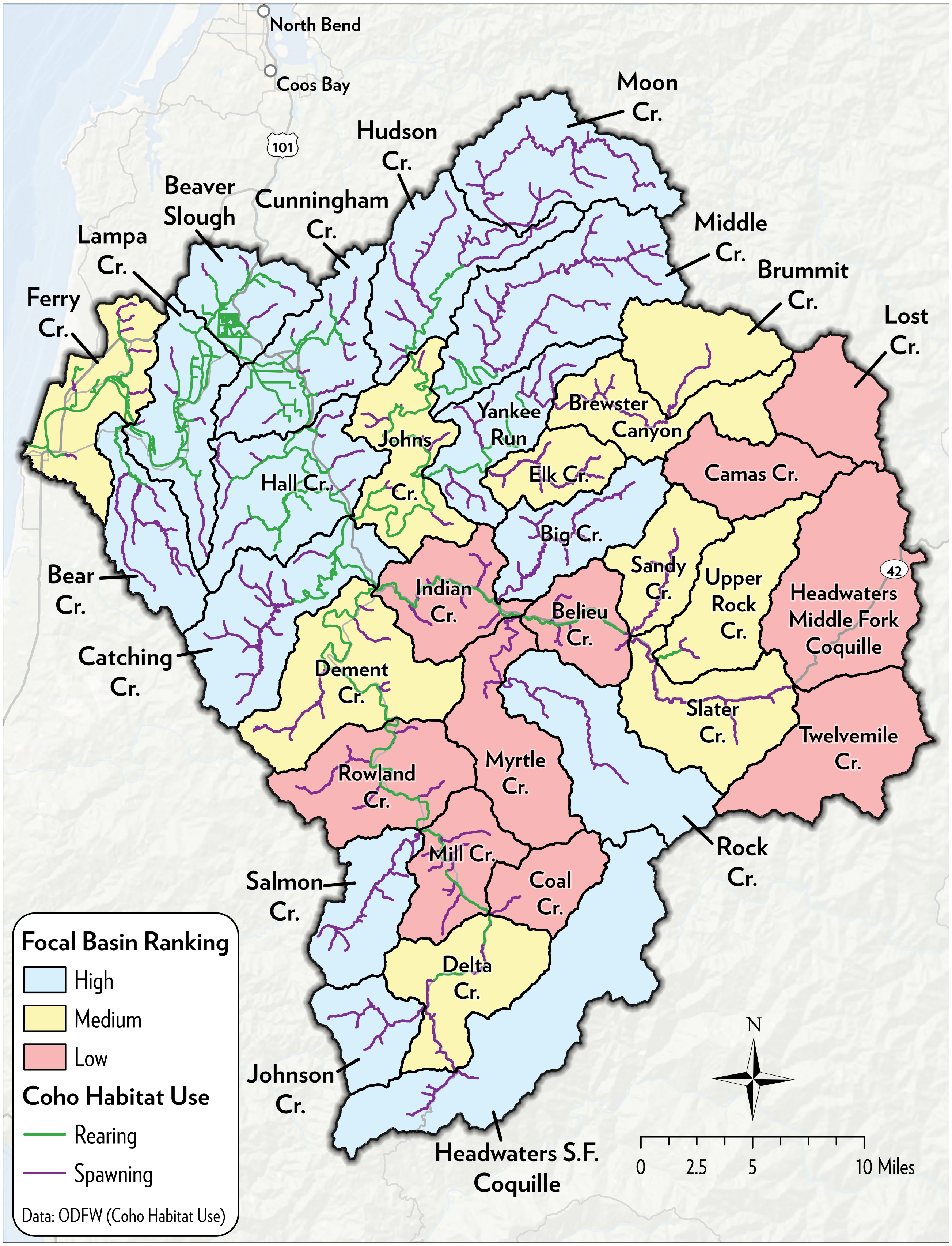
The weighted ranking scores for each parameter, in each sub-watershed, were then summed. We then divided the thirty-five sub-watersheds into approximate thirds, with the highest-ranking sub-watersheds identified as high priority, the middle third as medium priority, and the lowest third as low priority. For the high-priority sub-watersheds, there was a three-way tie between the ranking scores of Beaver Slough, Catching Creek, and Johnson Creek. Additionally, the ranking model identified Ferry Creek as a high-priority sub-watershed, but the technical team was concerned with this ranking for a number of reasons: 1) the Bandon Fish Hatchery is located on Ferry Creek and hatchery origin fish occupy most of the rearing habitats; 2) there is no Coho spawning habitat present; 3) there are large agricultural cranberry bogs that withdraw a significant amount of water in the summer and; 4) there are sedimentation/water quality issues. For these reasons, the technical and full stakeholder teams decided to move Ferry Creek to medium priority. The final ranking and prioritization process resulted in 15 high-priority sub-watersheds, 12 medium priority sub-watersheds, and 10 low priority sub-watersheds. The 13 high-priority sub-watersheds became the Coquille Coho SAP's focal areas.

