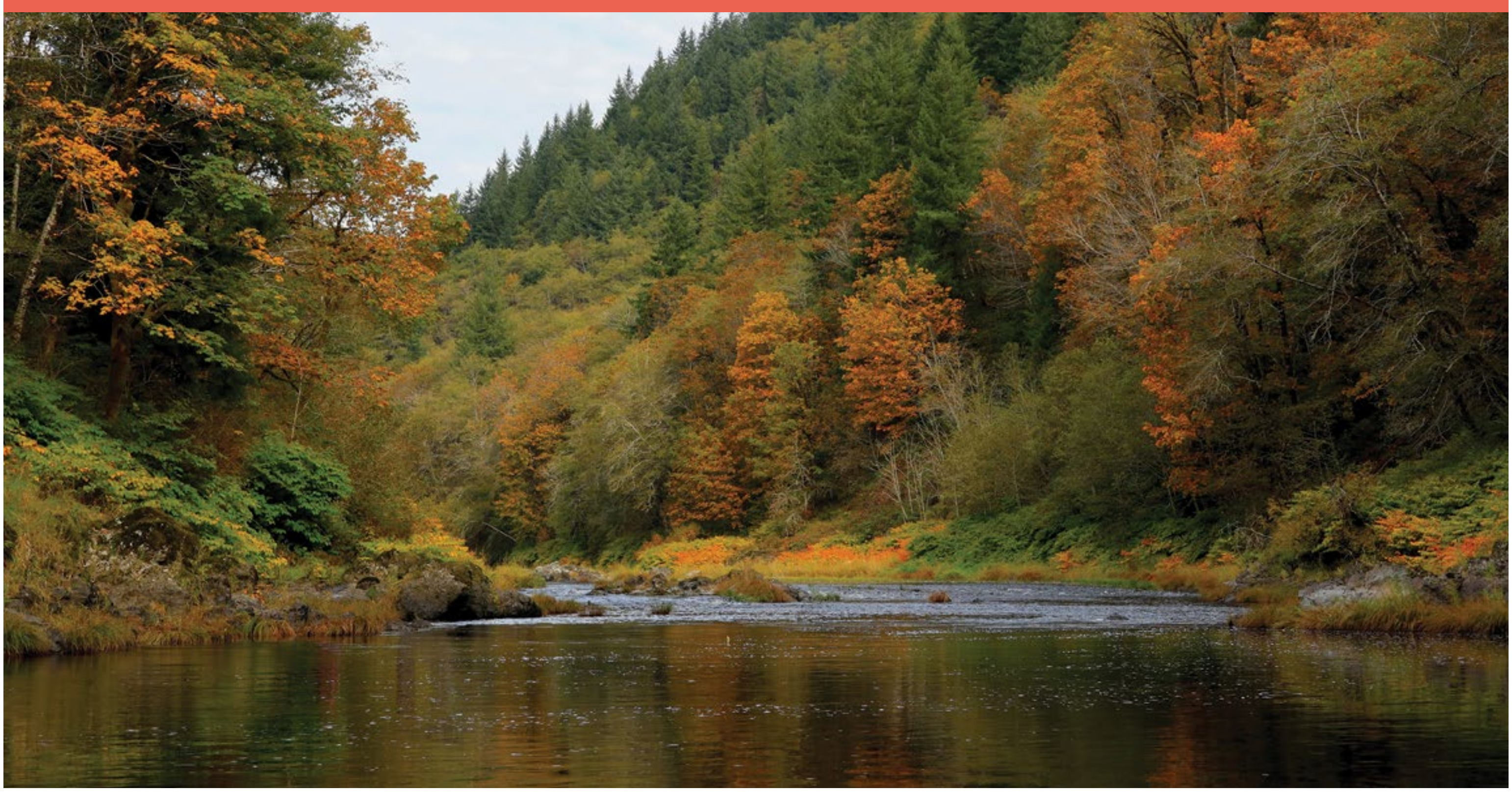
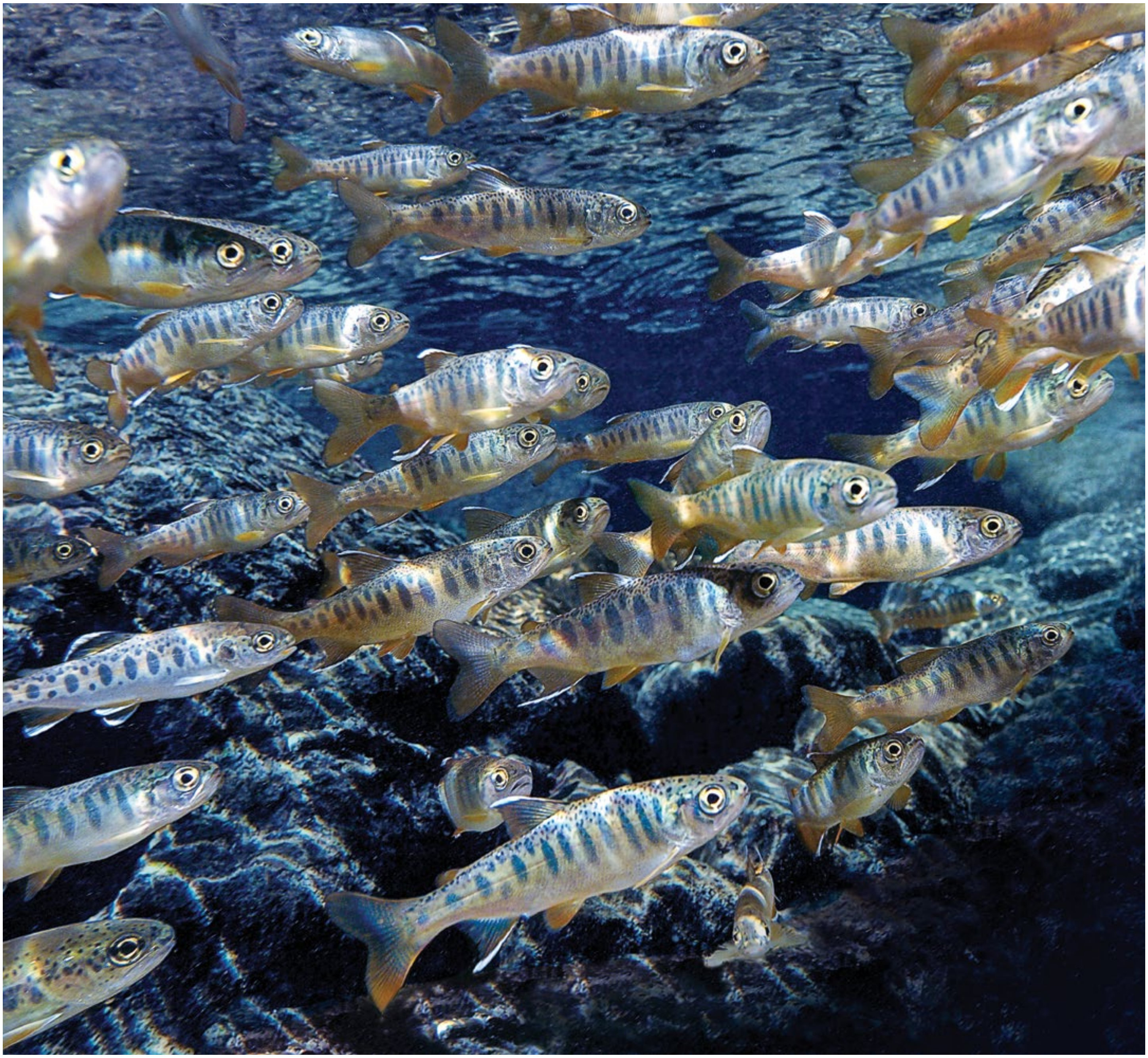
# Strategic Action Plan for the Protection & Restoration of Coho Salmon Habitat

## *~ The Nehalem River ~*





*Coast Coho juveniles by John McMillan. Cover photos: Coho by iStock and Nehalem River by Wild Salmon Center. Back cover by Alamy.*

# Contributors and Acknowledgements

The "Strategic Action Plan for the Protection and Restoration of Nehalem River Coho Salmon Habitat" (SAP) was developed by the ***Nehalem Basin Partnership*** (Nehalem Partnership), a team of dedicated resource managers and conservation professionals, representing the following agencies, organizations, and businesses:

- **Columbia Soil and Water Conservation District (SWCD)**
- **Lower Nehalem Watershed Council (LNWC)**
- **National Oceanic and Atmospheric Administration (NOAA)**
- **Oregon Department of Environmental Quality (DEQ)**
- **Oregon Department of Fish and Wildlife (ODFW)**
- **Oregon Department of Forestry (ODF)**
- **Tillamook Estuaries Partnership (TEP)**
- **Upper Nehalem Watershed Council (UNWC)**
- **Weyerhaeuser**

The Nehalem Partnership would like to thank the members of the Coast Coho Partnership (CCP), which includes the Oregon Watershed Enhancement Board (OWEB), ODFW, NOAA Fisheries, NOAA Restoration Center, National Fish and Wildlife Foundation (NFWF), and Wild Salmon Center (WSC), for their facilitation and technical support of the planning process. We would also like to acknowledge the critical contributions of several project consultants, including: Steve Trask and BioSurveys for sharing 30 years of experience in Coast Coho population research and habitat restoration; PC Trask for producing the literature review and bibliography; TerrainWorks for generating the Netmap layers and conducting the initial spatial analyses; and Barbara Taylor and Rob Walton for their editorial support. Finally, we are grateful to The Nature Conservancy for their development of the Voluntary Conservation Action Plan for Nehalem River Watershed, which informed this SAP.

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## Acronyms

| | |
|---|---|
| AQI | Aquatic Inventories Project |
| BDA | Beaver Dam Analogue |
| BLM | Bureau of Land Management |
| BMP | Best Management Practice |
| CAP | Conservation Action Plan |
| CCP | Coast Coho Partnership |
| CFS | Cubic Feet per Second |
| CMECS | Coastal and Marine Ecological Classification System |
| 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 |
| 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 |
| OWRI | Oregon Watershed Restoration Inventory |
| 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 |
| WSC | Wild Salmon Center |

# Contents

# List of Figures

## List of Tables


# Executive Summary

Prior to European settlement, an estimated quarter million Coast Coho salmon *(Oncorhynchus kisutch)* returned to spawn in the Nehalem River watershed, representing the largest Coho run on the north coast. A century and a half after the initial influx of European settlers – who were drawn to the region's booming timber, fishing, and farming industries – watershed health has declined in the Nehalem basin. These and other land uses have impaired critical watershed processes, leading to the loss and degradation of the habitats that sustain Nehalem Coho and other Pacific Salmon species.

A steady decline in habitat quality and quantity throughout the 20th century – coupled with high hatchery Coho production, high harvest rates, and poor ocean conditions – led to a crash in the Nehalem Coho population in the 1990s. An assessment completed by the Oregon Department of Fish and Wildlife (ODFW) determined that the Nehalem Coho population was no longer viable, primarily due to a lack of stream complexity to support overwintering juveniles. Elevated water temperatures, especially in the mainstem Nehalem River, also limited the quality and quantity of summer rearing habitat.

The decline of Nehalem Coho – and the habitat stressors that caused it – reflected broader, coast-wide trends. As a result, the Oregon Coast (OC) Coho "evolutionarily significant unit" (ESU) was listed as "threatened" under the federal Endangered Species Act (ESA) in 1998. Two plans to rebuild the ESU's 21 independent Coast Coho populations resulted from the ESA listing. First, in March 2007, ODFW published the "Oregon Coast Coho Conservation Plan." Then in December 2016, the National Oceanographic and Atmospheric Administration (NOAA) published the "Final ESA Recovery Plan for Oregon Coast Coho Salmon."

This Strategic Action Plan (SAP) represents a locally led effort to implement the broad recommendations contained in these state and federal recovery plans. In 2015, the Nehalem Partnership convened to develop an SAP that could achieve two long-term goals:

| LONG-TERM GOALS | |
|---|---|
| 1 | Protect and restore summer, winter, and incubation habitats sufficient to produce a detectable change (i.e., improving trends) in Coho production in high-priority 6th field subwatersheds. |
| 2 | Protect and restore watershed processes to ensure sufficient habitat diversity for the expression of multiple life-history strategies within the Nehalem Coho population. |

To achieve these goals, the SAP emphasizes restoration of the watershed processes that generate and maintain critical Coho habitats. This process-based approach relies heavily on an “anchor habitat strategy,” which seeks to identify, protect, and restore the stream reaches most capable of supporting Coho across the full spectrum of their freshwater residency, including spawning, egg incubation, rearing, and smolting. The primary strategies presented in this plan to restore watershed processes and conserve anchor habitats include:

- protecting selected upland timber stands to safeguard large woody debris (LWD) delivery to anchors;
- installing LWD and promoting dam-building by beavers to increase instream complexity and floodplain interaction in and around anchor habitats;
- enhancing long-term riparian function;
- improving fish passage and longitudinal connectivity; and
- reconnecting tidal wetlands.

The SAP sets forth six long-term outcomes that the Nehalem Partnership seeks to achieve through the implementation of these strategies in 17 “focal areas” (priority subwatersheds where partners have agreed to focus and coordinate restoration efforts). These measurable outcomes are consistent with the state’s broad sense recovery goal for the Nehalem Coho population of restoring 311 miles of instream habitat to “high quality habitat.”

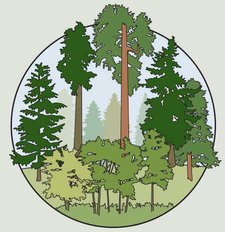

Photo: Lindsey Ray Aspelund

The Nehalem Partnership is confident that these outcomes will lead to achievement of the SAP's two over-arching goals. However, this SAP is not a recovery plan. It does not recommend changes in land use or resource management that may be required to achieve broad sense recovery. In addition, the goals and outcomes contained in the SAP are built on assumptions and imperfect data. Most notably, projected changes in climate will impact the Nehalem Coho population and the effectiveness of habitat restoration in ways that cannot yet be fully understood. Ultimately, the achievement of the Nehalem Partnership's vision – healthy ecological, economic, and social conditions in the watershed that can ensure a sustainable future for native Coho – relies on the adaptive implementation of this plan coupled with the sustained stewardship of resource managers and public and private landowners.

Recognizing the importance of adaptive management, the Nehalem Partnership developed a monitoring framework to assess SAP implementation. The framework provides guidance on how to evaluate both the rate at which the SAP is being implemented and the degree to which it's producing the desired results. The adaptive management chapter concludes with a discussion of several important data gaps, which, once filled, may revise the priorities presented in this plan.

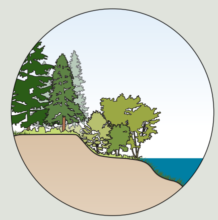
The Nehalem Partnership estimated the costs of all projects presented in the SAP's short-term work plan (2023-2027). To achieve the plan's five-year objectives, partners propose projects with a total estimated cost of $3.44 million. This estimate does not reflect fish passage projects, which will require design and engineering to generate informed cost estimates and likely increase this estimate by several million dollars. Extrapolation of these short-term costs plus fish passage and additional work planned over the life of the plan indicates a total cost of SAP implementation between $45m and $50m.

**By 2045 the Nehalem Coho Partnership will achieve the following restoration outcomes:**



**Upland Forests: 536 acres** of upland timber are protected to ensure long-term delivery of large wood to anchor habitats.

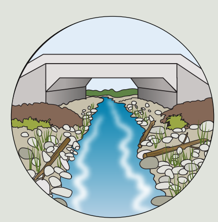
**Instream:** Instream complexity is restored within **66 miles** of focal area anchor habitats.



**Riparian:** Riparian function is enhanced along **58 miles** of focal area tributaries.

**Off-Channel:** Beavers colonize and build dams along an additional **40 miles** of Coho-bearing tributaries, increasing off-channel habitats available for Coho rearing.

**Tidal Wetlands: 300 acres** of tidal wetlands and other estuarine habitats are reconnected.



**Fish Passage:** 52 barriers to fish passage are removed, restoring Coho access to **92 miles** of anchor habitats and cold-water refuge.

*Illustrations: Elizabeth Morales*

**By reaching these six restoration outcomes, the Nehalem Partnership seeks to achieve the SAP's long-term goals and advance the vision of a healthy Nehalem Coho population.**

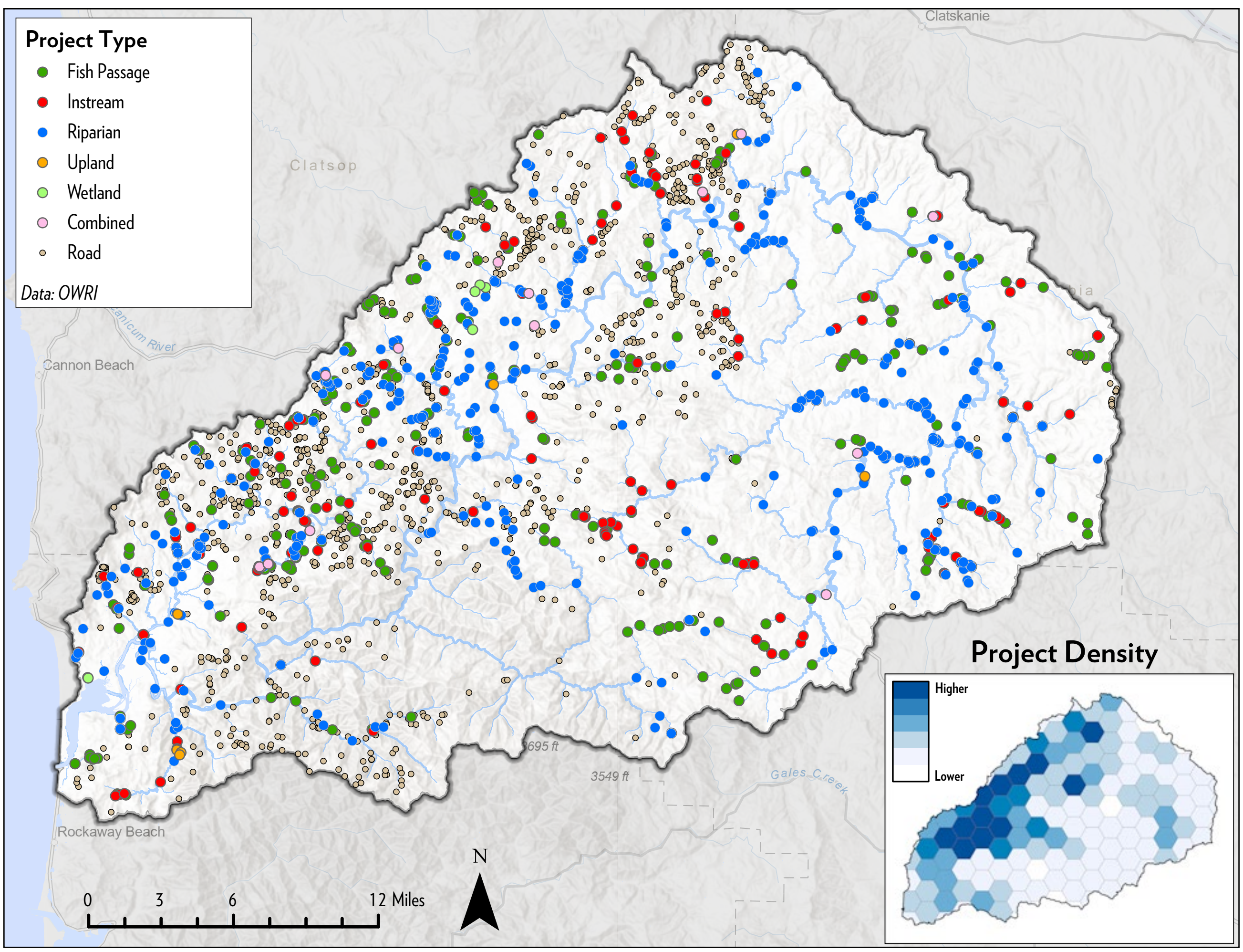
## Chapter 1

# Introduction: The Nehalem Basin Partnership and the Purpose of this Plan

Scientists estimate that one to two million adult Coho salmon *(Oncorhynchus kisutch)* once returned to the Oregon Coast (OC) Coho Evolutionarily Significant Unit (ESU) (NMFS 2016), which includes populations from Cape Blanco, Oregon north to the Columbia River (ODFW 2007). In the late 19th and early 20th centuries, these runs drove the settlement of small fishing communities and fueled a nascent coastal economy. While the runs began to decline in the early 20th century, Coho and other Pacific Salmon continued to support commercial and recreational fisheries through most of the century, bolstering local economies up and down the coast. The Coho fishery was largely closed following the initial listing of the OC Coho ESU as "threatened" under the Endangered Species Act (ESA) in 1998. For the past 20 years, a recovery effort has been underway focused heavily on the protection and restoration of critical Coho habitats.

As one of 21 independent populations in the OC Coho ESU, the viability of the Nehalem Coho population has mirrored that of the ESU. Once numbering an estimated 240,000 fish in the 1800s (Meengs and Lackey 2005), population abundance declined to less than 3,000 in 2012 (ODFW 2022). Since the passage of the Oregon Plan for Salmon and Watersheds (ODFW 1997), state and federal agencies, local watershed groups, NGOs,

**Figure 1-1.** Habitat Restoration and Forest Road Maintenance Projects (1995 – 2018).



and public and private landowners have led a substantial local recovery effort. Figure 1-1 shows many restoration projects implemented within the Nehalem watershed over the last two decades.

Along the rural, resource-dependent coast of northwest Oregon, watershed conservation and species recovery require the establishment of strategic partnerships in which a variety of public and private stakeholders work together toward a common vision. This vision must coalesce economic, ecological, and social goals and align the limited social and financial capital available in the region towards solutions that promote sustainable watershed and community health. Development of this Strategic Action Plan (SAP) by the Nehalem Basin Partnership (Nehalem Partnership) intends to meet these needs. Through this plan, the partners listed below seek to engage local stakeholders in developing and implementing habitat protection and restoration actions that will recover the Nehalem Coho population, while sustaining and nurturing the long-term viability of working farms, forests, and communities.

The Nehalem Partnership includes the following federal, state, local, and corporate partners:

- **Columbia Soil and Water Conservation District (SWCD)**
- **Lower Nehalem Watershed Council (LNWC)**
- **National Marine Fisheries Service (NMFS)**
- **Oregon Department of Environmental Quality (DEQ)**
- **Oregon Department of Fish and Wildlife (ODFW)**
- **Oregon Department of Forestry (ODF)**
- **Tillamook Estuaries Partnership (TEP)**
- **Upper Nehalem Watershed Council (UNWC)**
- **Weyerhaeuser**

## 1.1 The Vision of a Healthy Coho Population

The Nehalem Partnership envisions healthy ecological, economic, and social conditions in the Nehalem basin that ensure a sustainable future for native Coho through highly connected, functional, and productive landscapes.

Through the implementation of this plan, the partners hope to achieve the following long-term ecological goals:

- Protect and restore summer, winter, and incubation habitats sufficient to produce a detectable change (improving trends) in Coho production in high-priority 6th field watersheds, and
- Protect and restore watershed processes to ensure sufficient habitat diversity for the expression of multiple life-history strategies within the Nehalem Coho population.

## 1.2 Why Coho?

**Coho have a unique life cycle among Pacific Salmon that makes them an excellent indicator of watershed health**. Adult Coho return from the ocean to the Nehalem River each fall, spawning in the basin's low-gradient tributaries. The resulting offspring emerge from the gravel the following spring, then – unlike other Pacific Salmon – most spend a full year in freshwater before migrating to the ocean. This extended freshwater residency requires a watershed that is functioning sufficiently to maintain a variety of habitat types throughout the year, especially "off-channel" areas such as beaver ponds, oxbows, and

***Coho salmon are a "keystone species," which means numerous plant and animal species rely on them to survive.***

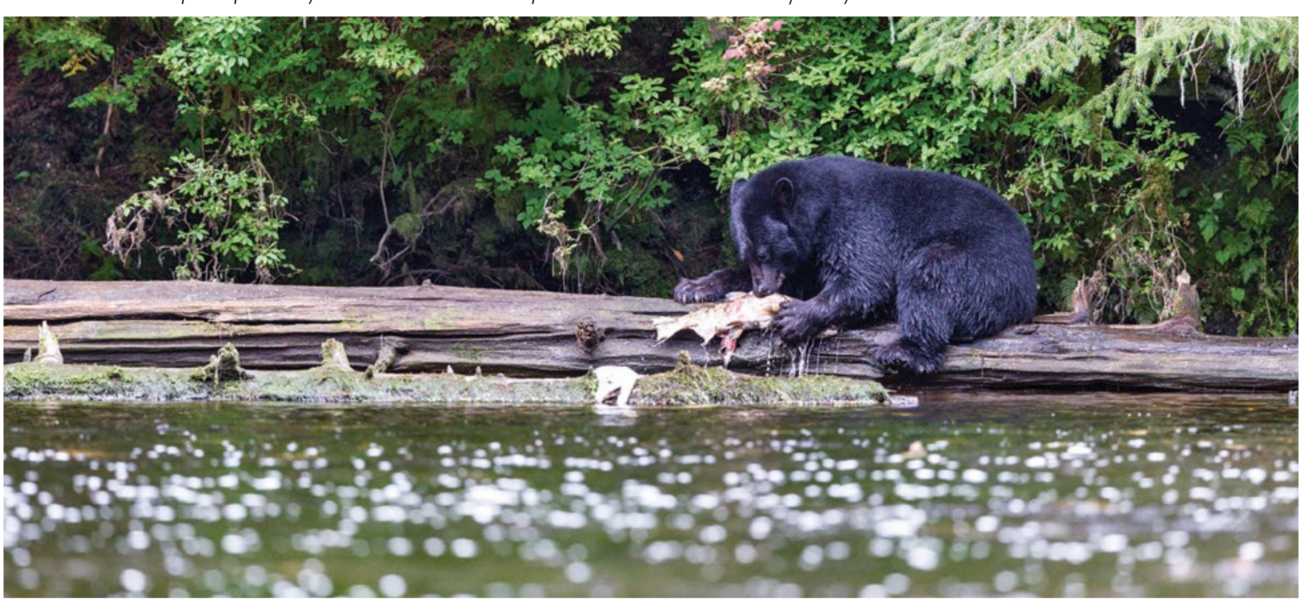
side channels. These habitats allow juvenile Coho to find pockets of cool water when the mainstem heats up in the summer, and resting areas in the winter when peak flows threaten to sweep them downstream. Also, when a watershed can generate and maintain enough complex instream and off-channel habitats to sustain a viable Coho population, the system is likely capable of producing services that communities rely on, such as clean drinking water, flood control, groundwater recharge and recreation.

**Restoring Coho habitats also benefits other species**. Coho habitats are created by the interaction of complex watershed processes like hydrology, sediment delivery, and riparian (streamside) and floodplain interactions. The protection and restoration of these and other natural processes for Coho help the watershed produce and maintain habitats for Chinook *(Oncorhynchus tshawytscha),* chum *(O. keta)*, steelhead *(O. mykiss)*, and cutthroat trout *(O. clarki clarki)*, and a range of plant and animal species, many of which Coho require for their survival.

Finally, Coho are a "keystone species," which numerous plants and animals rely on at some point during their lives. All life stages of Coho (egg, fry, smolt, and adult) provide sustenance to aquatic and terrestrial organisms ranging from otter and black bear, which consume returning adults, to the smallest aquatic invertebrates that shred the carcasses of decaying fish after they have spawned.

**Forest and plant communities also directly benefit from the decaying fish**. Adult Coho return to the watershed after taking up phosphorus, nitrogen, and other nutrients from the ocean. After they spawn, they decompose and release these critical "marine-derived nutrients" (MDN) into the ecosystems where they become available to grasses, shrubs, trees, and other plant life. Studies on MDN have not been conducted in the Nehalem basin, but according to Merz and Moyle (2006), "research over more than three decades has shown that the annual deposition of salmon-borne (MDN) is important for the productivity of freshwater communities throughout the Pacific coastal region." Helfield and Naiman (2001) found "that trees and shrubs near spawning streams derive ~22-24 percent of their foliar nitrogen (N) from spawning salmon." Subsequent research by Naiman et al. (2002) suggests that even in highly modified watersheds in northern California, "robust salmon runs continue to provide important ecological services with

*Numerous animal and plant species rely on coho and other salmon for survival. Photo: Tim Plowden / Alamy*



high economic value…. Loss of Pacific Salmon can not only negatively affect stream and riparian ecosystem function, but can also affect local economies where agriculture and salmon streams coexist."

## 1.3 Scope of this Strategic Action Plan

The federal government and the State of Oregon have developed recovery plans for the OC Coho ESU that encompass the Nehalem population, including the Final ESA Recovery Plan for Oregon Coast Coho Salmon (NMFS 2016) and the Oregon Coast Coho Conservation Plan (ODFW 2007). While these ESU-level plans identify population-scale limiting factors and recommend a suite of strategies to recover each population in the ESU, both plans stress that recovery can only be achieved by implementing plans that are locally generated and include finer-scale, targeted conservation actions. Decisions on where and how these actions are implemented must be made in locally convened forums, so input from the landowner community and other stakeholders can be fully integrated into both the long-term habitat restoration strategy and the selection of short-term projects.

This SAP seeks to meet these needs for the Nehalem River community. Chapter 5 presents a long-term "strategic framework" for Coho habitat protection and restoration. This framework describes the habitat restoration strategies that will have the highest potential to restore watershed function and identifies locations throughout the basin where these strategies can generate the greatest benefit. Chapter 6 presents a short-term work plan that maps the specific locations where the social, economic, and regulatory conditions exist to put projects on the ground that advance the long-term strategic framework.

It is important to note that the Nehalem Partnership's ability to achieve the goals described in Section 1.1 is influenced by a va-

*Decomposing salmon feed riparian forests. Three decades of research shows that trees and shrubs near spawning streams derive an estimated 22-24% of their foliar nitrogen (N) from spawning salmon. Photo: Wild Salmon Center*

riety of threats that cannot be fully addressed by this SAP since it focuses largely on freshwater and estuarine habitat restoration. Over the course of this plan's development, participants considered many of these threats, including predator management (sea lions, cormorants, etc.); the sufficiency of state water quality rules; and fishery, farm, and forest management. Ultimately, the partners opted to limit the scope of this plan to priorities that the Nehalem Partnership has greater control over: namely, where, when, and how Coho habitats can and should be restored in the watershed. Reviewers of this plan are

*Photo: Ken Morrish*

***This SAP does not propose any new regulations or the modification of existing regulations. Implementation of this plan is entirely voluntary.***

encouraged to consider the policies governing land use and species/habitat management in the Nehalem basin alongside this plan's restoration goals, and to use existing venues to support policies that align with the vision of Coho recovery as described above.

Finally, the Nehalem Partnership wishes to underscore that implementation of this plan is entirely voluntary. The plan identifies high-quality habitats on both public and private lands to guide outreach to landowners, but the plan's implementation relies entirely on voluntary actions. No new actions will be required of public or private landowners. Consequently, while this plan's maps identify instream and upland habitats on some private lands as a high priority for restoration, the implementation of actions on these lands is up to individual landowners. Likewise, this SAP does not propose any new regulations or the modification of existing regulations.

## 1.4 SAP Implementation Timeline: Long-Term Outcomes & Short-Term Goals

The Nehalem Partnership projects the implementation of this plan – including new projects identified through the adaptive management process – to run through 2045. Such a long implementation horizon will be necessary to achieve the plan's goals in part because of the time required for the system

*Coho salmon have a unique life cycle among Pacific Salmon that makes them an excellent indicator of watershed health. If a watershed can generate and maintain enough complex instream and off-channel habitats to sustain a viable Coho population, the system is likely capable of producing services that communities rely on, such as clean drinking water, flood control, and recreation. Photo: Jim Yuskavitch*

to respond to restoration treatments. For example, trees planted in a riparian zone may take a decade or more to begin providing sufficient shade to improve water temperatures. In addition, the Nehalem Partnership recognizes that it will take many years for the implementation of a sufficient number of projects to demonstrate an improvement in subwatershed function.

We hope to reach the goals stated in Section 1.1 by achieving six restoration outcomes by 2045:

- The long-term potential for large wood delivery to anchor habitats is improved through the protection of 536 acres of selected timber stands throughout the Nehalem basin (343 acres in focal areas).
- Instream complexity and stream interaction with off-channel habitats are restored within 66 miles of focal area anchor habitats.
- Riparian function is restored along 58 miles of focal area tributaries, reducing stream temperatures and erosion, increasing macro-invertebrate abundance, and increasing the long-term potential for large wood recruitment.
- Beavers colonize and build dams along an additional 40 miles of Coho-bearing tributaries in the focal areas, increasing the quality and quantity of off-channel habitats available for Coho rearing.
- Three hundred acres of tidal wetlands and other estuarine habitats are reconnected, increasing the quality and extent of tidal rearing habitats and associated freshwater habitats.
- Fifty-two barriers to fish passage are removed, enhancing longitudinal connectivity in focal area tributaries, and restoring Coho access to 92 miles of anchor habitats, cold water refugia, and off-channel habitats.

## 1.5 Implementing Partners

While this SAP has been developed by the team of partners listed in the introduction to this chapter, a subset of agencies and organizations will lead its implementation on the ground. Table 1-1 lists these partners and the role each will play in implementing this SAP.

| IMPLEMENTATION OUTCOMES | |
|---|---|
| 1 | **536 acres** of upland timber are protected to ensure long-term delivery of large wood to anchor habitats. |
| 2 | Instream complexity is restored within **66 miles** of focal area anchors. |
| 3 | Riparian function is enhanced along **58 miles** of focal area tributaries. |
| 4 | Beavers colonize and build dams along an additional **40 miles** of tributaries, increasing off-channel habitats available for Coho rearing. |
| 5 | **300 acres** of tidal wetlands and other estuarine habitats are reconnected. |
| 6 | 52 barriers to fish passage are removed, restoring Coho access to **92 miles** of anchor habitats and cold-water refuge. |


*Photo: Danita Delimont*

**Table 1-1**. Core Implementation Partners

| Core Implementation Partners | | |
|---|---|---|
| *Partner* | *Experience* | *Anticipated Contributors* |
| Columbia SWCD | The Columbia SWCD was created in 1946 to support private landowners with stewardship and conservation of working (timber and agriculture) and non-working lands. It has partnered with private landowners throughout Columbia County within the Nehalem watershed on instream and riparian restoration, weed management, and other restoration projects. | The Columbia SWCD will implement the SAP by providing technical assistance to landowners within the parts of the Nehalem watershed that intersect with Columbia County. The SWCD will undertake outreach to landowners, raise implementation funds, manage project implementation, and monitor and report on progress. |
| Lower Nehalem Watershed Council | The LNWC is dedicated to the protection, preservation, and enhancement of the Nehalem watershed through leadership, cooperation and education. Since its inception in the 1990s, the LNWC has been working with public and private landowners in the watershed to implement habitat restoration, monitoring, and education projects. | The LNWC will be a lead implementer of the SAP in the lower watersheds within their coverage area. It will conduct landowner outreach, raise implementation funding, manage the implementation of habitat restoration projects, and monitor and report on progress. |
| Oregon Department of Forestry | As the owner and manager of the Tillamook-Clatsop State Forest, ODF is the largest public landowner in the Nehalem basin. The agency has partnered with the watershed councils and other groups on the implementation of the Oregon Plan for Salmon and Watersheds since the 1990s and has decades of experience leading and supporting upland, instream, and riparian habitat restoration projects. | ODF will provide technical support for project implementation, in-kind donation of trees and other project materials as feasible, and access to sites for SAP implementation. |
| Oregon Department of Fish and Wildlife | ODFW has expertise in regional fisheries, aquatic and terrestrial habitat issues, and supporting and leading state-wide partnerships. Local field staff for the Nehalem have provided technical assistance to the vast majority of the habitat restoration projects implemented in the Nehalem since the development of the Oregon Plan. | ODFW staff will continue to provide technical support for locally led habitat restoration projects, and assist in data management, landowner outreach, public education, and project development. |
| Tillamook Estuaries Partnership | TEP is a 501 (c) (3) non-profit organization dedicated to the conservation and restoration of Tillamook County's estuaries and watersheds. It has managed habitat restoration, monitoring, and education projects in the Nehalem watershed since 2002, when it expanded its service area beyond just Tillamook Bay. | TEP will implement habitat restoration projects in the Nehalem watershed, while providing technical and financial support to the lead implementers as resources are available. |
| Upper Nehalem Watershed Council | Founded in 1996, the mission of the UNWC is to foster stewardship and understanding of the natural resources of the Upper Nehalem Watershed among the stakeholders of the watershed communities in order to protect, conserve, restore and sustain the health and functions of the watershed. For over 20 years, it has collaborated with public and private landowners to implement numerous habitat restoration projects, while also supporting local research, monitoring, and education efforts. | The UNWC will be a lead implementer of the SAP in the upper part of the basin within their coverage area. It will conduct landowner outreach, raise implementation funding, manage the implementation of habitat restoration projects, and monitor and report on progress. |
| Weyerhaeuser | Weyerhaeuser is one of the largest private landowners in the U.S. and offers a diverse suite of resource-based services and products. The company is the largest private landowner in the Nehalem watershed. In addition to ongoing timber operations and other land management activities, it partners with local conservation organizations to restore critical habitats. | Weyerhaeuser will continue to partner with the watershed councils and other stakeholders to implement habitat restoration projects on its lands, as well as support restoration efforts on other lands within the watershed. |

# Chapter 2

# The Nehalem River Watershed

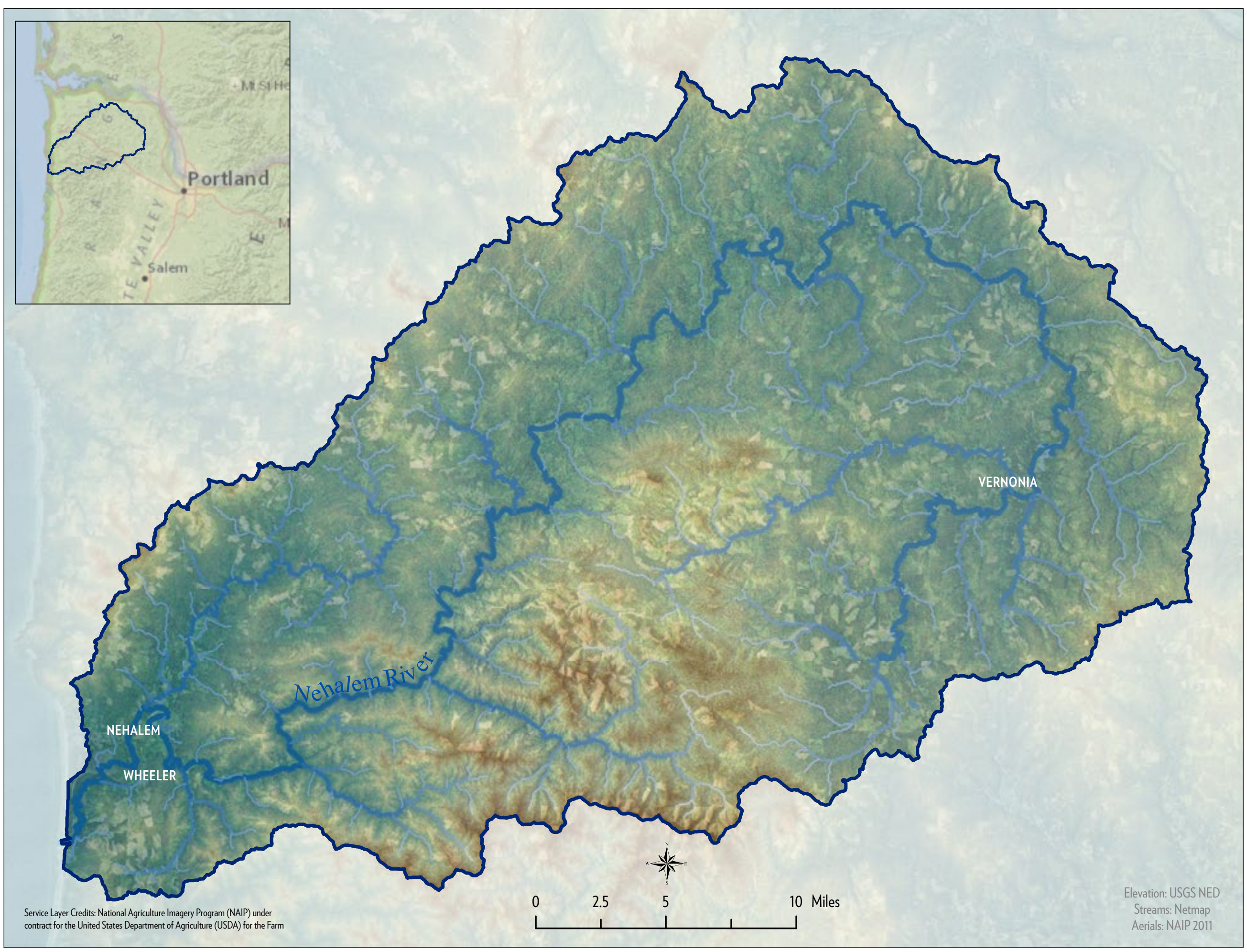
The Nehalem River is the third-longest coastal river in Oregon. Located in the state's northwest corner, the river drains approximately 855 square miles of Washington, Columbia, Clatsop, and Tillamook Counties (Figure 2-1). The Nehalem River flows 118.5 river miles from its source on Giveout Mountain (west of the town of Timber) to Nehalem Bay and the Pacific Ocean. Along the way, the mainstem Nehalem River collects input from over 935 miles of tributaries (Maser 1999).

