Salmonid Habitat Restoration Priorities (SHaRP) Action Plan for the Mendocino Coast

Cover photo credits: Kaydee Boozel, California Department of Fish and Wildlife (top); Kelly Ampersee, California Department of Fish and Wildlife (bottom)

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Available for download through the NOAA Salmon Habitat Restoration Priorities (SHaRP) Page[1] and the CDFW North Coast Salmon Project Page[2]

[1] https://www.fisheries.noaa.gov/west-coast/habitat-conservation/collaborating-identify-salmon-habitat-restoration-priorities

[2] https://wildlife.ca.gov/Conservation/Fishes/Coho-Salmon/North-Coast-Salmon-Project

California Native American Tribes

The Mendocino Coast region is the ancestral homeland of the Northern Pomo, Central Pomo, Southern Pomo, Coastal Pomo, Noyo, Coast Yuki, Yuki, Huchnom, Round Valley, Wailaki, and Cahto People. Through Traditional Ecological Knowledge, these communities have practiced fishing, hunting, foraging, seed propagation, and fire management in ways that support the enduring health and productivity of the land and adjacent waterways.

Eurocentric colonization disrupted tribal peoples' relationship to the ocean, land, plants, and animal species central to their being. The forced removal and systemic oppression inflicted on tribal communities caused profound trauma and loss; the effects of which are felt by their descendants today (Madley 2016). They continue to face ongoing challenges to their sovereignty and stewardship of their ancestral homelands.

Today, tribal communities lead efforts to preserve their languages and cultural traditions, advocate for their rights, and uphold enduring relationships with their ancestral lands. The California Department of Fish and Wildlife (CDFW) and National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries) acknowledge the importance of reconnecting California Native American Tribes back to these resources through communication, engagement and collaboration. We encourage users of this report to educate themselves about the history of the areas they work in and to actively engage with tribal communities to ensure meaningful inclusion in watershed restoration planning and implementation.

Dedication

In dedication to Marjorie Caisley and Bill Lemos for their lifelong work in river restoration.

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Participating Organizations

Redwood Timber Co

California Conservation Corps
CCC
Est. 1976

The Conservation Fund

California Trout
Fish · Water · People

Fish Friendly Farming

Prunuske Chatham, Inc.

Mendocino County
Resource Conservation District

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Abbreviations

AGOL – ArcGIS Online
CCC – Central California Coast
CDFG – California Department of Fish and Game
CDFW – California Department of Fish and Wildlife
CESA – California Endangered Species Act
CMP – California Monitoring Plan
CWM – Collaborative Water Management
ECS – Egg Collection Station
ESA – Endangered Species Act
ESU – Evolutionarily Significant Unit
FRGP – Fisheries Restoration Grant Program
GIS – Geographic Information System
HUC – Hydrologic Unit Code
IP – Intrinsic Potential
MCRCD – Mendocino County Resource Conservation District
MRC – Mendocino Redwood Company
NCSP – North Coast Salmon Project
NOAA Fisheries – National Oceanic Atmospheric Administration National Marine Fisheries Service
PIT – Passive Integrated Transponder
PSMFC – Pacific States Marine Fisheries Commission
SHaRP – Salmonid Habitat Restoration Priority/Priorities
TCF – The Conservation Fund
TMDL – Total Maximum Daily Load
TNC – The Nature Conservancy
TU – Trout Unlimited
WBD – Watershed Boundary Dataset

Executive Summary

Setting Habitat Restoration Priorities: The Inception of SHaRP

The Salmonid Habitat Restoration Priorities (SHaRP) planning effort was initiated by the California Department of Fish and Wildlife (CDFW) and the National Oceanic Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries) to focus recovery efforts for listed species of salmon and steelhead in coastal Northern California. While federal species recovery plans and the California Coho Salmon Recovery Strategy provide a range of management actions to protect and improve populations, the vast scale of watershed restoration needed often outweighs available resources. SHaRP was developed as a method to prioritize habitat restoration and accelerate multi-species population level recovery.

Given the ongoing threats to native salmonid populations, restoration efforts focused on salmon and steelhead strongholds will provide strategic support for recovery. Retaining and restoring freshwater habitats that provide refuge, spawning, and rearing areas is essential for improving salmonid survival. Habitat restoration enhances habitat diversity, enabling salmon and steelhead to express diverse life history strategies, making populations more resilient to impacts from climate change. Implementing restoration treatments identified through the SHaRP process will help address acute stressors and restore natural watershed processes.

Led by representatives of CDFW and NOAA Fisheries, SHaRP is a structured collaboration among federal, state, and local governmental agencies; California Native American Tribes; researchers; consultants; non-profits; restoration practitioners; private landowners; and watershed groups. It was piloted in the South Fork Eel River in 2017 and applied to the lower Russian River tributaries, Lagunitas Creek, and the Mendocino Coast beginning in 2020. SHaRP has seven foundational principles that emphasize the use of science, a focus on strongholds and multiple species, community planning, and agency alignment to guide restoration efforts. The SHaRP process leverages data and collective knowledge to select high-priority watersheds, determine factors limiting salmonid survival, and identify site-specific restoration treatments.

SHaRP for the Mendocino Coast

Historic land management practices that began over a century ago caused extensive damage to watersheds throughout the Mendocino Coast region, contributing to the decline of salmon and steelhead. Although legacy effects of past land use continue to persist and new threats have emerged, the sparsely populated region is encompassed by large tracts of protected and managed lands. These areas feature intact watersheds with ongoing restoration efforts, providing a strong foundation for strengthening salmon and steelhead populations through additional habitat restoration.

The Mendocino Coast SHaRP region includes the federally and state-listed endangered Central California Coast (CCC) Coho Salmon (*Oncorhynchus kisutch*) Evolutionary Significant Unit (ESU) (NMFS 2005; CDFW 2023b). It also includes the California Coastal Chinook Salmon (*O. tshawytscha*) ESU and the Northern California steelhead (*O. mykiss*) Distinct Population Segment, both of which are federally listed as threatened. These species are found in 48 Hydrologic Unit Code 12 (HUC 12) subwatersheds within the Mendocino Coast region, extending from Usal Creek south to the Gualala River.

The SHaRP steering team evaluated all 48 HUC 12 subwatersheds using datasets that characterized watershed conditions related to salmonid abundance, distribution, habitat, restoration potential, and watershed disturbance. The HUC 12 subwatersheds were ranked, and the top scores were those with the greatest potential for recovery. The sixteen highest ranked HUC 12 subwatersheds (nine from the Lost Coast-Navarro Point Diversity Stratum in Ten Mile River, Noyo River and Big River watersheds, and seven from the Navarro Point-Gualala Point Diversity Stratum in the Navarro River and the Garcia River watersheds) were selected for further habitat restoration planning. Through a series of virtual watershed planning meetings, participants used collective knowledge and data to identify factors limiting salmon and steelhead survival, then applied this information to develop recommended restoration treatments aimed at improving habitat conditions.

The Mendocino SHaRP process used collaboration and the best available data to identify the most promising locations for salmon and steelhead habitat restoration to support species recovery. The result was identification of a total of 192 discrete restoration treatments in the selected HUC 12 subwatersheds. Restoration treatment types included (1) addition of large wood, (2) off-channel/floodplain enhancement, (3) fish passage improvement, (4) riparian enhancement, (5) road assessment/improvement, (6) streamflow enhancement, (7) beaver dam analogs as part of low-tech process-based restoration, (8) habitat assessment, and (9) conservation easement.