FISH	HABITAT	CLIMATE CHANGE
Spawning Habitat X 1.5	High-Quality Habitat X 1	Mean August Flow (% change) in 2040 X 0.5
Rearing Habitat X 1	Coho Intrinsic Potential X 1	Mean August Flow (% change) in 2080 X 0.5
Oasis Spawning Surveys X 1.5	Land Ownership X 1.5	Temperature (C) in 2040 X 0.5
Current Temperature (C) X 1.5	Anchor Habitat X 1	Temperature (C) in 2080 X 0.5
	Beaver Habitat X 1	Landward Migration Zones X 0.5
	Cold Water Sources X 1	
	Cold Water Refugia X 1	

6TH FIELD	Land-ownership	Spawning Habitat	Rearing Habitat	Flow 2040	Flow 2080	LMZ	Anchor Habitat	Coho IP	Beaver Habitat	HQH	Spawning Density	Current Temperatures	Cold Water Sources	Temperature 2040	Cold Water Refuges	Temperature 2080	Total
Middle Creek	4.5	6	2	1.5	1.5	0	4	4	3	3	6	4.5	0	1.5	2	1.5	**45.0**
Moon Creek	3	6	0	1.5	1	0	4	2	2	4	6	4.5	0	1.5	2	1.5	**39.0**
Bear Creek	1.5	4.5	1	1.5	1	0.5	3	3	3	3	3	4.5	4	1.5	1	1.5	**37.5**
Hudson Creek	3	6	2	1.5	1.5	0	3	4	2	4	3	3	0	1	0	1	**35.0**
Cunningham Creek	1.5	3	3	1.5	1	1.5	4	4	4	1	1.5	1.5	3	0.5	0	0.5	**31.5**
Hall Creek	1.5	3	3	1.5	1	1	4	4	4	1	1.5	1.5	3	0.5	0	0.5	**31.0**
Headwaters South Fork Coquille	6	1.5	0	0.5	0.5	0	1	1	3	2	1.5	6	0	2	4	2	**31.0**
Rock Creek	3	3	0	1	1	0	2	1	1	2	4.5	6	0	2	2	2	**30.5**
Ferry Creek	1.5	1.5	3	1.5	1	1.5	3	3	3	2	4.5	1.5	2	0.5	0	0.5	**30.0**
Salmon Creek	3	3	0	1.5	1.5	0	3	1	1	3	1.5	4.5	3	1.5	1	1.5	**30.0**
Big Creek	3	4.5	0	1.5	1	0	1	2	1	2	3	4.5	3	1.5	0	1.5	**29.5**
Beaver Slough	1.5	1.5	4	1.5	1	1	2	3	4	4	?	1.5	3	0.5	0	0.5	**29.0**
Catching Creek	1.5	4.5	2	1.5	1	0.5	2	4	3	1	1.5	1.5	4	0.5	0	0.5	**29.0**
Johnson Creek	3	3	0	1.5	1.5	0	1	1	1	2	0	6	2	2	3	2	**29.0**
Lampa Creek	1.5	1.5	4	1.5	1	2	3	4	4	2	1.5	1.5	0	0.5	0	0.5	**28.5**
Yankee Run	3	4.5	2	1.5	1.5	0	2	3	2	2	4.5	1.5	0	0.5	0	0.5	**28.5**