The Nehalem River watershed is home to an independent population of OC Coho salmon (NOAA 2007; Lawson et al. 2007) that relies on the watershed and its habitat-forming processes for adult spawning, juvenile rearing, and migration to and from the ocean.

**The Nehalem River**
is the third-longest coastal river
in the state of Oregon.

| 855 | 118.5 | 935 |
|---|---|---|
| sq mile drainage in 4 counties | river miles long | miles of tributaries |

**Figure 2-1.** The Nehalem River Watershed.



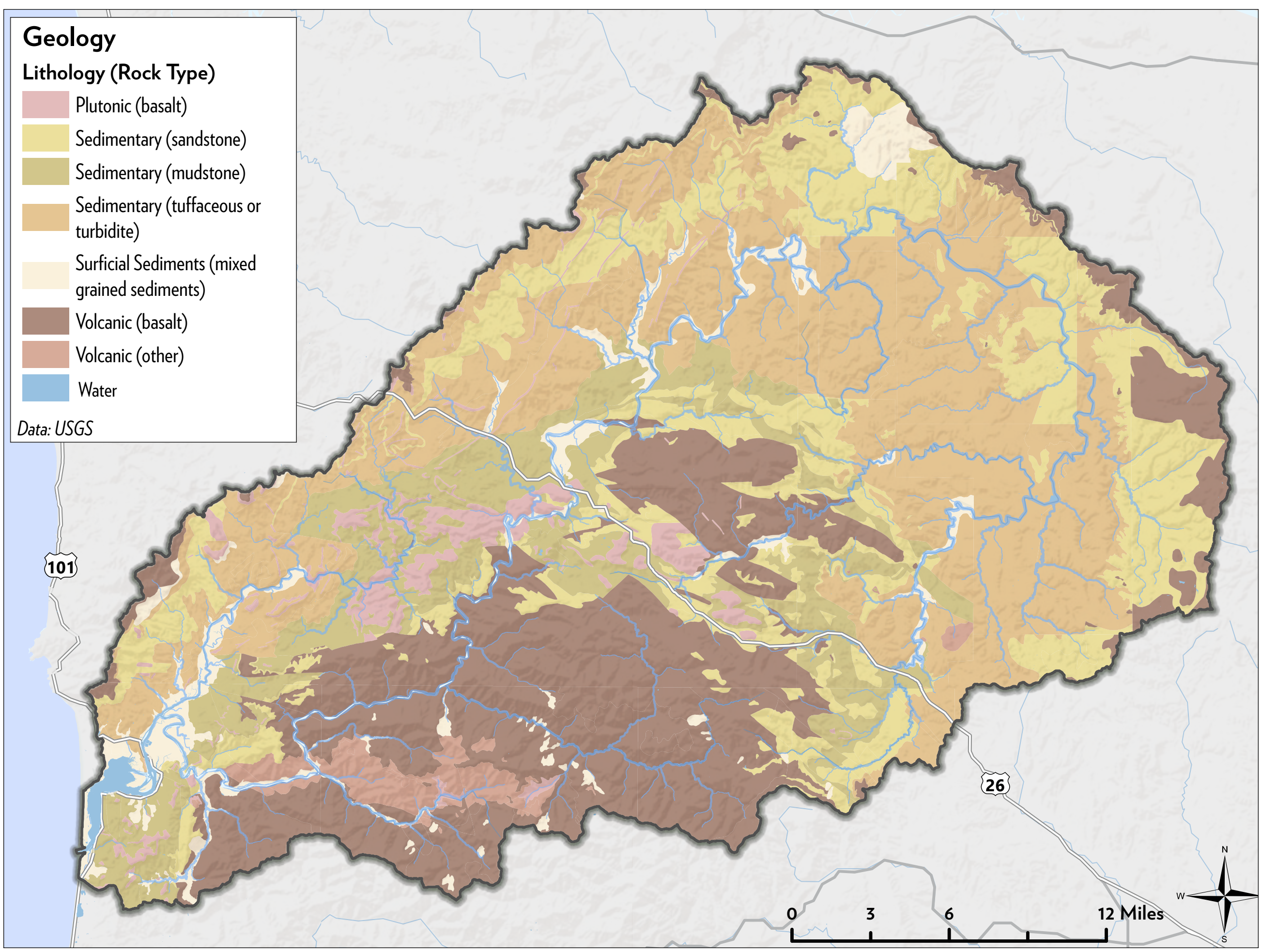
## 2.1 Geology and Physical Geography

The Nehalem River watershed lies within the Oregon Coast Range Ecoregion. Coniferous forests dominate this region, with 98 percent of the watershed in forest cover (NRCS 2005). Sitka spruce, Douglas-fir, western red cedar, and western hemlock are common in these forestlands (NOAA 2007). Elevation in the watershed ranges from sea level to 4,000 feet, with average temperatures of 50 degrees Fahrenheit and annual rainfalls of 60 to 180 inches.

The watershed contains four EPA Level IV Ecoregions (EPA 2019): coastal lowlands (sea level to 300 feet), coastal uplands (elevations up to 500 feet), volcanics (from 1,000 to 3,200 feet), and Willapa hills. The Nehalem River estuary is a "drowned river mouth estuary" created from the inundation of the lower river mouth and coastal plains resulting from rising sea levels that followed the last ice age. Bounding the coastal lowlands – and the extensive network of marshes, sloughs, and swamps – are coastal uplands. Upland areas in the Nehalem basin include uplifted marine-consolidated and semi-consolidated sandstones and siltstones. Volcanic geology includes Tillamook volcanics in the southern part of the watershed and Columbia Basalt in the northeast (Francisco 2012). Between the volcanic outcroppings lie the Willapa hills, a series of low-lying hills in the western hemlock zone (NOAA 2007). Figure 2-2 provides a map of Nehalem basin geology.

According to Jones et al. (2012), the Nehalem basin is mostly comprised of sedimentary rocks that break down quickly. Stream power is high until the head of tide, where gravel from volcanic rock settles. Sand and

**Figure 2-2.** Geology of the Nehalem River Watershed.



silts from sedimentary rocks settle mostly in the tidal reaches and on floodplains.

Prior to the arrival of European and American homesteaders and the rise of the commercial timber and agriculture industries, the Nehalem River and its tributaries were a complex mosaic of habitat types providing a variety of functions for aquatic species and sustenance for indigenous cultures. In the upper reaches, large wood (both standing and downed), beaver dams, and boulders promoted interaction between tributary and mainstem channels and their adjacent floodplains. High flows across this complex landscape generated well-connected side channels, oxbows, and ponds of cool, calm water ideal for Coho rearing. High flows also sorted river substrates, creating gravel and cobble riffles well suited to spawning salmon. In the lower reaches of the basin, the floodplain broadened into a connected network of sloughs, marshes, and swamps. Plentiful large wood contributed to the dynamic river as it moved across the floodplain, creating side channels, alcoves, bars, and islands.

Many watershed conditions changed as European settlers moved into the basin. The settlers leveed much of the lower river for flood protection and agriculture, disconnecting the Nehalem River from its historic floodplain and straightening and deepening the mainstem. Marshes and swamps were drained to support agricultural use. Past logging activities – including the use of log drives, slash dams, and diversion dams to float cut logs down the Nehalem River and tributaries to lumber mills – scoured entire reaches of critical spawning substrates. The log drives, along with “river cleaning” to support boating, led to the clearing of habitat-forming large woody debris. Altered hydrology from human management of the landscape also greatly simplified stream habitats. Timber harvest and land clearing for agriculture and development stripped riparian areas of large wood.

*Photo: Maggie Peyton*

## 2.2 Water Resources

Rainfall in the Nehalem basin ranges from 55 inches per year near Vernonia to 200 inches in the higher elevations of the Salmonberry subwatershed (Maser 1999). The United States Geologic Survey (USGS) maintains a long-term gage on the Nehalem River near Foss, Oregon. Average discharge during the 1940-1999 period of record was 2,672 cubic feet per second (cfs) with a maximum discharge of 70,300 cfs recorded on February 8, 1996 following a rain-on-snow event. The minimum discharge was 34 cfs from August 29-31, 1967. The average peak flow is 28,776 cfs. Eighty-five percent of the total discharge in the watershed occurs between November and April (Maser 1999).

Water quantity has been identified as a stressor for Coho in the Upper Nehalem River, Middle Nehalem River, and Lower Nehalem River – Cook Creek hydrologic units (Bauer et al. 2008). There are 569 permitted water rights in the Nehalem watershed (OWRD 2023) representing at least 93.25 cfs of cumulative authorized water diversions (Maser 1999), an amount that can have a substantial impact on summer stream temperatures and juvenile fish migration.

## 2.3 Forest Resources

The vast majority (almost 90%) of the Nehalem River watershed is in state and private forest ownership. The history of the Nehalem forests is one of disturbance, both natural and anthropogenic. Prior to timber harvest by European and American homesteaders, old-growth Douglas fir forests dominated the watershed, with areas periodically disturbed by fire. According to the Nehalem Valley Historical Society (via Maser 1999), the Nehalem Indians regularly managed forestland with fire to allow meadows to persist for deer and elk grazing. Timber harvest by white settlers began in the 1870s with the construction of the Pittsburg lumber mill on the East Fork Nehalem River (Maser 1999; Ferdun 2003). The industry expanded with the construction of the Wheeler sawmill, which operated from 1902 to 1930. With timber production booming, roads and railroads were built to support the industry, and by 1945 virtually all of the Nehalem watershed's timber had been harvested or burned (Sword 1999 via Maser 1999; Ferdun 2003).

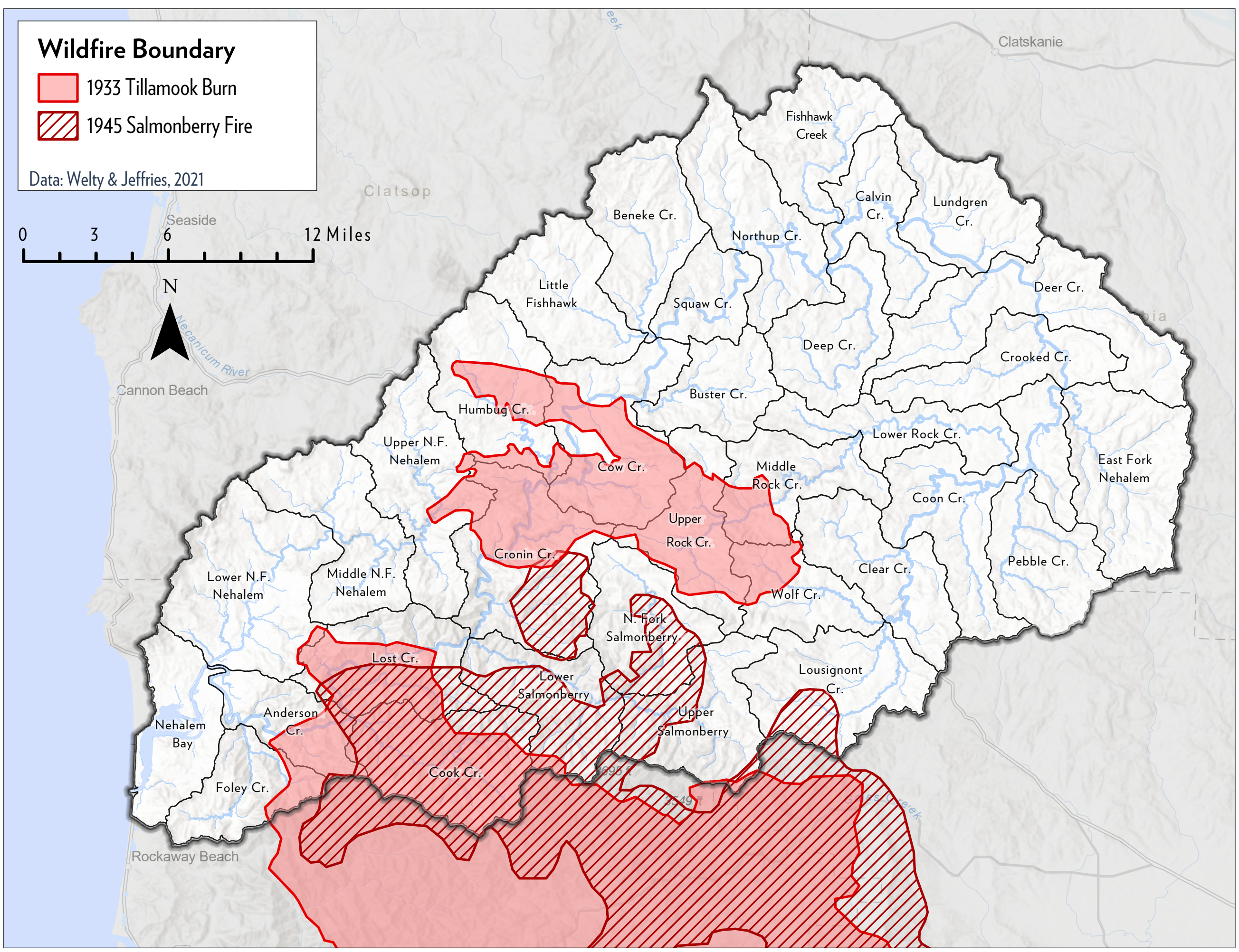
As shown in Figure 2-3, two major fires affected large areas of the Nehalem basin. In 1933, the infamous Tillamook Burn torched 270,000 acres in the Salmonberry River, Cook, Humbug, and Rock Creek drainages, as well as 30 river miles of the Nehalem River mainstem. Twelve years later, in 1945, the Salmonberry Fire burned much of the Salmonberry River and Cook Creek drainages. The damage from these fires stripped the forest of its timber value, forcing many landowners into foreclosure. This loss resulted in land ownership being transferred to the State of Oregon, which initiated a massive reforestation program from 1949 to 1973.

Today, commercial timber harvest occurs on these reforested lands. Tillamook-Clatsop State Forest lands are managed by the Oregon Department of Forestry (ODF) under the Northwest State Forest Management Plan. Private lands are held by small woodlot owners, timber investment management organizations, and logging companies. ODF regulates all of these privately owned forests under the Oregon Forest Practices Act (FPA). Due to this combination of historic clearcutting, catastrophic fire, and ongoing harvest (often 30- or 40-year rotations on private lands), most of the forested land in the watershed is younger than 70 years.

*Historic logging photo. By 1945 virtually all of the Nehalem watershed's old-growth timber had been harvested or burned. Photo: Nehalem Valley Historical Society.*

*Historic logging photo. Photo: Nehalem Valley Historical Society.*

**Figure 2-3.** Extent of the 1933 Tillamook Burn and 1945 Salmonberry Fires.



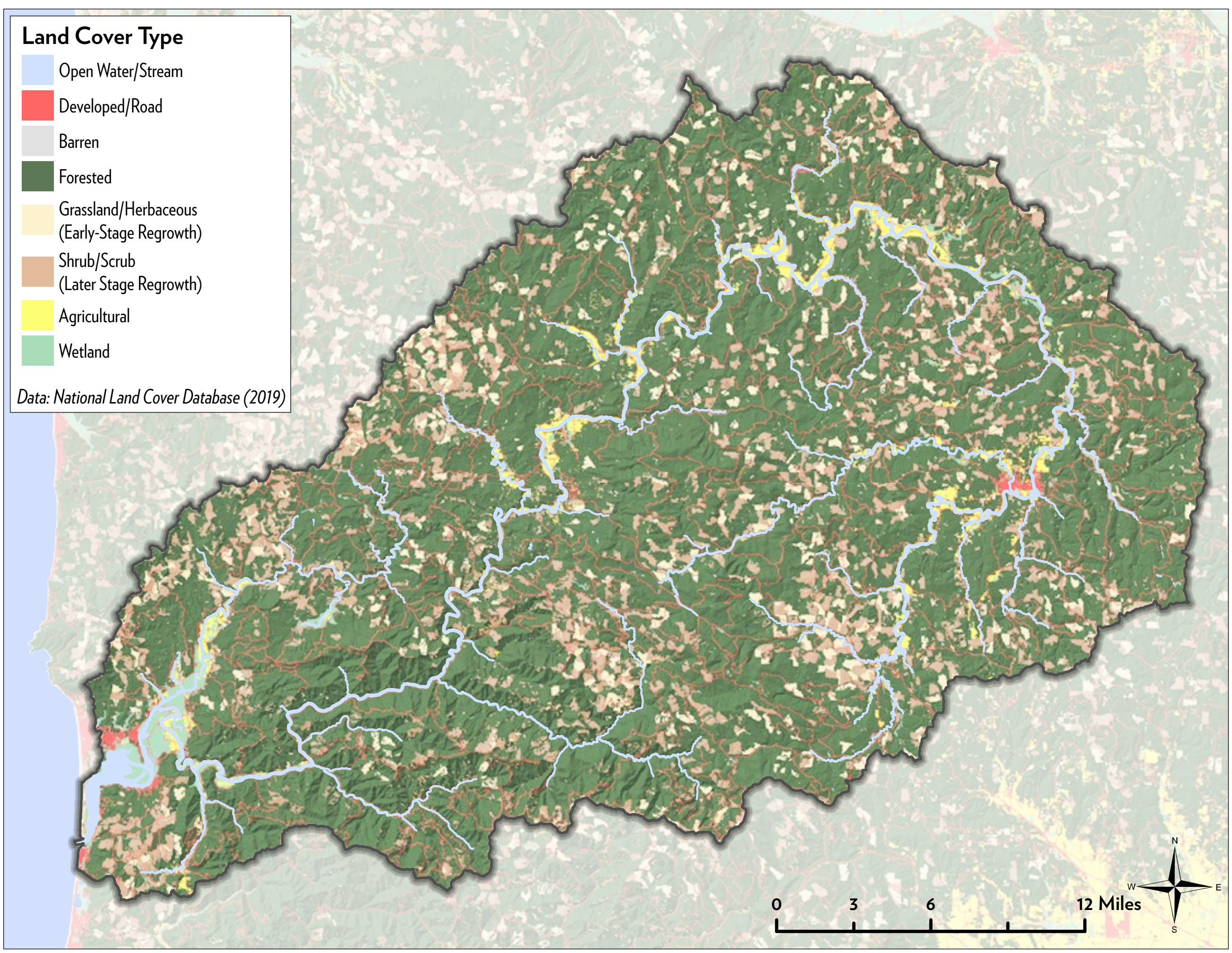
## 2.4 Biotic Systems

The Nehalem River watershed vegetation structure and composition vary with elevation, proximity to the Pacific Ocean, and timber harvest history (Figure 2-4). The higher elevation areas are dominated by conifer trees, while lower elevation areas, particularly mainstem riparian areas, are dominated by stands of broadleaf species or a mix of broadleaf and conifers (Maser 1999). Within the Nehalem River estuary, habitats include mudflats, aquatic beds, emergent marsh, scrub-shrub, and forested wetlands (Brophy and So 2005).

Figure 2-5 shows the distribution of salmon and steelhead throughout the basin. Four salmon and steelhead species – Coho, fall and early-run fall Chinook, chum, and winter steelhead – occur in the mainstem and tributaries of the Nehalem basin. Of these, only Coho are protected under the ESA. Resident and anadromous cutthroat trout, white sturgeon *(Acipenser transmontanus)*, and Pacific lamprey *(Lampetra tridentata)* are also present within the basin (Kavanagh et al. 2005, 2006).

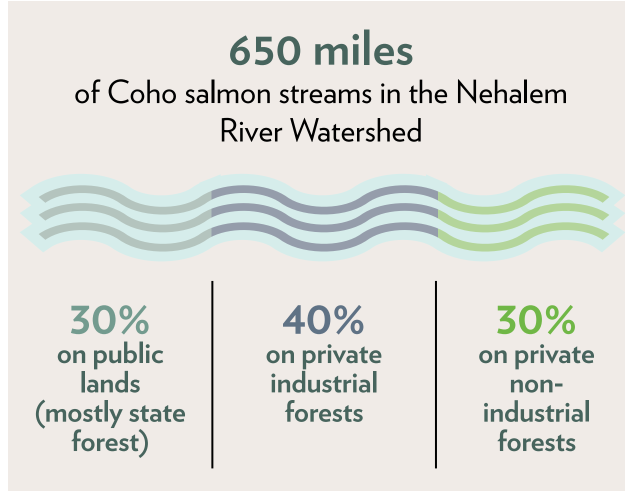
*Coal Creek. Photo: Wild Salmon Center*

**Figure 2-4.** Land Cover in the Nehalem River Watershed.



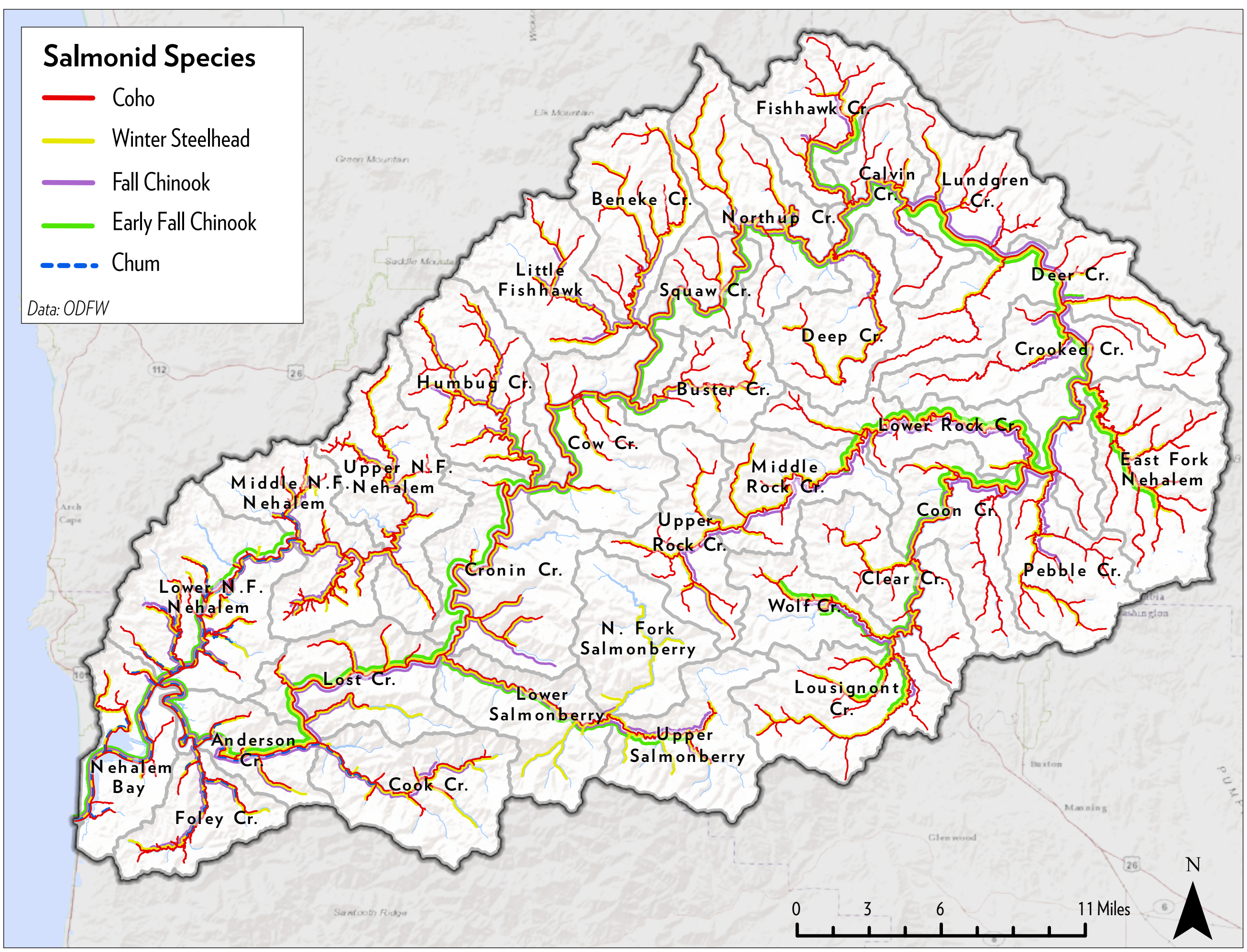
## 2.5 Human Settlement and Demographics

Today, the Nehalem River watershed has relatively low population growth and economic development compared to its boom period in the early 1900s. The watershed is sparsely populated, with large amounts of forested land. Timber harvest is the dominant land use, with a smaller area supporting agriculture and rural development. Land ownership within the watershed includes 48 percent private industrial timberlands, 40 percent public lands (primarily the Tillamook-Clatsop State Forest), and 12 percent private non-industrial lands (Figure 2-6). Of the approximately 650 miles of Coho streams in the basin, 40 percent of the total length is on private industrial forest lands, 30 percent on public lands, and the remaining 30 percent on private non-industrial forest lands (Watershed Professionals Network 2007).




*Breakdown of stream ownership in the Nehalem River Watershed.*

**Figure 2-5.** Fish Distribution in the Nehalem River Watershed.



Chum salmon. Photo; Stock Connection Blue / Alamy

**Selected species supported by the freshwater and estuarine reaches of the Nehalem River system.**

- Coho salmon
- Fall and early-run fall Chinook salmon
- Chum salmon
- Winter steelhead trout
- Pacific lamprey
- Cutthroat trout
- White sturgeon

The Nehalem River is named for the native people who first inhabited the watershed and have remained for thousands of years (Maser 1999). European explorers began exploring the region that is now Oregon as early as 1579 (Ferdun 2003). The 1770s and 1780s brought more European explorers, and the diseases they brought with them led to the decimation of native populations. Estimates of losses to the native populations range from 75 percent to as high as 90 percent (Maser 1999).

Nearly a century later, in 1866, Hans Anderson was the first European settler in the Nehalem River valley (Maser 1999; Ferdun 2003). Shortly after Anderson's arrival, settlers established the towns of Nehalem and Wheeler just upstream of Nehalem Bay. In 1878, they built a lumber mill in Pittsburg along the East Fork Nehalem River (Maser 1999; Ferdun 2003). With the establishment of towns came industry and development, which led to canneries, lumber mills, and farms.

The resource-dependent economy boomed as settlers continued to move to the Nehalem watershed and establish homesteads. The early 1900's economy was built on timber harvest, dairy farming, and fishing, and all three industries continued to grow through the 1920s as export markets expanded. This period brought the most significant changes to the physical and social environment of the Nehalem watershed to date (Ferdun 2003).

The resource-based economy continued through the 1930s, 40s, and 50s. The commercial fishing industry grew as canneries and hatcheries were constructed. Aggressive logging and the Tillamook Burn significantly altered the forests, and little to no old-growth forest remained in the watershed after 1945 (Maser 1999; Ferdun 2003). Numerous dairy farms operated in the Nehalem River floodplain by this time. These farms leveed wetlands and converted them to pasture for dairy production. In 1960, the Nehalem's remaining cheese factories consolidated under the Tillamook County Creamery Association (Ferdun 2003). Coho runs continued to return in viable numbers to the Nehalem River, and in 1976 managers witnessed the highest recorded harvest rate on OC Coho salmon, at about 90 percent of the run (ODFW 2007).

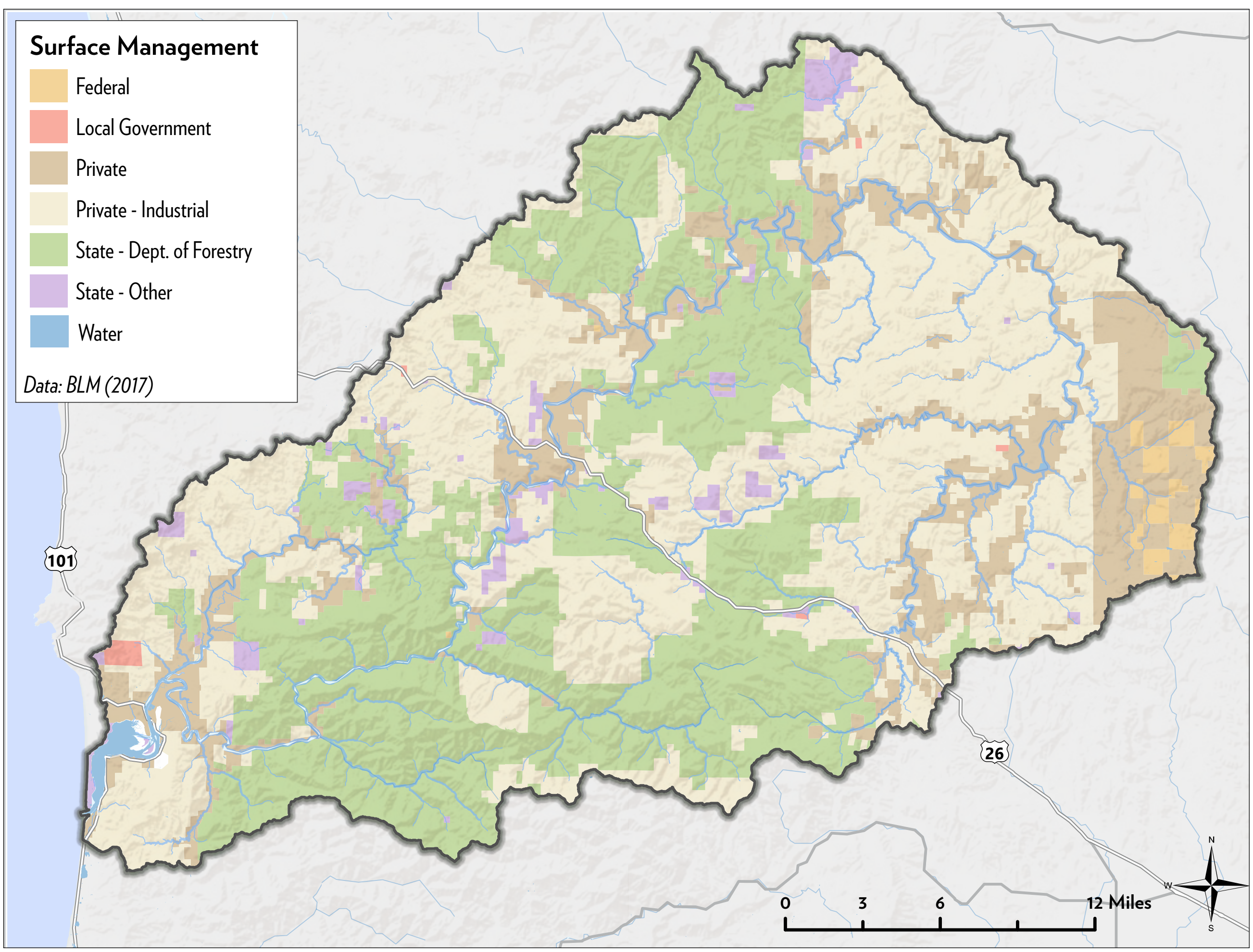
Today, recreation, retirement, and tourism services drive the local economy (Headwaters Economics 2019). Farming continues, with approximately 250 farms in operation (NRCS 2005), as do timber harvest operations. While the river remains closed to commercial fishing, opportunities for recreational fishing persist. The Coho runs are evaluated annually for each population and fisheries depend on annual forecasts that allow abundance goals to be met and protect the weakest stocks. Harvest impact rates to wild OC Coho continue to be managed through the

Pacific Fishery Management Council's Salmon Fishery Management Plan, which NOAA Fisheries found to be consistent with the recovery of OC Coho.

The watershed today supports three main population centers: the towns of Vernonia, Wheeler, and Nehalem. These communities supported a combined population of 3,009 people in 2009 (US Census Bureau, 2010) and 3,079 people in 2019 (US Census Bureau, 2020). Several other smaller towns and isolated farms sit outside of these main population centers. The area's average median income is roughly $38,000, and 42 percent of jobs are in educational, social, and health care services and manufacturing. Agriculture, forestry, fishing/hunting, and mining account for nine percent of the jobs in the towns and five percent in the counties (not including Washington County, since it includes much larger urban areas in the Willamette Valley) (TNC 2012).

*Setting a crab ring in Neawanna Creek. Photo: Graham Hardy / Alamy*

**Figure 2-6.** Land Ownership in the Nehalem River Watershed.



Chapter 3

# Nehalem Basin Coho and Habitats

## 3.1 Coho Salmon Life Cycle and Habitat Needs

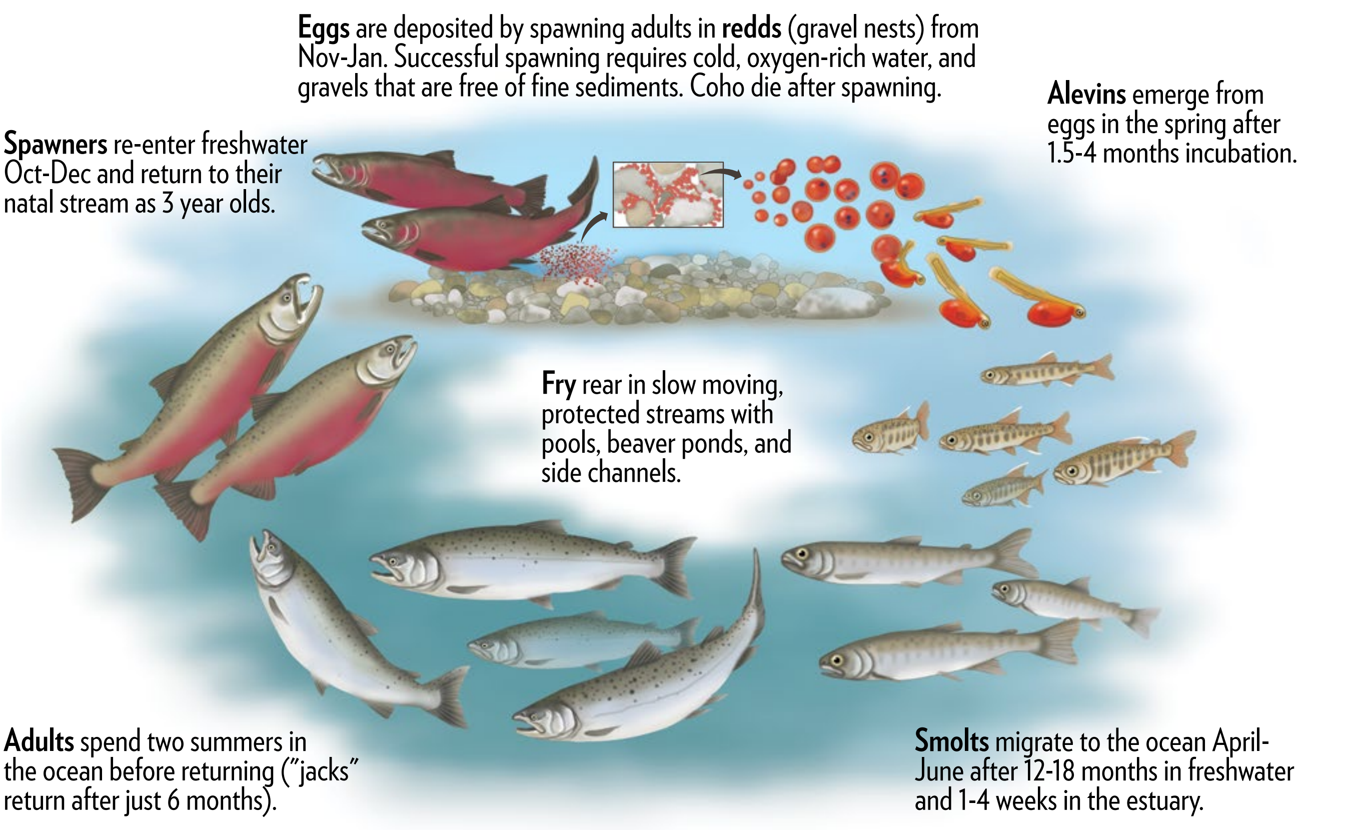
Adult Coho return to the Nehalem River from the ocean and migrate to their natal streams from October through December, spawning between November and January (Kavanagh et al. 2015). Coho preferentially spawn in tributaries but have been observed spawning in the Nehalem's upper mainstem as well (Kavanagh et al. 2005, 2006). Successful spawning requires the appropriate mix of gravels and cobble substrate in stream riffles. Female Coho build redds (gravel nests) and deposit their eggs, which one or more males then fertilize. Adults die soon after spawning, typically within two weeks (Maser 1999). Figure 3-1 depicts the standard Coho salmon life cycle.

Coho redds require a steady flow of oxygenated water to allow eggs and alevins (juveniles that have emerged from the egg but rely on attached yolk sacs for nourishment while they remain within the gravels) to survive (Kavanagh et al. 2005, 2006).

The common understanding of Coho maturation has focused on a "standard" or "conventional" life-history type in which Coho fry rear near their natal stream for a year or so before migrating to the estuary in spring as smolts (juvenile salmon undergoing physiological changes to adapt from freshwater to a saltwater environment) (Sandercock 1991; Nickelson 1998). However, as early as the 1960s, researchers described age-zero (first year of life) fry, which migrate downstream shortly after emergence (Chapman 1962).

The early migration of these individuals, called "nomads," was originally believed to

**Figure 3-1.** The Coho Salmon Life Cycle. Artwork by Elizabeth Morales.



*A smolt is a juvenile salmon undergoing physiological changes to adapt from freshwater to a saltwater environment. Photo: Seth Mead.*

be caused by density dependence, a natural population dynamic in which juveniles migrate due to a habitat having reached carrying capacity. Subsequent research into Coho and other Pacific Salmon species indicates that these migrations are not driven by density dependence, high flows, or other sources of displacement; instead, they represent alternative life-history strategies (Reimers 1973; Bottom et al. 2005; Koski 2009; NMFS 2016). 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 a key to the species' success (Moore et al. 2014; Koski, K V. 2009).

The component of the Nehalem Coho population expressing this alternative "nomadic" life-history trait represents an unknown, but likely underestimated, percentage of the total population. The contribution of nomads to the total watershed production of Coho smolts can be substantial and may be important in repopulating both natal and non-natal streams.

In addition to the standard and nomadic life-history types, research on juvenile Nehalem Coho migration and residency patterns indicates that several other life-history strategies may be expressed within the population (Bio-Surveys 2011a). During the development of this SAP, the team recognized the presence of six potential unique life-history variations based on a range of environmental and behavioral variables. These life-history types are described in Appendix 2.

Adult Coho generally spend about 18 months in the ocean before returning to their natal streams to spawn in their third year of life (ODFW 2007); however, some males return to freshwater after only one year in the ocean (Mullen 1979). These precocious males, commonly called "jacks," offer another example of the life-history variation observed within Coho populations.