Across all selected HUC 12 subwatersheds, the most common factor identified as limiting salmonid survival was the lack of instream structural complexity and off-channel habitat at the juvenile life stage. Therefore, the top restoration treatment was the addition of large wood, followed by off-channel/floodplain enhancement. In some instances, the addition of large wood included supplementing locations that were treated previously to meet large wood density targets provided in federal recovery plans. Fish passage improvement was the third most recommended treatment overall, with the Big River watershed having the most projects identified. Water quality and quantity were identified as key factors limiting survival during juvenile summer rearing and across all life stages during spring and summer migrations in the Navarro River watershed. As a result, the highest number of streamflow enhancement treatment recommendations occurred in the Navarro River.

Through most of the selected HUC 12 subwatersheds, habitat assessments were recommended in locations that were either known to have high quality habitat or have had restoration efforts previously completed but had not been recently evaluated. The least recommended treatment throughout the selected HUC 12 subwatersheds was conservation easement, which was likely a result of the abundance of protected land and privately owned timberland that is actively managed in the region.

How to Use This Plan

This action plan outlines specific restoration treatments in prioritized watersheds within the Mendocino Coast region to improve freshwater and estuarine habitats. The plan serves as a tool for restoration practitioners for developing projects and can be used when applying for funding. However, using the plan does not guarantee funding and restorationists may need to reevaluate restoration recommendations as more current information becomes available.

The final chapter provides a list of funding opportunities and resources for navigating permitting processes. The progress of SHaRP restoration treatments and implemented projects will be tracked using an online geodatabase hosted by CDFW's North Coast Salmon Project (NCSP). The geodatabase will also help to facilitate ongoing collaboration and identify where future restoration efforts are needed.

Recommended restoration treatments are detailed in tables and maps at the end of each watershed chapter (Chapters 5–9) and summarized in Chapter 10. The action plan is organized as follows:

- Chapters 1–4: These chapters provide an overview of the SHaRP process for the Mendocino Coast, including its timeline, goals, and application. It includes an overview of the region's characteristics, land use history, restoration efforts, and salmon population trends. Methods are described for the watershed ranking and selection process, and the limiting attribute analysis used to develop restoration recommendations.
- Chapters 5–9: Each chapter covers a selected watershed including Ten Mile River, Big River, Noyo River, Garcia River, and Navarro River. Chapters include a brief watershed overview, the selected HUC 12 subwatershed ranking summary, and a watershed meeting summary with limiting attribute analysis results, and restoration treatment recommendations listed in tables and visualized on maps.
- Chapter 10: This chapter provides a brief discussion summarizing the SHaRP process for the Mendocino Coast. It also outlines the next steps for SHaRP, including securing funding, navigating permitting processes, and tracking restoration progress through an online geodatabase.
- Appendix A: This appendix details the datasets and metrics used to develop the watershed rankings.
- Appendix B: This appendix provides a glossary of data layers available on ArcGIS Online (AGOL) for the Mendocino SHaRP.

- Appendix C: This appendix summarizes the restoration treatments in the Mendocino SHaRP.

Chapter 1. Introduction

1.1 What is SHaRP?

Salmonid Habitat Restoration Priorities (SHaRP) was initiated by the California Department of Fish and Wildlife (CDFW) and the National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries) to guide recovery efforts for salmon and steelhead listed under the Endangered Species Act (ESA) and the California Endangered Species Act (CESA) in coastal Northern California. SHaRP is a collaborative process where agencies, scientists, restoration practitioners, and community members work together to identify restoration actions that support salmonid recovery.

SHaRP's objectives are threefold:

(1) Identify salmon and steelhead strongholds – watersheds with high-quality habitat and strong extant populations.

(2) Identify attributes limiting salmonid survival.

(3) Recommend restoration treatments aimed at strengthening these strongholds by improving freshwater and estuarine habitat within a 10-year timeframe.

1.2 Need for SHaRP

Northern California salmon and steelhead populations have declined due to degraded habitat, poor water quality, poor ocean conditions, overfishing, reduced water availability, and lack of habitat connectivity. These factors, and others, have resulted in the listing of these species as endangered or threatened under the ESA and CESA. In response to these listings, recovery plans have been developed to outline strategies for species protection and habitat restoration, as well as provide a framework to recover species at the population level (CDFG 2004; NMFS 2012; NMFS 2016). With salmonid populations below recovery targets and limited resources, both NOAA Fisheries and CDFW recognized the importance of prioritizing habitat restoration efforts at the watershed scale to recover populations and prevent extirpation. SHaRP builds upon species recovery plans by identifying site-specific restoration actions in areas with the highest potential to support population level recovery. While recovery will also likely need habitat restoration in other watersheds within each Evolutionary Significant Unit (ESU), SHaRP targets salmon and steelhead strongholds to increase recovery potential.

Given the ongoing threats to native salmonid populations, retaining and restoring freshwater habitat is essential for improving salmonid survival. Habitat restoration enhances habitat diversity, enabling salmon and steelhead to express diverse life history strategies, making populations more resilient to impacts from climate change (Beechie et al. 2013; Herbold et al. 2018). Implementing restoration treatments identified through the SHaRP process will help address acute stressors and restore natural watershed processes.

Recent federal and state agencies' calls for action have highlighted SHaRP as a resource to help direct salmon and steelhead recovery. NOAA Fisheries' Species in the Spotlight Five-Year Priority Action Plan identified SHaRP as a high-priority effort for recovering Central California Coast (CCC) Coho Salmon populations (NMFS 2021). Similarly, completion of the Mendocino Coast region SHaRP Action Plan was highlighted as a priority action in the California Salmon Strategy for a Hotter, Drier Future, supporting the state's commitment to restoring and expanding salmon spawning and rearing habitat amid changing climate conditions (California Office of the Governor 2024).

1.3 Pillars of SHaRP

The SHaRP effort was led by a joint steering team from CDFW and NOAA Fisheries, guided by principles known as the Pillars of SHaRP (Figure 1).

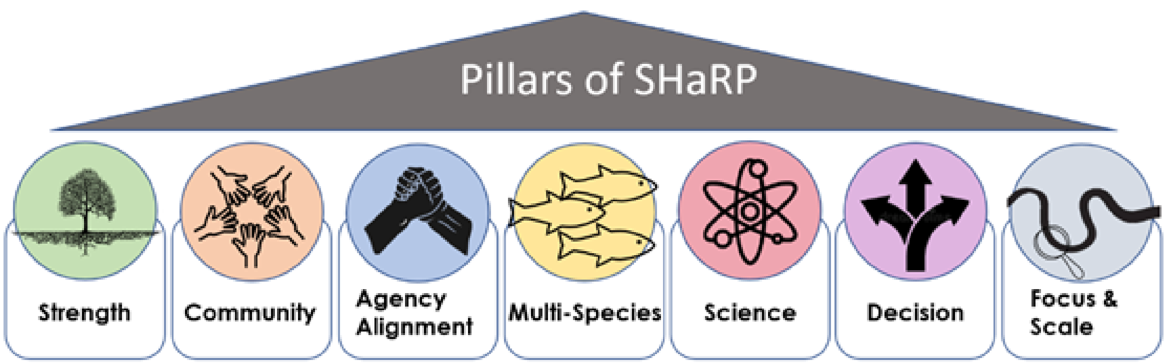


Figure 1. Pillars of SHaRP.