6TH FIELD	Land-ownership	Spawning Habitat	Rearing Habitat	Flow 2040	Flow 2080	LMZ	Anchor Habitat	Coho IP	Beaver Habitat	HQH	Spawning Density	Current Temperatures	Cold Water Sources	Temperature 2040	Cold Water Refuges	Temperature 2080	Total
Elk Creek	3	3	0	1.5	1	0	1	1	1	3	1.5	4.5	2	1.5	2	1.5	**27.5**
Upper Rock Creek	3	1.5	1	1	0.5	0	1	1	1	2	0	6	1	2	3	2	**26.0**
Brewster Canyon	3	3	0	1	1	0	2	1	2	1	3	4.5	0	1.5	1	1.5	**25.5**
Slater Creek	1.5	3	0	1	1	0	1	1	1	4	4.5	4.5	0	1.5	0	1.5	**25.5**
Brummit Creek	3	1.5	0	1	1	0	1	1	1	2	?	6	0	2	3	2	**24.5**
Johns Creek	1.5	1.5	4	1.5	1.5	0.5	2	4	3	1	1.5	1.5	0	0.5	0	0.5	**24.5**
Delta Creek	4.5	1.5	1	1	1	0	2	1	1	1	0	4.5	0	1.5	2	1.5	**23.5**
Dement Creek	1.5	3	2	1.5	1	0	1	3	2	2	1.5	1.5	2	0.5	0	0.5	**23.0**
Sandy Creek	3	3	0	1	0.5	0	1	1	1	2	3	4.5	0	1.5	0	1.5	**23.0**
Lost Creek	3	0	0	1	1	0	0	0	1	3	?	6	0	2	3	2	**22.0**
Rowland Creek	1.5	3	2	1.5	1	0	1	2	2	3	1.5	1.5	1	0.5	0	0.5	**22.0**
Camas Creek	4.5	0	0	1	1	0	0	0	1	1	?	6	0	2	3	2	**21.5**
Headwaters Middle Fork Coquille	3	0	0	2	2	0	0	0	4	3	?	4.5	0	1.5	0	1.5	**21.5**
Coal Creek	1.5	1.5	0	0.5	0.5	0	0	0	1	1	?	6	1	2	2	2	**19.0**
Indian Creek	3	1.5	2	1.5	1.5	0	1	2	1	1	1.5	1.5	0	0.5	0	0.5	**18.5**
Belieu Creek	1.5	1.5	2	1.5	1	0	1	1	1	1	1.5	3	0	1	0	1	**18.0**
Mill Creek	1.5	3	2	1	1	0	1	1	1	1	0	3	0	1	0	1	**17.5**
Myrtle Creek	1.5	1.5	0	1	1	0	1	1	2	2	1.5	3	0	1	0	1	**17.5**
Twelvemile Creek	3	0	0	1	0.5	0	0	0	2	1	?	4.5	0	1.5	0	1.5	**15.0**


Middle Creek
Moon Creek
Bear Creek
Hudson Creek
Cunningham Creek
Hall Creek
Headwaters South
Rock Creek
Ferry Creek
Salmon Creek
Big Creek
Beaver Slough
Catching Creek
Johnson Creek
Lampa Creek
Yankee Run
Elk Creek
Upper Rock Creek
Brewster Canyon
Slater Creek
Brummit Creek
Johns Creek
Delta Creek
Dement Creek
Sandy Creek
Lost Creek
Rowland Creek
Camas Creek
Headwaters Middle
Coal Creek
Indian Creek
Belieu Creek
Mill Creek
Myrtle Creek
Twelvemile Creek
Landownership
Spawning Habitat
Rearing Habitat
Temperature 2040
Temperature 2080
Flow 2040
Flow 2080
LMZ
Anchor Habitat
Coho IP
Beaver Habitat
HQH
Spawning Density
Current Temperatures
Cold Water Sources
Cold Water Refuges


North Bend
Coos Bay
101
Moon Cr.
Hudson Cr.
Beaver Slough
Cunningham Cr.
Lampa Cr.
Middle Cr.
Brummit Cr.
Ferry Cr.
Lost Cr.
Brewster Canyon
Yankee Run
Johns Cr.
Hall Cr.
Elk Cr.
Camas Cr.
Big Cr.
Bear Cr.
Sandy Cr.
Upper Rock Cr.
42
Headwaters Middle Fork Coquille
Indian Cr.
Belieu Cr.
Catching Cr.
Dement Cr.
Slater Cr.
Twelvemile Cr.
Rowland Cr.
Myrtle Cr.
Rock Cr.
Mill Cr.
Coal Cr.
Salmon Cr.
Delta Cr.
Johnson Cr.
Headwaters S.F. Coquille
N
0
2.5
5
10 Miles
Focal Basin Ranking
High
Medium
Low
Coho Habitat Use
Rearing
Spawning
Data: ODFW (Coho Habitat Use)