*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 a key to the species' success.*

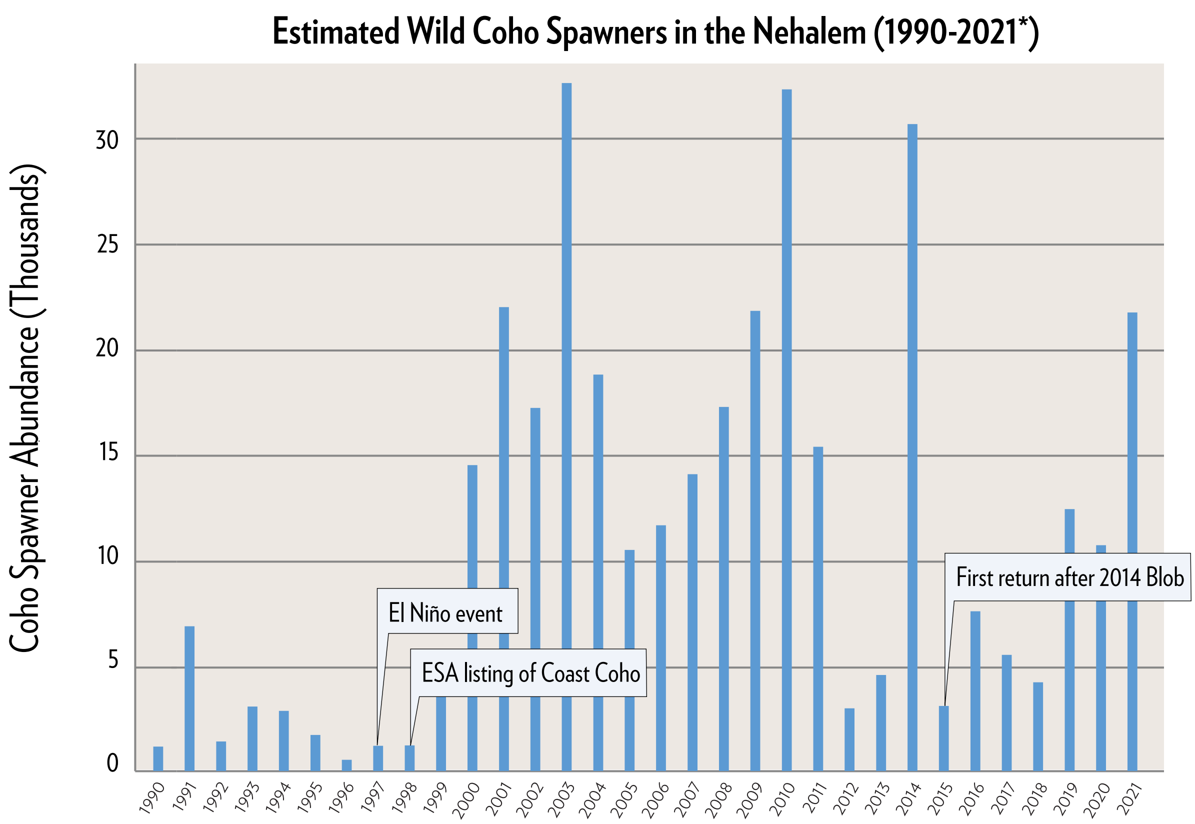
Photo: Eiko Jones

## 3.2 Coho Salmon Population Abundance

A long-term assessment of Nehalem Coho abundance indicates a steadily declining trend from historical to contemporary estimates (Ferdun 2003). Fisheries catch data from the 1920s and 1930s show an average annual catch of over 50,000 Coho from the Nehalem River, with a severe decline in the catch after 1950. Coho numbers continued to decline steadily from the 1960s through much of the 1990s (ODFW 1993).

Since the mid-1990s, under the Oregon Plan for Salmon and Watersheds, ODFW has utlizized several sampling methods to understand adult spawner abundance, juvenile abundance, and adult escapement. These sampling efforts have been employed at the scale of the North Coast stratum down to the subwatershed, and examined both wild and hatchery Coho. As shown in Figure 3-2, the data indicate large fluctuations in the numbers of natural-origin Coho returning to spawn in the Nehalem watershed in recent years. The Nehalem Coho population bottomed out in 1996 with an estimated abundance of just over 500 natural-origin spawners. This pattern reflected an ESU-wide trend, which led NMFS to list OC Coho under the ESA in 1998, attributing the species' decline to the following factors: high harvest rates, high hatchery production, significantly degraded habitat, and periods of poor ocean conditions. Over the next 15 years, wild spawner abundance estimates ranged from a low of roughly 10,000 natural-origin spawners in 2005 to over 30,000 in 2003 and 2010. Wild spawner abundance dipped to pre-2000 levels in 2012, 2013, 2015, and 2018 (ODFW 2022).

**Figure 3-2.** Wild Nehalem Coho Salmon Spawner Abundance (1990-2021). **Spawning data for the Nehalem population in 2020 and 2021 are extrapolations based on calculated proportional estimates from 2017-2019. Source: ODFW Salmon and Steelhead Recovery Tracker (ODFW 2022).*

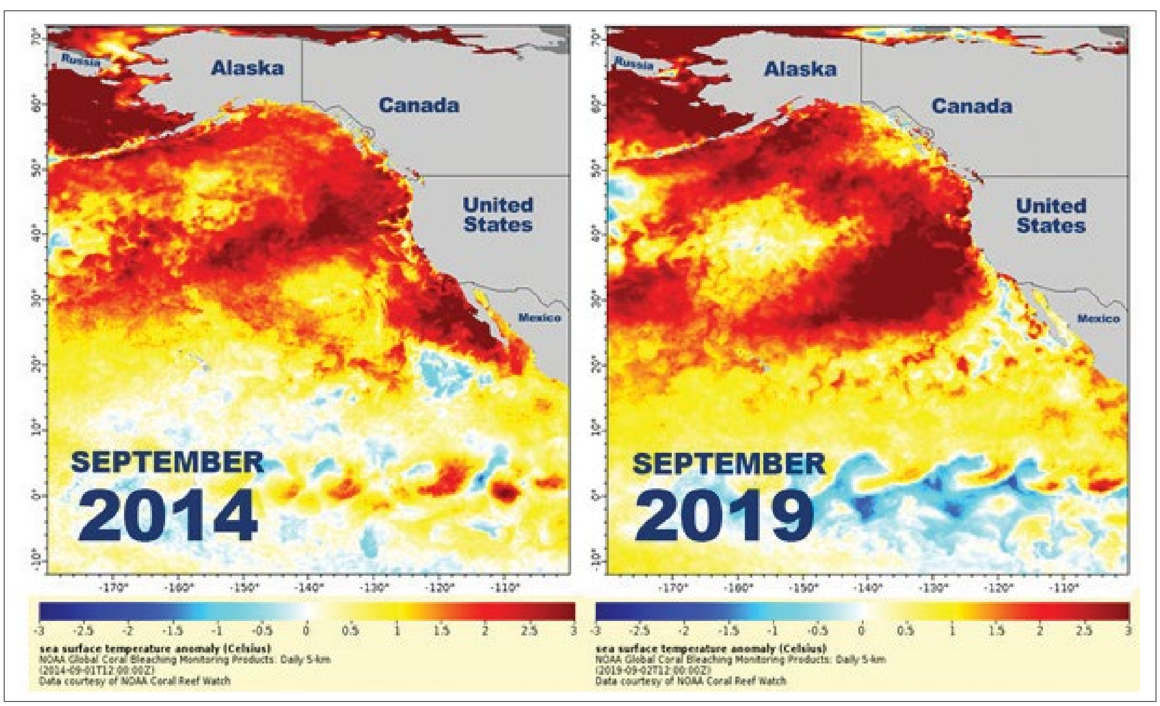


## 3.3 Ocean Conditions


As previously discussed, Coho spend one to two years in the ocean maturing. During this time, physical conditions of the ocean play a vital role in their growth and survival. El Nino and marine heat wave events cause temperature and salinity changes in the ocean that adversely affect salmonid prey, competition, and predator abundances that directly influence salmon growth potential and survival. In 2014, salmon managers witnessed formation of the largest marine heat wave on record in the North Pacific Ocean. "The Blob" as it became known, limited ocean mixing and spread warm temperatures across the Northeast Pacific Ocean until 2016. This was followed by an El Nino event that sustained abnormally high ocean temperatures.

These events created a significant biological response that was observed at all levels of the marine ecosystem, including a massive die-off of seabirds from a lack of food along the Oregon and Washington coast in 2014, and higher mortality of sea lions and whales in 2015. After the Blob subsided and ocean temperature anomalies returned to neutral, a new marine heat wave developed in 2019 that created additional unfavorable conditions for Coho and other cold-water species. The effects of these events continued for several years (Laurie Weitkamp, NOAA Fisheries), including the low abundance of OC Coho since 2015.

**Figure 3-3.** Ocean Temperature Anomalies. Image compares sea surface temperature anomalies (how much cooler or warmer the water is compared to normal levels) when the Blob developed in September 2014 and the heat wave started in September 2019. (https://research.noaa.gov/ So-what-are-marine-heat-waves)



## 3.4 Climate Change

It is well established that the global climate system is warming at an unprecedented rate and subsequently causing ocean warming and acidification (IPCC 2014). There is strong scientific support for projections that the warming will continue through the 21st century and that the magnitude and rate of change will be influenced substantially by the amount of greenhouse gas emissions (IPCC 2014). Ocean acidification is also expected to continue through the end of the century under most greenhouse gas emission scenarios and could accelerate as the ocean's buffering capacity diminishes (Jiang et al. 2019).

In the Pacific Northwest, climate change and the loss of biodiversity represent profound threats to ecosystem function. Research suggests that if greenhouse gas emissions continue at current levels, the average annual air temperature in Oregon will increase by 5°F (2.8°C) by the 2050s and 8.2°F (4.6°C) by the 2080s, with the largest seasonal increases occurring in summer (Dalton and Fleishman 2021). Seasonal changes in precipitation and increased drought frequency are also expected to significantly impact stream flow volume and timing (Dalton and Fleishman 2021). Late fall and winter flows are projected to increase, while spring, summer, and early fall flows are expected to decrease on the Oregon Coast throughout the 21st century.

*Because most young Coho spend a full year in freshwater before ocean entry, the juvenile freshwater stage is considered to be highly vulnerable. Photo: Brian Kelley*

Summer stream temperatures are expected to increase in the future 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). High stream temperatures have been linked to reduced Coho 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 Salmon ESU. The factors limiting the recovery of this species will be amplified by climate change. Currently, poor water quality, including high summer water temperatures and excess fine sediment, is recognized as a secondary limiting factor for most OC Coho populations, including the Nehalem population. If increases in summer stream temperatures outpace actions that increase shade and reduce water temperatures, water quality may become a primary limiting factor (ODFW 2019b). Therefore, instream restoration will need to be coupled with 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 2019b). Additionally, thermally stressful summer rearing conditions could reduce subsequent overwinter survival, worsening the winter bottleneck that may also be exacerbated by increased flows (Ebersole et al. 2006).

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 stream 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 2019b). Local climate, geomorphology, and riparian conditions differ across the OC Coho Salmon ESU; therefore, Coho populations are likely to be affected by climate change in different ways based on their vulnerability.

Vulnerability is a function of the three following components: 1) *exposure*- the physical, chemical, biological,and other changes occurring in a selected geography due to broader shifts in climate, 2) *sensitivity*- the unique characteristics of watersheds and species that determine the impacts of exposure, and 3) *adaptability*- the capacity of wild populations to change in ways that allow them to survive in changing conditions (IPCC 2007; Crozier et al. 2019). The more vulnerable a species or system is to climate change, the greater the impact. A recent vulnerability assessment of ESA-listed Pacific salmon and steelhead ESUs completed by Crozier et al. (2019) indicates that OC Coho have a high overall vulnerability, high sensitivity and high exposure, and only moderate adaptive capacity. Because most young Coho spend a full year in freshwater before ocean entry, the juvenile freshwater stage is considered to be highly vulnerable. OC Coho salmon also scored high in sensitivity at the marine stage due to expected changes from ocean acidification. These results are consistent with the Wainwright and Weitkamp (2013) climate change assessment and highlight the importance of implementing actions to increase the resilience of these populations.

Projected changes in the ocean environment (sea level rise, increasing sea surface temperature, increased ocean acidification) are largely outside of 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 (ODFW 2019b). Riparian ecosystems are naturally resilient when not degraded, and may provide adaptive support in mitigating impacts from climate change (Seavy et al. 2009). Riparian areas have higher water content than surrounding upland areas and can absorb heat, buffer air and water temperatures, maintain pockets of cool water, and provide refugia (Seavy et al. 2009). Therefore, salmonids are better able to migrate through temperature-impacted river reaches when there are intact riparian areas creating pockets of cooler water refugia.

Additionally, restoring floodplain connectivity and stream flow regimes, re-aggrading incised channels, restoring riparian vegetation, and promoting beaver and beaver-related pond habitat are most likely to improve stream flow and temperature changes, support biodiversity, increase flood, drought and fire resiliency, bolster carbon sequestration and increase overall resilience to projected climate change impacts (Jordan and Fairfax 2022). Maintaining and restoring diverse and productive rearing habitats will help sustain populations through cycles in ocean productivity, which may become more extreme and unfavorable in the future.

| VULNERABILITY TO CLIMATE CHANGE | |
|---|---|
| 1 | **Exposure:** The physical, chemical, biological, and other changes occurring in a selected geography due to broader shifts in climate. |
| 2 | **Sensitivity:** The unique characteristics of watersheds and species that determine the impacts of exposure. |
| 3 | **Adaptability:** The capacity of wild populations to change in ways that allow them to survive in changing conditions. |

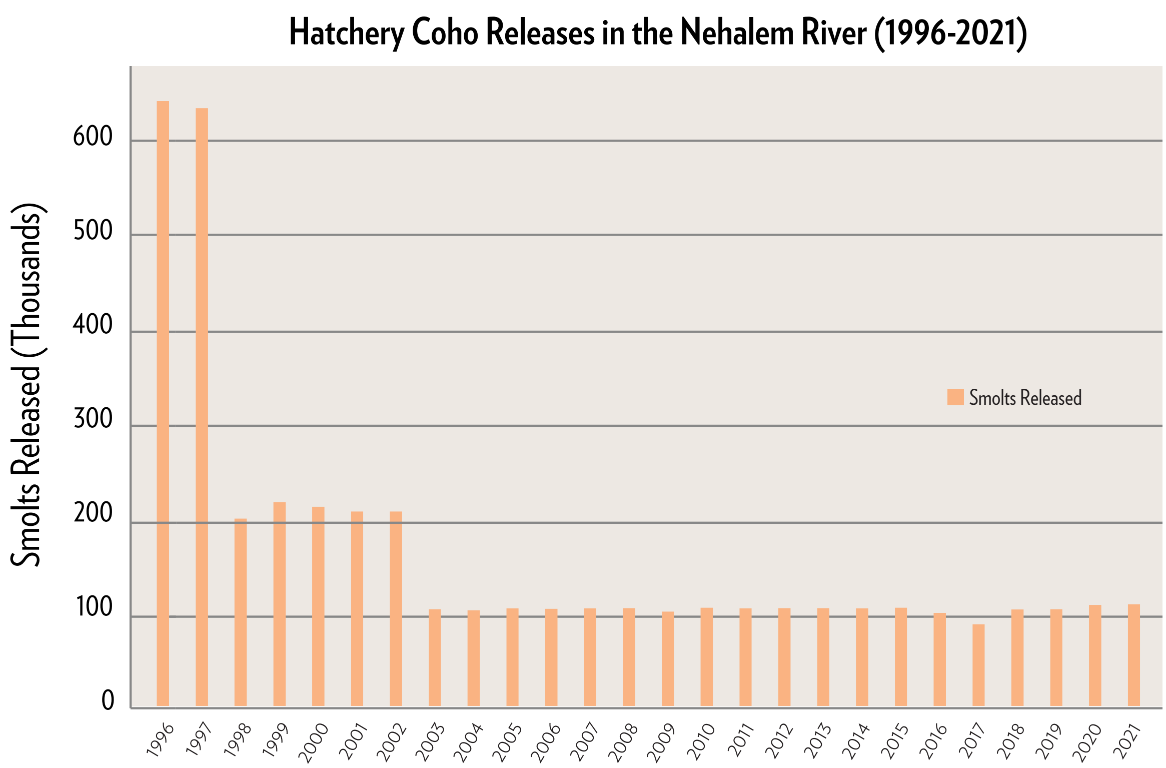
## 3.5 Hatchery Production

Early 20th-century declines in salmon population abundance and the growth of commercial fishing in the Nehalem River spurred the creation of Nehalem hatchery programs. Hatcheries have influenced the Nehalem fisheries since 1926, when the Foley Creek Hatchery began supplementing wild populations of cutthroat and winter steelhead trout. The Foley Creek Hatchery closed in 1966 and was replaced that year by the North Fork Nehalem Hatchery, which still operates today, producing Coho, fall Chinook, winter steelhead, and rainbow trout.

High hatchery production of Coho was described by NMFS (2016) as adversely impacting Coho populations ESU-wide and was a contributor to the ESA-listing determination. The federal recovery plan points to two impacts: 1) the interaction of wild and hatchery fish on the spawning grounds leading to a reduction in the fitness of the resulting offspring, and 2) inadvertent harvest of natural-origin Coho resulting from recreational angling that targeted the hatchery run (NMFS 2016). The proportion of hatchery Coho found on the spawning grounds in the OC Coho ESU declined from levels of 15-25 percent during 1990-1998 to within established policy guidelines (approximately 9%) as a result of reduced release numbers, reduced release locations, and increased returns of wild Coho.

In the 1980s and early 1990s, the North Fork Nehalem Hatchery released an average of 535,000 Coho smolts per year. Between 1990 and 1995, the average annual release increased to 822,000 before steadily declining over the next decade (Ferdun 2003). As shown in Figure 3-4, since 2003, releases have held steady at roughly 100,000 (ODFW 2019b). This reduction occurred when hatchery managers reduced and eliminated Coho hatchery programs across the Oregon coast starting in the mid-1990s, generating a drop in production from a high of 35 million smolts in 1981 to approximately 260,000 smolts in 2005 across the OC Coho ESU. More recently, the North Fork Nehalem Hatchery has released 100,000 smolts on-site

**Figure 3-4.** Hatchery Coho Releases. Source: Regional Mark Information System Database, 2022. http://www.rmpc.org



*Spawning adult Coho. Alternative life-history pathways contribute to the species' resilience and ability to adapt in a changing environment. Photo: Seth Mead*

to "provide fish for sport and commercial harvest in both the ocean environment and the Nehalem Bay and North Fork Nehalem River" (ODFW 2019). Until 2020, the North Fork Nehalem Hatchery reared a stock of varied origin (known as the "32 stock") every two years. In the third year, ODFW reared stock from Fishhawk Lake. Known as the "99 stock," this stock was established in 1978, and smolts return as adults just one year after release (Suring et al. 2015).

Initially, the North Fork Nehalem Coho stocks were managed as an isolated harvest program. Natural-origin fish were not intentionally incorporated into the broodstock since 1986, and only adipose fin-clipped broodstock have been taken since the late 1990s. Because of this, the stock is considered to have substantial divergence from the native natural population and is not included in the Oregon Coast Coho salmon ESU (NMFS 2016). Recently, beginning with the 2020 brood year, the Nehalem Hatchery started converting the Coho hatchery program to a wild broodstock program with naturally produced Coho from the North Fork Nehalem River. The previous lines of long-term hatchery stocks are being phased out, with the transition completed after the 2022 brood year. The first smolt releases occurred in the spring of 2022, and the first adult returns will occur in the fall of 2023 (jacks will return in the fall of 2022). Once the conversion is complete, the program will operate as an integrated stock, with wild Coho incorporated into the broodstock annually at levels specified in the Hatchery Genetic Management Plan (Robert Bradley, personal communications).

## 3.6 Overview of Habitat Needs and Watershed Components

Coho seek different habitat types during their various life stages, and spatial and temporal use of these habitats varies according to the life-history strategy being expressed by the individual. In order to fully express the range of life-history strategies present within a population, Coho require diverse, complex, and highly connected habitats in freshwater and estuarine ecosystems. During their freshwater residency, juvenile Coho rely on slow-moving water (ideally flows of less than two cfs) with complex in-stream and riparian structure capable of generating and maintaining pools, off-channel rearing areas, and channel-floodplain interaction. Among

**LIMITING FACTOR FOR NEHALEM COHO**

The limiting factor for Nehalem River coho is a lack of *winter rearing habitat,* driven largely by the **loss of instream complexity.** Instream complexity refers to a suite of instream and off-channel features – like large wood, pools, connected off-channels, alcoves, and beaver ponds – that provide high-quality rearing habitat for juveniles.

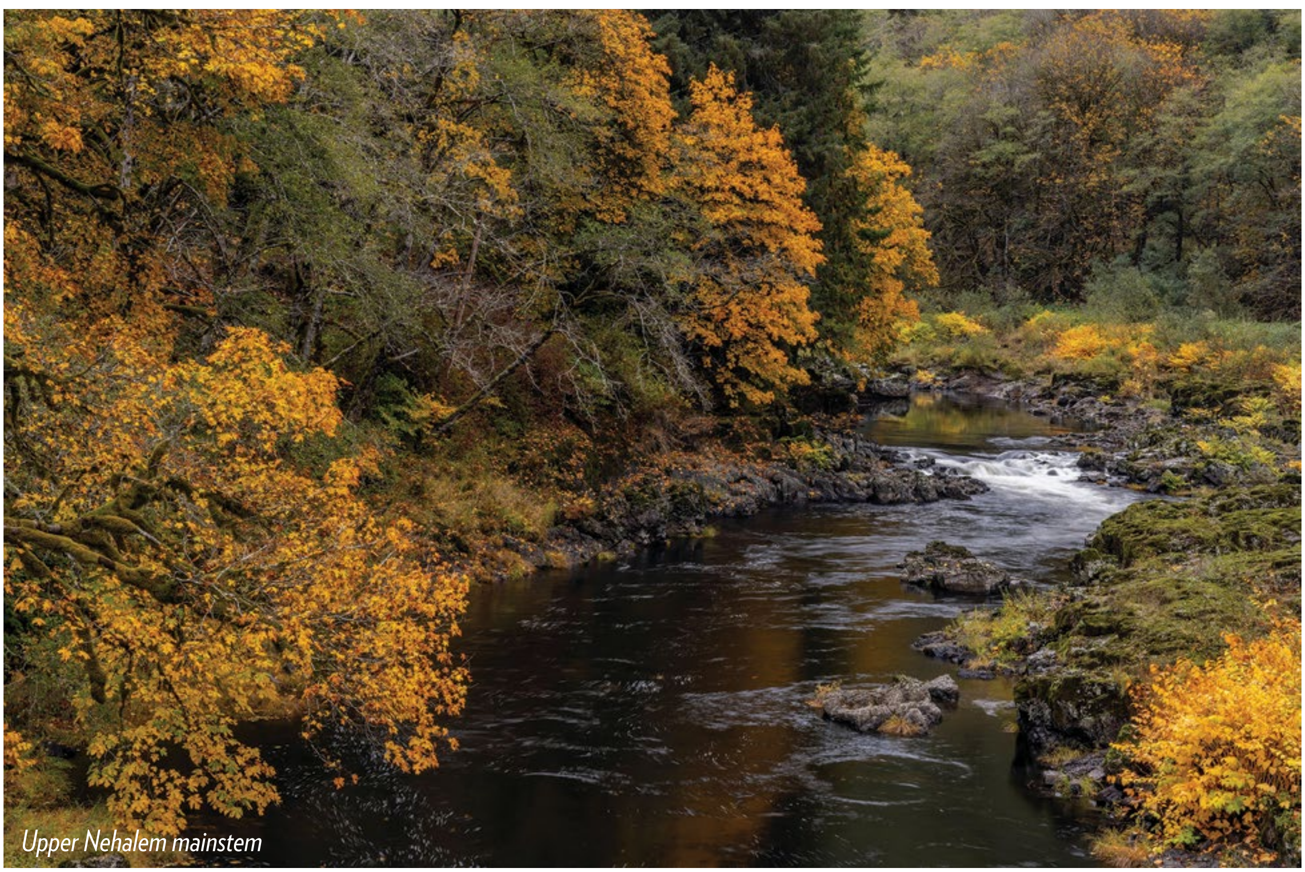
other attributes important to Coho, these conditions generate food, shelter from predators, refuge from high water temperatures in summer, and low velocity resting areas during fall/winter high flows.

While it's described in the Oregon Coast Coho Conservation Plan by the broader term "instream complexity," insufficient winter rearing habitat is the most common factor limiting Coho populations in the OC Coho ESU, including the Nehalem population (ODFW 2007). 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-channels, alcoves, beaver ponds, lakes, connected floodplains, and wetlands" (ODFW 2007). Recently, the planning team has grown increasingly concerned that the extensive spatial range of summer temperature limitations in the mainstem Nehalem River and many tributaries may become the primary factor limiting future OC Coho production.

The specific habitats that Coho require are generated and maintained within a complex, interconnected system of watershed "components." 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 Nehalem Partnership used the Coast Coho Partnership's common framework to develop this SAP but adapted the habitat definitions to fit the characteristics of the Nehalem watershed.

The Nehalem Partnership defined the following watershed habitat characteristics:

*Adult Coast Coho use the mainstem river channel to migrate upstream to their natal tributaries, where they will spawn and die. Juveniles use the mainstem to migrate down to the ocean, accessing tributary, off-channel, and estuarine habitats as they go. High flows in winter and hot water in the summer are the major stresses that juveniles encounter on their downstream migration. Cold water tributaries and off-channel habitats provide important sources of refuge from these and other stresses. Photo: Danita Delimont*



*Upper Nehalem mainstem*

- **The Mainstem River** includes portions of rivers above the head of tide (Coastal and Marine Ecological Classification Standard [CMECS] definition); these are typically 5th order, downstream of Coho spawning distribution, and "non-wadeable." The mainstem river component includes associated riparian and floodplain habitats. Mainstem areas support upstream migration for adults, downstream migration for juveniles, summer rearing for the nomadic life history, and limited spawning.

- **Tributaries** include all 1st to 4th order streams with drainage areas > 0.6 km². This includes fish-bearing and non-fish-bearing, perennial and intermittent streams, and the full aquatic network, including headwater areas, and riparian and floodplain habitats. Tributaries support spawning, incubation and larval development, fry emergence, and summer and winter juvenile rearing.

- **Freshwater Non-Tidal Wetlands** include areas inundated or saturated by surface or groundwater at a frequency and duration sufficient to support – and under normal circumstances do support – a prevalence of vegetation typically adapted for life in saturated soil conditions. Habitats include depressions, flat depositional areas that are subject to flooding, broad flat areas that lack drainage outlets, sloping terrain associated with seeps, springs and drainage areas, bogs, and open water bodies (with floating vegetation mats or submerged beds). This component is restricted to those wetlands that are hydrologically connected to Coho streams. (Estuarine-associated wetlands are addressed in the estuarine section.) Wetlands are essential to capturing sediment and other contaminants before they enter tributaries and mainstem rivers, and for maintaining and regulating cold water flows. In addition, non-tidal wetlands historically provided thermal refugia for the nomadic coho life-history strategy originating in headwater wadeable streams.

*Freshwater wetlands like this near an upper Nehalem tributary provide streams with cold, clean water through underground seeps. Photo: Maggie Peyton*

- **Off-channel areas** include locations other than the main or primary channel of mainstem or tributary habitats that provide velocity and/or 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.

- **Estuaries** include areas in tidally influenced lower reaches of rivers that extend upstream to the head of tide and seaward to the mouth of the estuary. Head of tide

*Adult Coho spawn and juveniles rear in low gradient tributaries like this one in God's Valley. Photo: Wild Salmon Center*

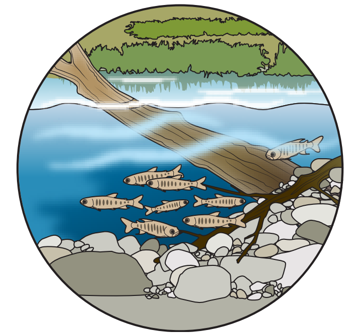

*Tidal wetlands like these in the Nehalem estuary are the critical final stop for coho to rear and grow before entering the ocean. Photo: Maggie Peyton*

is the inland or upstream limit of water affected by a tide of at least 0.2 feet (0.06 meter) amplitude (CMECS). This includes tidally influenced portions of rivers that are considered to be freshwater (salinity <0.5 parts per thousand). Estuaries are considered to extend laterally to the uppermost extent of wetland vegetation (mapped by CMECS). Estuarine habitats include saltmarsh, emergent marsh, open water, subtidal, intertidal, backwater areas, tidal swamps, and deep channels. This includes the ecotone between salt and freshwater and the riparian zone. Estuary areas have been historically available for feeding, rearing, and smolting Coho. They have also provided summer and winter habitat used by nomadic coho dropping out of headwater reaches as emergent fry.

*Off-channel habitats like these found along Sand Lake are essential for rearing coho. Photo: Maggie Peyton.*


- **Uplands** include all lands that are at a higher elevation than adjacent 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 another non-floodplain surface. Uplands provide the majority of wood and gravel resources that are required for maintaining natural processes in a properly functioning ecosystem.
- **Lakes** include inland bodies of standing water. Habitats include deep and shallow waters in the lakes, including alcoves, and confluences with streams. Lakes can provide important rearing habitats for coho, and also help mitigate summer water temperatures through stratification.

**Figure 3-5.** Components of a Watershed. The map below is a conceptual illustration (not a map of the Nehalem) 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.

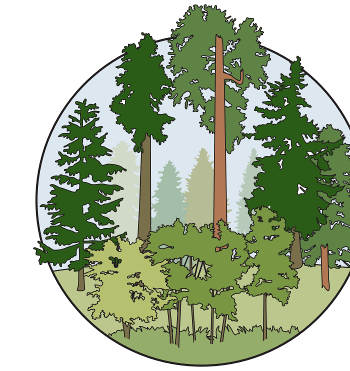


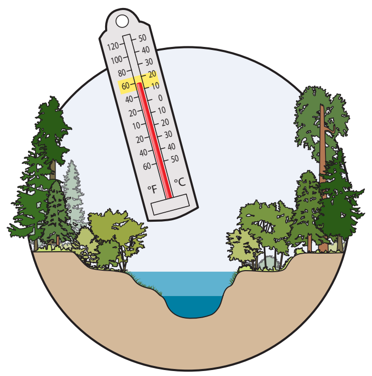
**Instream Complexity:**

Lack of instream complexity is the primary factor limiting Nehalem 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:**

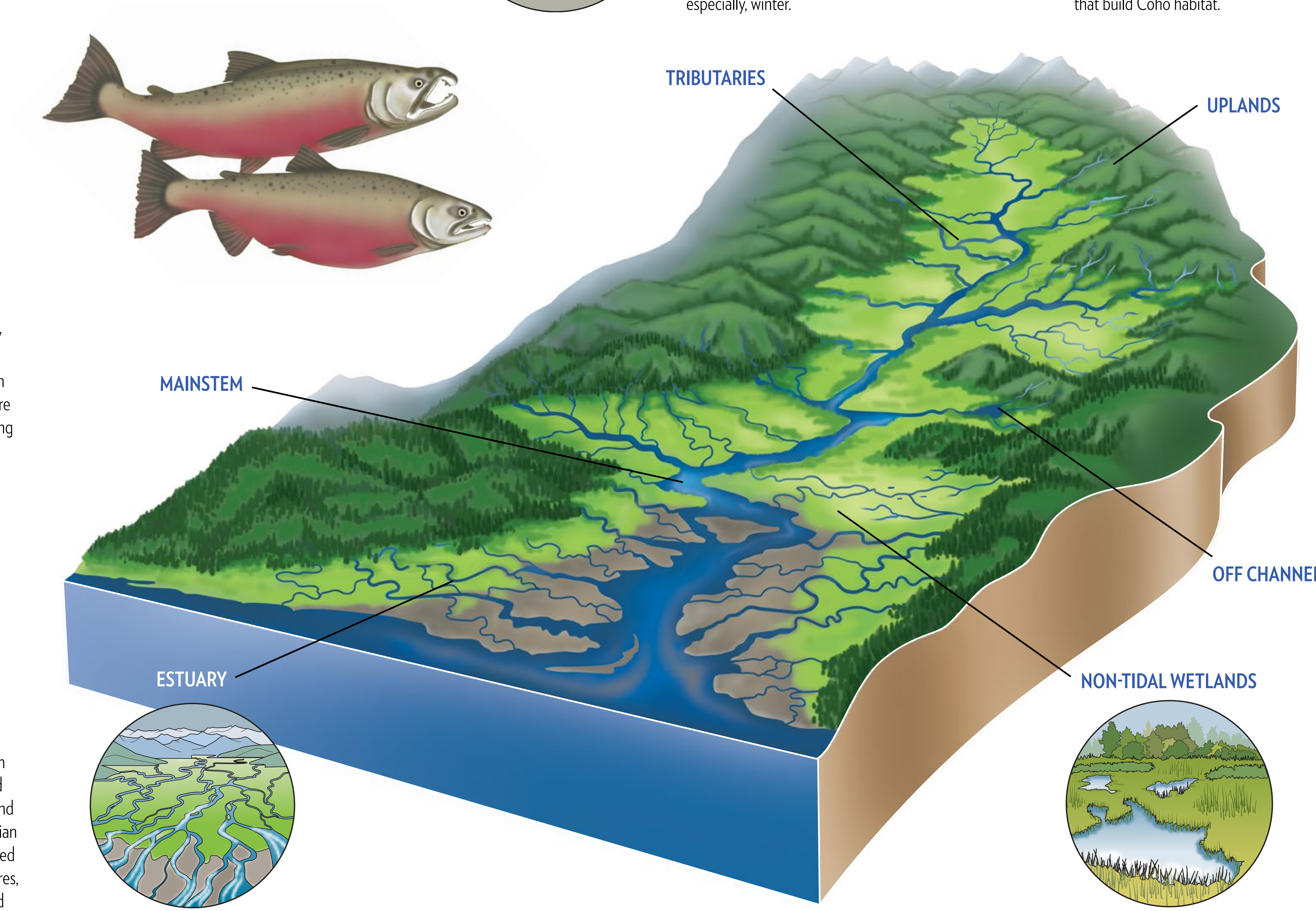
Healthy upland forests contribute large wood, gravel, and other inputs to streams, which enhances the channel's biological and structural complexity. The range and distribution of forest stand size, type, age, and composition determines the extent to which forests can provide the inputs to streams that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

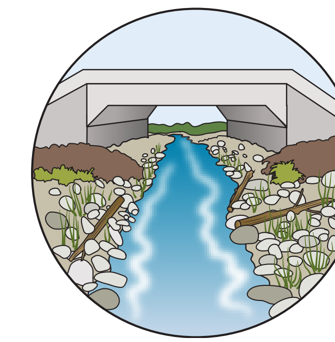




**Water Quality:**

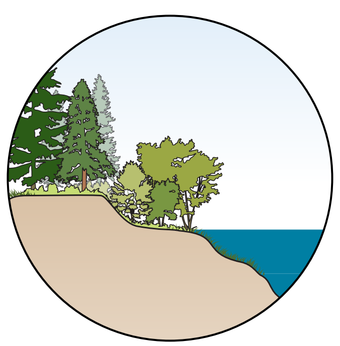
In tributary, mainstem, off-channel, and estuarine habitats, degraded water quality also limits the Nehalem Coho population. Elevated water temperatures (especially in the mainstem Nehalem) and sediments are the primary water quality issues confronting Coho.



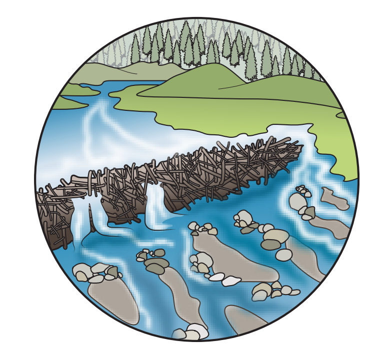
**Longitudinal Connectivity:**

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 Nehalem is heavily degraded contributing to elevated water temperatures, reduced instream complexity, and reduced lateral connectivity.

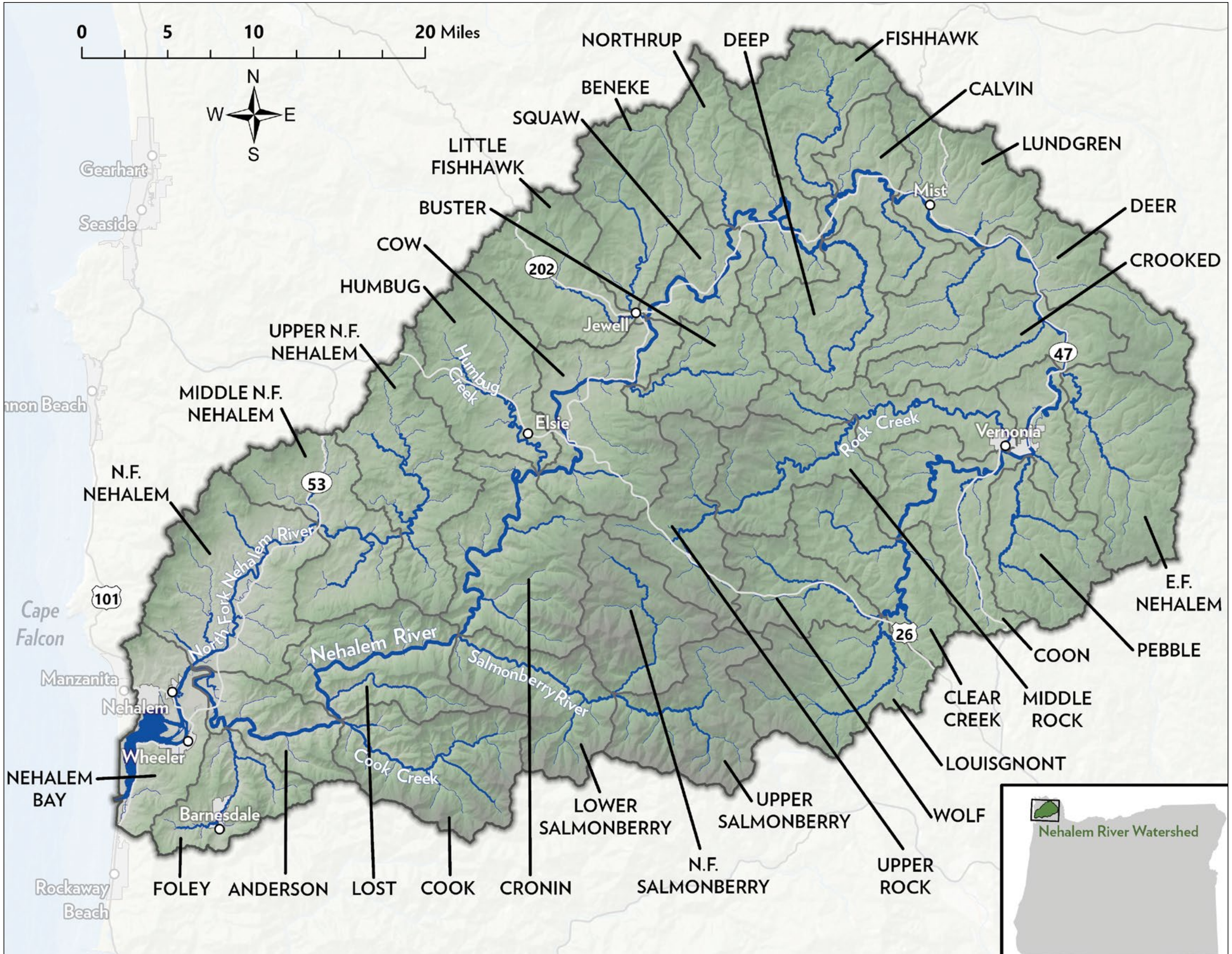


**Beaver Ponds:**

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 Nehalem, significantly reducing available off-channel habitats.

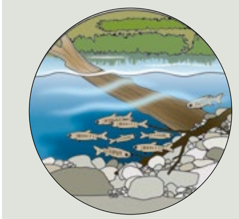
*Artwork by Elizabeth Morales.*

**Figure 3-6.** The Nehalem River Watershed.

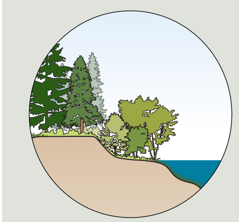



**By 2045 the Nehalem Coho Partnership will achieve the following restoration outcomes:**

**Upland Forests:** **536 acres** of upland timber are protected to ensure long-term delivery of large wood to anchor habitats.



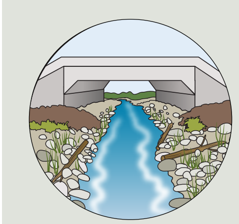
**Instream:** Instream complexity is restored within **66 miles** of focal area anchor habitats.



**Riparian:** Riparian function is enhanced along **58 miles** of focal area tributaries.

**Off-Channel:** Beavers colonize and build dams along an additional **40 miles** of Coho-bearing tributaries, increasing off-channel habitats available for Coho rearing.

**Tidal Wetlands:** **300 acres** of tidal wetlands and other estuarine habitats are reconnected.



**Fish Passage:** 52 barriers to fish passage are removed, restoring Coho access to **92 miles** of anchor habitats and cold-water refuge.

*Illustrations: Elizabeth Morales*

**By reaching these six restoration outcomes, the Nehalem Partnership seeks to achieve the SAP's long-term goals and advance the vision of a healthy Nehalem Coho population.**

*Chapter 4*

# Development of the Nehalem River Strategic Action Plan

The Nehalem Partnership generated this plan following guidance described in the document, *Components of a Strategic Action Plan for Participation in the Focused Investment Partnerships Program* (OWEB 2017). This process is summarized below.