Strength: Many species in decline undergo local extirpation of isolated or dependent populations, thereby narrowing the species' range to only a few robust populations. SHaRP identifies the most promising areas for establishing source populations, which is essential for widespread species recovery. It also helps prioritize restoration actions that will continue to bolster these populations.

Community: SHaRP is a community planning effort. Fisheries agencies guide the process but do not dictate or determine the outcomes. Tribal Nations, non-governmental organizations, landowners, restorationists, as well as fisheries and habitat experts contribute throughout the process.

Agency Alignment: SHaRP builds on agency recovery plans and watershed assessments. CDFW and NOAA Fisheries are heavily involved and aligned in SHaRP efforts. Proponents seeking to implement projects identified in the plan are assured the agencies agree with the premise and the need for those projects.

Multi-Species: All listed salmonid species in a focal area are explicitly considered in the SHaRP process, although one species may direct the initial focus.

Science: Through the SHaRP process, the steering team seeks out all data and local expertise that may be relevant and makes these resources accessible to SHaRP participants. Decisions are based on (1) available regional data, (2) relevant scientific literature, and (3) expert opinions. These data are analyzed to identify constraints on salmonid growth and survival, which then inform recommendations on the type and location of the most appropriate restoration actions.

Decision: Decisions should be made while acknowledging data gaps and/or uncertainty, rather than waiting until the optimal data are available. Decisions are based on transparent processes that are thoroughly described, documented, and grounded in data and science.

Focus and Scale: Salmon populations are restored by identifying and enhancing areas of relative strength, which will support adjacent watersheds. The SHaRP approach intends to produce a restoration plan that directs limited restoration resources to the habitat that will most benefit salmon populations. The resulting SHaRP action plan recommends further enhancement of subwatersheds and smaller areas with the potential for high-quality habitat and strong extant populations.

1.4 Watersheds Selected for SHaRP

SHaRP was first developed and completed on the South Fork Eel River (South Fork Eel River SHaRP Collaborative 2021). Beginning in 2020, it expanded to the Mendocino Coast region (the focus of this report), lower Russian River tributaries, Lagunitas and Olema Creeks, and the lower Eel River (Figure 2). This report summarizes the outcomes of the SHaRP process for the Mendocino Coast region. The general timeline and stepwise process for the Mendocino Coast SHaRP are shown in Table 1.

Figure 2. Map showing watershed regions selected for the SHaRP process as of 2024. County boundaries are shown in grey.

Table 1. General timeline and description of the phases for the Mendocino Coast Salmonid Habitat and Restoration Priorities (SHaRP).

Timeline	Phase
January 2020	NOAA Fisheries and CDFW Steering Team formed
March 3, 2020	Introductory in-person meeting with potential participants
March – June 2020	Steering team data analysis and watershed ranking
July – August 2020	Ranking review with selected experts
September 2020 – January 2021	Steering team finalized ranking scores and selected watersheds
February 3, 2021	Selected watersheds presented to participants
July 2021 – November 2022	Watershed meetings to determine life stage limiting factors and restoration treatments
January 2023 – August 2025	Final reporting summarizing effort and restoration treatments

Chapter 2. Mendocino Coast Region Overview

The Mendocino Coast region was an ideal candidate for SHaRP for several reasons:

- Large geographic area with important salmonid populations
- Rich in salmonid population and habitat data
- Large tracts of relatively intact land with favorable land use practices
- Active and supportive restoration community
- Cooperative landowners willing to host habitat restoration projects

2.1 Regional Characteristics

Salmonids

The Mendocino Coast SHaRP region includes the federally and state-listed endangered CCC Coho Salmon (*Oncorhynchus kisutch*) Evolutionary Significant Unit (ESU) (NMFS 2005; CDFW 2023b), supporting two diversity strata and eight functionally independent populations (Bjorkstedt et al. 2005). It also includes the California Coastal (CC) Chinook Salmon (*O. tshawytscha*) ESU and the Northern California (NC) steelhead (*O. mykiss*) Distinct Population Segment, both of which are federally listed as threatened (NMFS 2005; NMFS 2006).

Watersheds

Along the Mendocino Coast, watersheds range in size from approximately 10–800 square kilometers and flow directly into the Pacific Ocean. River flows are not regulated by dams, and there are only a few small impoundments that block fish passage. The region has both riverine and lagoonal estuaries, the latter being bar-built and closed to the ocean during low flow periods (Heady et al. 2014; Largier et al. 2019). Many of the estuaries along the Mendocino Coast are part of California's Marine Protected Areas Network, with several containing ecologically important eelgrass beds (Sherman & Debruyckere 2018).

Principal Communities

The Mendocino Coast and its inland watersheds are the ancestral homeland of the Cahto, Central Pomo, Coast Yuki, Coastal Pomo, Huchnom, Kashia, Northern Pomo, Noyo, Round Valley, Southern Pomo, Wailaki, and Yuki Nations, whose communities continue to reside in the region today. Coastal city centers include Fort Bragg, Mendocino, Point Arena, and Gualala, while Philo and Boonville are located further inland.

Land Use

Timber is the main export; however, other land use includes commercial farming, cannabis, viticulture, and cattle grazing (Butsic et al. 2018). Rural residential communities are spread throughout the region, with higher densities around the coastal population centers. The Noyo Harbor, one of four major port communities north of San Francisco, supports a both a commercial and recreational fishing industry. It also serves as the base of operations for the United States Coast Guard, conducting search and rescue operations along the Northern California Coast (Pomeroy et al. 2010).

Water Use

Groundwater extraction and surface flow diversions are used for residential, municipal, and agricultural purposes, while surface water storage is limited (NCRWQCB 2018). The largest city center in the region, Fort Bragg, extracts surface water from Hare Creek and the Noyo River using small reservoirs and tanks for storage. In the absence of a water delivery system, water is directly supplied through diversions and privately-owned wells in the rural and small coastal communities of the region. Groundwater extraction in alluvial reaches may reduce streamflow and harm aquatic habitat, with the greatest impacts occurring during the dry season when natural flows are at their lowest (Grantham et al. 2012; de Graaf et al. 2019).

Geology

The bedrock of the Mendocino Coast primarily consists of marine sedimentary rock with pockets of volcanic rocks and alluvium/marine deposits (Jennings et al. 2010). These sedimentary and volcanic deposits are part of a larger accretion called the Franciscan Complex (Langenheim et al. 2013). Much of the Mendocino Coast lies within the coastal belt, which consists primarily of sandstone with laumontite veins, along with smaller amounts of sandstone mélange around conglomerate rock (Langenheim et al. 2013). Localized fractures within these strong, lithified rocks have created steep, mountainous ridges that surround the rivers and tributaries that flow through well-incised, gorge-like valleys with narrow bottomlands (Mangelsdorf et al. 2000). Along the eastern edge and southern portions of the region, the central belt features an older accretion of pervasively sheared sandstone and shale mélange surrounding conglomerate rocks (Langenheim et al. 2013). The higher water storage capacity of interior mélange helps sustain summer baseflow during the dry season (Dralle et al. 2023).

The geology is further disrupted by seismic activity located between the San Andreas and Macamba fault lines (Jennings et al. 2010). Near the ocean, the central belt features high bluffs and marshes, while further inland, the landscape shifts to temperate, mountainous, redwood rainforests (Mangelsdorf 1997).