Water Temperature Exceedances in the Coquille Basin

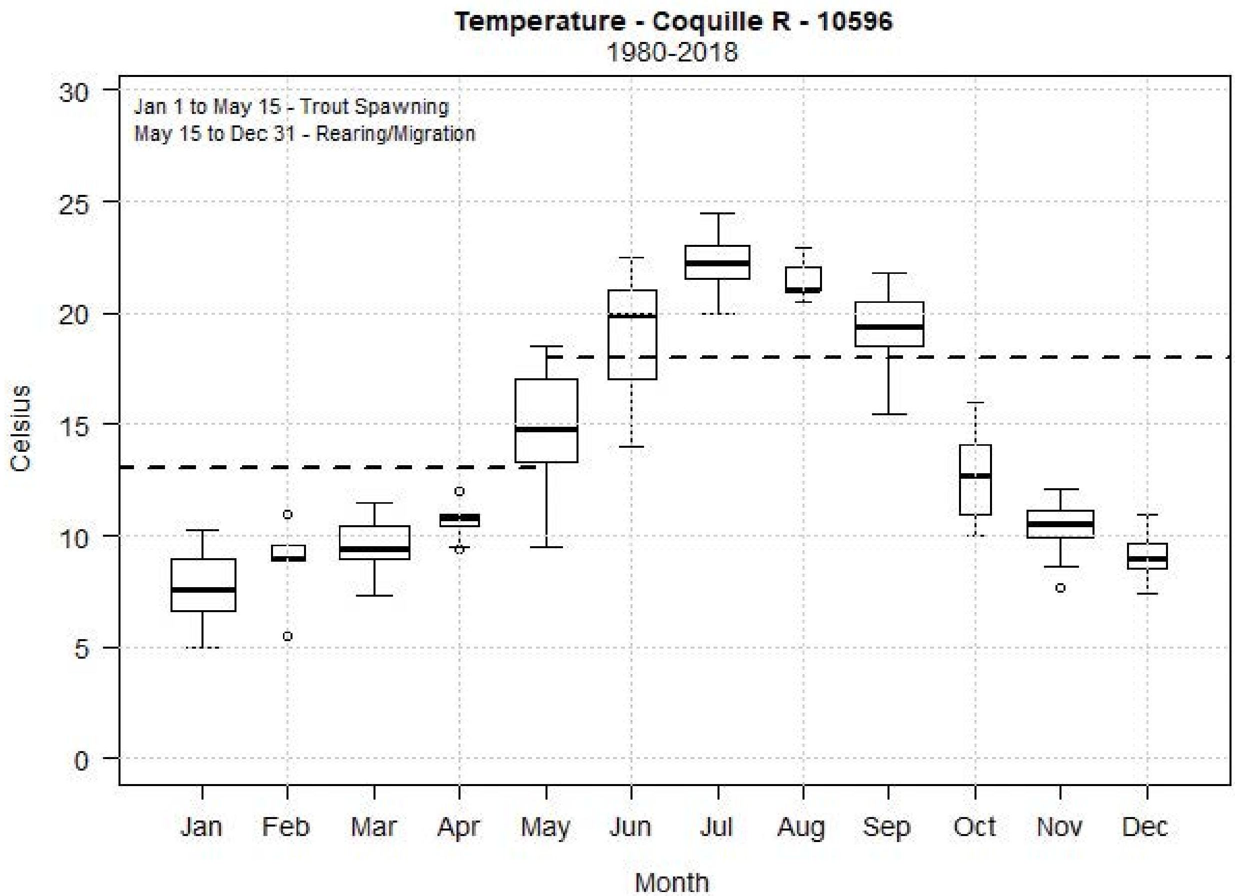


Figure AIII.1. Boxplot of monthly water temperatures from DEQ's Ambient Water Quality Monitoring System (AWQMS) in the Lower Coquille River from 1980 to 2018. Figure shows the median (bold bar), 25th and 75th percentiles (upper and lower box), maximum and minimum values (whiskers), and statistical outliers (circles). Dashed lines represent water quality standards set for life-stage-specific fish use (i.e., spawning, rearing, and migration). Station name: Coquille River at Sturdivant Park dock: #10596.