## 4.1 Visioning

The Nehalem River SAP process began with a discussion of participant values and priorities that would guide the planning process and generate a long-term vision statement for the Nehalem Basin. The exercise explored ways Coho conservation aligns potentially competing social, economic, and ecological priorities among local stakeholders. In addition to a vision statement, the discussion yielded guiding principles for the planning process, as well as two goal statements, which articulate the Nehalem Partnership's desired long-term results from the implementation of the plan. The discussion also led to the development of outreach documents for team members to share when describing the planning process to landowners, stakeholder groups, and the general public.

## 4.2 Defining Terms

The Nehalem Partnership used the "Common Framework," a document produced by the Coast Coho Partnership to standardize the terminology used in the development of SAPs for Coho populations up and down the Oregon coast. The Nehalem Partnership tailored the framework to incorporate social and ecological conditions unique to the Nehalem River watershed. The Nehalem common framework: 1) defines the habitat types (called "components") used by the Nehalem

*Wild salmon deliver the nutrients derived from their ocean journey back to their natal watersheds, nourishing the ecosystem. Photo: Paul Jeffrey / Alamy*

### *Common Framework Terminology*

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

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

***Habitat Components:*** Components are the types of habitats that are essential to support the (non-marine) life cycle of Coho salmon. The Nehalem River common framework identifies and defines these habitat types, which are presented in Chapter 3.

***Threats:*** Threats are the human activities that have caused, are causing, or may cause the stressors that destroy, degrade, and/or impair components. The common framework includes a list of threats with definitions and commonly associated stressors. This list is based on threats listed (sometimes using different terms) in existing Coho recovery plans. The definitions are based on previous classifications (IUCN 2001; Salafsky et al. 2008) with minor modifications reflecting the work of the Coast Coho Partnership.

Coho population; 2) identifies the essential functions that these habitats must provide for Coho to persist (called "key ecological attributes" or KEAs); and 3) lists the "stressors" and "threats" that impair or have the potential to impair the KEAs. The framework also provides a list of indicators that can be used to assess and track the KEAs. In aggregate, these indicators signal whether watershed function is improving or declining over time at the watershed or subwatershed scale.

The terminology adopted in the Nehalem common framework is included throughout this plan. The full document is contained in Appendix 3.

## 4.3 Determining Focal Areas

The Coast Coho Partnership convened, in part, due to recognition among both restoration practitioners and funders of the immense challenges faced in generating benefits from habitat restoration that can be detected beyond just the project scale. This challenge is due partially to restoration organizations working in large geographies and lacking the capacity to implement projects at the pace and scale necessary to produce measurable impacts. In addition, coordination among restoration partners is often undermined by the varying ownerships and land uses present within a basin and the complex funding and regulatory landscape that implementers must navigate to put projects on the ground. Because of these and other factors, it's challenging to focus and coordinate restoration efforts sufficiently to generate a measurable watershed response (e.g., improving trends in abundance or habitat quality) beyond just the project or reach scale.

Partners in the Nehalem sought to address this challenge by focusing this SAP on a limited number of focal areas (or "high-ranked subwatersheds" as they were called during the planning process). The selection of focal areas was driven by the goals and guiding principles generated in step one above.

First, the team applied a stronghold approach, which argues that in the long run, the most cost-effective strategy is to protect and restore habitats that are in good or excellent condition. The stronghold approach adopts a "build from strength" model, which is founded on the belief that expanding areas of functioning habitat is more likely to provide the desired results and show a more immediate return on investment than starting in more highly degraded systems. The approach recognizes that the stressors on highly modified systems are either so numerous (e.g., in urbanized areas) or take so long to reverse (e.g., severe channel entrenchment) that restoration benefits are often uncertain or unrealized. Accordingly, this plan gives priority to subwatersheds that are relatively intact and demonstrate greater ecosystem function than other more degraded systems.

**A "6th Field"** is a geographic scale established under a hierarchical classification system developed by the USGS that divides river basins into hydrologic unit codes or "HUCs." Commonly referred to as a "sub-watershed," a 6th field HUC is typically between 10,000-40,000 acres or 15-60 square miles.

The process used to assess ecosystem function and habitat productivity across all 34 of the Nehalem basin's 6th field subwatersheds is detailed in Appendix 6. After evaluating a range of criteria to assess function and productivity, the Nehalem Partnership determined that the extent of "anchor habitat" was the most effective indicator of Coho production potential. The anchor habitat approach is described in Section 4.5.

The second criterion used to identify focal areas was the degree to which each subwatershed could support unique life-history variations. For example, two subwatersheds selected as focal areas are the Salmonberry River and Cook Creek watersheds. Both are north-flowing tributaries originating in volcanic geology. Due to their geomorphology and large watershed area, the Salmonberry River

*Lower Nehalem River above its confluence with the Salmonberry River. Photo: Ken Barber / Alamy*

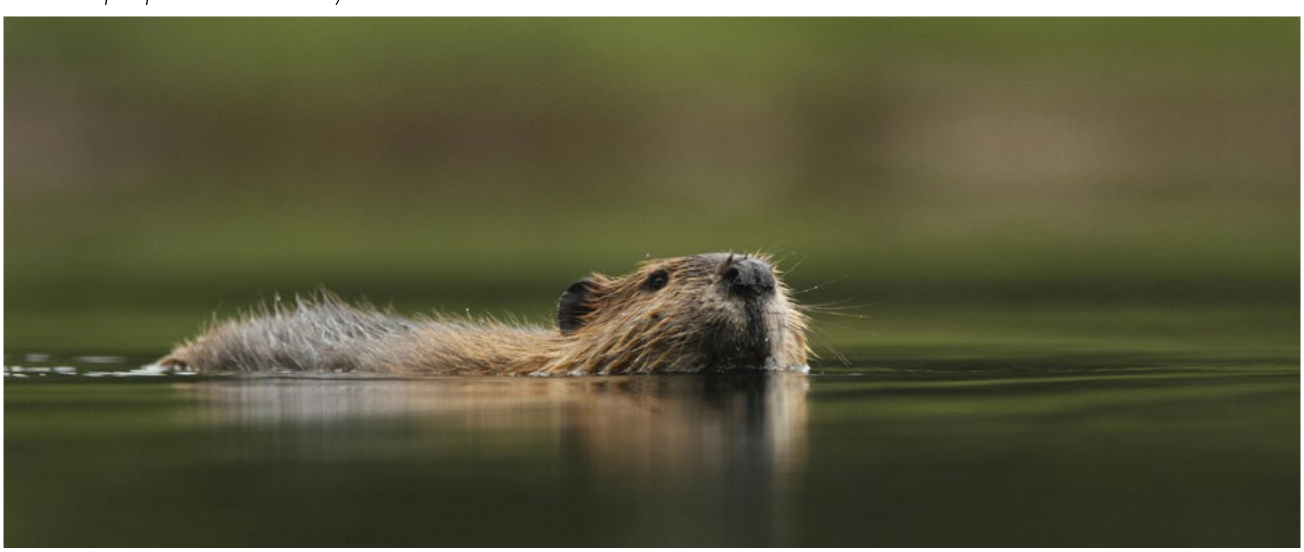
and Cook Creek represent the two most important contributions of both flow and cold water to the mainstem Nehalem (PC Trask 2017; Oregon DEQ 2003), which is temperature limited from the head of tide to RM 112 (Oregon DEQ 2003). Because Coho parr cannot persist in the mainstem during the summer months when temperatures often exceed 80 degrees Fahrenheit (Sullivan et al. 2000), these two drainages provide important thermal refugia and flow volumes that mitigate elevated mainstem temperatures and shorten their duration. Results of ongoing and recently completed juvenile Coho monitoring indicate that the nomadic components of several unique Nehalem Coho life histories depend on these two systems for survival in periods of elevated summer water temperatures (Bio-Surveys 2020).

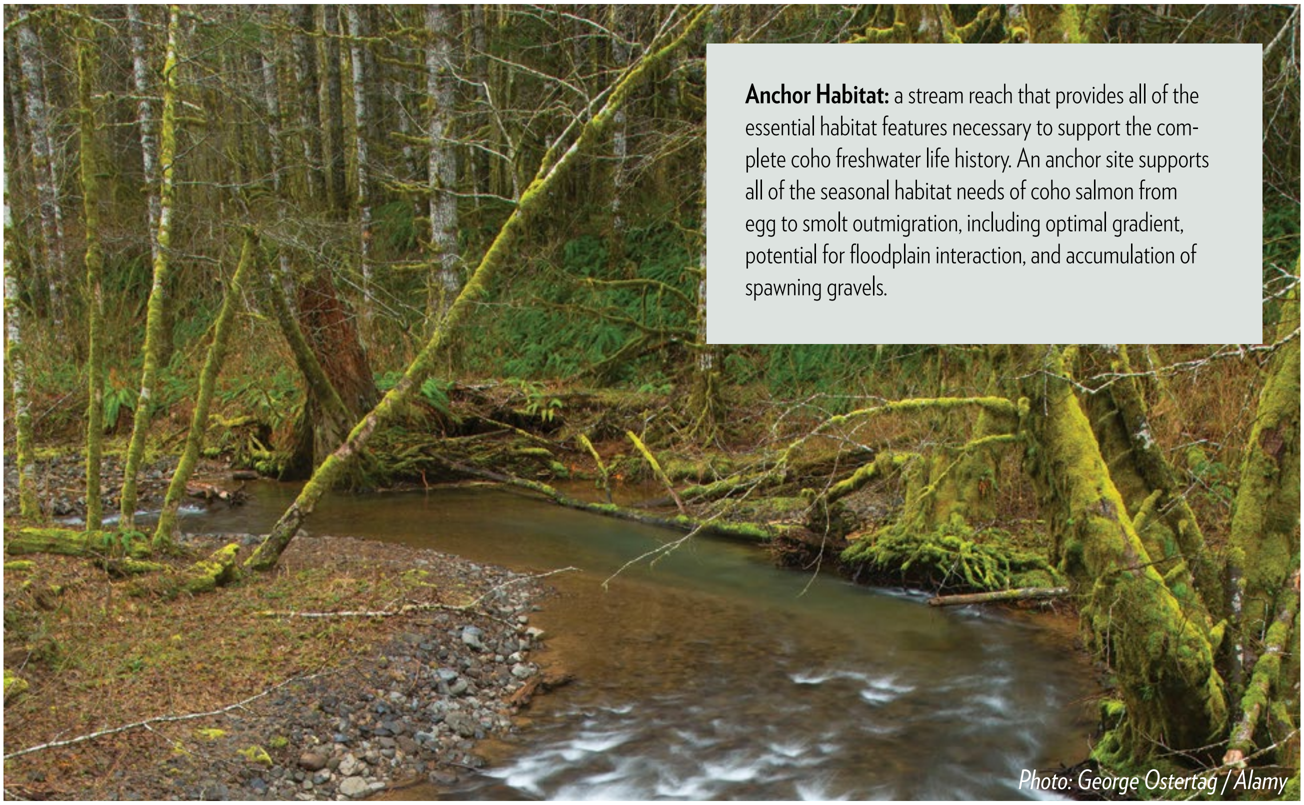
The main purpose of ranking subwatersheds (i.e., selecting focal areas) was to assist the Nehalem Partnership in coming to an agreement on a long-term habitat restoration strategy within the Nehalem basin. The ranking is not intended to recognize one subwatershed as more important than another or to disregard the contributions of subwatersheds that were not identified as focal areas to the productivity of the basin as a whole. **The Nehalem Partnership recognizes the inherent challenges in focusing on discrete pieces of an interconnected system, but participants agree that geographic focus is essential to most effectively invest scarce restoration resources.**

## 4.4 Determining Restoration Priorities by Focal Area

After identifying focal areas, the team evaluated the major stressors present in each. In the absence of limiting factors analyses in all but the Rock Creek watershed, the planning team agreed that restoration strategies should be determined based on a combination of best professional judgement and modeling. At the outset of the SAP process, NOAA commissioned TerrainWorks to use its Netmap tool to model the optimal locations for restoration strategies best suited to address priority stressors. Netmap is a process based model that develops a "virtual watershed" using a LiDAR digital elevation model (DEM) (with 10m DEMs where LiDAR is unavailable). The virtual watershed enumerates multiple aspects of watershed landforms, processes, and human interactions over a range of scales (Benda et al. 2015; Barquin et al. 2015). NetMap's virtual watershed contains six analytical capabilities to facilitate optimization analyses: 1) delineating watershed-scale

*Beavers build ponds that maintain a flow of cold, clean, slow moving water in a river system. These ponds provide homes for juvenille salmon and small invertebrates at the base of the food chain. Photo: Alamy.*





**Anchor Habitat:** a stream reach that provides all of 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.

*Photo: George Ostertag / Alamy*

synthetic river networks using DEMs; 2) connecting river networks, terrestrial environments, and other parts of the landscape; 3) routing watershed information downstream (such as sediment) and upstream (such as fish); 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.

The TerrainWorks' analyses included a range of outputs that were considered by the planning team, including prioritized sites for riparian restoration, thermal refugia protection, road maintenance/decommissioning, anchor habitat protection, including their key contributing tributaries, and fish passage improvement. NOAA modelers and the planning team also developed a model using Netmap to prioritize locations for beaver recruitment that built upon existing approaches and applied Nehalem-specific beaver data. Through all of these analyses, Netmap provided managers with modeled priority sites in subwatersheds where data or participant expertise was limited. Chapter 5 provides details on the model runs and the results generated.

The UNWC and LNWC both retain a license to use the Nehalem River Netmap data, as well as access to the Netmap software. Partners are encouraged to continue using Netmap to periodically update the analyses completed during the planning process and run new analyses as TerrainWorks makes them available in updates to the software.

## 4.5 Identifying Anchor Habitats

**ODFW (2007) identified reduced instream complexity as the primary limiting factor for the Nehalem Coho population.** While limiting factors analyses have not been completed for each of the 34 Nehalem 6th-field subwatersheds, reduced instream complexity resulting in insufficient over-wintering habitat, is a major stressor in most Nehalem subwatersheds. Accordingly, it is essential that practitioners are able to invest in strategies that enhance complexity with a high degree of confidence that projects are being located in reaches that can deliver the greatest benefit. To facilitate this, the Nehalem Team adopted an anchor habitat approach.

**Anchor habitat is a stream reach that provides all of the essential habitat features necessary to support the complete Coho freshwater life history.**

Anchor habitat features meet the seasonal habitat needs of Coho from egg to smolt out-migration. They are characterized by an optimum gradient (1-2.5%), high potential for channel-floodplain interaction (brood floodplains and low terraces), and accumulation of spawning gravels (Bio-Surveys 2011a). The protection, restoration, and expansion of sites exhibiting these conditions provide important opportunities to enhance function and increase instream complexity.

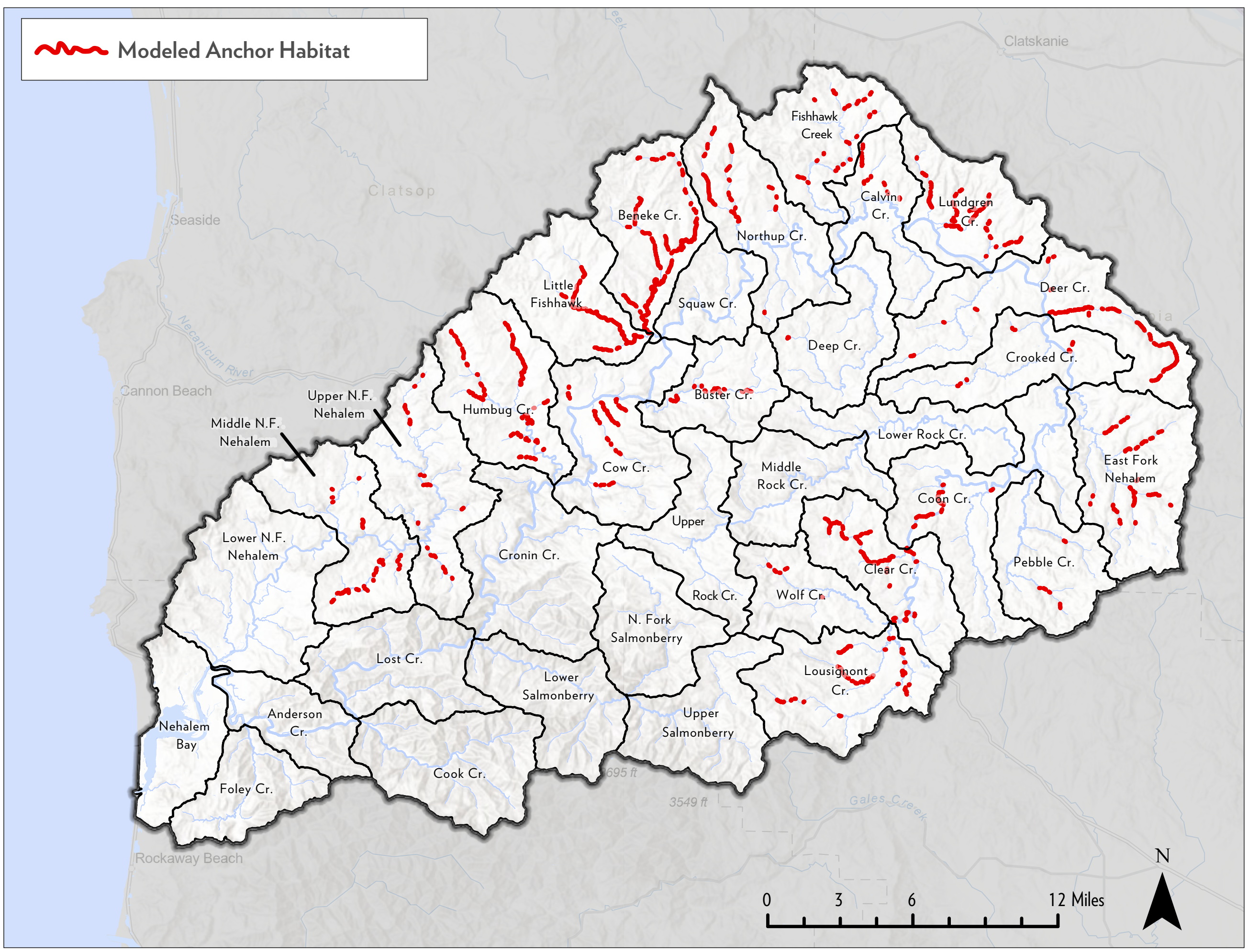
Chapter 5 presents the potential anchor sites where local partners will improve in-stream complexity through floodplain and off-channel habitat reconnection, large wood and beaver dam analogue (BDA) installation, and the protection of upland areas capable of delivering large wood and gravel to anchor habitats.

Appendix 6 contains a detailed description of how Coho anchor habitats are modeled in the Nehalem basin. Figure 4-1 provides the results of this exercise.

## 4.6 Monitoring and Indicators

Using the common framework, the Nehalem Partnership developed a list of indicators to monitor the pace and effectiveness of

**Figure 4-1.** Modeled Anchor Habitats in the Nehalem River Watershed. Note: Additional anchor habitats were determined through field data collection. See Figure 5-2.




SAP implementation. This was an important step towards addressing one of the main concerns leading to the development of Coast Coho SAPs: that managers were struggling to detect the cumulative benefits of restoration at a subwatershed or population scale. During the development of the Nehalem common framework, the Nehalem Partnership identified a list of indicators to track through SAP implementation. This list was revisited and revised after the SAP process to incorporate information generated and lessons learned during the process.

Chapter 7 presents the final list of indicators to evaluate the health of Nehalem Basin Coho habitat and watershed function. The Nehalem Partnership is confident that tracking these indicators over time will allow managers to detect changes from ongoing restoration beyond just the reach scale.

## 4.7 Estimating SAP and Project Costs

The Nehalem Partnership's final step in drafting this SAP was to estimate the anticipated costs of projects selected for the plan. Costs were generated by reviewing the OWEB Oregon Watershed Restoration Inventory (OWRI) database and comparing costs from previous projects implemented in the Nehalem River area by local partners. The OWRI database was queried to focus on projects implemented within the Oregon Coast Coho ESU from 2010 to 2020. These costs were reviewed and modified for use in the Nehalem SAP by partners with extensive experience implementing projects on the north coast. Project costs are presented in Chapter 8.

## 4.8 Community Outreach

The Nehalem Partnership includes a variety of public and private partners. Throughout the SAP development process, participants maintained consistent communication with the boards and management of the participating groups. Equally important, the managers who work with private landowners provided periodic updates to landowners and industry representatives. This ongoing outreach ensured that questions and concerns raised by local stakeholders were considered by the Nehalem Partnership and acted upon during plan development.

*Chapter 5*

# Impaired Watershed Processes and the Strategies to Restore Them

The previous chapter provided an overview of the Nehalem Partnership's process to develop this SAP. This chapter describes the plan's "Strategic Framework," the long-term restoration road map that resulted from this process. The Strategic Framework includes 1) the protection and restoration strategies that the Nehalem Partnership deems essential to restore watershed function in the Nehalem watershed, and 2) the locations where implementation of these strategies can generate the greatest benefit. Current and future managers and practitioners will use this strategic framework to guide how and where they invest in landowner outreach, habitat assessments, project implementation, and monitoring.

Figures 5-11 through 5-16 map the strategic framework, indicating the locations where specific KEAs will be protected or restored in the focal area watersheds. Tables 5-2 and 5-3 summarize the projected outcomes according to the linear miles and total acres protected or restored in each focal area. Chapter 6 presents the specific locations within these priority areas where partners intend to implement restoration projects through 2027.

The strategic framework presented in this chapter seeks to generate sustainable improvements in the natural processes that create and maintain high-quality rearing habitat for Coho. The planning team considered four principles of 'process-based restoration' (Roni and Beechie 2013) in examining how and where restoration can enhance watershed function. Two of these principles helped guide the Strategic Framework: 1) target the root causes of habitat and ecosystem change, and 2) clearly define expected outcomes, including recovery time. Implementing partners are encouraged to consider the two additional principles when designing the projects listed in Chapter 6: tailor restoration actions to local potential, and match the scale of restoration to the scale of physical and biological processes targeted.

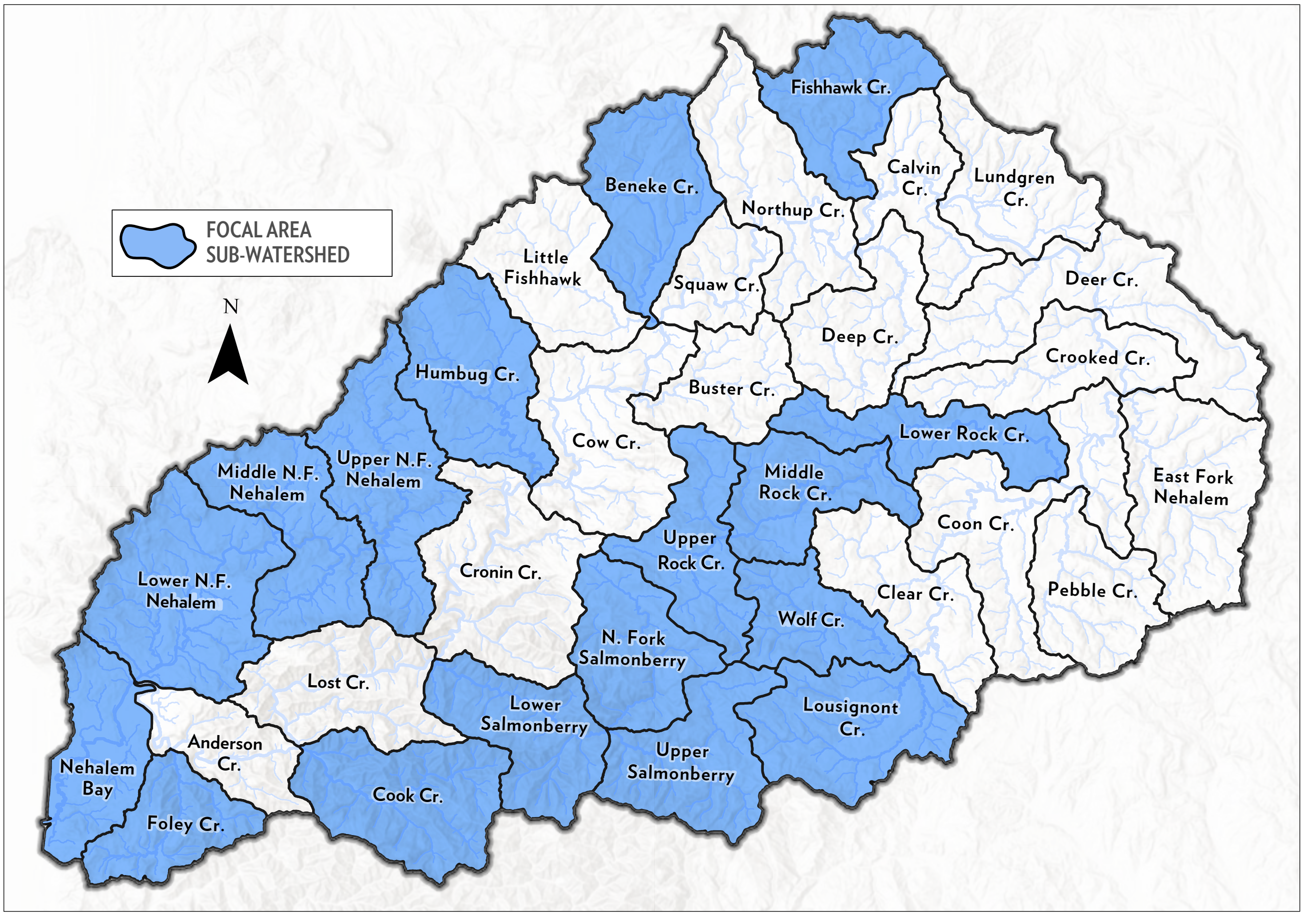
It should be noted that the strategies presented in this chapter are limited to those that local restoration partners have the authority and capacity to implement. To fully address the root causes of historic and ongoing habitat loss and more fully restore long-term watersthed function, state and federal partners are encouraged to examine the adequacy of current resource management policies and regulations. **Habitat restoration provides a net benefit only when the policies governing resource use sufficiently protect remaining watershed function.**

## 5.1 Focal Areas: Ranking the Subwatersheds

Through the process described in Chapter 4, the planning team ranked the following subwatersheds as high restoration priorities in the near term. These focal areas, shown in Figure 5-1, include 17 6th field subwatersheds and the mainstem Nehalem River.

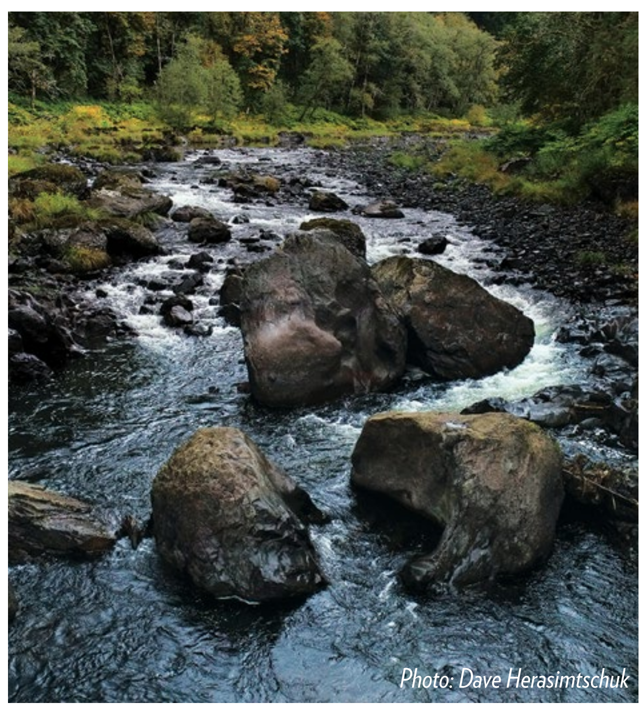
- Nehalem Bay
- Foley Creek
- North Fork Nehalem (lower, middle, and upper)
- Humbug Creek
- Beneke Creek
- Fishhawk Creek
- Rock Creek (lower, middle, and upper)
- Wolf Creek
- Lousignont Creek
- Salmonberry River (lower, upper, and north fork)
- Cook Creek

**Figure 5-1.** Focal Areas in the Nehalem River Watershed.




As described in Chapter 4, the Nehalem Partnership's purpose for identifying focal areas is not to characterize one subwatershed as more or less important than another but rather to focus and coordinate restoration investments among multiple stakeholders. This focus is intended to concentrate efforts in parts of the Nehalem watershed that are most likely to generate a positive signal (i.e., a quantifiable benefit) from the implementation of protection and restoration actions.

Additionally, these subwatersheds were selected to ensure that ongoing restoration efforts serve multiple life-history types present in the watershed. While this SAP relies heavily on a limiting factors approach to prioritization, the Nehalem Partnership recognizes that the spatial distribution and diversity of habitat types available are essential to life-history diversity and long-term population resilience. Ensuring restoration is carried out across a broadly distributed network of focal areas, regardless of their influence on basin-scale production, helps advance this priority.



## 5.2 Habitat Stressors, Limiting Factors, and the Anchor Habitat Approach

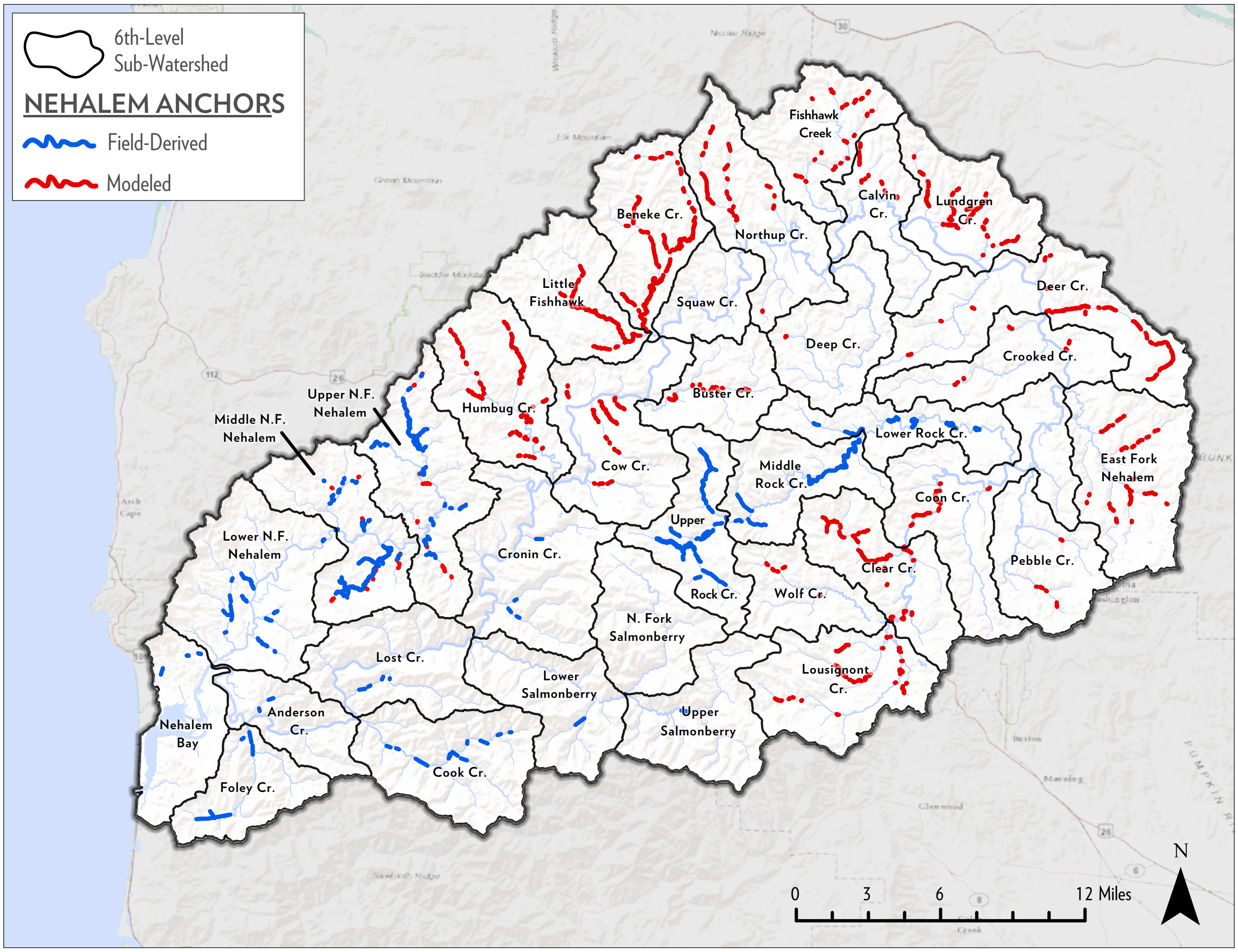
According to the Oregon Coast Coho Salmon Recovery Plan, "loss of stream complexity, including connected floodplain habitat, is the primary limiting factor for many Coho populations, and overwinter rearing of juvenile Coho is especially a concern. This instream habitat is critical to produce high enough juvenile survival to sustain productivity, particularly during periods of poor ocean conditions" (NMFS 2016). The ODFW defines stream complexity as "habitat of sufficient quality to produce over-winter survival at rates high enough to allow Coho spawners to replace themselves at full-seeding during periods of poor ocean conditions (3% smolt to adult survival)" (ODFW, 2007). "High quality over-winter rearing habitat for juvenile Coho salmon typically includes features such as large wood, pools, connected off-channel alcoves, side channels, beaver ponds, lakes, connected floodplains, and wetlands" (ODFW, 2007; NMFS, 2016).

The lack of instream complexity throughout the watershed is the primary factor limiting the production of Nehalem Coho. While evaluating KEAs in each focal area, the Nehalem Partnership consistently identified reduced wood delivery, lack of pools, bed coarsening, decreased lateral connectivity, and/or decreased beaver ponds as primary stressors. A limiting factors analysis (LFA) undertaken in Rock Creek identified instream complexity as the primary stressor limiting Coho production in all three subwatershed units (Bio-Surveys LLC 2011a). More recent "Rapid Bioassessments," which were used to generate "LFA lights" in the entire LNWC coverage area, also found a lack of instream complexity resulting from inadequate wood to be limiting production (Bio-Surveys LLC 2020).

In addition to the loss of physical habitat complexity, reduced water quality – especially increased summer water temperature – was also identified as a major stressor in several focal areas. Improving water temperatures during summer rearing will improve egg-to-smolt survival and increase the expression of

*Improving water temperatures during summer rearing will improve egg-to-smolt survival. Photo: Wild Salmon Center*

**Figure 5-2.** Anchor Habitats in the Nehalem River Watershed.




life histories now limited by thermal barriers in the mainstem and lower tributaries.

This chapter presents several protection and restoration strategies to address reduced instream complexity and water quality impairments, including protecting upland timber stands; adding large wood in anchor habitats; enhancing riparian vegetation; encouraging dam-building by beaver colonies; and removing physical barriers to fish passage.

To assist in prioritizing locations for upland habitat protection, instream restoration, and floodplain/off-channel reconnection, the Nehalem Partnership identified anchor habitats within all of the Nehalem's subwatersheds. These areas are shown in Figure 5-2. Many anchor habitats were identified through habitat assessments and surveys of Coho distribution and density collected during several rapid bioassessments. These field-determined anchors are shown in blue. Where field data was not collected, the team used Netmap to model anchors, which are shown in red. The process used to model anchors is summarized in Chapter 4 and detailed in Appendix 6.

Anchor habitats provide – or have the potential to provide if restored – all of the essential habitat features necessary to support the complete Coho freshwater life history for the "standard" life history strategy. Thus, the protection and restoration of these sites provides a unique opportunity to deliver a sustained increase in Coho production. Projects that improve key habitat features by augmenting instream complexity, reconnecting floodplains, restoring off-channel habitats, and improving riparian function in

**Table 5-1.** Lost or Altered Tidal Wetland Habitats by Type. Source: Nehalem Conservation Action Plan, 2012.

| Habitat | Current Acres | Historic Acres | Acres Lost | % Loss |
|---|---|---|---|---|
| Spruce swamp | 426 | 1326 | 900 | 68% |
| Salt marsh | 441 | 880 | 439 | 50% |
| Shrub swamp | 0 | 56 | 56 | 100% |
| **Total** | **867** | **2262** | **1395** | **62%** |

these areas can increase the functionality of an existing anchor and collectively restore stream function at the subwatershed scale. The anchor habitat strategy gives local partners a high degree of confidence that the strategies presented in this chapter represent the best opportunities to generate the greatest return on future restoration investments.

The final strategy presented in this chapter is the reconnection and restoration of tidal wetlands and associated freshwater habitats. In addition to reduced instream complexity and impaired water quality in tributaries and the Nehalem mainstem, the loss of tidal connectivity in the estuary is also a major stressor on the Coho population. Since European settlers moved into the watershed, modification of tidal processes has substantially reduced the availability and quality of estuarine rearing habitat for Nehalem Coho. A variety of anthropogenic practices – including agriculture, urbanization, and rural residential development – have led to the construction of barriers that have substantially reduced the connectivity of estuarine habitats, both spatially and temporally. Channel form and connections to side channels, overflow channels, tidal marshes and swamps, alcoves, backwater ponds, and floodplains have all been heavily altered or disconnected in the tidally influenced areas of the lower Nehalem River and estuary. The Nehalem Conservation Action Plan estimates that 62 percent of spruce swamp, salt marsh, and shrub swamp habitat have been altered or lost due to development. (See Table 5-1.)


Photo: Broken Banjo Photography

Estuarine habitats are essential to facilitate the physiological changes that occur in adult and juvenile Coho as they migrate between salt and freshwater. Suitable tidal exchange, water flow, salinity, and water quality are all required to support the acclimation of downriver migrating Coho smolts. Juvenile growth and maturation also require good to excellent water quality, forage, and cover. Forage includes aquatic invertebrate and fish species that support growth and maturation. Cover includes aquatic vegetation, side channels, undercut banks, brush and trees providing shade, large wood and log jam complexes, large rocks and boulders, beaver ponds, and freshwater wetlands (NMFS 2016). Key off-channel estuarine habitats include sloughs, side channels, overflow channels, tidal marshes and swamps, alcove or ponds, groundwater channels, and seasonally flooded wetlands (Lestelle 2007.)

## 5.3 Strategies to Conserve Critical Coho Habitats in the Nehalem Watershed

The Strategic Framework presented in this chapter is intended to guide landowner outreach, project implementation, and habitat monitoring over the long term (two or more decades). Of course, the strategies presented here do not represent all of the restoration opportunities present in the Nehalem watershed. They simply represent those within the Nehalem Partnership's purview and have the highest likelihood of improving watershed function and increasing Coho habitat production over the long term. As these strategies are implemented, the Strategic Framework will be evaluated and priorities may change as monitoring data becomes available. This is discussed further in Chapter 7: Evaluation and Adaptive Management.