Ecoregion

The Mendocino Coast lies within the Coast Range Ecoregion, where redwood forests dominate the landscape (Omernik 1987). Coastal forests are a mixture of conifers and hardwoods including tanoak, madrone, bigleaf maple, California bay, and red alder. Coastal headlands are characterized by high and low marine terraces, sand dunes, and beaches. The eastern edge and southern portions of the region feature hummocky rolling hills of mixed evergreen forests, oak woodlands, grasslands, and chaparral (Griffith et al. 2016).

Climatic Conditions

The maritime mediterranean climate consists of cool, foggy summers and mild, wet winters. Fog density varies across the Mendocino Coast and varies based on topology (Torregrosa et al. 2020). Nearly all precipitation falls between November and April, with average annual rainfall totals ranging between 101.6 centimeters (40 inches) along the coast and more than 203.2 centimeters (80 inches) in the mountainous headwaters (Farrar 1986).

Like other California rivers, flow patterns in streams on the Mendocino Coast are characterized by brief but significant rain events in the fall that initiate the wet season. Elevated winter base flows are punctuated by extreme discharge peaks, followed by a period of spring recession, with low flows through the dry summer season (Yarnell et al. 2020). In areas where the bedrock has fractured, or the sediment is unstable, intense rainstorms can cause landslides, flooding, flashy streams, accelerated erosion, and high sediment deposits. Along the coast, the fog layer can lower stream temperatures and act as a source of precipitation in the rainless summers (Dawson 1998; Torregrosa et al. 2020). In watersheds where fog drip is prevalent, certain plants extract water from the air instead of the ground, thereby slowing the baseflow regression of streams during the summer (Torregrosa et al. 2020).

2.2 Land Use History

California Native American History

Historically, the Mendocino Coast region was home to tens of thousands of California Native American people, reflecting the richness and diversity of their distinct cultures (Madley 2016). Early ethnographers disregarded these cultural distinctions contributing to challenges in recognition of tribal sovereignty (Keter 2024).

While many communities shared certain customs, they spoke unique languages (Miller 1979). Each tribe practiced its own form of subsistence, shaped by the landscapes they called home. Tools were made from local stone, while feathers, beads, and shells were used in regalia. Additionally, grass was skillfully braided into renowned basketry (California State Parks n.d.; Keter 2024; Madley 2016; Pinoleville Pomo Nation n.d.) Some tribes were semi-nomadic, forging alliances with neighboring villages to access resources that could only be found in certain parts of the region, whether in the mountains, river valleys, or along the coast, often far from their home villages (Keter 2024; Madley 2016). For example, the Northern Pomo and Cahto maintained inland villages year-round but traveled to the coast in the spring and summer to harvest coastal resources (Pinoleville Pomo Nation n.d.). The coastal Pomo and Yuki, lived year-round in resource-rich homelands, where fish, game, berries, tubers, and acorns provided abundant sustenance for their communities (Keter 2024; Sherwood Valley Band of Pomo Indians n.d.; Skoggard 2003).

California Native American communities were forcefully displaced by the arrival of European settlers. Eurocentric settlements were established alongside the first logging camps and mills, displacing California Native American communities from their ancestral lands. In 1856, the Mendocino Indian Reservation was established in Fort Bragg, spanning the coast from the Noyo River to the Ten Mile River and overseen by a military post (Winn 1986). The reservation was closed in 1865, with Indigenous communities subsequently forced to march inland to Nom Cult Farm (Round Valley Reservation) in Covelo, CA (Rogers 1948).

European Colonization and Logging Era

Although European explorers arrived as early as the 1500s, the region's rocky shores sheltered it from sustained contact. It wasn't until the early 1800s, with the arrival of Russian fur trappers, that the first significant contact with California Native American communities began. In 1850, the wreck of the clipper ship 'Frolic' off the coast marked a significant turning point for land development on the Mendocino Coast. The salvage crews sent from San Francisco returned with reports of giant redwood trees, leading to the creation of the first sawmills in the region.

For over a century, logging companies clear-cut stands of trees, burned the remaining vegetation, and hauled the logs across the barren soil using oxen, and later tractors. Large trees were removed from riparian corridors while stream channels were filled with logging debris (Figure 3). This labor-intensive process necessitated the creation of road networks throughout the region (Carranco & Labbe 1975). In some watersheds, particularly Big River, splash dams and crib dams were built to temporarily store logs before they were flushed to mills located downstream.

Railroads were constructed along the stream channels to facilitate the transportation of timber to mills. After World War II, timber extraction practices rapidly expanded, coinciding with land development driven by societal growth. This fueled the development of an extensive network of roads, many of which were gravel roads that were washed out annually. In the 1950s, gravel mining was unregulated and primarily used to build logging roads (Maahs 1992). Following this intense period of accelerated logging and mining, the December 1964 flood brought unprecedented flow magnitudes, delivering catastrophic sediment levels from bare hillslopes, resulting in dramatic channel changes in many northern California watersheds. While the Mendocino coastal watersheds were impacted by this flood, they were affected to a lesser extent than the Eel River and Klamath River basins (Waananen et al. 1971).

Collectively, these activities and events led to the loss of riparian trees, erosion, accumulation of legacy sediment in channels and on floodplains, channel simplification, incision, and disrupted floodplain connectivity. While logging marked the first large-scale landscape changes to these watersheds, it is also important to note that some ecological shifts likely began as early as the 1700s, following the removal of beavers throughout California from the fur trade (Lanman et al. 2013; Lundquist et al. 2013). By the early 1950s, the Mendocino Coast, like many northern coastal California watersheds, faced a major fisheries crisis due to poor land use practices, overharvested fisheries, and land development associated with human population growth.

Figure 3. Historical photo of logging activities in the Navarro River watershed (June 21, 1890; photo credit: The Klamath Resource Information System).

2.3 Efforts to Restore Salmonid Populations

Efforts to restore salmon and steelhead populations in northern California's coastal watersheds have been ongoing for many years. In 1950, The Sport Fish Restoration Program was enacted to address fishery declines by using sport license fees to support the restoration and management of fish species. Small-scale salmon and steelhead hatcheries were initiated to revive the fishery. Despite their operation through the mid-1990s, these hatcheries were largely unsuccessful at bolstering fish populations (Bjorkstedt et al. 2005). In the 1970s, several important state and federal environmental laws were passed that provided regulatory protection that benefited salmon, steelhead, and their habitat. This included the Forest Practice Act of 1973 (Z'berg-Nejedly Forest Practice Act of 1973), which improved forestry practices by requiring timber harvest plans and regeneration of forested areas in California. During this time, local citizen efforts also prompted legislative actions to help declining salmonid populations. These efforts include the formation of the Citizen's Advisory Committee on Salmon and Steelhead, the Salmon Restoration Association in Fort Bragg, and the development of the commercial fisherman Salmon Stamp Program (Lufkin 1990).

Starting in the 1950s, the first stream habitat restoration efforts were initiated by fisheries agencies to improve spawning habitat and fish passage by removing excessive logging waste from stream channels (Stillwater Sciences 1997). This practice was applied throughout the North Coast and continued through the early 1990s. Under the 1980 legislative act Senate Bill 201, the California Conservation Corps Salmon Restoration Project implemented many of these projects (Lufkin 1990) and continues to play an integral role in habitat restoration today.