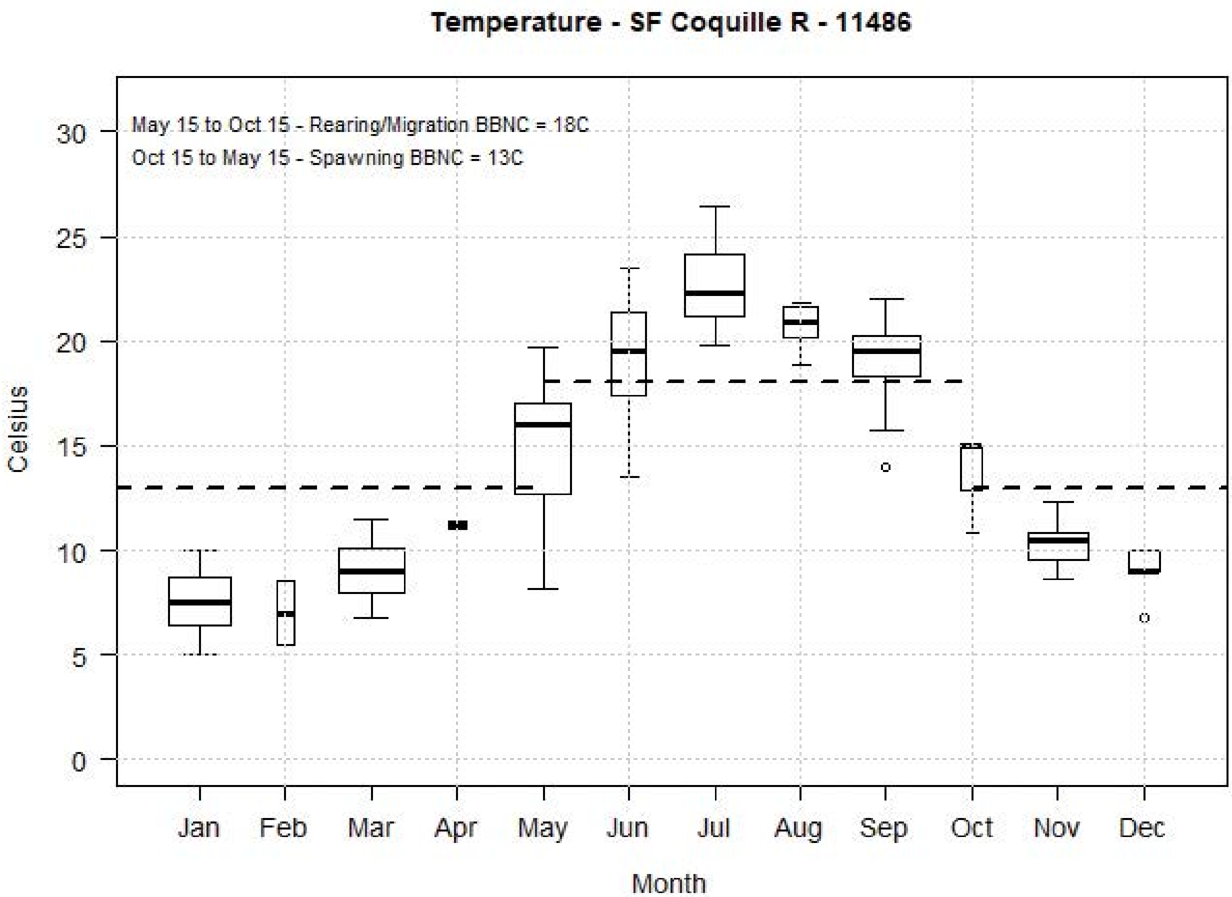


Figure AIII.2. Boxplot of monthly water temperatures from DEQ's Ambient Water Quality Monitoring System (AWQMS) in the South Fork Coquille River from 1980 to 2018. Figure shows the median (bold bar), 25th and 75th percentiles (upper and lower box), maximum and minimum values (whiskers), and statistical outliers (circles). Dashed lines represent water quality standards set for life-stage-specific fish use (i.e., spawning, rearing, and migration). Station name: SF Coquille River at Broadbent: # 11486.