**Strategy 1. Protect selected timber stands to promote large wood delivery to anchor habitats within debris-flow prone Type-N tributary corridors.**

*2045 Outcome #1: The long-term potential for large wood delivery to anchor habitats is improved through the protection of 536 acres of selected timber stands throughout the Nehalem basin (343 acres in focal areas).*

While the installation of large wood in selected stream reaches can significantly increase stream complexity, these projects typically provide benefits for a relatively short term (one to two decades). Protecting carefully selected stands of large diameter timber can increase the natural recruitment of large instream wood continuously and over a longer horizon. Passive

**Figure 5-3.** Upland Sites with the Highest Potential to Deliver Large Wood into Anchor Habitats.

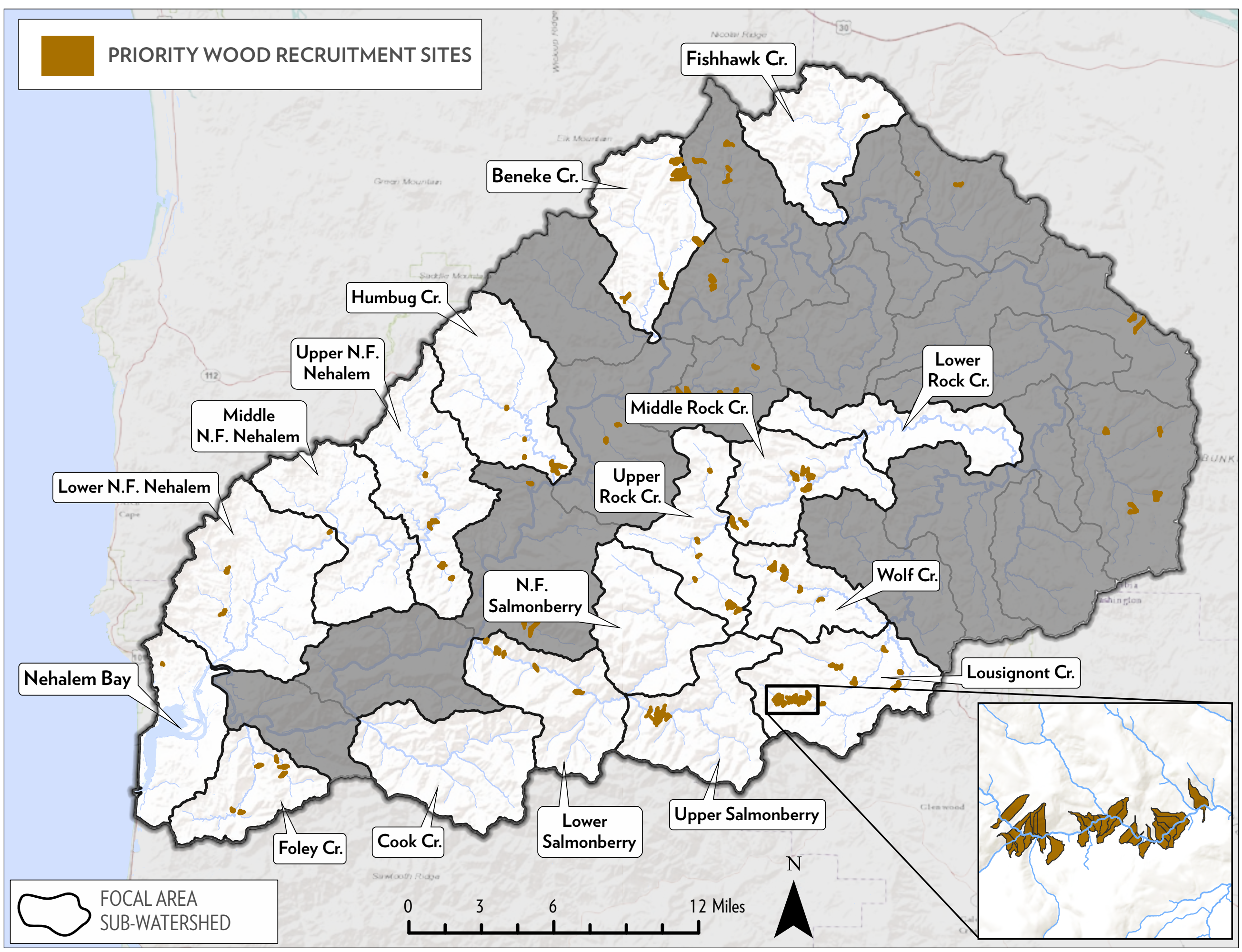


**Table 5-2.** Acres of Upland Wood Recruitment Sites Recommended for Permanent Protection in the Nehalem River Basin.

| Tributary Name | Acreage | Tributary Name | Acreage |
|---|---|---|---|
| Lousignont Creek-Nehalem River | 113 | Northup Creek-Nehalem River | 13 |
| Foley Creek | 61 | Cow Creek-Nehalem River | 12 |
| Anderson Creek-Nehalem River | 53 | Deep Creek | 12 |
| Lost Creek-Nehalem River | 46 | Middle North Fork Nehalem River | 10 |
| Cook Creek | 43 | Upper Salmonberry River | 8 |
| Wolf Creek | 36 | Humbug Creek | 7 |
| Lower North Fork Nehalem River | 33 | Lower Rock Creek | 6 |
| Buster Creek | 29 | East Fork Nehalem River | 6 |
| Cronin Creek-Nehalem River | 22 | Fishhawk Creek | 5 |
| Lower Salmonberry River | 21 | **Total** | **536** |

large wood delivery provides a sustainable and cost-effective approach to increasing and maintaining habitat complexity over the long term.

The Nehalem Partnership used NetMap to locate and map areas with the greatest opportunity to provide for natural recruitment of large wood into or above anchor habitats through delivery from upland sources. Areas highlighted in Table 5-2 and Figure 5-3 contain large, old trees that grow (or may be downed) on steep slopes and have a high likelihood of sliding and delivering wood into identified anchor habitats. Methods to identify these locations are detailed in Appendix 7.

*Large wood significantly increases stream complexity. Photo: Wild Salmon Center*

It should be noted that managing selected timber stands under longer rotations supports this plan's goal of delivering large wood into anchor habitats. Although this plan does not recommend specific forest management prescriptions, the recently approved Private Forest Accords call for reducing harvest on steep slopes found on private timberlands. Regulations currently under development to implement the Accords are anticipated to increase the long-term availability of large wood to streams.

The modeling approaches developed through this SAP were adopted and modified for use in the Accords. Managers are encouraged to update the maps generated in this SAP to further prioritize locations to protect upland habitats in the Nehalem Basin. Additionally, the Nehalem Partnership encourages ODF to use the debris flow and anchor habitat models in development of the Western Oregon State Forests Habitat Conservation Plan.

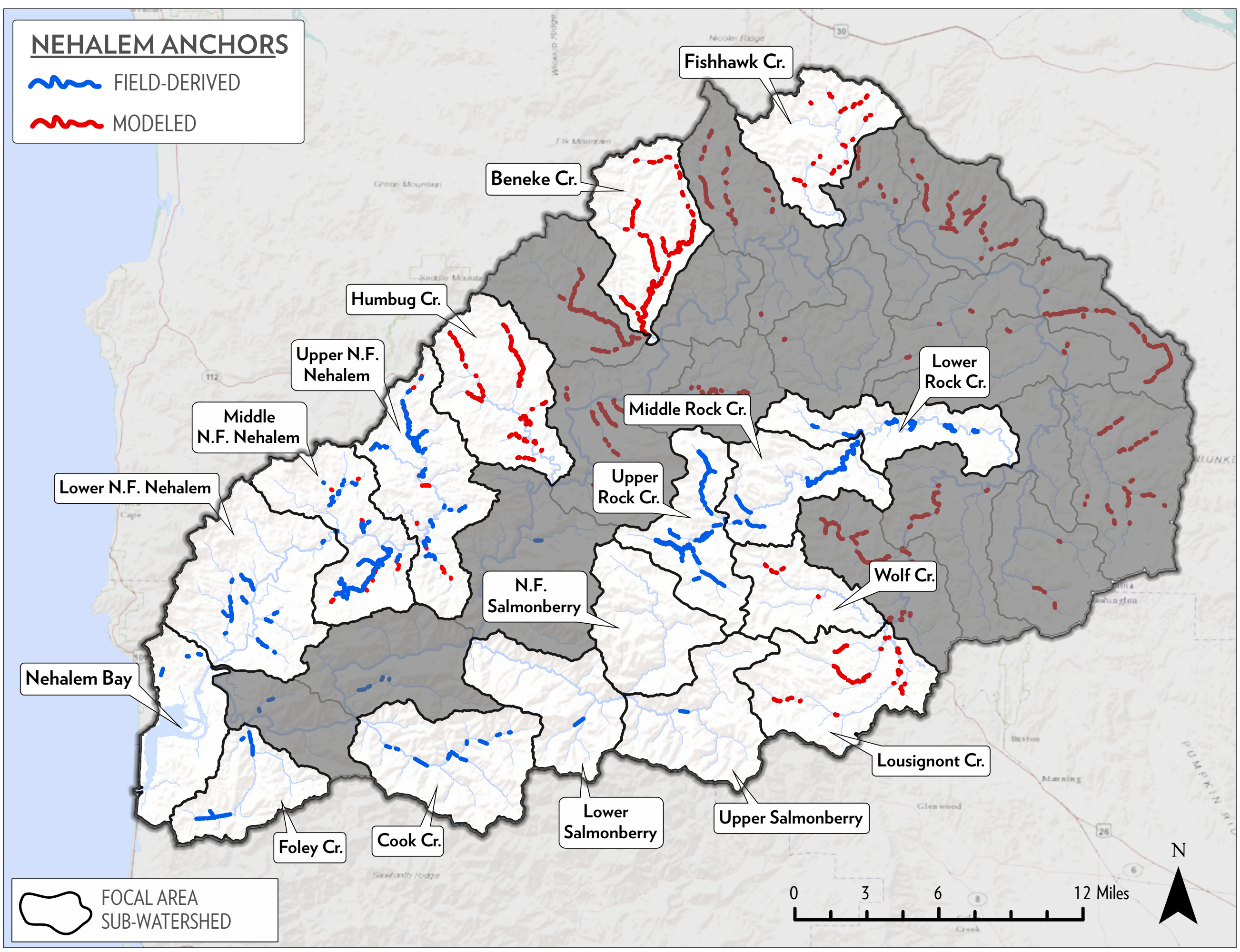
## Strategy 2. Add large wood to identified anchor habitats and priority reaches of cold water refugia.

***2045 Outcome #2*: Instream complexity and stream interaction with off-channel habitats are restored within 66 miles of focal area anchor habitats.**

Stream complexity results from several factors, including (but not limited to) geology, valley slope and width, the degree of streambank hardening, and the presence of large trees and other instream structure. Large, downed trees can change the morphology of rivers and streams, creating hydrogeomorphic conditions suitable to providing velocity refuge and other important aspects of high-quality juvenile rearing habitat. 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 alcoves, beaver ponds, lakes, connected floodplains and wetlands" (ODFW 20007).

Following decades of stream cleaning (in which large wood was removed from streams to enhance mainstem transportation and fish migration) and extensive clearcutting (which reduced passive wood delivery to streams), tributaries in the Nehalem are now well below the desired benchmarks for wood. As a complement to Strategy 1, which supports long-term, passive wood delivery into Nehalem River tributaries, this strategy calls for the targeted placement of large wood. The installation of large wood can boost short-term

**Figure 5-4.** Anchor Habitats Identified in the Focal Areas.



Coho production while enhancing watershed function in anchors and other priority reaches.

Wood placement locations called for in Chapter 5 are focused largely in areas with significant amount of anchor habitat, shown in Figure 5-4. Criteria considered in determining priority locations included:

1) whether the reach is an identified anchor habitat (i.e., the site can support the full range of seasonal habitat requirements for Coho, including spawning, incubation, and summer/winter rearing);

2) the current level of connectivity (i.e., the site is currently accessible to juvenile salmonids); and

3) the estimated proportion of the 6th field's Coho production that is generated by a site (i.e., the site is highly productive – or capable of being highly productive with restoration).

In addition to applying the anchor strategy, the planning team prioritized locations to increase instream complexity through a review of tributary confluences that provide cold water inputs to the lower mainstem Nehalem. These tributary nodes may serve as life boats for juvenile salmonids seeking refuge from lower mainstem water temperatures that reach over 25 degrees Celsius in the summer (Bio-Surveys 2020). Juveniles seeking to ride out the summer in these cold water plumes are likely subject to high predation due to the limited availability of cover caused by reduced instream complexity.

Bio-Surveys (2020) prioritizes the cold water confluences from the estuary upstream to Humbug Creek (RM 34.7). The following tributaries were identified as high priorities for restoration at their confluences with the Nehalem mainstem based on field work conducted in 2018. These include (in order of priority): Fall Creek, Cook Creek, Hel-off Creek, Spruce Run Creek, Candyflower Creek, Foley Creek, Salmonberry River, Lost Creek, George Creek, an unnamed tributary, and Buchanan Creek. A review of data gaps provided in Chapter 7 recommends further refining this list through additional data collection and undertaking a similar assessment in the upper basin.

*The installation of large wood can boost short-term Coho production and enhance watershed function. Photo: Dave Herasimtschuk*

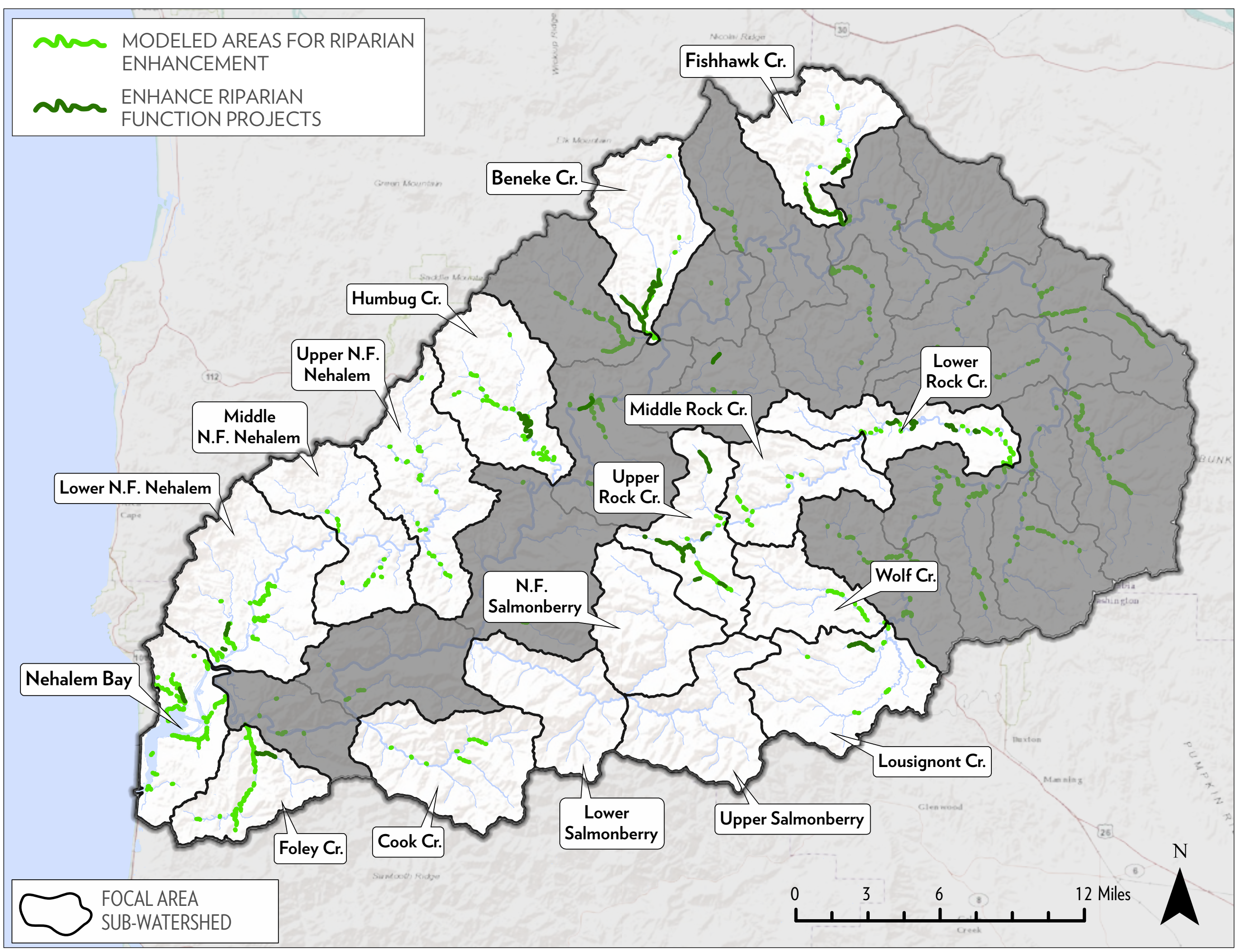
**Strategy 3. Enhance riparian habitats along tributaries through native plantings and the management of invasive species.**

***2045 Outcome #3**: Riparian function is restored along 58 miles of focal area tributaries, reducing stream temperatures and erosion, increasing macro-invertebrate abundance, and increasing the long-term potential for large wood recruitment.*

Both the state's Oregon Coast Coho Conservation Plan and the federal recovery plan establish that healthy riparian areas are a key component of high-quality rearing habitat for juvenile Coho. Functioning riparian habitats maintain channel connectivity to floodplains, wetlands, and side channels; provide shading; generate large wood and litter; retain sediments; support macro-invertebrate communities and provide other important aspects of a healthy stream ecosystem. These functions have been lost or reduced in many parts of the Nehalem Basin from the headwaters to the bay due to forest and pasture management, rural residential and urban development, and the proliferation of non-native species.

The restoration of riparian areas also serves as a critical buffer to climate change. Elevated summer temperatures in the mainstem Nehalem and many lower tributaries already create a thermal barrier to juvenile migration in summer, shown in Figures 5-6 and 5-7. In addition to limiting access to critical habitats and diminishing overall habitat availability, the impaired migration of juveniles also threatens

**Figure 5-5.** Modeled Priority Reaches for Riparian Enhancement and Proposed Near-term Projects.



the expression of alternative life-history strategies like the nomadic Coho. Loss of life history diversity threatens the viability and resilience of the Nehalem Coho population. The restoration of riparian zones presents a tool to combat the impacts of climate change on thermal regimes in the Nehalem, supporting juvenile migration and access to critical cold water habitats in summer. Figure 5-5 shows priority reaches for riparian habitat enhancement.

The riparian enhancement activities in this plan focus primarily on removing non-native vegetation and planting native vegetation. Where necessary, managers may also incorporate livestock exclusion through fencing and off-channel watering. Additionally, the LNWC proposes to form a regional working group to enhance riparian silvicultural approaches and establish "pockets" of mid to late-successional conifers in the riparian zone near large wood placement sites, in debris-flow source areas, and adjacent to beaver dam analogue installations.


*Healthy riparian zones are essential to maintaining cold water, recruiting large wood to the stream, and filtering out fine sediments and other contaminants.*

**Figure 5-6.** Modeled Stream Temperatures in the Nehalem River Watershed.

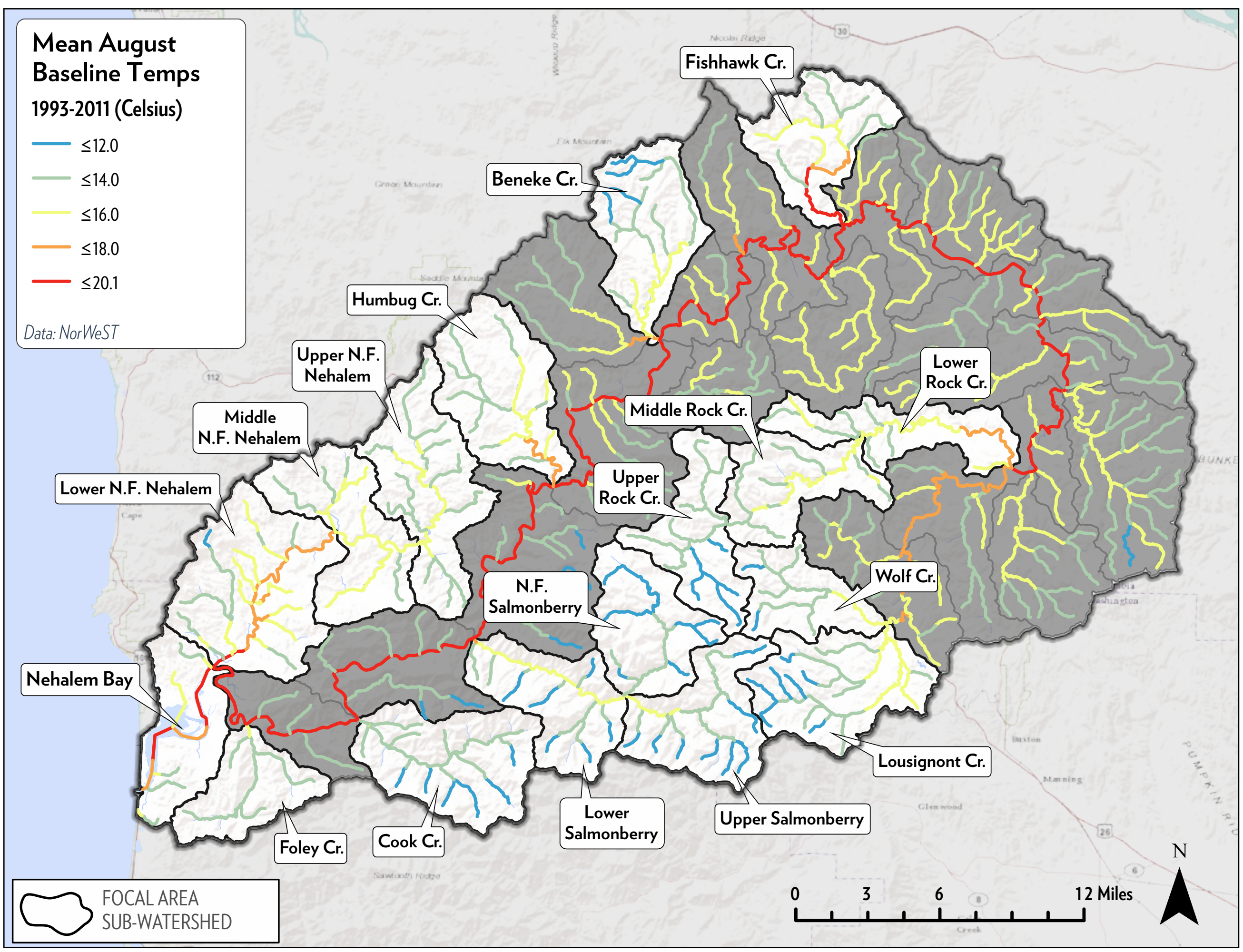
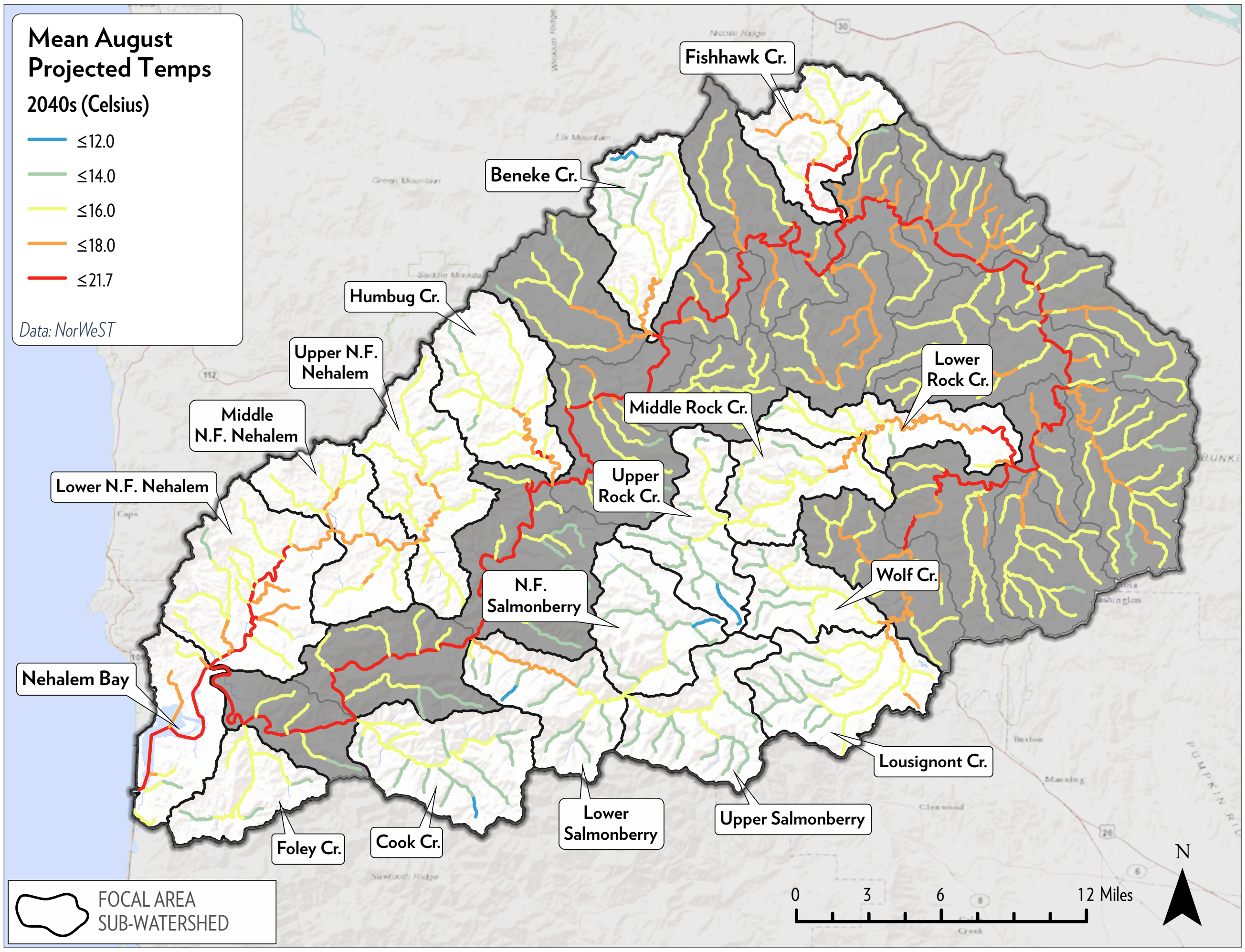


**Figure 5-7.** Modeled 2040 Stream Temperatures in the Nehalem River Watershed.




## Strategy 4. Recruit and promote beaver colonization and encourage dam-building in selected 1st - 3rd order tributaries.

*2045 Outcome #4: Beavers colonize and build dams in an additional 40 miles of Coho- bearing tributaries in the focal areas, increasing the quality and quantity of off-channel habitats available for juvenile rearing.*

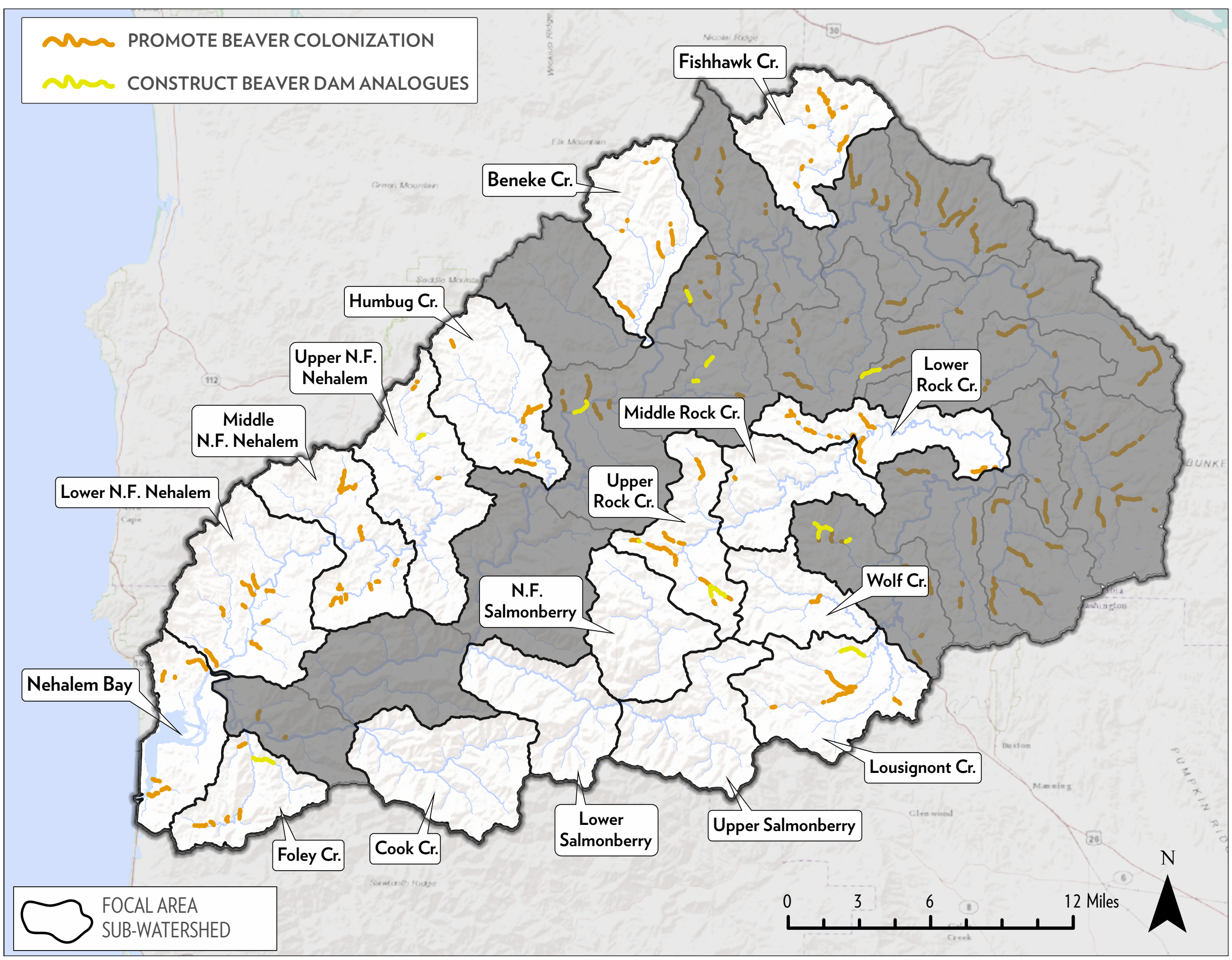
As detailed in the Beaver Restoration Guidebook (USFWS, Castro et al. 2015), beaver ponds provide excellent habitat for Coho and other fish species because they slow stream flow and generate abundant off-channel and edge habitat. Among other benefits, these conditions offer refuge from flood flows in winter and from high water temperatures found in the mainstem and many tributaries during the summer months. They also provide cover from predators and abundant food, which requires substantially less energy to find than in higher velocity tributary habitats.

In addition to the physical habitats created, beaver ponds drive watershed processes that recruit and retain spawning gravels and forest nutrients, increase hyporheic flow, elevate local water tables, and generate lateral connectivity between the stream channel and floodplain. This capacity to restore watershed function and enhance habitats beyond just a reach scale makes their damming activity particularly effective at increasing over-winter survival (often the limiting factor) at a subwatershed scale. In addition, beaver colonization and dam building can benefit every Coho life-history type present in the Nehalem Basin, while also benefiting the full range of Coho life stages. **Therefore, the recruitment of beavers and restoration of beaver pond habitats represents one of the most impactful and economical restoration strategies available to the recovery effort.**

The Oregon Coast Coho Conservation Plan states, "Increasing the number of beaver dams in areas where dams are limited.... will create stream complexity and increase the Coho smolt capacity of populations and the ESU, which will help the populations and ESU build towards desired status." Similarly, the federal recovery plan recommends increasing the number of beavers and beaver ponds as a range-wide strategy.

The Nehalem Partnership's primary strategy to increase the number of beaver ponds focuses on installing Beaver Dam Analogues (BDAs), wood structures that can mimic and potentially catalyze dam construction. The BDAs proposed in the SAP will be designed and constructed to provide salmon habitat at sites chosen to avoid conflict with humans. Three years of monitoring results from recently implemented BDAs in the upper Nehalem watershed demonstrate that BDAs may encourage beaver colonization and increase over-winter Coho habitat where dams are constructed. Additional long-term monitoring is needed to capture the cyclical nature of beaver site colonization. Food availability is a critical factor for site utilization; therefore, evaluating if the site has sufficient food resources and augmenting food availability through planting will be an important component.

**Figure 5-8.** Modeled Stream Reaches with the Highest Potential for Beaver and Locations Proposed for Beaver Dam Analogues in the Near-term.



*Beaver Dam Analogues are wood structures that can mimic beaver dam construction. Photo: Maggie Peyton*

To identify the best sites for installing BDAs, the team developed an intrinsic potential model for beaver and ran it with Netmap. The model is driven by the identification of geomorphology conducive to persistent beaver dam habitat. After ground-truthing the model and locating several potential sites, the team invited a group of BDA expert scientists and agency personnel to visit the locations and offer feedback on site selection, design, and construction techniques. The preferred locations for testing BDAs were on public property where there was little or no risk of harming roads, buildings, or private property.

Figure 5-8 presents the results of the Beaver Intrinsic Potential model. This map does not represent all of the sites that beaver may occupy. It simply shows the locations where the most suitable geomorphic conditions exist for site establishment. Successful implementation of BDAs has already occurred on several of these sites. Additional sites proposed for near-term BDA construction are also shown in Figure 5-8.

While this plan seeks to promote beaver colonization and dam-building, the Nehalem Partnership recognizes that some beaver management strategies may undermine and diminish the benefits of beaver establishment. In addition, maintaining existing colonies of beavers is a more cost-effective strategy to generate Coho habitat than restoring these habitats once beaver have been removed. Currently, the only mandatory reporting is for recreational harvest of beaver on public lands through the furtaker report. The Partnership encourages state and federal managers and policy makers to consider the following changes in beaver management and policy:

- Require mandatory reporting of beaver trapping across all land ownership;
- Collect baseline data on current population status;
- Provide support to private landowners seeking to implement non-lethal management strategies;
- Support regional efforts to create "quick response teams" that can remove and relocate beavers when necessary due to human conflict;
- Increase awareness of the role of beavers in generating high-quality salmon habitat; and
- Remove beaver as a predatory rodent on private lands under the jurisdiction of ODA to a managed furbearer by ODFW.

## Strategy 5. Reconnect and restore tidal wetlands and sloughs and associated freshwater habitats.

***2045 Outcome #5*: Three hundred acres of tidal wetlands and other estuarine habitats are reconnected, increasing the quality and extent of tidal rearing habitats and associated freshwater habitats.**

Drowned-river mouth estuaries like the Nehalem Bay generate a variety of habitats that are important to Coho rearing, including saltmarsh, emergent marsh, open water, subtidal, intertidal, backwater areas, tidal swamps, mudflats, tidal channels, scrub-shrub, and deep channels. Collectively, these habitats provide important and diverse opportunities for juvenile Coho to feed, grow, and smolt before entering the ocean. Under the standard life-history strategy for Nehalem Coho, smolts typically spend less than a month in the estuary feeding, growing, and adapting to saline environments before entering the Pacific Ocean.

Ongoing studies of Coho use of the Salmon River estuary (about 60 miles south of the Nehalem Bay) show estuaries are more than simply short-term stopovers for Coho on the way to the ocean. The habitat complexity and connectivity within and between the freshwater and estuarine environments enable young salmon to express a variety of alternative life-history strategies (Bisson et al. 2009; Moore et al. 2015; Flitcroft et al. 2019). Jones et al. 2011 describes "a wide range of sizes and times of juvenile Coho migration to the estuary and ocean, including many nomads that successfully rear and grow in the estuary for extended periods."

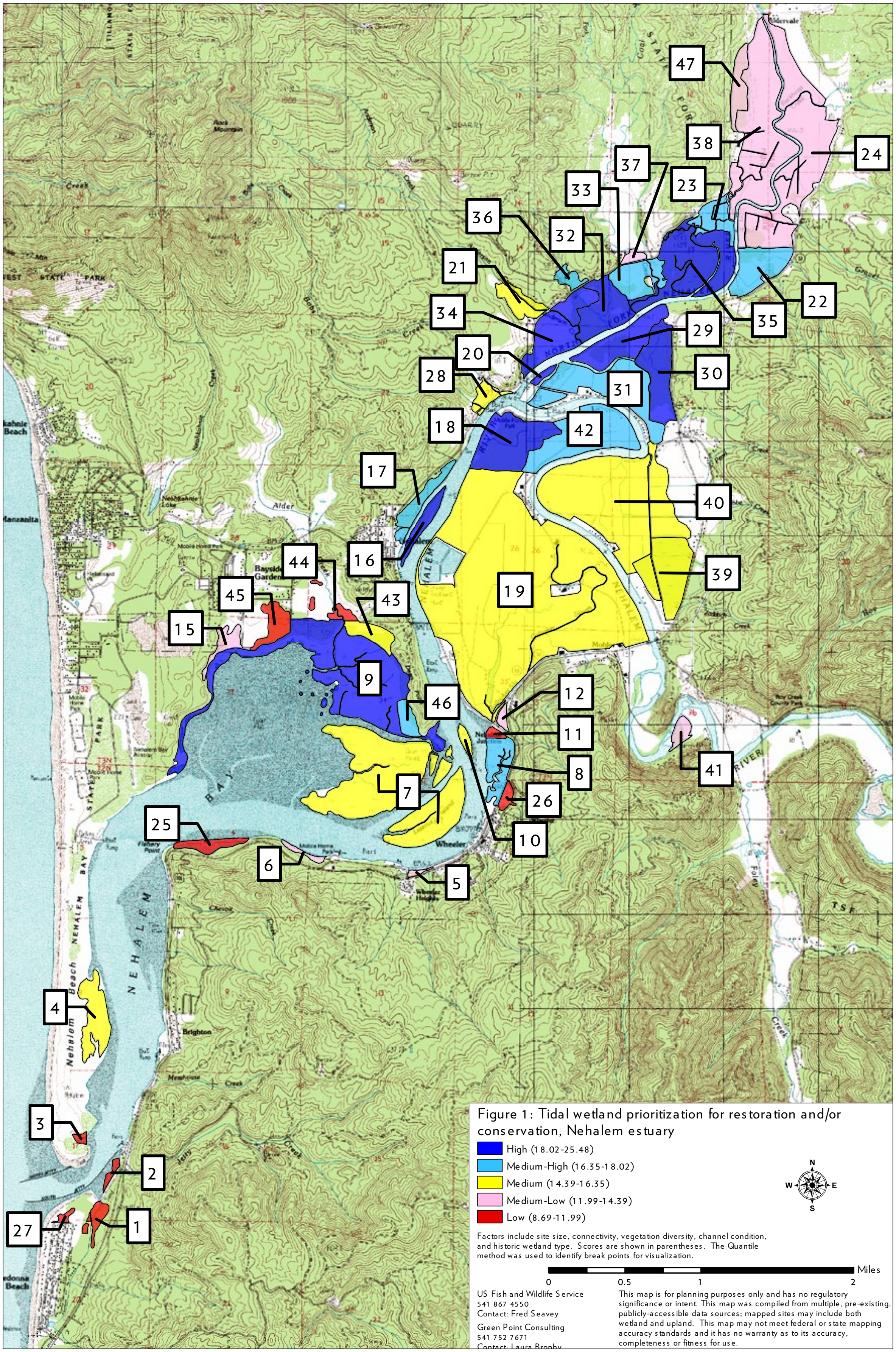

Neahkanie Farm Wetland

More recent research details the diverse temporal and spatial use of these habitats by Coho. Some juvenile cohorts enter tidal areas as fry in spring within months of emerging from the gravel; others as parr in the fall after a short summer in spawning-adjacent habitats; and many more enter the estuary as yearlings headed out to the ocean (Jones et al. 2021).

Jones et al. (2014) describes the importance of reconnecting tidal habitats, explaining "estuary restoration has re-established a variety of habitats capable of rearing juveniles that were not supported by stream habitats in the upper [Salmon] basin. Under the environmental conditions experienced during this survey, estuarine wetlands accounted for as much as 30 percent of the adult *O. kisutch* that now return to spawn in Salmon River. These results suggest that life-history diversity and the habitat opportunities that sustain it are fundamental to the productivity as well as the resilience of Salmon River *O. kisutch*."

Findings by Jones et al. (2021) provide further evidence that "estuary-focused" life-history strategies can comprise an important component of an OC Coho run. In one of seven years of the study, alternate (estuary-focused) strategies represented the majority of returning adults (58%). Following an assessment of juvenile Coho distribution in the lower Nehalem tributaries, Bio-Surveys (2020) described a similar finding; "Coho found rearing in lower mainstem thermal refugia and estuarine habitats represent an important subset of the population."

**Figure 5-9.** Tidal Wetland Restoration Priorities in the Nehalem Bay (Brophy et al. 2005).



*Tidal wetlands in Nehalem Bay. Photo: Wild Salmon Center*

Finally, monitoring in the lower Salmon River indicates that some cohorts of rearing Coho retreat to estuary-adjacent streams in fall and winter before re-entering the estuary in spring (Jones et al. 2014). These streams, which are often small and not easily recognized as critical habitat, provide a source of cold water refugia and freshwater for juveniles not yet ready to enter the more saline habitats. These contributions strongly point to estuary-adjacent streams as a key habitat component for Coho and a priority for protection and restoration.

Brophy et al. (2005) prioritized tidal wetlands in the Nehalem Bay, and the Nehalem Partnership has incorporated the priorities recommended in that report into this SAP (Figure 5-9). The study highlights land areas in the Nehalem River estuary where tidal wetland restoration or other conservation action can offer the greatest ecosystem benefit for the cost. Criteria for prioritization included the size of the site, tidal channel condition, wetland connectivity, salmonid habitat connectivity, historic vegetation type, and diversity of current vegetation types. The report identified 1,350 hectares (ha) (3,336 acres) of current and former tidal wetlands in the Nehalem River estuary. Over 70 percent of the estuary's historic tidal wetlands (970 ha) have undergone major site alterations that greatly restrict or alter tidal flows, such as diking and ditching. Roughly 3 percent (37 ha) have undergone minor alterations like culverted drainages and road crossings, and 25 percent (340 ha) are relatively undisturbed.