By the late 1980s, Brown and Moyle (1991) estimated that fewer than 5,000 wild Coho Salmon were spawning annually in California. Throughout the Mendocino Coast region, Coho Salmon were notably absent from many of the watersheds within their historical range (Brown & Moyle 1991; Brown et al. 1994). One of the earliest comprehensive spawning surveys in coastal Mendocino County watersheds found low numbers of spawning Coho Salmon, Chinook Salmon, and steelhead, despite hatchery plantings in many of the streams (Brown & Moyle 1991; Nielsen et al. 1991).

The ESA and CESA listings of Coho Salmon, Chinook Salmon, and steelhead provided important protection for these species and their habitats. Recovery plans, developed as part of the ESA and CESA listing processes, provided strategies to avoid population extirpation and track population status (CDFG 2004; NMFS 2012; NMFS 2016).

Total Maximum Daily Loads

Due to the legacy effects from past land practices, many coastal watersheds were designated as water quality impaired because sediment loads exceeded the protective water quality standards under California's 1995 Clean Water Act 303(d) list. In response, by the early 2000s, Total Maximum Daily Load (TMDL) water quality improvement action plans were implemented in several Mendocino coastal watersheds to restore and maintain clean surface waters. These plans include instream water quality goals for salmonids and are implemented by the North Coast Regional Water Quality Control Board (Regional Water Board) using existing permitting and enforcement tools. To reduce chronic sediment input, many restoration projects have focused on decommissioning and improving roads.

Habitat Restoration

Large wood restoration projects are among the key contemporary restoration actions aimed at addressing population-specific habitat concerns along the Mendocino Coast (NMFS 2016). Logging and land development vastly altered riparian forests, reducing natural recruitment processes, resulting in a deficit of large wood that is crucial to instream habitat forming processes. Under current conditions, riparian zones consist of even-aged, forested stands with good structure and canopy cover, but limited variation in age and size classes.

Since the adoption of the Z'berg-Nejedly Forest Practice Act of 1973 and the designation of streamside management areas (Williams et al. 2004), as well as watercourse and lake protection zones (CDF 2003), forest practices have incorporated riparian protections that have promoted passive restoration of stream channels over the last few decades. Although legacy logging impacts continue to pose challenges requiring active restoration, Mendocino's commercial timberlands offer extensive, undeveloped areas where sustainable forestry supports healthier habitat conditions for salmonids.

While early wood removal habitat restoration efforts likely improved passage by removing excess logging debris, these efforts also resulted in the removal of too much wood in some locations. Since the 1990s, large wood has been reintroduced into stream channels as a restoration technique. This technique builds complex habitats and initiates channel forming processes important for salmonid migration, spawning, and rearing. More recently, restorationists have developed new techniques to implement large, phased, design plans aimed at restoring habitat and improving salmon survival. Recent methods include using engineered, large, complex wood jams, localized excavation to reconnect floodplains and estuaries (as shown in Figure 4), and monitoring to evaluate fish and geomorphic responses to restoration (Stillwater Sciences 2011; Stillwater Sciences 2013a; Stillwater Sciences 2013b; PCI 2014; PCI 2018).

The Wood for Salmon Working Group was formed in 2011 as a collaborative effort to help accelerate the pace and scope of instream habitat restoration for salmonid recovery in Northern California (Wood for Salmon Working Group 2011). The group remains active to this day, with members comprised of county, state, and federal agencies, non-profits, landowners, and consultants. Their goal is to improve and simplify permitting, while providing guidance for restoration practitioners and landowners for large wood enhancement projects.

Substantial investments have been made in salmonid habitat restoration through federal and state funding sources, including the Fisheries Restoration Grant Program (FRGP) since 1981 and the Pacific Coastal Salmon Recovery Fund since 2000 (CDFW 2023b; NMFS 2023). Using these resources as well as other grants, funding, and partnerships, both non-profits and private landowners have completed stream habitat restoration projects with a focus on addressing sedimentation, fish barriers, and degraded habitat. Between 2004 and 2018, FRGP awarded over $12 million to fund 97 projects in the Noyo River, Garcia River, Navarro River, Pudding Creek, and Ten Mile River (CDFW 2021). Nearly 75% of this funding was allocated to instream and/or upslope habitat improvement, sediment control, and road improvement, targeting actions identified in both state and federal recovery plans

(CDFW 2021). Project descriptions and spatial data for FRGP funded habitat restoration that has taken place since 1981 can be found on CDFW's (CDFW) FRGP webpage.[3]

Land Protection and Stewardship

Large tracts of land in the Mendocino Coast region are protected and managed as state parks, state forests, private timber, and conservation easements. These large parcels provide landscape level protection and support sustainable forestry management. These land designations have provided opportunities for large-scale habitat restoration projects through partnerships with non-profits such as Trout Unlimited (TU), The Nature Conservancy (TNC), The Conservation Fund, and The Mendocino Land Trust.

Figure 4. Photo of large wood jam construction in the Garcia River estuary, June 2022 (photo credit: Sarah Gallagher, California Department of Fish and Wildlife).

Streamflow Restoration

The Mendocino County Resource Conservation District in collaboration with non-profit organizations have developed partnerships with landowners to improve water management practices as well as enhance and restore streamflow. The Nature Conservancy has worked on updating water policies and helped develop a community-

[3] https://wildlife.ca.gov/Grants/FRGP

based water management guidebook aimed at building water supply resiliency (Alford et al. 2021), while TU's Conservation Hydrology program[4] measures and monitors streamflow to guide streamflow enhancement strategies.

Coho Salmon-specific Initiatives

Agencies have initiated several supplemental efforts to support CCC Coho Salmon recovery in the region. In 2012, the Priority Action Coho Team was formed to develop recommendations for habitat restoration, water management, and hatchery supplementation for each watershed within the CCC Coho Salmon ESU (PACT 2019). In 2015, CCC Coho Salmon were added as a NOAA Fisheries Species in the Spotlight, an initiative focused on highly at-risk species managed by NOAA Fisheries that are on the brink of extinction (NMFS 2015). As part of this initiative, a five-year action plan was created to allocate resources to critical efforts aimed at preventing extirpation (NMFS 2015). The inclusion of CCC Coho Salmon as a Species in the Spotlight was renewed in 2021, emphasizing the ongoing priority for their recovery (NMFS 2021).

In 2018, CDFW formed the North Coast Salmon Project (NCSP) to promote efforts to recover Coho Salmon. NCSP was guided by an advisory team consisting of representatives from conservation groups and resource management agencies. The goal of NCSP is to support Coho Salmon recovery in focus watersheds by assessing the effectiveness of past actions and developing a strategic approach to identify and implement high priority recovery actions. As part of this endeavor, the NCSP adopted SHaRP as an approach to develop habitat restoration plans. Concurrently with SHaRP, CDFW implemented changes to its grants program through the Cutting the Green Tape Initiative. This initiative streamlined the permitting process by offering pre-proposal consultations to assist applicants and help accelerate the pace and scale of habitat restoration (California Landscape Stewardship Network 2020).