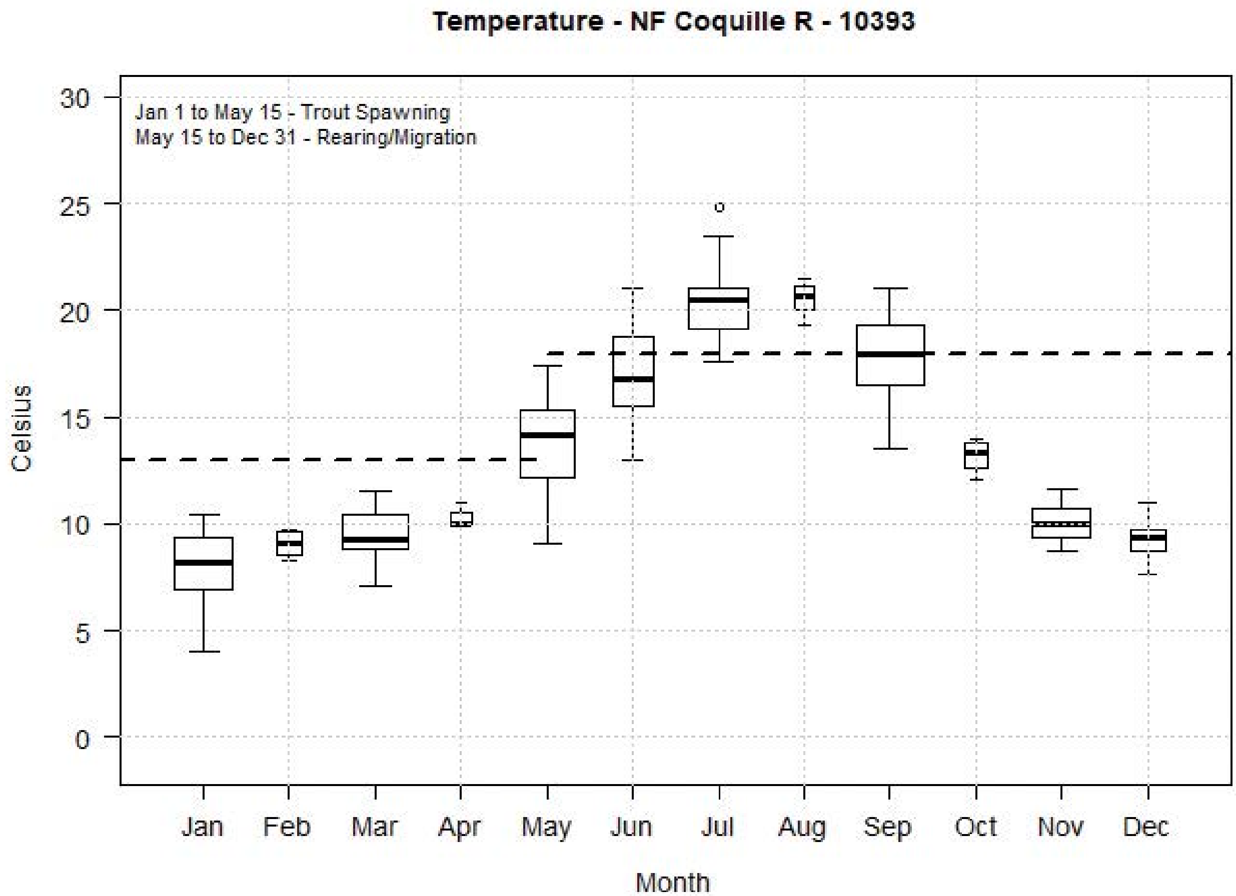


Figure AIII.3. Boxplot of monthly water temperatures from DEQ's Ambient Water Quality Monitoring System (AWQMS) in the South Fork Coquille River from 1980 to 2018. Figure shows the median (bold bar), 25th and 75th percentiles (upper and lower box), maximum and minimum values (whiskers), and statistical outliers (circles). Dashed lines represent water quality standards set for life-stage-specific fish use (i.e., spawning, rearing, and migration). Station name: NF Coquille River @ Hwy 42: #10393.