In addition to this report, local partners recently completed an inventory of Nehalem Bay tide gates. The data generated from this work will support the prioritization of tide gate replacements using the Opti-Pass model developed by The Nature Conservancy. Local partners may overlay the results from the Opti-Pass analysis on the Brophy (2005) prioritization and SAP focal area and anchor habitat maps to inform a long-term tidal wetland reconnection strategy.

In addition to this work, the Nehalem Partnership recommends three additional priorities for restoring the Nehalem River estuary and its tributaries:

1) Enhance fish passage and/or reconnect tidal areas and floodplains containing 1st – 3rd order tributaries draining into the estuary. These tributaries provide important salinity refuges for 0+ age nomads, which cannot yet tolerate elevated salinity.

2) Prioritize tributaries on the south side of the bay (north-flowing creeks) because of their capacity to serve as thermal refugia.

3) Protect landward migration zones.

## Strategy 6. Replace or remove culverts and other barriers to fish passage.

*<u>2045 Outcome #6</u>: Fifty-two barriers to fish passage are removed, enhancing longitudinal connectivity in focal area tributaries, and restoring Coho access to 92 miles of anchor habitats, cold water refugia, and off-channel habitats.*

The ODFW fish passage barrier list contains numerous culverts, tide gates, dams, and other barriers to fish migration in the Nehalem River basin. Several other assessments also prioritize barriers within selected subwatersheds, including a culvert inventory and Rapid Bioassessment completed in the lower basin and the Rock Creek LFA from the upper basin. The Nehalem Partnership reviewed these sources and identified 52 high-priority barriers to OC Coho. These barriers are mapped in Figure 5-10. In Chapter 6, the Partnership presents the barriers that it intends to eliminate in the next five years. In addition to providing juvenile and adult access to anchor habitats, cold water refugia and other key habitats, the removal of these barriers will enhance longitudinal connectivity, improving the transport of gravel and wood through the system.

## 5.4 Outcomes by Restoration Strategy in SAP Focal Areas

Tables 5-3 and 5-4 summarize the outcomes sought in the upper and lower Nehalem focal areas from implementing the strategies described above through 2045. The focal area maps in Figures 5-11 through 5-16 show the locations where partners seek to implement these strategies.

**Figure 5-10.** Fish Passage Reconnection Priorities in the Focal Areas.

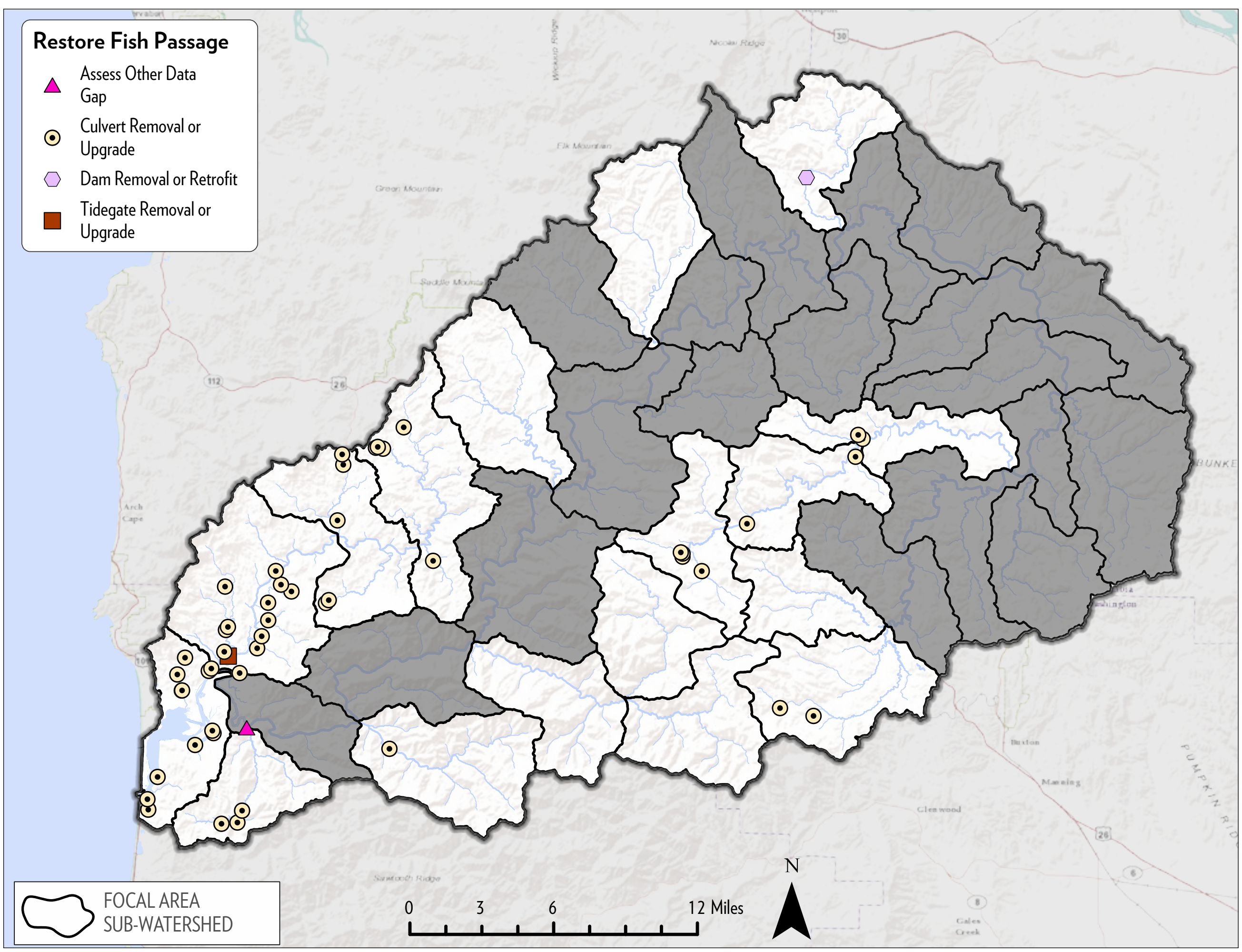


**Table 5-3.** Projected Outcomes in the Lower Nehalem Focal Areas (2023 - 2045).

| KEY ECOLOGICAL ATTRIBUTES RESTORED OR ENHANCED | Focal Areas | | | | | |
|---|---|---|---|---|---|---|
| | Foley Creek | Nehalem Bay | North Fork Nehalem | Cook Creek | Salmon-berry | Total |
| Stands of selected large timber protected (acres) | 61 | 0 | 43 | 43 | 29 | **176** |
| Increased instream complexity in anchor habitats from large wood (miles) | 2.6 | .3 | 6.3 | 2.4 | .8 | **12.4** |
| Instream complexity increased by beaver enhancement activities (miles) | 2 | 3 | 9.5 | 0 | 0 | **14.5** |
| Enhanced riparian function along tributaries (miles) | 5.8 | 10.2 | 8.5 | .9 | 0 | **25.4** |
| Fish passage barriers replaced (number) | 4 | 13 | 23 | 1 | 0 | **41** |
| Longitudinal connectivity increased in tributaries (miles of habitat reconnected) | 7 | 21 | 36 | 1 | 0 | **65** |
| Increased tidal connectivity in priority areas (acres) | N/A | High priority | Highest priority | N/A | N/A | **300** |

**Table 5-4.** Projected Outcomes in the Upper Nehalem Focal Areas (2023 - 2045).

| KEY ECOLOGICAL ATTRIBUTES RESTORED OR ENHANCED | Focal Areas | | | | | | |
|---|---|---|---|---|---|---|---|
| | Humbug Creek | Beneke Creek | Fishhawk Creek | Rock Creek | Wolf Creek | Lousignant Creek | Total |
| Stands of selected large timber protected (acres) | 7 | 0 | 5 | 6 | 36 | 113 | **167** |
| Increased instream complexity in anchor habitats from large wood (miles) | 7.3 | 13 | 2.1 | 26.1 | .5 | 4.1 | **53.1** |
| Instream complexity increased by BDAs and beaver colonization dam-building (miles) | 3.1 | 2.7 | 3.4 | 11.1 | .6 | 3.6 | **24.5** |
| Enhanced riparian function along tributaries (miles) | 5.5 | 5.7 | 4.7 | 13.1 | 1.4 | 2.4 | **32.8** |
| Fish passage barriers replaced (number) | 0 | 0 | 1 | 8 | 0 | 2 | **11** |
| Longitudinal connectivity increased in tributaries (miles of habitat reconnected) | 0 | 0 | 2 | 21 | 0 | 4 | **27** |

## 5.5 Priority Reaches by Restoration Strategy in the Focal Areas

The following maps in Figures 5-11 to 5-16 present the river reaches and upland locations identified as the highest priorities for implementing the strategies presented in this chapter. These locations represent the areas where investment in protection and restoration projects will provide the greatest benefit and highest return on investments made in Nehalem Coho recovery. Chapter 6 presents a short-term (5-year) work plan, which identifies specific locations within these priority areas where landowners are prepared to implement projects, or outreach is underway, and partners have a high degree of confidence that a project can be implemented in the foreseeable future.

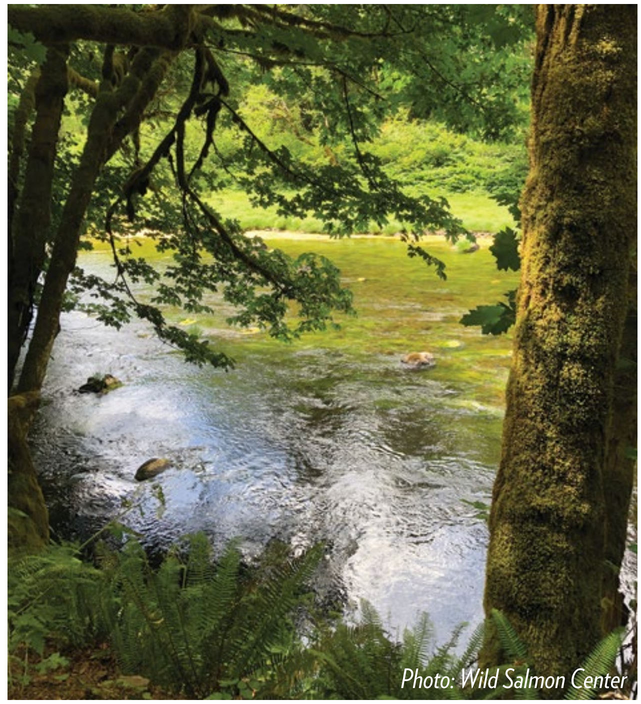



**Figure 5-11.** Priority Reaches by Restoration Strategy in the Tidally Connected Focal Areas, including Foley Creek, Nehalem Bay, and the lower North Fork Nehalem Watersheds.

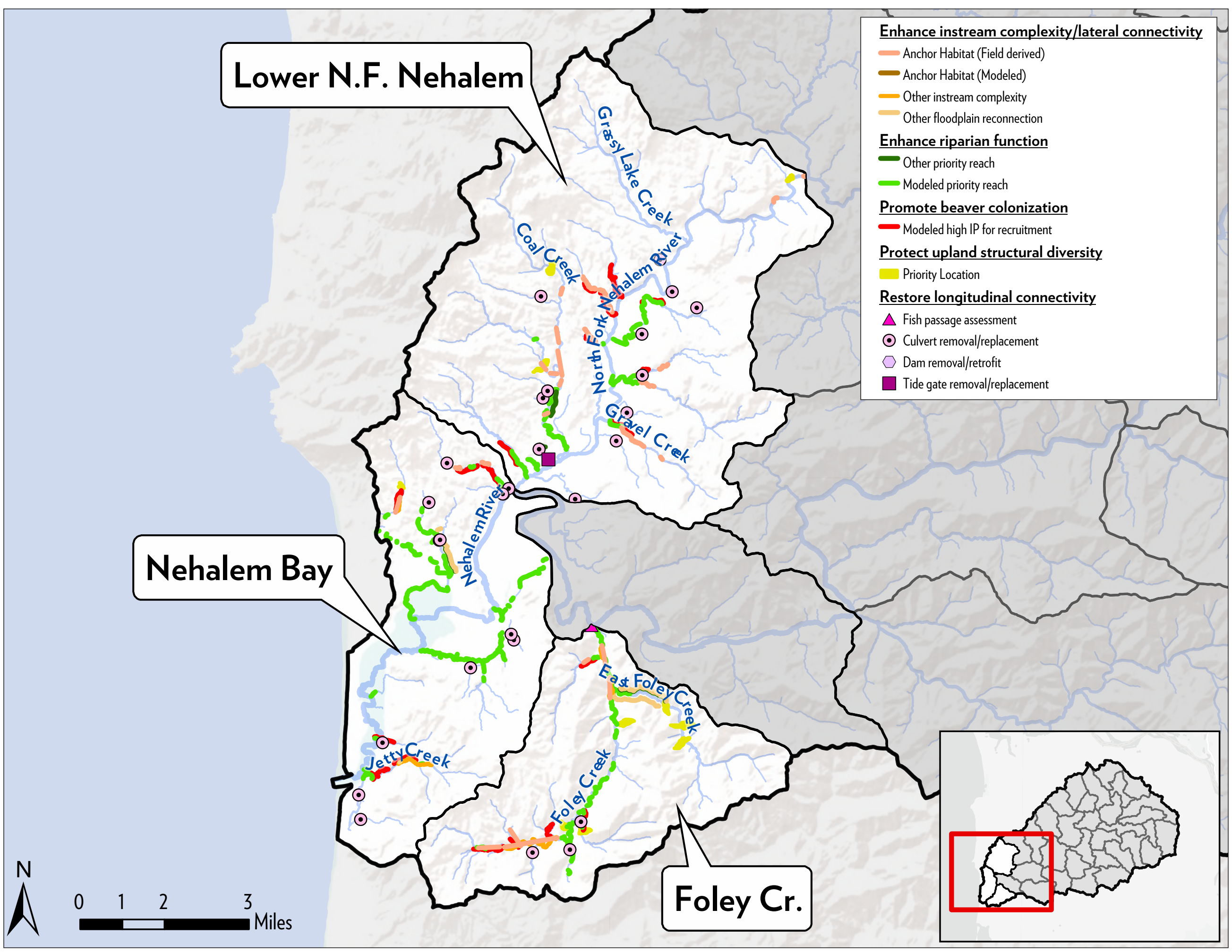


**Figure 5-12.** Priority Reaches by Restoration Strategy in the Middle and Upper North Fork Nehalem and Humbug Creek Focal Areas.

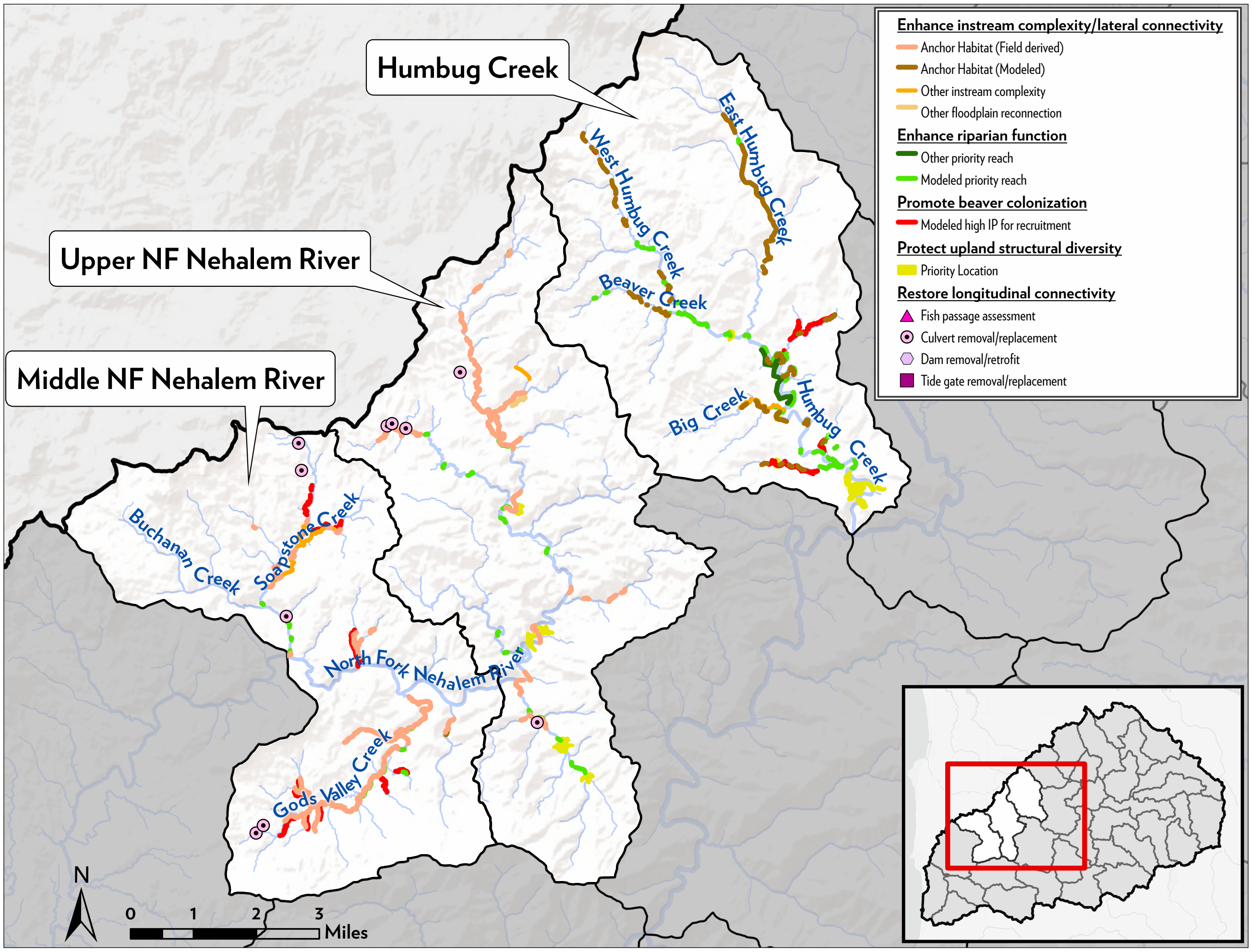




**Figure 5-13.** Priority Reaches by Restoration Strategy in the Beneke and Fishhawk Creek Focal Areas.

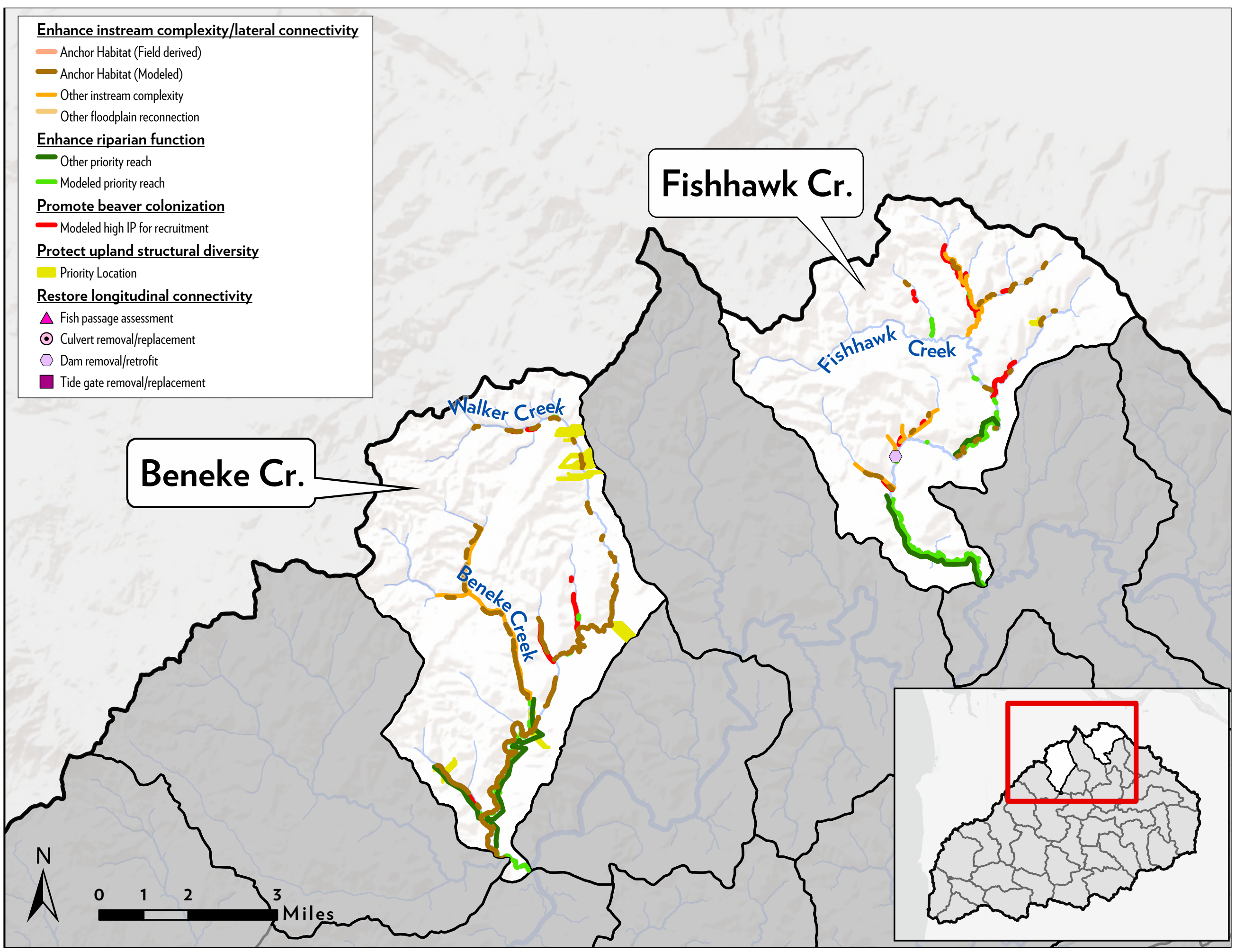


**Figure 5-14.** Priority Reaches by Restoration Strategy in the Lundgren, Deer, Crooked, Pebble Creek, and East Fork Nehalem Subwatersheds. Note: these watersheds were not selected as short-term focal areas, but all provide high-quality habitat and reaches with high-restoration potential.

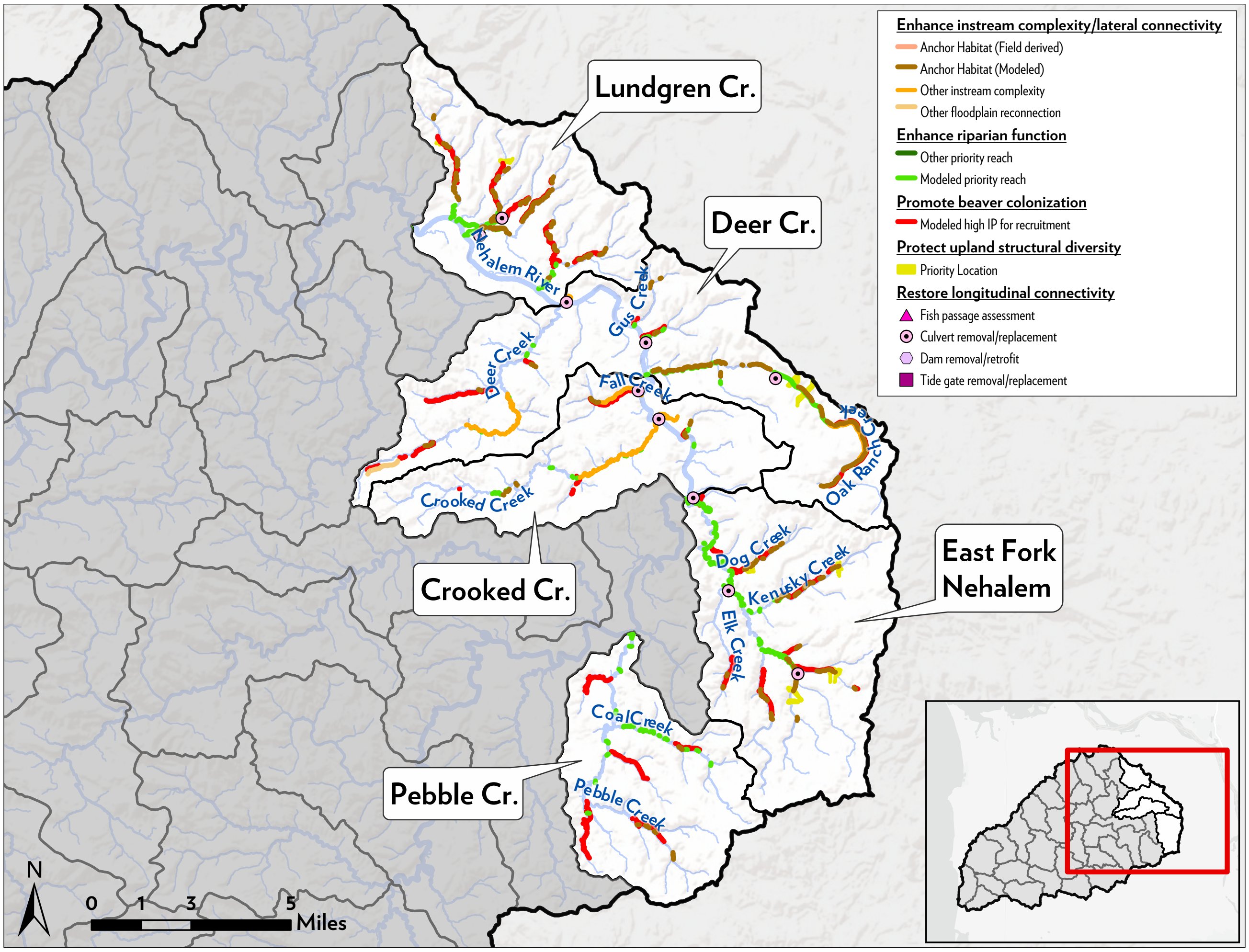




*Photo: Freshwaters Illustrated / J Monroe*


**Figure 5-15.** Priority Reaches by Restoration Strategy in the Rock, Wolf, and Lousignont Creek Focal Areas. Note: this map includes the priorities presented in the Rock Creek Limiting Factors Analysis (see Figures 6-1 and 6-2) and subsequent modeling on potential beaver colonization sites and priority upland areas for large wood recruitment.

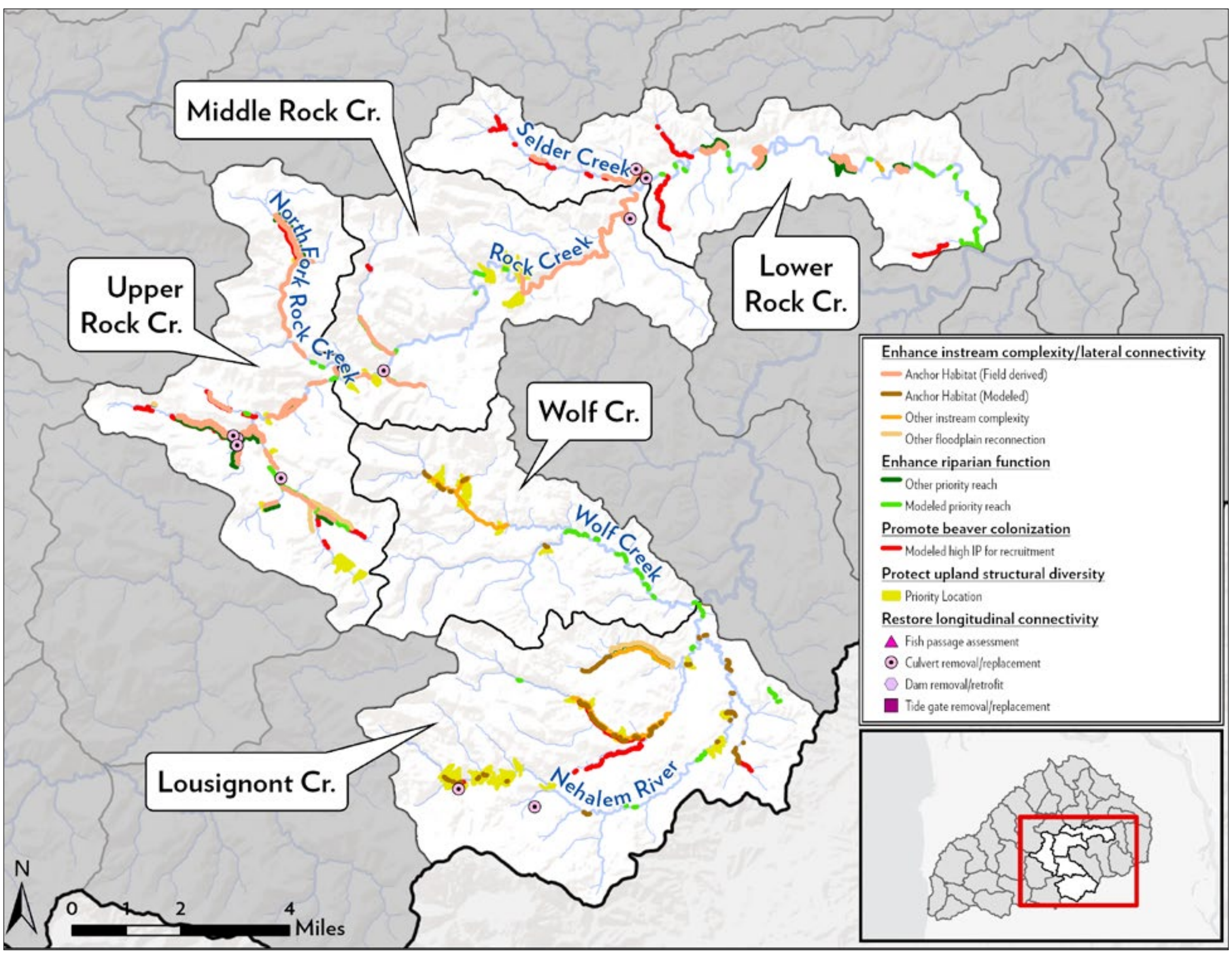
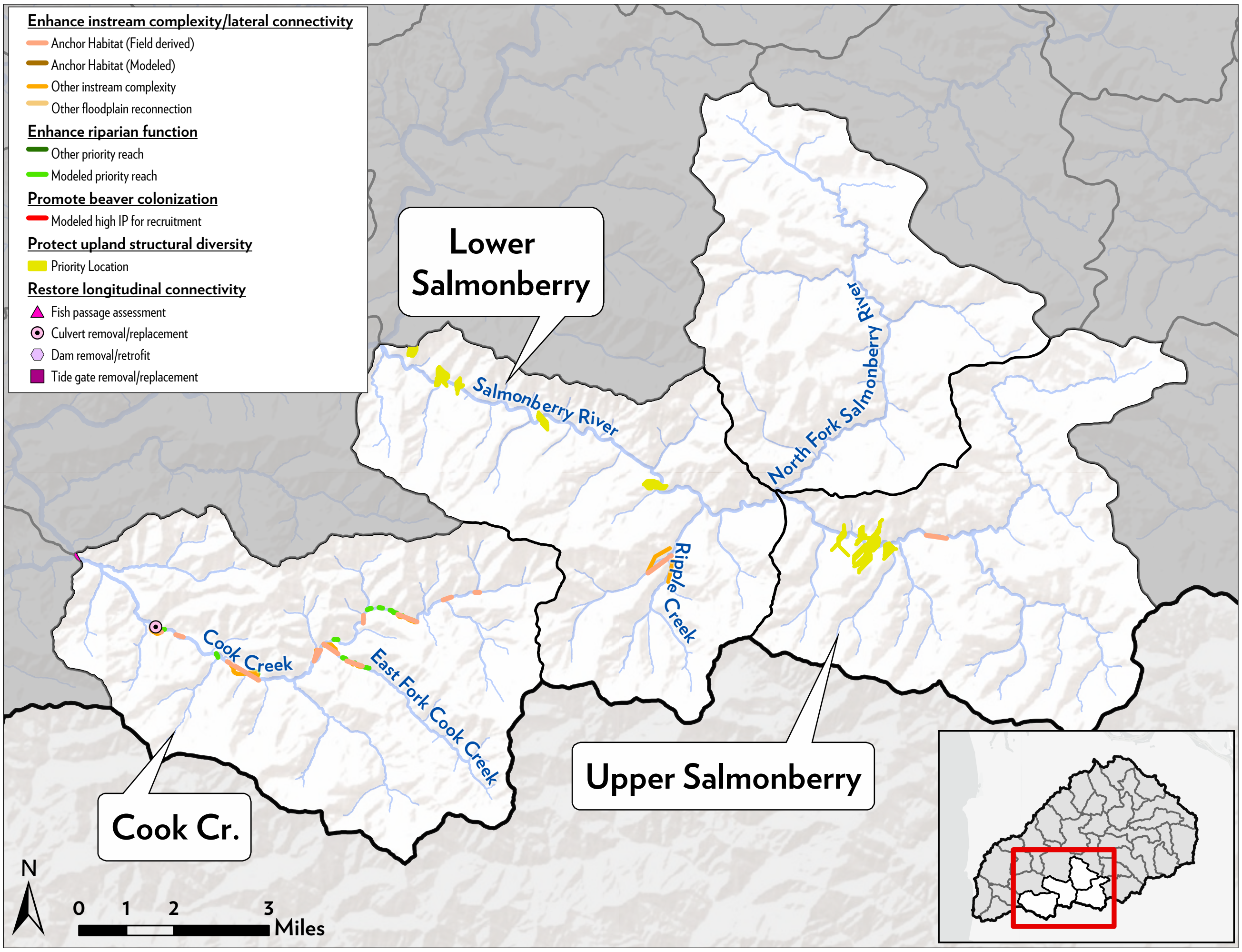


**Figure 5-16.** Priority Reaches by Restoration Strategy in the Cook Creek, Upper Salmonberry, and Lower Salmonberry Focal Areas.




*Chapter 6*

# Project Implementation Plan: 2023 – 2027

Chapter 5 describes the protection and restoration strategies that the Nehalem Partnership will employ over the long term and the locations where the coordinated implementation of these strategies can generate the greatest benefit. The following chapter outlines a short-term work plan in which a subset of locations have been selected from these priority areas for implementation of projects within the next five years. The projects presented below reflect the locations where the scientifically determined priorities shown in Chapter 5 align with the conditions necessary for project implementation (willing landowners, high potential for funding, permits feasible, etc.). In short, these are the locations where science and opportunity meet.

## 6.1 Emerging Opportunities

While this SAP identifies focal areas in which to focus investment and coordinate implementation, the Nehalem Partnership recognizes the contributions of the other subwatersheds to the basin-wide dynamics that have made the Nehalem such a highly productive Coho system. To that end, the Partnership agrees that focusing implementation in the focal areas does not restrict any participating partners from undertaking projects in the other subwatersheds.

However, to be recognized as a funding priority, projects outside of the focal areas should meet one or more of the following criteria: 1) demonstrate the application of new conservation incentives or techniques; 2) engage an influential landowner or partner who can accelerate work in the focal areas; 3) exploit a finite window of opportunity; and/or 4) advance a large-scale project with a high cost-benefit. Partners developing this SAP agreed to an 80-20 guideline, where each partner will seek to direct 80 percent of its investments in project implementation and landowner outreach within this plan's focal areas. In addition to meeting one or more of the criteria above, projects undertaken outside the focal areas should also adhere to the anchor strategy presented in this SAP.

## 6.2 Near-Term Actions and Objectives

The Nehalem Partnership proposes the following actions for implementation from 2023 to 2027. These SAP proposed near-term actions are listed according to the long-term outcomes that they support.