Population Monitoring

The California Monitoring Plan (CMP)[5] was developed to monitor parameters that assess the long-term viability of salmon and steelhead populations in coastal California as a measure of recovery (Adams et al. 2011). Since 2008, CDFW Region 1, in partnership with the Pacific States Marine Fisheries Commission (PSMFC), Mendocino Redwood Company (MRC), and Redwood Timber Company, have implemented population monitoring for salmon and steelhead in coastal Mendocino County watersheds following CMP methods (McGuire et al. 2021). These methods produce annual estimates of salmonid redds, adults, smolt abundance, and survival indices, and provide information on species distribution. The Mendocino Coast monitoring region provides estimates of CCC Coho

[4] https://www.tu.org/magazine/science/delivering-the-data-tus-conservation-hydrology-program/
[5] https://wildlife.ca.gov/Conservation/Fishes/Salmonid-Monitoring/CMP

Salmon, CC Chinook Salmon and NC steelhead, covering two diversity strata for each species. This work is primarily funded through NOAA Fisheries Pacific Coastal Salmon Recovery Fund and administered by CDFW through FRGP.

Restoration Effectiveness and Validation Monitoring

Most grant-funded habitat restoration projects incorporate implementation monitoring to ensure the project is completed to design. They may also include short-term pre- and post-project effectiveness and validation monitoring to determine if the desired outcome related to habitat changes and/or fish use were achieved.

The 2022 NOAA Fisheries Central Coast Programmatic Biological Opinion requires CDFW to monitor a portion of funded projects. Within the Mendocino Coast, the CDFW Region 1 Monitoring and Evaluation of Salmonid Habitat Restoration team has been conducting Before-After, Control-Impact studies on Olds Creek (Noyo River watershed) and Ramon Creek (Big River watershed). These sites have been monitored for up to 10 years post-restoration with the most recent surveys completed in 2024. These monitoring assessments support permitting requirements and are used to evaluate project performance, habitat changes, and salmon and steelhead use.

Additional studies evaluating fish response to habitat restoration treatments have been implemented on the Ten Mile River (TNC/Stillwater Sciences) and Pudding Creek (TU/CDFW). In conjunction with long-term salmonid population and life cycle monitoring, findings from these studies build evidence on how management actions that increase habitat quantity and quality can affect survival, growth, abundance, and recovery of salmonid populations.

Conservation Rearing

Following Priority Action Coho Team and Species in the Spotlight recommendations, a pilot captive rearing project was implemented in the Garcia River and Navarro River from 2018 to 2023 to improve Coho Salmon populations in the Navarro-Gualala Point Diversity Stratum. Three cohorts of wild juvenile Coho Salmon were captured from the Navarro River and Garcia River (approximately 200 individuals annually in 2018, 2019, and 2020) and transported to Don Clausen Fish Hatchery in Sonoma County, which has a program specific to CCC Coho Salmon recovery. Juveniles were reared in captivity until maturity, genotyped, and then released into groups as adults to maximize outbreeding when ocean run fish were also spawning. Spawning survey observations and parental based genetic tagging were completed to assess the breeding success of project fish. Findings from the project evaluation will help inform any future supplementation efforts.

2.4 Current Population Status

Coho Salmon

The most recent NOAA Fisheries status review determined that all populations in the CCC Coho Salmon ESU are below recovery targets and continue to face the threat of extirpation (Spence 2022). However, in the Mendocino Coast region, there have been slight improvements in population abundance in the Lost Coast-Navarro Point and Navarro-Gualala Point Diversity Strata since the 2016 status review (Spence 2022). The average adult population estimate for the Mendocino Coast region was 4,926 (range 869–15,394) from 2008/09 to 2022/23 (n = 14). The Noyo River has had adult returns exceed the NOAA Fisheries recovery target in both 2015/16 and 2023/24 (Figure 5). The Ten Mile River has shown strong returns in recent years and recently exceeded its recovery target in 2023/24 (Figure 5).

Coho Salmon persist in many of their historical watersheds throughout the Mendocino Coast region. However, they have been extirpated from the Gualala River since 2004 and were found to be absent from Usal Creek since 2014 (McGuire et al. 2021) until fry and redds were documented in winter 2024/25 during spawning surveys (Sarah Gallagher personal communication).

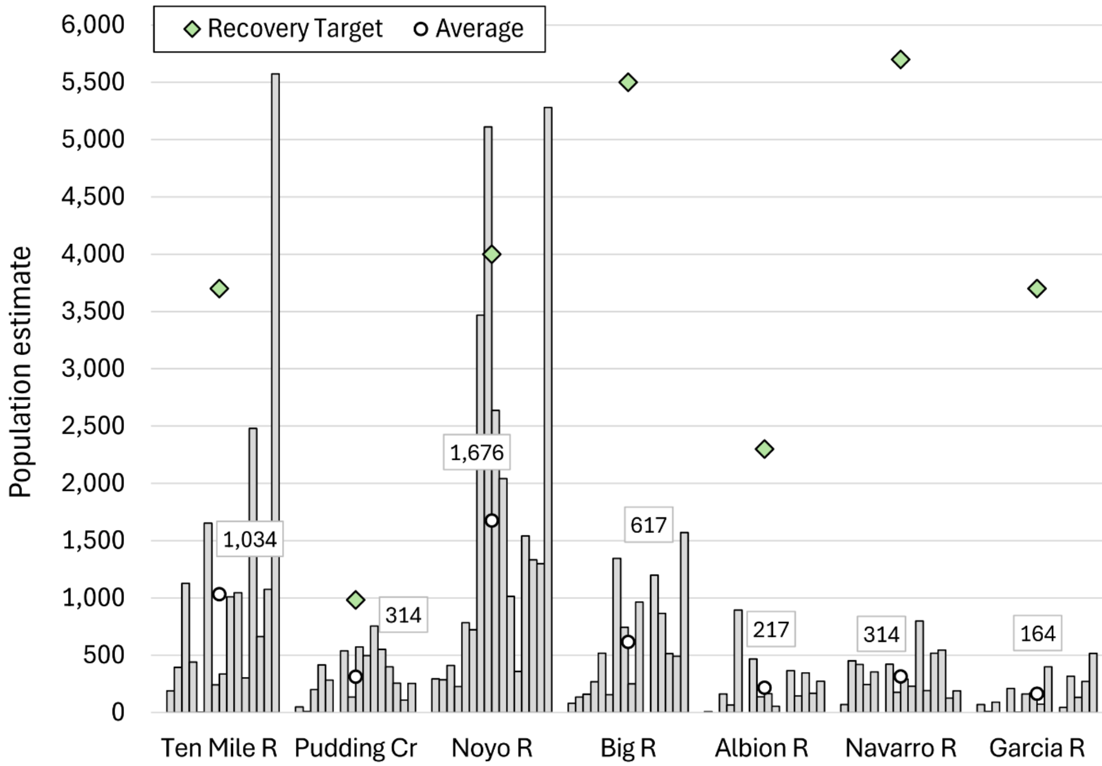


Figure 5. Coho Salmon adult estimates in key populations within the Mendocino Coast CMP monitoring region. Grey bars represent annual estimates from spawning season 2008/09 through 2023/24 (left to right) for each population. Number of survey years (n = 16), excluding Big River, Albion River, and Garcia River that were not surveyed in 2017/18 (n = 15). The NOAA Fisheries recovery target (diamond symbol) and time series average (circle symbol and value) are shown for each population.

Steelhead

Steelhead inhabit almost all accessible watersheds along the Mendocino Coast and typically have a broader distribution than Coho Salmon. Populations monitored in both the North-Central Coastal and Central Coastal Diversity Strata are at low abundance and remain below recovery targets (Spence 2022). The average adult population estimate for the Mendocino Coast region was 3,557 (range 442–9,013) from 2008/09 to 2023/24 (n = 15) (Figure 6).