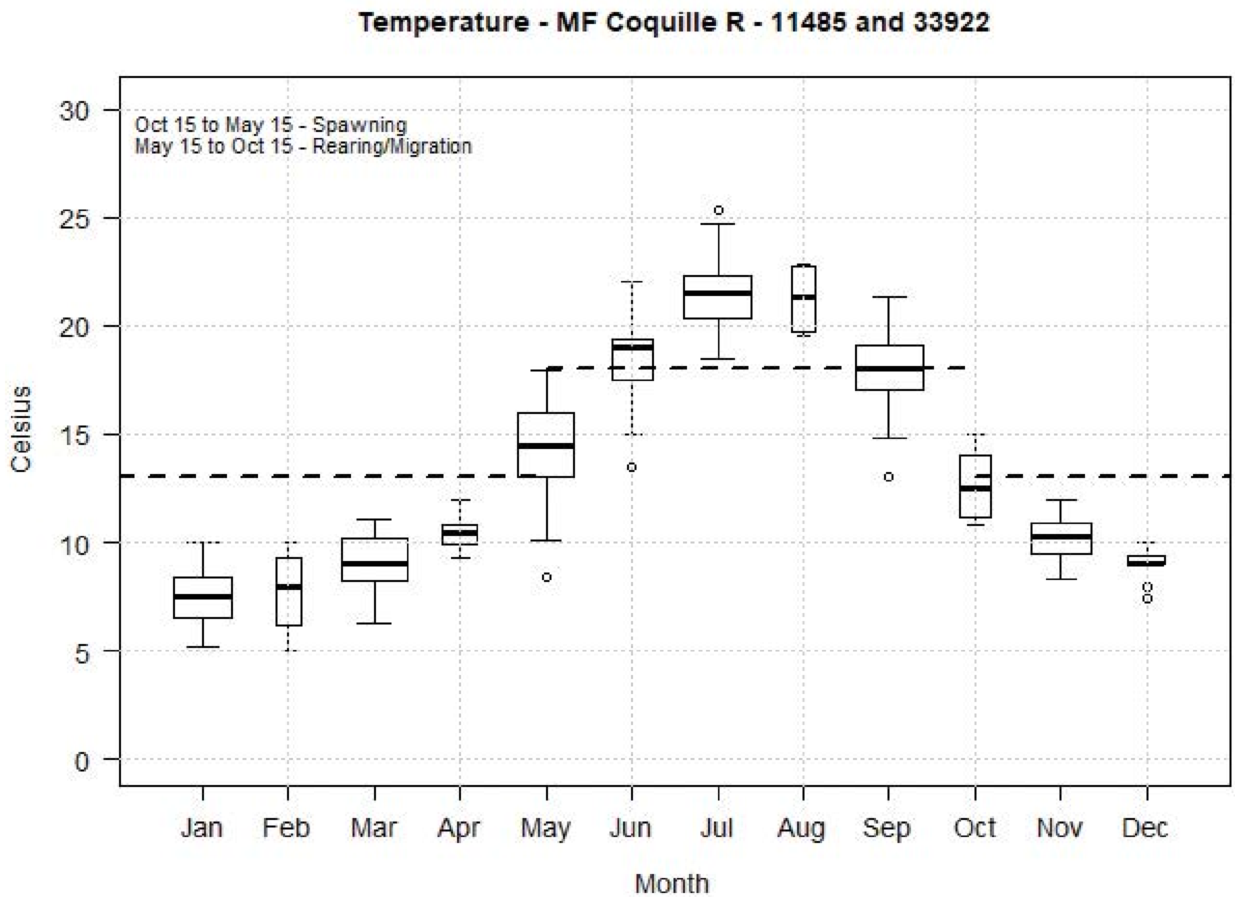
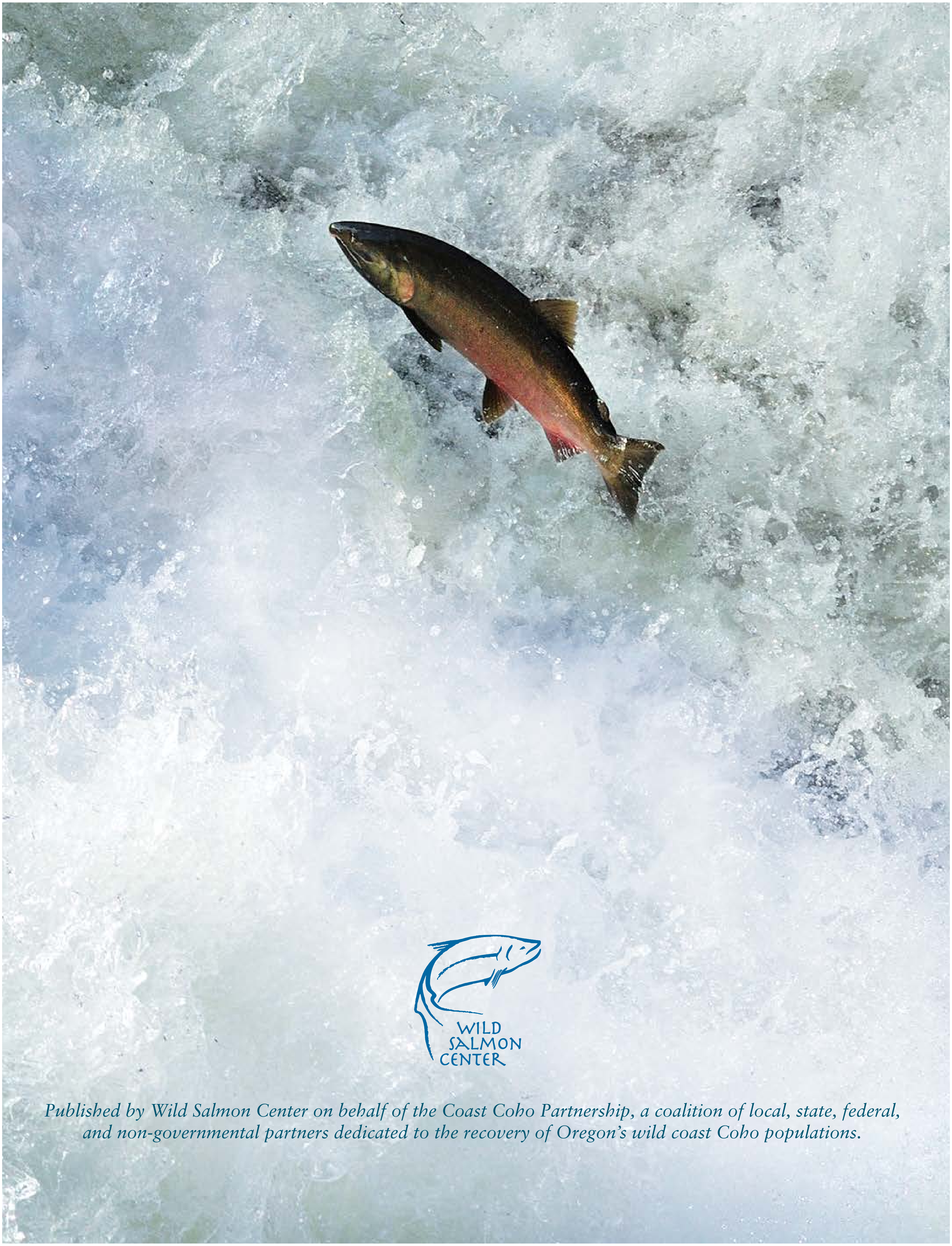


Figure AIII.4. Boxplot of monthly water temperatures from DEQ's Ambient Water Quality Monitoring System (AWQMS) in the South Fork Coquille River from 1980 to 2018. Figure shows the median (bold bar), 25th and 75th percentiles (upper and lower box), maximum and minimum values (whiskers), and statistical outliers (circles). Dashed lines represent water quality standards set for life-stage-specific fish use (i.e., spawning, rearing, and migration). Station names: MF Coquille River @ Hwy 42 #11485 & MF Coquille @ RM 1.25: #33922.

Middle Fork Coquille River. Photo: Dennis Frates / Alamy



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