**2045 Outcome #1: The long-term potential for large wood delivery to anchor habitats is improved through the protection of 536 acres of selected timber stands throughout the Nehalem basin (343 acres in focal areas).**

| *Objective 1.1 – By 2025, engage all public and private landowners in the focal areas with lands containing habitats modeled as high priority for future wood recruitment.* | |
|---|---|
| Action 1.1 – A | Overlay SAP maps of 'priority upland sites to protect' (Figure 5-3 and Appendix 7) on debris flow and steep slope maps generated under the Forest Accords to determine which SAP priority areas are now protected under the revised FPA. Collaborate with private industrial forest landowners to determine the feasibility and costs of protecting upland sites that are not protected. Develop an initial list of sites deemed as opportunities for protection. |
| Action 1.1 – B | Review map of priority timber stands with ODF to support protection priorities generated under the Western Oregon State Forests Habitat Conservation Plan. |
| Action 1.1 – C | Support voluntary protection of priority upland stands through implementation of the Forest Accords in the Nehalem Basin. |

## 2045 Outcome #2: Instream complexity and stream interaction with off-channel habitats are restored within 66 miles of focal area anchor habitats.

| *Objective 2.1 – By 2029, add LWD to 32.6 miles of focal area anchor habitats.* | |
|---|---|
| Action 2.1 – A | Add LWD to 4.1 miles of anchor habitats on upper mainstem Beneke Creek - GIS 100. |
| Action 2.1 – B | Add LWD to 2.4 miles of anchor habitat on ODF lands on NF Wolf Creek - GIS 101. |
| Action 2.1 – C | Add LWD to 1.3 miles of anchor and cold water refugia habitats on Fishhawk and Boxer Creeks – GIS 106. |
| Action 2.1 – D | Add LWD to 2.9 miles Hamilton Creek - GIS 900. |
| Action 2.1 – E | Add LWD and re-meander 0.8 miles of Dass Creek – GIS 904. |
| Action 2.1 – F | Add LWD to 0.3 miles of O'Black Creek - GIS 902. |
| Action 2.1 – G | Add LWD to 1.4 miles of Fall Creek (Olympic: Crooked sub). |
| Action 2.1 – H | Add LWD to 1 mile of anchor habitats on Big Creek - GIS 109. |
| Action 2.1 – I | Add LWD to 2.8 miles of Upper Lousignont Creek – GIS 400. |
| Action 2.1 – J | Add LWD to 0.7 miles of Jetty Creek – GIS 920. |
| Action 2.1 – K | Add LWD to 2.2 miles of Foley Creek – GIS 401. |
| Action 2.1 – L | Add LWD to 0.3 miles of Upper Neah-Kah-Nie Creek – GIS 21. |
| Action 2.1 – M | Add LWD to 2.6 miles of Soapstone Creek – GIS 22. |
| Action 2.1 – N | Add full spanning LWD to 0.3 miles of Spruce Run Creek – GIS 34. |
| Action 2.1 – O | Add LWD to 0.4 of Grand Rapids Creek – GIS 600. |
| Action 2.1 – P | Add LWD to 0.7 miles of Gravel Creek – GIS 910. |
| Action 2.1 – Q | Add LWD to 0.2 miles of the Little North Fork Nehalem– GIS 911. |
| Action 2.1 –R | Add LWD to 1.7 miles of Upper Oak Ranch Creek on ODF lands in Deer Creek – GIS 402. |
| Action 2.1 – S | Add LWD to 0.1 miles of Bob's Creek (Anchor 1 & 2) – GIS 40. |
| Action 2.1 – T | Add LWD to 1.5 miles of East Foley Creek – GIS 11 (.5) and 14 (1). |
| Action 2.1 – U | Add LWD to 2.5 miles of Gods Valley Creek (mainstem). |
| Action 2.1 – V | Add LWD to 0.85 miles of Gods Valley Creek Trib A. |
| Action 2.1 – W | Add LWD to 0.5 miles of Gods Valley Creek Trib C. |
| Action 2.1 – X | Add LWD to 0.8 miles of Gods Valley Creek Trib D. |
| Action 2.1 – Y | Add LWD to 0.25 miles of Gods Valley Creek Trib E. |
| Action 2.1 – Z | Add LWD to the confluence of the Salmonberry and the mainstem Nehalem River. |
| Action 2.1 – AA | Add LWD to the confluence of Cook Creek and the mainstem Nehalem River. |
| Action 2.1 – BB | Add LWD to the confluence of Spruce Run Creek and the mainstem Nehalem River. |

| | |
|---|---|
| *Objective 2.2 – By 2025, initiate implementation of the LWD recommendations in the Rock Creek Limiting Factors Analysis (LFA).* | |
| Action 2.2 – A | Identify and engage all landowners containing priority reaches in the Rock Creek LFA (Figures 6-1 and 6-2). |
| Action 2.2 – B | Determine an implementation schedule based on the project prioritization contained in the LFA (Appendix 9) and landowner willingness. |
| Action 2.2 – C | Support voluntary protection of priority upland stands through implementation of the Forest Accords in the Nehalem Basin. |
| *Objective 2.3 – By 2025, add 7 miles of LWD to anchor habitats in selected locations outside of the focal areas (see Section 6.1 Emerging Opportunities).* | |
| Action 2.3 – A | Add LWD to 0.9 miles of Buster Creek – GIS 116. |
| Action 2.3 – B | Add LWD to 3.3 miles of Crooked Creek (Olympic) – GIS 907. |
| Action 2.3 – C | Add LWD to 1.4 miles of Upper Northrup Creek (ODF) – GIS 403. |
| Action 2.3 – D | Add LWD to 1.2 miles of Clear Creek – GIS 125. |
| Action 2.3 – E | Add LWD to 0.2 miles of lower North Fork Clear Creek – GIS 126. |

## 2045 Outcome #3: Riparian function is restored along 58 miles of focal area streams, reducing stream temperatures and erosion, increasing macro-invertebrate abundance, and increasing the long-term potential for large wood recruitment.

| | |
|---|---|
| *Objective 3.1 – By 2027, plant 14.4 miles of riparian vegetation in locations modeled as highest priority within the focal areas.* | |
| Action 3.1 – A | Plant 3.9 miles of riparian vegetation on Fishhawk Creek above and below dam – GIS 104. |
| Action 3.1 – B | Plant 2.3 mile of riparian vegetation on ODFW Wildlife Refuge along Humbug Creek – GIS 108. |
| Action 3.1 – C | Augment riparian plantings on 5 miles of Beneke tract of Jewell Meadows – GIS 110. |
| Action 3.1 – D | Plant riparian vegetation on 0.9 miles of Tweedle Creek – GIS 128. |
| Action 3.1 – E | Plant 0.6 miles of riparian vegetation on Coal Creek – GIS 601. |
| Action 3.1 – F | Plant 0.7 mile of riparian vegetation on Alder Creek and tributary downstream of Hwy 101 – GIS 20. |
| Action 3.1 – G | Plant 1 mile of conifer understory on East Foley Creek (along anchor 1) – GIS 14. |
| *Objective 3.2 – Enhance riparian vegetation adjacent to all instream and off-channel habitat projects.* | |
| Action 3.1 – A | Plant native species at selected LWD installation sites. |
| Action 3.2 – B | Plant beaver-preferred forage at selected BDA sites (see 4.1 - E). |

## 2045 Outcome #4: Beavers colonize and build dams on an additional 40 miles of Coho-bearing tributaries in the focal areas, increasing the quality and quantity of off-channel habitats available for Coho rearing.

| *Objective 4.1 – By 2027, construct, augment, and/or maintain 58 BDAs in focal area reaches modeled as high beaver intrinsic potential.* | |
|---|---|
| Action 4.1 – A | Construct BDA on Tweedle Creek - GIS 129. |
| Action 4.1 – B | Construct BDAs on Crawford Creek – GIS 410. |
| Action 4.1 – C | Construct BDAs (3) on Grand Rapids Creek (GIS 699; 600 is LWD). |
| Action 4.1 – D | Augment and maintain as needed BDAs installed in 2018 and 2019 in Lousignont (GIS 120 - BDA/130 – riparian), Buster/Walker Creeks (GIS 119 & 123 /131 – riparian), Rock Creek (GIS 121), Bear Creek (GIS 411), and Deer Creek (GIS 122). |
| Action 4.1 – E | Plant beaver preferred forage at completed BDA sites. |
| Action 4.1 – F | Determine the feasibility of BDA sites on upper mainstem Beneke Creek and ODF lands on Wolf Creek. |
| *Objective 4.2 – By 2023, initiate outreach to private landowners and the general public on the role of beaver in restoring Coho habitats and improving watershed function.* | |
| Action 4.2 - A | Host "living with beaver" forums with the industrial timber owners, including Weyerhaeuser, Stimson, and Olympic Resource Management. |
| Action 4.2 - B | Ground truth Netmap-modeled High Beaver IP for sub-watersheds that were not completed in this SAP. |
| Action 4.2 - C | Implement a local outreach campaign focused on public education regarding the role of beavers. |

## 2045 Outcome #5: 300 acres of tidal wetlands and other estuarine habitats are reconnected, increasing the quality and extent of tidal rearing habitats and associated freshwater habitats.

| *Objective 5.1 – Complete two tidal reconnection projects by 2026.* | |
|---|---|
| Action 5.1 – A | Create tidal sloughs and freshwater wetlands near mouth of Alder Creek on the Alder Creek Farm property (GIS 20). |
| Action 5.1 – B | Enhance tidal connectivity of McCoy (GIS 850) and Zimmerman (GIS 851) wetlands. |
| Action 5.1 – C | Use 2021 tide gate inventory and TNC Opti-Pass model to identify additional priorities for tidal wetland and estuarine reconnection and restoration. |

**<u>2045 Outcome #6</u>: 52 barriers to fish passage are addressed, enhancing longitudinal connectivity in focal area tributaries, and restoring Coho access to 92 miles of anchor habitats, cold water refugia, and off-channel habitats.**

| *Objective 6.1 – By 2026, address nine high-priority fish passage barriers impeding access to anchor habitat in the focal areas.* | |
|---|---|
| Action 6.1 – A | Improve passage through Fishhawk dam and implement temperature abatement measures – GIS 107. |
| Action 6.1 – B | Replace Harliss culvert #407 (high) on Cook Creek Road (assess feasibility of decommissioning Cook Creek Road) – GIS 2. |
| Action 6.1 – C | Replace culverts to Coal Creek tributary under Anderson Road (#188: 1.15 miles habitat, #189: .34 miles of habitat) – GIS 413. |
| Action 6.1 – D | Replace culvert #371 on Batterson Creek to reconnect summer refugia – GIS 701. |
| Action 6.1 – E | Replace culvert #285 on McPherson Creek to reconnect summer refugia – GIS 702. |
| Action 6.1 – F | Replace Little Rackheap culvert – GIS 700. |
| Action 6.1 – G | Remove/replace culvert on Fall Creek on Olympic Resources property – GIS 905. |
| Action 6.1 – H | Remove/replace culvert #3 (Weyerhaeuser) on Clear Creek – GIS 908. |
| *Objective 6.2 – By 2035, partner with ODOT to upgrade ten priority culverts under state highways in SAP focal areas.* | |
| Action 6.2 - A | Assess the feasibility of upgrading priority culverts under:<br><u>Highway 53</u><br>• culvert #529 – high priority (GIS 529)<br>• culvert #606 – high priority (GIS 606)<br>• culvert #562 – medium priority (GIS 562)<br>• culvert #565 – medium priority (GIS 565)<br><br><u>Highway 101</u><br>• Alder Creek culvert #293 – high priority (GIS 19)<br>• culvert #462 – medium priority (GIS 19)<br>• culvert #175 – medium priority (GIS 415)<br><br><u>Highway 47</u><br>• Dass Creek culvert – high priority (GIS 903)<br>• O'Black Creek culvert – high priority (GIS 901)<br><br>Highway #26<br>• Rock Creek culvert and trash rack – high priority (GIS 823) |

**Figure 6-1.** Project Recommendations in the Limiting Factors Analysis, Upper Rock Creek.

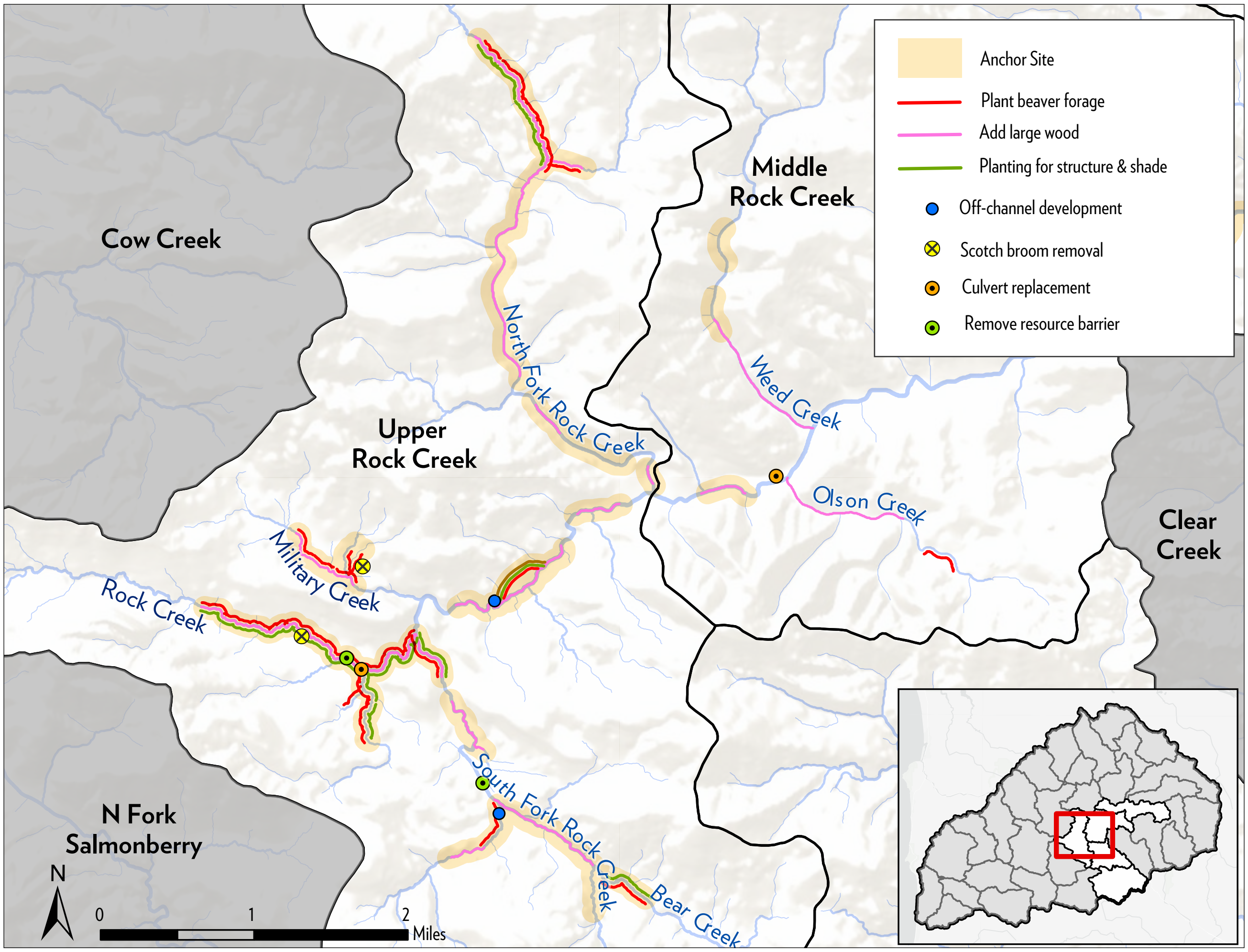
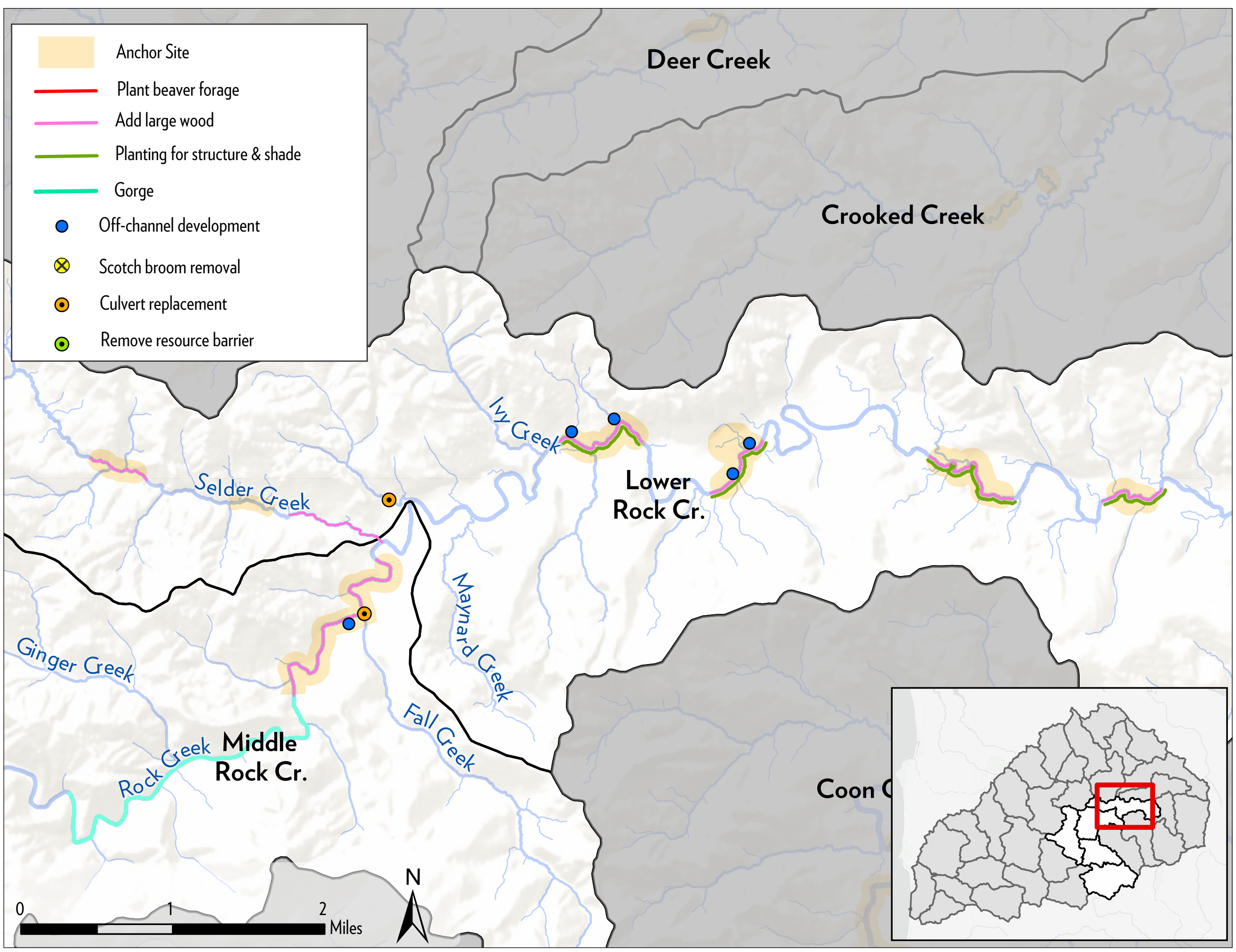




**Figure 6-2.** Project Recommendations in the Limiting Factors Analysis, Lower Rock Creek.



## 6.3 Schedule of Near-Term Restoration Projects by Focal Area

**Table 6-1.** Implementation Schedule for Near-Term Projects (2023-2027) in the Nehalem Basin Focal Areas.

| FOCAL AREA | RESTORATION PROJECT | LEAD (LANDOWNER) | Project Start | | |
|---|---|---|---|---|---|
| | | | 2023 | 24-25 | 26-27 |
| **Rock - Lousignont - Wolf** | Upper Lousignont LWD | UNWC (ODF) | X | | |
| | Wolf Creek LWD | UNWC (ODF) | | X | |
| | BDA augmentation | UNWC (ODF) | | X | |
| | Highway 26 culvert (feasibility) | UNWC (ODF) | | | X |
| **Humbug - Fishhawk - Beneke** | Fishhawk dam passage | UNWC (private) | | X | |
| | Big Creek LWD | UNWC (Weyerhauser) | | X | |
| | Fishhawk and Boxler Creek LWD | UNWC (ODF) | | X | |
| | Beneke Creek LWD / riparian | UNWC (ODF) | X | | |
| | Fishhawk riparian | UNWC (multiple) | | | X |
| | Humbug Creek (ODFW refuge) | UNWC (ODFW) | | | X |
| **Small mainstem / estuary tribs** | Tweedle Creek BDA, LWD, riparian (private) | UNWC (private) | X | | |
| | Jetty Creek LWD | LNWC (Greenwood Res) | X | | |
| | Upper Oak Ranch Creek LWD | UNWC (ODF) | X | | |
| | Crawford Creek BDA – direct | UNWC (ODF) | X | | |
| | Spruce Run Creek LWD | LNWC (ODF) | | X | |
| | Fall Creek LWD | UNWC (ORM Timber) | | X | |
| | Neah-Kah-Nie Creek LWD | LNWC (private) | | X | |
| | Spruce Run Confluence LWD | LNWC (ODF) | | | X |
| | Cook Creek confluence LWD | LNWC (State Parks) | | | X |
| | Fall Creek fish passage | UNWC (ORM Timber) | | | X |
| | Hamilton Creek LWD | UNWC (ODF) | | | X |
| | O'Black Creek LWD | UNWC (private) | | | X |
| | Dass Creek LWD | UNWC (private) | | | X |
| | Highway 47 culverts (feasibility) | UNWC (private) | | | X |

| FOCAL AREA | RESTORATION PROJECT | LEAD (LANDOWNER) | Project Start | | |
|---|---|---|---|---|---|
| | | | 2023 | 24-25 | 26-27 |
| **North Fork Nehalem** | Grand Rapids Creek LWD & BDA | LNWC (Greenwood Res) | X | | |
| | Coal Creek riparian planting | LNWC (private) | X | | |
| | Gravel Creek LWD | Stimson Timber | | | X |
| | Soapstone Creek LWD | LNWC (ODF) | | X | |
| | Cold water confluence pilot | LNWC (multiple) | | X | |
| | Little North Fork LWD | LNWC (private) | | | X |
| | Bob's Creek LWD | Stimson Timber | | | X |
| | Little Rackheap culvert replacement | LNWC (private) | | | X |
| | Coal Creek (Anderson Rd) culvert replacements | LNWC (Tillamook County Public Works) | | | X |
| | Highway 53 culverts (feasibility) | LNWC (multiple) | | | X |
| | God's Valley Creek LWD | LNWC (multiple) | | | X |
| **Foley - Cook and Nehalem Bay** | Harliss Creek culvert removal | LNWC (ODF) | | X | |
| | East Foley Creek LWD and riparian planting | LNWC (ODF) | | | X |
| | Foley Creek LWD and riparian | LNWC (private) | | | X |
| | Batterson and McPherson Creek culvert replacements | LNWC (ODF, OPRD) | X | | |
| | Zimmerman and McCoy tidal wetland reconnection | LNWC (LNCT) | | X | |
| | Alder Creek wetland and riparian restoration | LNWC (LNCT) | | X | |
| | Highway 101 culverts (feasibility) | LNWC (ODOT) | | | X |
| **Priority anchors outside of focal areas** | Upper Northrup Creek LWD | UNWC (ODF) | X | | |
| | Buster Creek LWD | UNWC (ODF) | | X | |
| | Crooked Creek LWD | (ORM Timber) | | X | |
| | Clear Creek LWD & fish passage | UNWC (Weyerhauser) | | X | |
| | LNF Clear Creek LWD | UNWC (Weyerhauser) | | X | |

## 6.4 Maps of Near-Term Actions (Projects) by Focal Area

Figures 6-3 through 6-8 map the locations of near-term (2023-2027) projects proposed in the focal areas (shown in white) and neighboring subwatersheds (light gray) (note: dark gray watersheds are contained in another figure). These projects represent the initial steps towards implementing the priorities described in Chapter 5, as mapped in Figures 5-12 through 5-16.

**Figure 6-3.** Near-term Projects Proposed in the Foley Creek, Nehalem Bay, and Lower North Fork Nehalem Focal Areas, and Neighboring Anderson Creek Subwatershed.

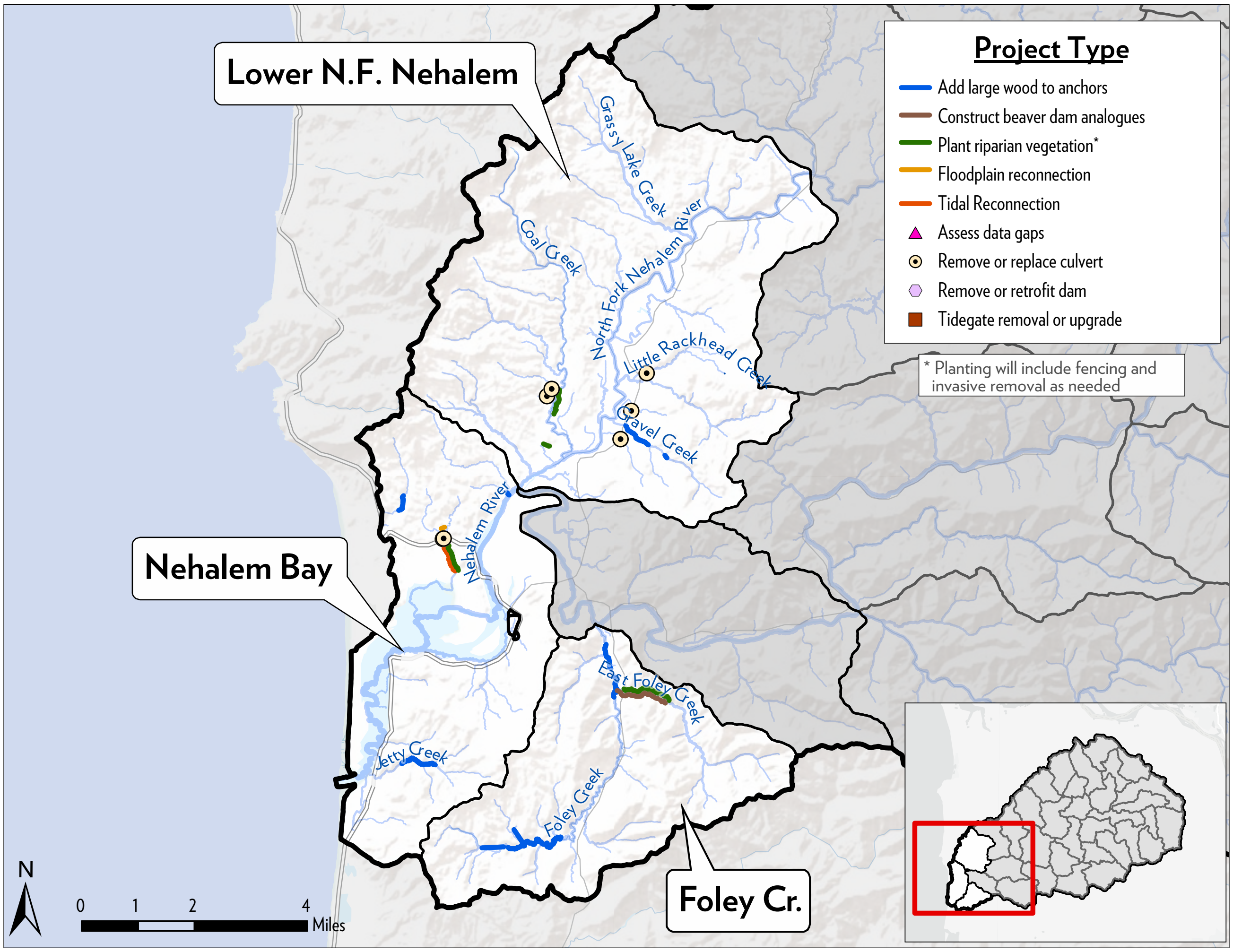




Photo: John McMillan


**Figure 6-4.** Near-term Projects Proposed in the Middle and Upper North Fork Nehalem and Humbug Creek Focal Areas, and Neighboring Cow, Cronin, and Lost Creek Subwatersheds.

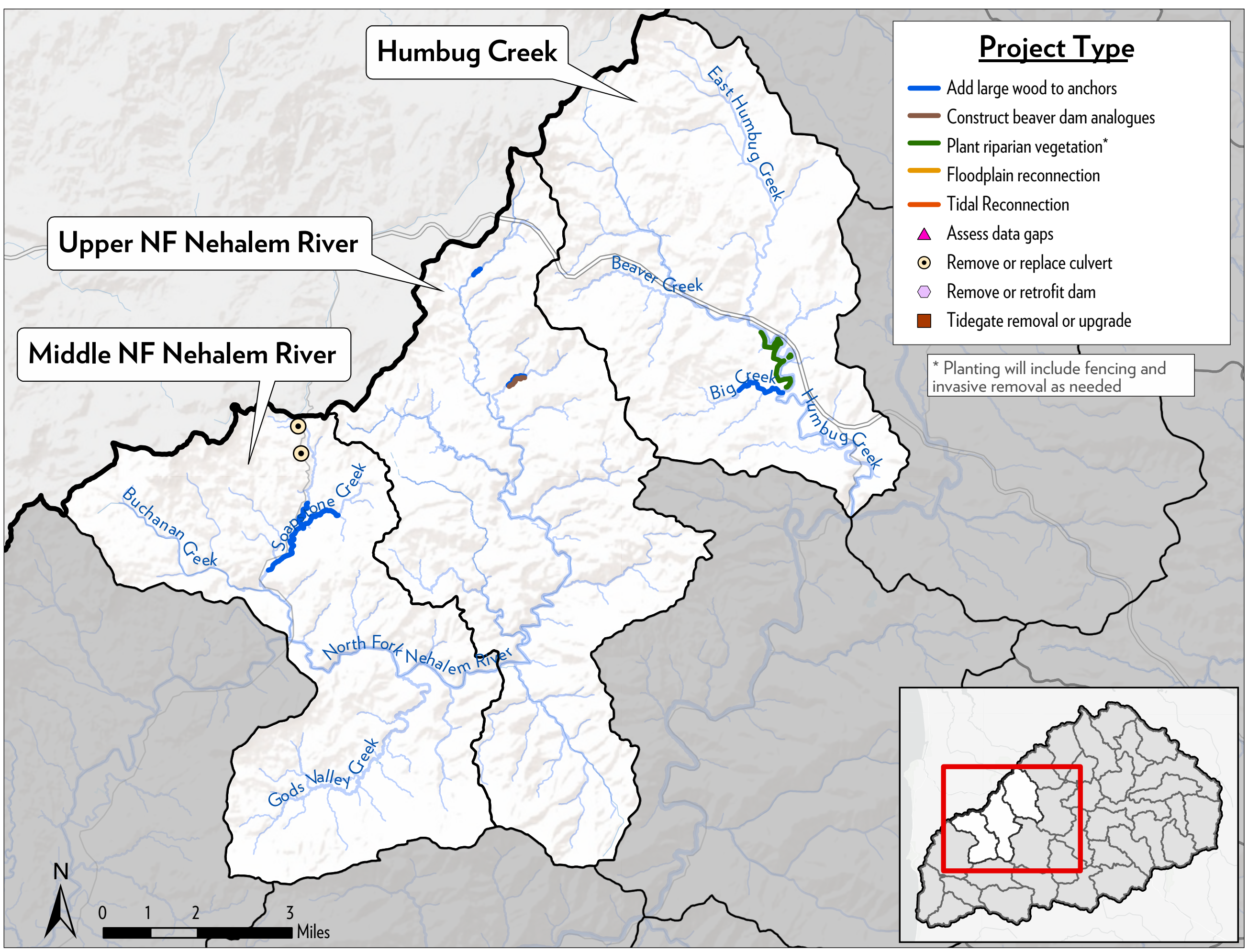


**Figure 6-5.** Near-term Projects Proposed in the Beneke Creek and Fishhawk Creek Focal Areas, and Neighboring Subwatersheds.

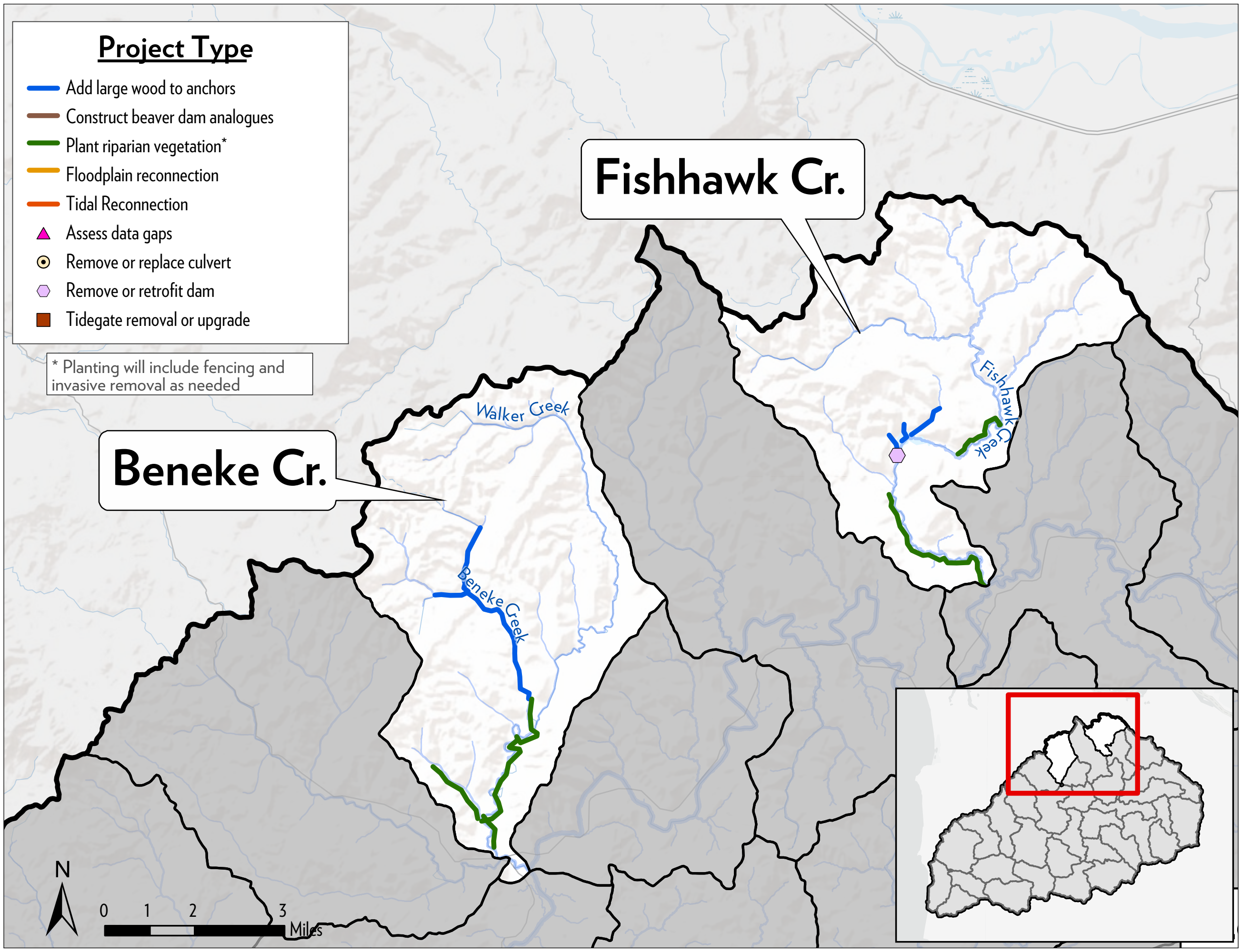




**Figure 6-6.** Near-term Projects Proposed in the Deer Creek and Crooked Creek Subwatersheds.

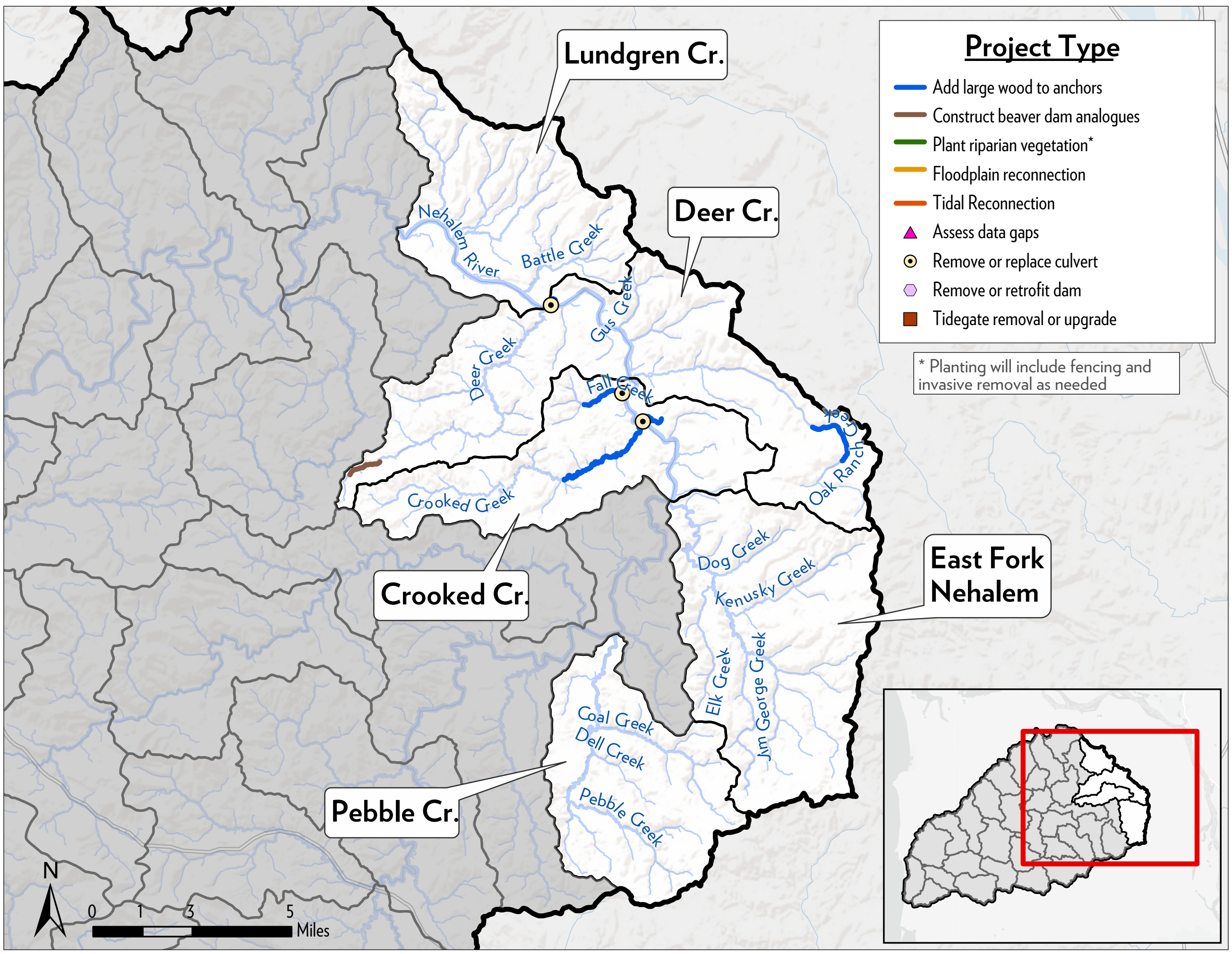


**Figure 6-7.** Near-term Projects Proposed in the Lower, Middle, and Upper Rock Creek, Wolf Creek, and Lousignont Creek Focal Areas, and Neighboring Clear Creek and Coon Creek Sub-watersheds.

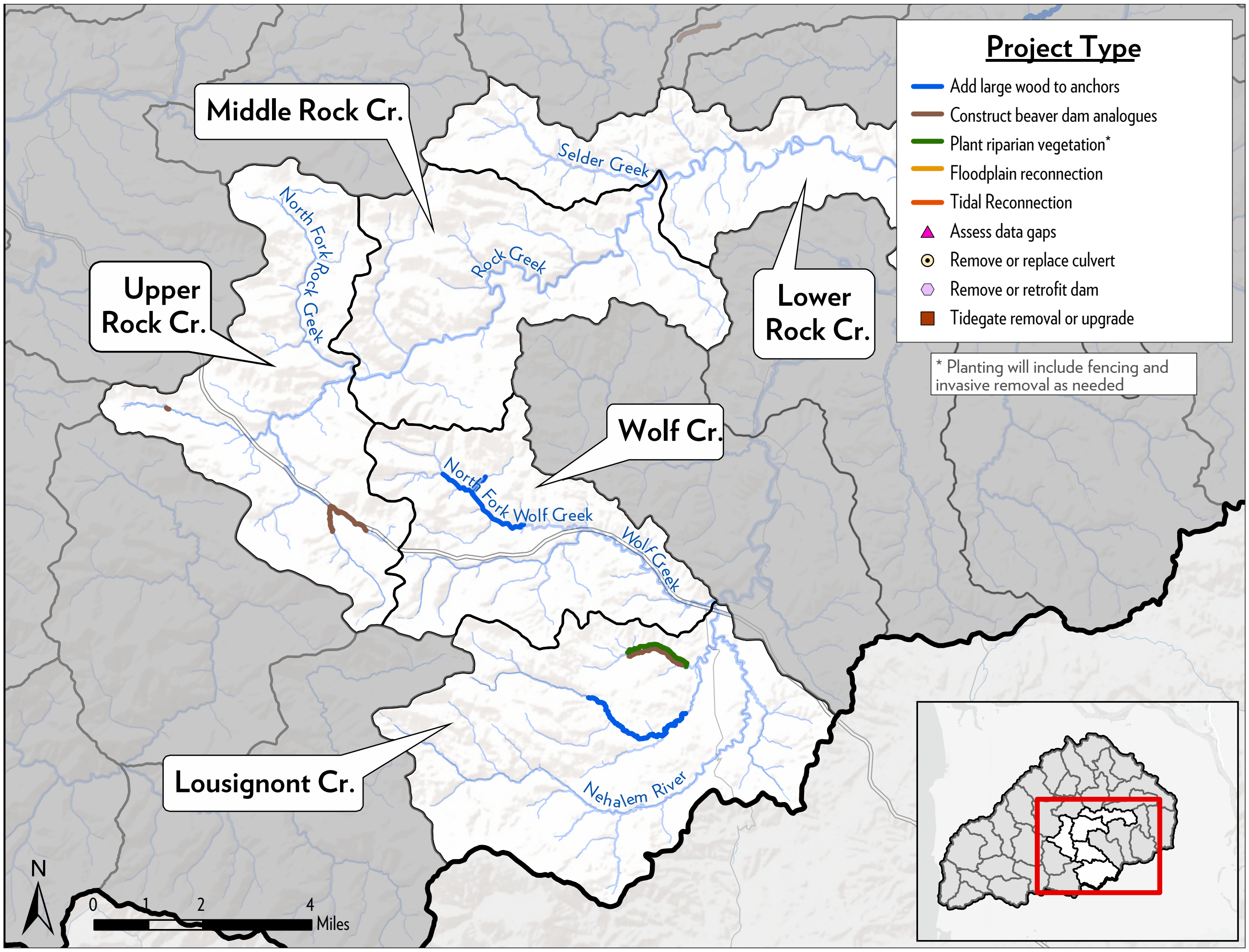
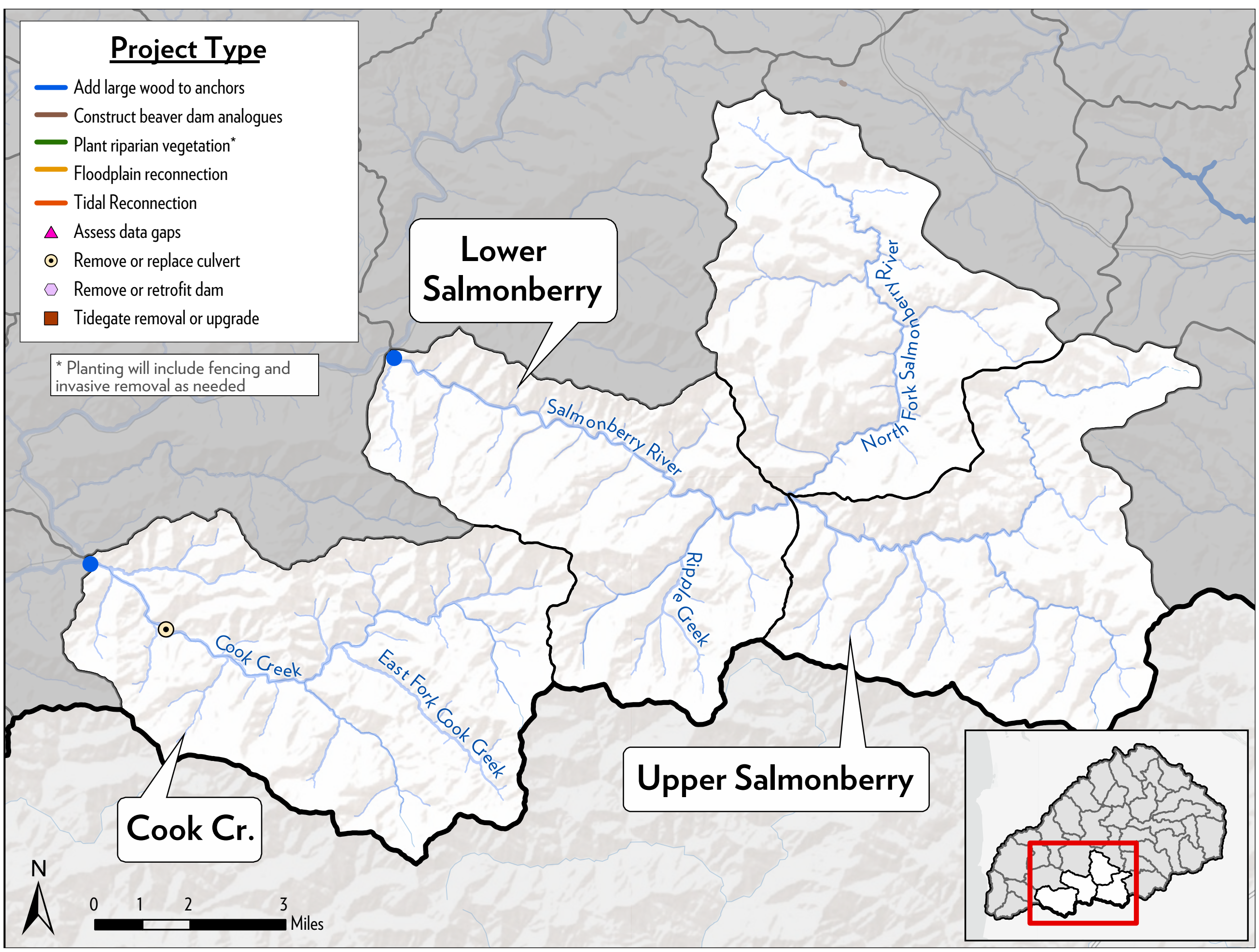




**Figure 6-8.** Near-term Projects Proposed in the Cook Creek-Salmonberry Focal Area.



Chapter 7

# Evaluation and Adaptive Management

The Nehalem Partnership recognizes that an adaptive management approach is essential to the long-term success of this plan. Section 7.1 presents a Monitoring Framework that partners will use to evaluate: 1) the rate at which the SAP is implemented, and 2) whether implementation is generating the anticipated benefits. This chapter concludes with a list of critical data gaps that, as filled, can support the adaptive implementation of this plan.