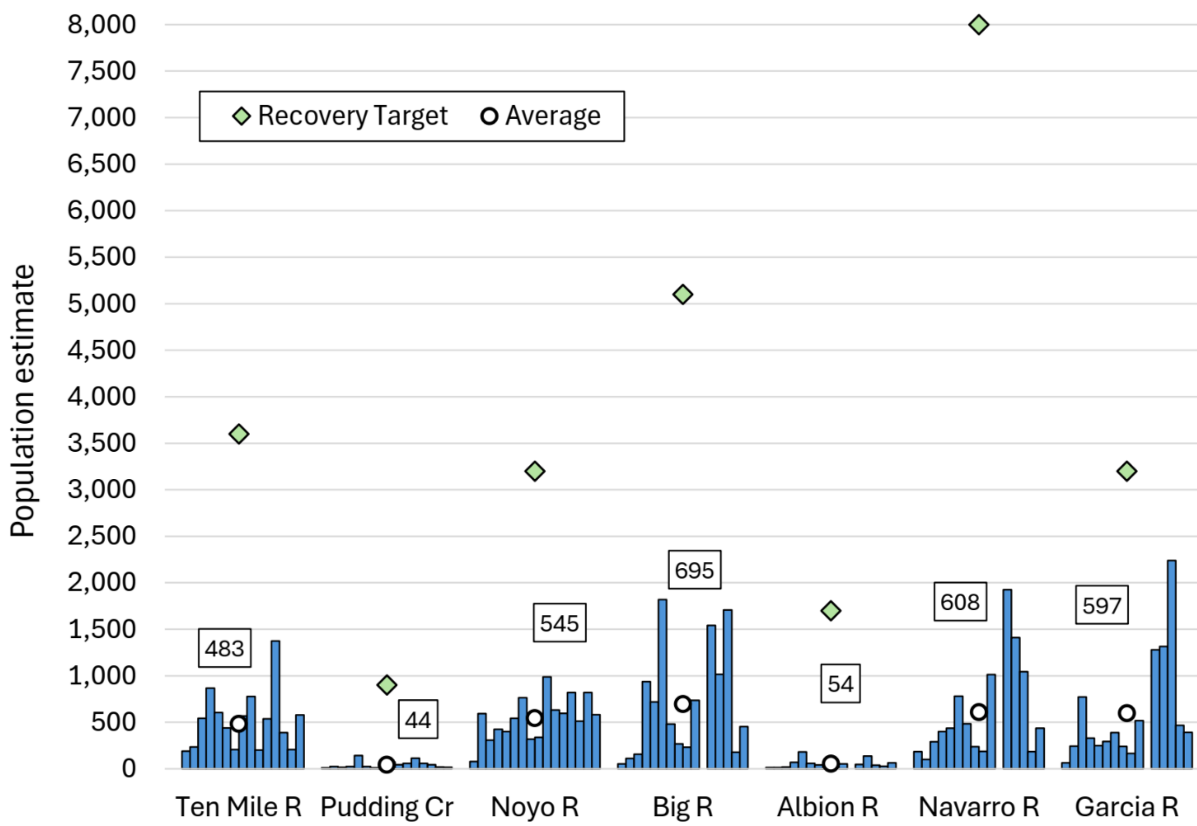


Figure 6. Steelhead adult population estimates in key watersheds within the Mendocino Coast CMP monitoring region. Blue bars represent annual estimates from spawning season 2008/09 through 2023/24 for each population. Number of survey years (n = 16) except in Big River, Albion River, Navarro River and Garcia River that were not surveyed in 2017/18 (n = 15). The NOAA Fisheries recovery target (diamond symbol) and time series average (circle symbol and value) are shown for each population.

Chinook Salmon

Chinook Salmon are the least abundant salmonid in the Mendocino Coast region, although spatial diversity within the California Coast ESU is likely greater than what was determined in the 2016 status review (NMFS 2016). From 2008/09 to 2023/24, adult abundance estimates ranged from 0 to 857 (n = 15) for the Mendocino Coast region. In most years, low numbers of Chinook Salmon and redds have been observed during annual spawning surveys in most independent population watersheds, with Ten Mile River and Garcia River having the most consistent and highest returns (McGuire et al. 2021). Chinook Salmon are least prevalent in the Navarro River, where they have not been observed during spawning surveys since 2008. They were last detected in small numbers in the North Fork Navarro River in 2014 (McGuire et al. 2021).

Summer estuary surveys for marine protected area monitoring documented juvenile Chinook Salmon in the Ten Mile and Big River watersheds from 2014 to 2016 (Shaughnessy et al. 2017). Smolts have been captured in the lower South Fork Ten Mile River outmigrant trap near the estuary from April through late July (Stillwater Sciences 2023). In the Garcia River, CDFW and TNC observed juvenile Chinook Salmon during late spring and summer in the upper mainstem river and the estuary in 2022 and 2023 (Sarah Gallagher, personal communication). During those same years, juveniles were observed by CDFW during summer snorkel surveys in Big River and the Noyo River (Sarah Gallagher, personal communication).

2.5 Current Threats

Although many restoration projects and regulations have been implemented to improve freshwater habitat for salmon and steelhead in coastal Mendocino watersheds, ongoing stressors remain and are important to consider for recovery planning. All three listed salmonid species are below NOAA Fisheries recovery levels across their range, with some populations extirpated from watersheds where they were historically present. Small population sizes and limited habitat diversity reduce genetic and phenotypic diversity, while also decreasing a population's capacity to endure and adapt to changes in the landscape that affect temperature and flow regimes (Herbold et al. 2018).

In most watersheds, geomorphic processes have been disrupted by the enduring impacts of past land use practices. Riparian and upland habitats have been altered by deforestation and roadbuilding, resulting in altered runoff patterns, reduced infiltration, and increased inputs of sediment. High quality, complex instream habitat is limited in many watersheds, particularly for the juvenile salmonid life stages.

Streamflow is impacted by both legal and illegal water diversions, groundwater pumping, and climate change. Residential properties and cannabis farms in the region pump groundwater during the late summer when water needs are highest. To support agricultural industries through the dry season, water is diverted from already low flowing streams (Butsic et al. 2018). These impacts are further compounded by landscape alterations that have greatly reduced precipitation infiltration and groundwater recharge (Zipper et al. 2019).

The effects of climate change on salmonids throughout their entire lifecycle have been well documented in the Pacific Northwest (Siegel & Crozier 2020). Climate change has intensified and shifted the water regime by delaying winter rains (Luković et al. 2021), creating rapid shifts between extreme drought and flood (Swain et al. 2018), and decreasing fog frequency (Johnstone & Dawson 2010). The North Coast region of California is projected to see average annual maximum temperatures rise by 2.8°C–5°C (5°F–9°F) by the end of the century under moderate to high CO_2 emission scenarios (Micheli et al.

2018). Fishes that require access to cold water are especially vulnerable to the increased water temperatures and the reduced summer flows associated with climate change (Moyle et al. 2012). Coho Salmon at the southern edge of their range in California and Southern Oregon are among the most climate-vulnerable Pacific salmonids, particularly in regions projected to experience the most severe impacts (Crozier et al. 2019).