## 7.1 The Monitoring Framework

Table 7-1 below presents the Monitoring Framework for the Nehalem Partnership to monitor SAP implementation and effectiveness. This framework is constructed around the SAP's six outcomes. Next to each outcome statement, the table defines the two types of monitoring, implementation monitoring and effectiveness monitoring, that should be conducted.

Photo: Ronald Hope

***Implementation monitoring*** seeks to assess the rate at which the SAP is being implemented. The columns on the left side of the goal statement list priority project locations and project tracking metrics that partners can use to evaluate the degree to which SAP implementation is occurring. Broadly, these metrics are intended to answer the question, "Is the SAP being implemented at the desired pace and scale?"

***Effectiveness monitoring*** aims to assess whether SAP implementation is producing the desired benefits. The columns to the right of the goal statements show: 1) the KEAs that partners seek to improve for a particular habitat component; 2) the indicator(s) used to assess the KEA; and 3) related notes. Evaluation of these KEAs using the selected indicators helps answer the question, "Are we moving towards our stated goals and desired outcomes?"

Note: many of the KEAs and indicators presented in Table 7-1 were derived from the common framework, but represent only those deemed by the Planning Team as the highest priority and most likely to reflect improving (or declining) watershed conditions for Coho. For a complete list of KEAs and indicators considered in this process, please refer to the 'Common Framework' in Appendix 3.

Currently, the Nehalem Partnership's capacity to apply the Monitoring Framework below is limited. Consequently, the purpose of this chapter is not to present a full monitoring plan (which is unlikely to be implemented), but to suggest a framework that aligns with SAP goals and can be selectively developed over time. The Nehalem Partnership recognizes the considerable limitations on funding now available for monitoring and will develop specific plans for each of the KEAs as priorities dictate and funds allow.

**Table 7-1.** Nehalem Monitoring Framework.

| SAP Monitoring Framework | | | | | |
|---|---|---|---|---|---|
| Implementation Monitoring – *Are the SAPs being implemented?* | | | Effectiveness Monitoring – *Is SAP implementation having the intended effects? Are we moving towards our goals?* | | |
| SAP Priority Locations for Projects | Implementation Metric | SAP 2045 OUTCOMES | Key Ecological Attribute (component) | Effectiveness Indicator (preferred in bold) | Location to Monitor & Notes |
| Priority timber stands in focal areas | • Number of sites placed under easement or administrative protection (review at 10-year increments)<br>• Acres or lineal distance of high priority runout zones acquired or placed under easement<br>• Acres of high priority stands harvested (if any) | **2045 Outcome #1**<br>***The long-term potential for large wood delivery to anchor habitats is improved through the protection of 536 acres of selected timber stands throughout the Nehalem basin (343 acres in focal areas).*** | Landscape array of structural diversity (uplands)<br>Habitat complexity (tributary) | • Amount of large wood available to be recruited to rivers and streams through watershed processes.<br>• Amount of large wood remaining in rivers and stream that is effectively increasing complexity and high quality habitat.<br>• **% of anchor habitats with increasing trends in extent of spawning gravel (m2).**<br>• **% total channel area represented by secondary channels (CAP) in anchor habitats**<br>• **% of treated anchor habitats with improving width: depth ratio (use AQI protocol)** [1,2] | Anchor habitats and identified upland debris flow areas within Rock Creek and NF Nehalem.<br>Anchor habitats and identified upland debris flow areas within Rock Creek and NF Nehalem. |
| Anchor sites in focal areas | • Lineal feet of anchor habitats treated with LWD.<br>• Lineal feet of areas treated outside of anchors. | **2045 Outcome #2**<br>***Instream complexity and stream interaction with off-channel habitats are restored within 66 miles of focal area anchor habitats.*** | Habitat complexity (tributary) | | |

[1] Nehalem Monitoring Framework included the following list of AQI metrics:
- Miles of high-quality habitat: produce 2,800 smolts/mile.
- % stream reach that is pool habitat
- % of stream reach that is slack water pool habitat
- % pools greater than 1 meter in depth
- # of wood pieces per 100m of stream
- # of key wood pieces (>12m long, 0.60 m dbh)
- Volume of LWD per 100 m
- # alcoves per reach

[2] Entrenchment indicator references:
- Aquatic and Riparian Effectiveness Monitoring Program (AREMP) Staff. 2005. Watershed Monitoring for the Northwest Forest Plan, Data Summary Interpretation 2005, Oregon/Washington Coast Province. USDA Forest Service, Pacific Northwest Regional Office; Bureau of Land Management, Oregon State Office; 4077 S.W. Research Way, Corvallis, OR 97333.
- http://www.reo.gov/monitoring/watershed EPA Watershed Academy. 2005. Fundamentals of the Rosgen Stream Classification System; Excerpts of copyrighted material used with permission from Rosgen, D.L. and H.L. Silvey. 1996. Applied River Morphology. Wildland Hydrology Books, Fort Collins, CO. http://www.epa.gov/watertrain/stream_class/index.htm

| SAP Monitoring Framework | | | | | |
|---|---|---|---|---|---|
| **Implementation Monitoring –** *Are the SAPs being implemented?* | | | **Effectiveness Monitoring –** *Is SAP implementation having the intended effects? Are we moving towards our goals?* | | |
| **SAP Priority Locations for Projects** | **Implementation Metric** | **SAP 2045 OUTCOMES** | **Key Ecological Attribute (component)** | **Effectiveness Indicator** | **Location to Monitor & Notes** |
| Priority sites identified in focal areas | • Acres planted<br>• % of anchor sites planted when LWD treatments occur<br>• % of sites planted that were identified (by Netmap) as high priority to improve temperature | **2045 Outcome #3**<br>***Riparian function is restored along 58 miles of focal area tributaries, reducing stream temperatures and erosion, increasing macro-invertebrate abundance, and increasing the long-term potential for large wood recruitment.*** | Water temperature (mainstem and tributaries) | • **Total # of days where monitoring locations exceed temperature standards (DEQ 7day running Average Max)**<br>• **Number of consecutive days exceeding 18°C temperature**<br>• **Presence of a thermal barrier in the mainstem that prevents migration of fish during warm periods (7-day moving mean of daily summer max temp is < 20°C) (CAP)** | 1) all focal areas;<br>2) key tribs and mainstem (to further determine where the problem tribs are); and<br>3) small 1st and 2nd order tribs offering thermal refugia (to further determine locations of these unique habitat types.<br>*Note: Fly FLIR to find thermal barriers at low flow)* |
| All focal areas | • lineal feet of riparian areas treated in priority beaver recruitment areas (assumes beaver-friendly species planted)<br>• # of BDA or dam- building support structures added to priority beaver areas | **2045 Outcome #4**<br>***Beavers colonize and build dams on an additional 40 miles of Coho-bearing tributaries in the focal areas, increasing the quality and quantity of off-channel habitats available for Coho rearing.*** | Beaver ponds (off-channel) | • **% of areas identified as 'high potential for beaver' that have beaver impoundments present**<br>*(Note: impoundments must be >12inches high and with different water elevations up and downstream of dam)* | Monitor for presence/ absence and count impoundments.<br>Baseline data in Upper Nehalem. Gather baseline data in other beaver priority areas and continue monitoring.<br>Data should be collected in February when dams are likely to blow out. |

| SAP Monitoring Framework | | | | | |
|---|---|---|---|---|---|
| Implementation Monitoring – *Are the SAPs being implemented?* | | | Effectiveness Monitoring – *Is SAP implementation having the intended effects? Are we moving towards our goals?* | | |
| **SAP Priority Locations for Projects** | **Implementation Metric** | **SAP 2045 OUTCOMES** | **Key Ecological Attribute (component)** | **Effectiveness Indicator** | **Location to Monitor & Notes** |
| • Anchor habitat in tribs in focal areas<br>• Entire mainstem<br>• All tidal areas contained in Lower NF Nehalem, Foley, Cook, & Nehalem Bay | • Number of floodplain reconnection projects completed<br>• Acres of wetlands acquired or placed under easement (review at 10-year increment).<br>• Acres of tidal wetland / slough and nontidal areas reconnected<br>• Acres of wetlands converted to other uses (if any) – use DSL permits<br>• Percentage of high priority sites reconnected (Brophy et al 2005, Figure 5-9) | **2045 Outcome #5**<br>***300 acres of tidal wetlands and other estuarine habitats are reconnected, increasing the quality and extent of tidal rearing habitats and associated freshwater habitats.*** | Tidal connectivity (estuary) | • **Acres of wetland relative to historic condition**<br>• **% of wetlands subject to disrupted hydrologic connectivity**<br>• **% of identified high priority refugia areas restored and/or protected**<br>• **Distribution of habitat types relative to historic condition (per HGM)** [3] | *Review/conduct aerial surveys for lowland areas.*<br>*Review Coastal and Marine Ecological Classification (CMECS) and Coastal Change Analysis Program (C-CAP) data* |
| • Anchor habitats in focal areas<br>• Entire mainstem<br>• All tidal areas contained in Lower NF Nehalem, Foley, Cook, & Nehalem Bay | • # of barriers addressed and crossings made accessible to fish passage (e.g. tide gates and culverts).<br>• Acres of tidal wetland / slough and non-tidal areas reconnected | **2045 Outcome #6**<br>***52 barriers to fish passage are addressed, enhancing longitudinal connectivity in focal area tributaries, and restoring Coho access to 92 miles of anchor habitats, cold water refugia, and off-channel habitats.*** | Longitudinal connectivity (tributaries)<br>Off-channel habitat (tributaries)<br>Extent of habitat (estuary) | • **Coho distribution above baseline** | All focal areas |

[3] Hydrogeomorphic (HGM) Assessment Guidebook, a Rapid Assessment Guidebook for Tidal Wetlands. A method that may be applied during a single visit to assess indicators of the functions and condition of a particular tidal wetland relative to others of its subclass. http://www.oregon.gov/dsl/WW/Documents/tidal_HGM_pt1.pdf

The Planning Team recognizes the magnitude of the challenge faced in detecting habitat responses at the subwatershed scale from the implementation of actions contained in this SAP. As stated in the Oregon Coast Coho Conservation Plan (ODFW 2007), "restoration of ecological processes that support high-quality habitat requires time and is constrained by patchwork landownership patterns, different regulatory structures, and historical land use practices. Even given an expected increase in the level of non-regulatory participation in habitat improvement work, it will take time to: (1) produce detectable improvements in habitat quality, and (2) restore the biological and ecological processes across the ESU." This Monitoring Framework will serve as a blueprint that local partners can use to build incremental and scalable monitoring plans that track both SAP implementation and progress towards its goals.

## 7.2 Data Gaps

During the course of developing this SAP, the planning team identified several data gaps that the Nehalem Partnership will work to fill through the development of future monitoring plans. The following summarizes the highest priority data gaps.

***1) Life history diversity.*** This SAP is the first restoration plan developed in the Nehalem Basin that considered the multiple life history types believed to be present in the population (Appendix 2). The plan identifies focal areas and recommends restoration strategies based on six unique life history types, which were derived largely from assessments of watershed lithology, habitat features, and juvenile habitat use. Partners should refine this list by collecting otolith samples and water chemistry to test these hypothesized life history types. The Coast Coho Partnership is working with partners on the mid and south coasts to collect and analyze otoliths to more fully understand Coho life histories. The Nehalem Partnership


Photo: Danita Delimont / Alamy

will review the results of these pilot projects and will consider implementing a similar or modified program.

***2) Water temperature.*** Temperature data reviewed in the development of the SAP indicates that elevated water temperatures in the mainstem Nehalem and the lower reaches of many tributaries limit juvenile migration, eliminating access to critical habitats. The projected impacts of climate change will exacerbate this problem. A Salmon Trout Enhancement Program (STEP) report on temperature monitoring in the Salmonberry undertaken between 1994 - 1997 and 2007 - 2018 indicates that climate-driven increases in water temperature are already underway. Findings show a trend of increasing summer average daily high temperatures at a rate of .068° C ± .04° C annually (p=.002) (Fergusson 2019).

The trends found in the Salmonberry River indicate that both the extent of cold water refugia and access to key areas will become increasingly limited. While the locations of many of the SAP's restoration strategies (e.g., riparian enhancement, anchor habitat restoration, and fish passage reconnection) are driven by temperature considerations, additional data is needed to refine these priorities. Temperature data collection priorities include the following.

*First, review temperature data collection recommendations and identify priorities.* During the development of this SAP, WSC hired PC Trask to review existing temperature data and make recommendations on additional data collection priorities. The Nehalem Partnership will begin the development of a temperature monitoring program with a review of these recommendations, which focus largely on: 1) validating relationships between elevated mainstem temperatures and tributary contributions of warm water, and 2) potential locations of thermal refugia. These outputs, which may refine some of the priorities presented in this SAP, will rely on

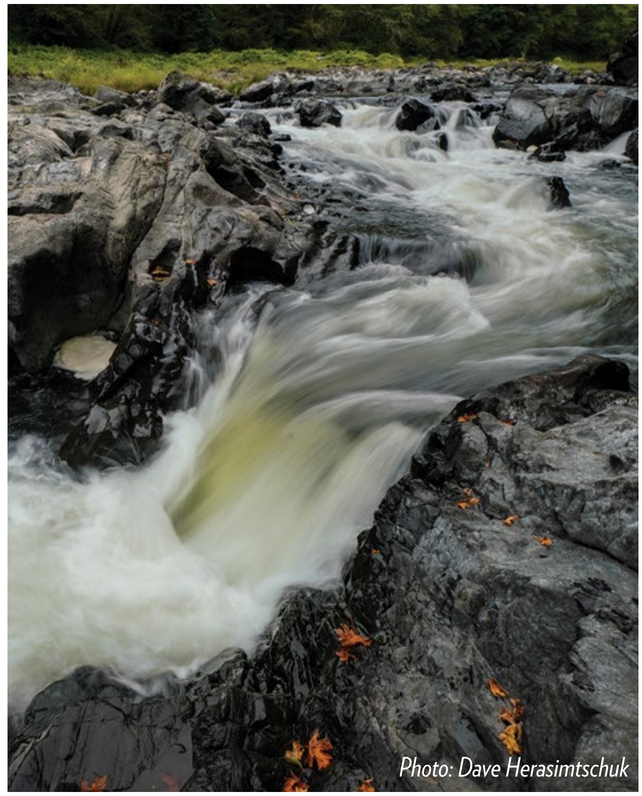


Photo: Dave Herasimtschuk

a basin-wide inventory of flow and temperature contributions basin-wide.

*Second, identify and monitor cold water refugia throughout the entire Nehalem watershed.* Bio-Surveys LLC (2020) identified tributaries in the lower Nehalem watershed that provide critical cold water contributions or thermal refugia to juveniles. Ongoing monitoring of identified locations should be undertaken to refine the list. This project should also be expanded to include the upper Nehalem watersheds.

*Third, continue to support and expand, as needed, annual temperature surveys conducted in the Salmonberry River.* Characterized by steep slopes underlain with erosion-resistant volcanic rock, the Salmonberry River is the largest source of cold water in the basin. The tributary's cold water contributions in summer are essential to maintaining the temperature of the lower mainstem. Increasing water temperatures in the Salmonberry and a potential reduction in cold water habitat are important indicators of thermal challenges throughout the basin. STEP data from the Salmonberry provides one of the longer records of collected temperature data in the basin. It's important to maintain and expand these data sources.

***3) Fish passage priorities.*** Extensive efforts have been made to identify and prioritize fish passage barriers in the Nehalem River basin. In addition to the ODFW fish passage barrier list, the Upper and Lower Nehalem Watershed Councils have completed culvert inventories, tide gate inventories, and identified barriers in Rapid Bioassessments and Limiting Factor Analyses. Important data gaps remain, however, that should be addressed.

*First, survey mainstem Type N tributaries in winter, and identify culverts with restricted fish passage.* Many small mainstem tributaries are disconnected from juvenile fish passage in the summer and, therefore, identified as non-fish bearing (Type N) following summer habitat surveys. Many of these tributaries are reconnected to the mainstem in high water and offer important flow refuge in winter. However, impassable culverts (often just upstream from the confluence with the mainstem) limit juvenile access to flow refuge. According to one ODFW biologist, "these tributaries that are a trickle in summer may have dozens of juveniles sitting in pools below culverts in winter. There is ideal winter habitat upstream, but juveniles are not able to pass through the culvert due to high water velocity." These Type N mainstem tributaries should be re-surveyed in winter flow conditions. Where fish are present and culverts are blocking upstream migration, pipes should be added to the ODFW inventory.


Photo: Barrie Kovish

*Second, prioritize tide gates in the lower watershed using the TNC OptiPass model.* In 2021, the LNWC and TNC completed an inventory of tide gates in the Nehalem Bay and its tidal sloughs and tributaries. Application of the TNC OptiPass model can help prioritize replacement or removal of these gates. Modelers are encouraged to consider the priorities established in this plan alongside the OptiPass results when prioritizing tide gate upgrades. These include such factors as the extent of anchor habitat available upstream, access to cold water refugia in summer, tidal wetland priorities (Figure 5-9), and riparian restoration priorities.

*Third, prioritize barriers that restrict juvenile access to cold water tributaries.* As described in this plan, access to cold water refuge is going to be increasingly important to ensure the viability of the Nehalem Coho population. The fish passage barriers presented in this plan for replacement were driven largely by assessments of fish use below the barriers and the extent of anchor habitat potentially accessible upstream. While access to cold water refugia was considered, limited data did not allow for a basin-wide assessment of barriers to cold water refuge. As TEP, DEQ, and the watershed councils partner on temperature data collection, it is essential that the data generated are used to update the fish passage barriers presented in this plan.

Chapter 8

# Costs

This chapter estimates the costs associated with executing the projects proposed in Chapter 6. The estimated project costs shown in Tables 8-1 through 8-6 are organized by outcome. Table 8-7 summarizes the overall estimated costs in the upper and lower watersheds according to restoration project type.

These costs were generated by reviewing comparable costs in the Oregon Watershed Restoration Inventory (OWRI) database and those associated with implementing similar projects in the Nehalem River area by local restoration practitioners. Several data points for maximum costs were left out of the OWRI results because they were not relevant to the Nehalem River watershed.


Photo: Jono Melamed

Where projects were far enough along in the planning process to have verified cost estimates, these cost estimates were used in the cost summary. Where project-specific cost estimates were not available, estimates were made based on project type. For floodplain reconnection and off-channel restoration projects, estimates from other projects with a similar level of complexity were scaled to the size of the proposed project. For instream complexity projects, estimates were generated by multiplying mileage calculated from GIS by an average cost per mile. For riparian enhancement projects, estimates were made by multiplying acreage by a mid-range cost per acre estimate. The riparian enhancement acreages were estimated by multiplying stream miles (calculated using GIS) proposed for treatment times 50 feet, which approximates the average buffer width treated watershed-wide over the last several years.

**Table 8-1.** Short-Term Project Costs for Outcome 1: Upland Sites to Protect (2023-2027).

| Action | Lead | Project | Cost |
|---|---|---|---|
| 1.1 – A | UNWC & LNWC | Review map of priority timber stands with ODF and Weyerhaeuser to determine feasibility and cost of protection. Develop initial list of sites deemed opportunities for protection. | $ 25,000 |
| 1.1 – B | UNWC & LNWC | Review map of priority timber stands with all other public and private forest owners. Identify protection opportunities. | 15,000 |
| 1.1 – C | WSC | Support voluntary protection of priority upland stands through implementation of the Forest Accords in the Nehalem Basin. | 100,000 |
| | | **Total** | **$140,000** |

**Table 8-2.** Short-Term Project Costs for Outcome 2: Increased Instream Complexity (2023-2029).

| Action | Lead | Project | Cost |
|---|---|---|---|
| 2.1 – A | UNWC | Add LWD to 4.1 miles of Beneke Creek LWD | $ 164,000 |
| 2.1 – B | UNWC | Add LWD to 2.4 miles of NF Wolf Creek | 96,000 |
| 2.1 – C | UNWC | Add LWD to 1.3 miles of Fishhawk and Boxer Creeks | 52,000 |
| 2.1 – D | UNWC | Add LWD to 2.9 miles Hamilton Creek | 116,000 |
| 2.1 – E | UNWC | Add LWD and re-meander 0.8 miles of Dass Creek | 32,000 |
| 2.1 – F | UNWC | Add LWD to 0.3 miles of O'Black Creek | 12,000 |
| 2.1 – G | UNWC | Add LWD to 1.4 miles of Fall Creek | 56,000 |
| 2.1 – H | UNWC | Add LWD to 1 mile of anchor habitats on Big Creek | 40,000 |
| 2.1 – I | UNWC | Add LWD to 2.8 miles of Upper Lousignont Creek | 112,000 |
| 2.1 – J | LNWC | Add LWD to 0.7 miles of Jetty Creek | 28,000 |
| 2.1 – K | LNWC | Add LWD to 2.2 miles of Foley Creek | 88,000 |
| 2.1 – L | LNWC | Add LWD to 0.3 miles of Upper Neah-Kah-Nie Creek | 12,000 |
| 2.1 – M | LNWC | Add LWD to 2.6 miles of Soapstone Creek | 104,000 |
| 2.1 – N | LNWC | Add full spanning LWD to 0.3 miles of Spruce Run Creek | 12,000 |
| 2.1 – O | LNWC | Add LWD to 0.4 miles of Grand Rapids Creek | 16,000 |
| 2.1 – P | LNWC | Add LWD to 0.7 miles of Gravel Creek | 28,000 |
| 2.1 – Q | LNWC | Add LWD to 0.2 miles of the Little North Fork Nehalem | 8,000 |
| 2.1 – R | UNWC | Add LWD to 1.7 miles of Upper Oak Ranch Creek | 68,000 |
| 2.1 – S | LNWC | Add LWD to 0.1 miles of Bob's Creek | 4,000 |
| 2.1 – T | LNWC | Add LWD to 1.5 miles of East Foley Creek | 60,000 |
| 2.1 U-Y | LNWC | Add LWD to 4.9 miles of Gods Valley Creek and tributaries | 296,000 |
| 2.1 – Z | LNWC | Add LWD to the Salmonberry-mainstem | 450,000 |
| 2.1 – AA | LNWC | Add LWD to the Cook Creek-mainstem | 250,000 |
| 2.1 – BB | LNWC | Add LWD to the Spruce Run-mainstem confluence. | 300,000 |
| 2.2 – A-B | UNWC | Engage Rock Creek landowners and determine implementation schedule | 25,000 |
| 2.3 – A | UNWC | Add LWD to 0.9 miles of Buster Creek | 36,000 |
| 2.3 – B | UNWC | Add LWD to 3.3 miles of Crooked Creek | 132,000 |
| 2.3 – C | UNWC | Add LWD to 1.4 miles of Upper Northrup Creek | 56,000 |
| 2.3 – D | UNWC | Add LWD to 1.2 miles of Clear Creek | 48,000 |
| 2.3 – E | UNWC | Add LWD to 0.2 miles of lower North Fork Clear Creek | 8,000 |
| | | **Total** | **$2,709,000** |

**Table 8-3.** Short-Term Project Costs for Outcome 3: Enhanced Riparian Function (2023-2027).

| Action | Lead | Project | Cost |
|---|---|---|---|
| 3.1 – A | UNWC | Plant 3.9 miles of riparian vegetation on Fishhawk Creek | $ 70,200 |
| 3.1 – B | UNWC | Plant 2.3 miles of riparian vegetation on Humbug Creek | 41,400 |
| 3.1 – C | UNWC | Augment riparian plantings on 5 miles of Beneke tract of Jewel Meadows Wildlife Area | 62,500 |
| 3.1 – D | UNWC | Plant riparian vegetation on 0.9 miles of Tweedle Creek | 16,200 |
| 3.1 – E | LNWC | Plant 0.6 miles of riparian vegetation on Coal Creek | 10,800 |
| 3.1 – F | LNWC | Plant 0.7 miles of riparian vegetation on Alder Creek and tributary | 25, 000 |
| 3.1 – G | LNWC | Plant 1 mile of conifer understory on East Foley Creek | 18,000 |
| 3.2 – A - B | LNWC / UNWC | Plant native species at BDA and LWD sites – Costs included in LWD/BDA estimates | 0 |
| | | **Total** | **$219,100** |

**Table 8-4.** Short-Term Project Costs for Outcome 4: Increased Beaver Colonization (2023-2027).

| Action | Lead | Project | Cost |
|---|---|---|---|
| 4.1 – A | UNWC | Construct BDA on lower Tweedle Creek | $ 10,000 |
| 4.1 – B | UNWC | Construct BDAs on Crawford Creek | 20,000 |
| 4.1 – C | LNWC | Construct BDAs on Grand Rapids Creek | 20,000 |
| 4.1 – D | UNWC | Augment BDAs installed in Lousignont, Buster/Walker, Bear, Rock, and Deer Creeks | 30,000 |
| 4.1 – E | UNWC | Plant beaver preferred forage at BDA sites | 50,000 |
| 4.1 – F | UNWC | Determine the feasibility and locations of BDAs for upper mainstem Beneke Creek and ODF lands on Wolf Creek | 5,000 |
| 4.2 – A | UNWC | Host beaver forum with major timber owners, including Weyerhaeuser, Stimson, and Olympic Resource Management | 10,000 |
| 4.2 – B | UNWC | Ground truth Netmap-modeled High Beaver IP for sub-watersheds that were not completed in this SAP | 7,500 |
| 4.2 – C | UNWC | Implement a local outreach campaign focused on public education regarding the role of beavers | 20,000 |
| | | **Total** | **$172,500** |

**Table 8-5.** Short-Term Project Costs for Outcome 5: Reconnected Tidal Habitats (2023-2027).

| Action | Lead | Project | Cost |
|---|---|---|---|
| 5.1 – A | LNCT | Create tidal sloughs and freshwater wetlands near mouth of Alder Creek on the Alder Creek Farm property (design/engineering/feasibility costs only) | $ 75,000 |
| 5.1 – B | LNCT | Reconnect Bott's, McCoy, and Zimmerman wetlands (design/engineering/feasibility costs only) | 100,000 |
| 5.1 – C | LNWC | Use recently completed tide gate inventory to identify additional priorities for tidal wetland and estuarine reconnection and restoration | 20,000 |
| | | **Total** | **$195,000** |

**Table 8-6.** Short-Term Project Costs for Outcome 6: Increased Longitudinal Connectivity (2023-2027).

| Action | Lead | Project | Cost |
|---|---|---|---|
| 6.1 – A | Fishhawk Lake Team | Improve passage through Fishhawk dam and implement temperature abatement measures | Site assessments and initial designs required for cost information |
| 6.1 – B | ODF | Replace Harliss culvert #407 (high) on Cook Creek Road (explore feasibility of decommissioning Cook Creek Road) | |
| 6.1 – C | LNWC | Replace culverts to Coal Creek tributary under Anderson Road (#188: 1.15 miles habitat, #189: .34 miles of habitat) | |
| 6.1 – D | LNWC | Replace culvert #371 on Batterson Creek to reconnect summer refugia | |
| 6.1 – E | LNWC | Replace culvert #285 on McPherson Creek to reconnect summer refugia | |
| 6.1 – F | LNWC | Replace Little Rackheap culvert | |
| 6.1 – G | UNWC | Remove/replace culvert on Fall Creek on Olympic Resource Management property | |
| 6.1 – H | UNWC | Remove/replace culvert #3 on Clear Creek | |
| 6.2 – A | UNWC and LNWC | Partner with ODOT to assess the feasibility of upgrading culverts under state highways in focal areas | $200,000 |
| | | **Total** | **N/A** |

**Table 8-7.** Short-Term Project Objectives and Costs by Outcome.

| Long-Term Outcomes (2045) | | Short-Term Objectives (2023-2027) | Short-Term Cost |
|---|---|---|---|
| **1** | Large wood delivery to anchor habitats is safeguarded through the protection of 536 acres of selected timber stands throughout the Nehalem basin (343 in focal areas). | • Engage all landowners in protection of priority areas | $ 140,000 |
| **2** | Instream complexity and stream interaction with off-channel habitats are restored within 66 miles of focal area anchor habitats. | • Add large wood to anchors (33 miles) and other priority areas (6 miles)<br>• Complete Rock Creek LFA outreach | 2,709,000 |
| **3** | Riparian function is restored along 58 miles of focal area streams, reducing stream temperatures and erosion, increasing macro-invertebrate abundance, and increasing the long-term potential for large wood recruitment. | • Plant 14 miles of priority riparian areas<br>• Enhance riparian function at all BDA and LWD sites | 219,100 |
| **4** | Beavers colonize an additional 40 miles of Coho-bearing tributaries in the focal areas, building dams and increasing the quality and quantity of off-channel habitats available for Coho rearing. | • Install and/or maintain 58 BDAs (51 complete and not included in cost)<br>• Initiate outreach campaign on "living with beavers" | 172,500 |
| **5** | 300 acres of tidal wetlands and other estuarine habitats are reconnected, increasing the quality and extent of tidal rearing habitats, and associated freshwater habitats. | • Complete two tidal reconnection projects (design costs only)<br>• Update prioritization with 2021 tide gate inventory | 195,000 |
| **Total Cost of SAP Implementation (2023 – 2027)*** | | | **$3,435,600** |
| **6** | 52 barriers to fish passage are removed, enhancing longitudinal connectivity in focal area tributaries, and restoring Coho access to 92 miles of anchor habitats, cold water refugia, and off-channel habitats. | • Replace nine high priority fish passage barriers<br>• Determine feasibility of replacing priority culverts on major state highways | N/A |

** Total costs do not include fish passage projects.*

*Chapter 9*

# Sustainability

Because all of the restoration strategies called for in this SAP are intended to enhance watershed processes, the Nehalem Partnership is confident that the results of our cumulative efforts will be sustained over time through the slow but steady improvement of watershed function. The functional benefits resulting from anchor habitat enhancements from LWD and beaver recruitment, for example, will: 1) increase channel-floodplain interaction, promoting greater habitat complexity and off-channel rearing for Coho in winter, while 2) elevating the water table and establishing more instream and off-channel temperature refugia in summer. As more and more anchor habitats are enhanced through beaver colonization, LWD installation, riparian enhancement, and selected barrier replacements, we are confident that the hydrologic, geomorphic, riparian, and biological processes that generate and maintain critical Coho habitats will improve at scales beyond just the reach at which each project was implemented. Once these benefits can be realized at scale, much of our work can be sustained naturally, with minimal future intervention.

The restoration of watershed function is at the core of our long-term approach to sustaining the benefits of SAP implementation. Ultimately, however, the goal of restoring function can only be achieved if the local partners are coordinated and have sufficient capacity to sustain on-the-ground project implementation year after year. To ensure these conditions exist, the Nehalem Partnership has established a Memorandum of Understanding (MOU) that secures commitments from public and private partners to sustain SAP implementation (Appendix 11). At the time of SAP printing, the following partners have signed on to the MOU: UNWC, LNWC, TEP, ODFW, DEQ, Columbia SWCD, Clatsop SWCD, USFWS, Weyerhaeuser, The Beaver Coalition, ODF, and Trout Unlimited.

*Maggie Peyton of the Upper Nehalem Watershed Council and Wild Salmon Center's Mark Trenholm on the Nehalem River. Photo: Dave Herasimtschuk*

Commitments from several other partners are anticipated following the final review of the completed plan. Core Partners who have signed on to the MOU have agreed to spend at least 126 hours over three years on partnership-building efforts like the creation of governing agreements, development of short and long-term work plans, and ongoing review of priorities established in the SAP. These and other commitments are intended to create a durable yet flexible implementation structure that can thrive for decades.

Private and public partners have a long history of collaboration in the Nehalem basin. Since 1997, the basin's two watershed councils have collaborated extensively with these and other stakeholders, resulting in numerous public and private landowners, researchers, consultants, contractors, and volunteers collaborating on efforts to improve watershed health and recover wild salmon populations. In addition to extensive community education and landowner outreach, this partnership has undertaken watershed health assessments, limiting factors analyses, rapid bioassessments, data syntheses, and water quality and quantity monitoring. These activities have led to the implementation of over 20 years of on-the-ground restoration projects. This extensive history of collaboration has built a strong foundation upon which to sustain SAP implementation.

In addition to the MOU, the Nehalem Partnership has acquired funding to hire a contract Coordinator, who will facilitate the administrative work of the Partnership and coordinate project planning and implementation activities. Specifically, the Coordinator will: facilitate quarterly meetings during which time the partners will review (and revise, as needed) the SAP implementation schedule; develop an annual implementation work plan; coordinate on-the-ground work to leverage resources and promote economies of scale; and support the implementation needs of participating partners (permit and grant writing, etc.).


*Photo: Dave Herasimtschuk*


## 9.1 Updating the SAP

The UNWC and LNWC convened the team to develop this SAP and will serve as long-term stewards of the plan. The boards of these two organizations will receive regular updates on project implementation. All partner organizations will also be reminded to update their boards and members on progress at regular increments. The two councils will also continually update the public on SAP implementation through outreach to print media, social media posts on their Facebook accounts, annual reports to the Tillamook, Clatsop, and Columbia boards of county commissioners, and ongoing outreach to numerous local agencies and organizations.

Finally, ensuring adaptive management of the plan will be a critical function of the two councils. The monitoring framework in Chapter 7 will, as funded, generate a steady stream of data that can be used to evaluate SAP implementation and re-assess priorities. This is particularly important in the case of BDA installation in anchor locations because the effort now underway as a result of this SAP represents the first of its kind in the Oregon coast range. The two councils will hold a joint annual meeting with the members of the core planning team to evaluate data generated from BDA monitoring, research aimed at the data gaps identified in Chapter 7, and any other research/monitoring efforts underway.

# References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# List of Appendices

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

1. Appendix 1) Glossary of Terms and Definitions
2. Appendix 2) Potential Unique Life History Types of Nehalem Coho
3. Appendix 3) Coast Coho Partnership SAP Common Framework
4. Appendix 4) ODFW Nehalem Life Cycle Monitoring Project Summary
5. Appendix 5) Annotated Bibliography
6. Appendix 6) Methods – Subwatershed Ranking and Anchor Habitat Identification
7. Appendix 7) Methods – Evaluating Upslope Large Wood Delivery Potential to Anchor Habitats
8. Appendix 8) Methods – Beaver Intrinsic Potential Mapping
9. Appendix 9) Rock Creek Limiting Factors Analysis
10. Appendix 10) Nehalem Rapid Bioassessment Inventory for Salmonids
11. Appendix 11) Nehalem Basin Partnership MOU


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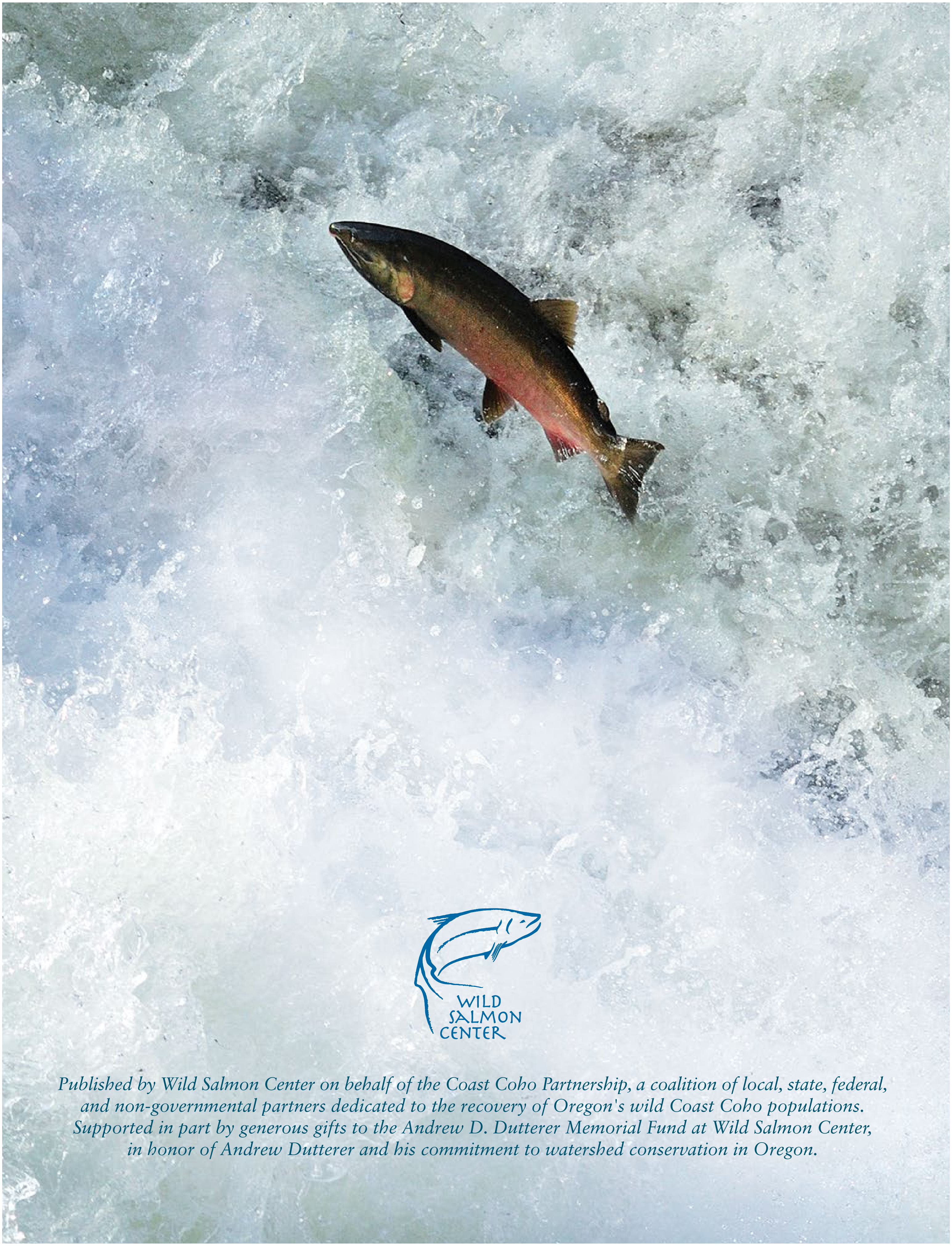

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