Chapter 3. Watershed Selection

3.1 Ranking Process

The Mendocino Coast SHaRP watershed ranking process for restoration prioritization was adapted from Bradbury et al. (1995), and generally followed the methods used for the South Fork Eel River SHaRP (South Fork Eel River SHaRP Collaborative 2021).

The ranking process was done at the Hydrologic Unit Code (HUC) 12 subwatershed scale using the national geospatial Watershed Boundary Dataset (WBD). The WBD is a collection of hydrologic unit data, defined by topographic and hydrologic features at a 1:24,000 scale, arranged in a nested, hierarchical system (USGS 2013). For each hierarchical level, hydrologic units are assigned to a two-digit numerical code sequence. The Mendocino Coast SHaRP included 48 HUC 12 subwatersheds (Figure 7).

Each HUC 12 subwatershed was scored using metrics developed from datasets relevant to salmonids. These datasets were nested under four categories: (1) *Biological Importance*, (2) *Habitat Condition*, (3) *Optimism and Potential*, (4) and *Integrity and Risk*. The steering team selected datasets that were available across most of the 48 HUC 12 subwatersheds to develop metrics.

The steering team used an iterative process to assign weights to each metric and added a qualitative scoring criterion to account for important aspects lacking available data. Each metric was ranked from 0 – 100 relative to the distribution of values for all subwatersheds. Rank-weighted scores were then assigned by quartiles. Metrics with a percent rank of 75 – 100 received the highest score of 4, followed by scores of 3 for ranks of 50 – 74, 2 for ranks of 25 – 49, and 1 for ranks of 0 – 24. If there was low confidence in a score due to questionable quality or representation of data, rank weighted scores were adjusted using a confidence multiplier to either increase or decrease the effect of that metric on the overall ranking process.

Scores were totaled for each category, then summed for each HUC 12 subwatershed. Figure 8 shows key metrics and scores by category. Appendix A describes specific metrics, scoring, and data sources used. For each category, higher scores indicated more favorable conditions.

The *Biological Importance* category carried the most weight. It included metrics of abundance (adult spawners) and current distribution for each salmonid species. The steering team developed a 'fish traffic' metric to identify key locations common to all salmonids for migration. Due to their endangered status, Coho Salmon were given more weight than Chinook Salmon and steelhead. The *Biological Importance* Score was reflective of the stream length of species distribution, spawning density, fish traffic, and number of species present.

Habitat Condition included both measured and modeled habitat metrics that are critical for salmonids. Habitat metrics were derived from physical stream habitat assessments conducted by California Department of Fish and Wildlife (CDFW). Habitat Suitability Index scores were calculated using the Ecosystem Management Decision Support program (Reynolds et al. 1996; Walker et al. 2007). Anchor habitat (a place that could support all life stages of Coho Salmon) was determined through a Geographic Information System (GIS)-based analysis using set criteria for both modeled water temperatures and Intrinsic Potential (IP). The *Habitat Condition* score reflected the amount of stream length with high-quality habitat based on Habitat Suitability Indices, the extent of anchor habitat, and large wood densities.

Optimism and Potential used metrics to evaluate a watershed's intrinsic capacity to support salmonids and its history of restoration efforts. This assessment included analyzing land ownership types to gauge conservation potential, conducting a qualitative evaluation of restoration potential based on community support and past financial investments, and examining IP to determine the quality of historical salmonid habitat. The *Optimism and Potential* score reflected the total stream length of high and medium IP for each species, total percentage of the watershed in timber, average parcel size, and the level of restoration/community support.

Integrity and Risk used metrics to assess anthropogenic threats and disturbances across the landscape to summarize watershed integrity and ecological risks. Key factors included impacts from summer water temperatures, diversion pressure, population density, and road density. The *Integrity and Risk* score was reflective of the total stream length of Coho Salmon IP below the mean August temperature threshold, road density per square mile, human population density per square mile, and water diversion pressure per square mile.

Figure 7. Map of the 48 HUC 12 subwatersheds evaluated for the Mendocino Coast SHaRP. The diversity strata boundary for Coho Salmon and steelhead is shown by a red dashed line.

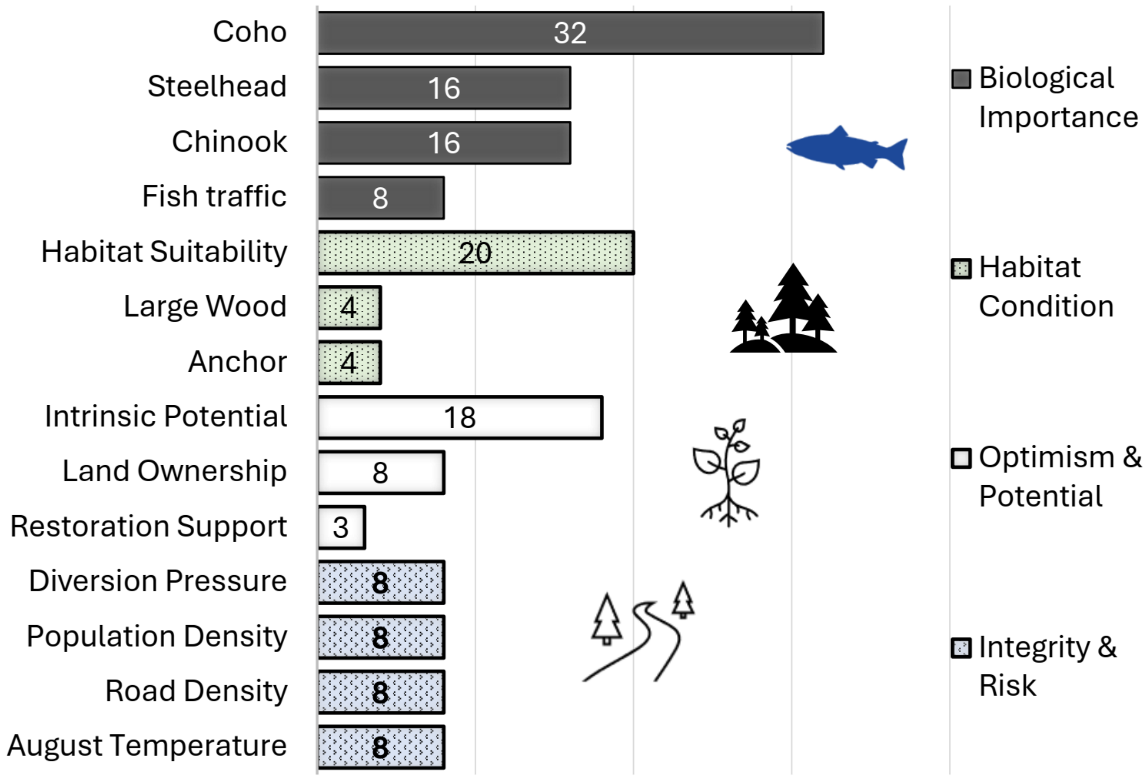


Figure 8. Metrics and available points used to rank and select watersheds for the Mendocino Coast SHaRP in each of four categories: Biological Importance, Habitat Condition, Optimism and Potential, and Integrity and Risk.

3.2 Advisor Review

After completing the ranking, the steering team reviewed the results during a series of six virtual meetings with watershed experts (advisors) who had local experience in restoration, land management, and/or fisheries. Meetings were structured to cover several HUC 12 subwatersheds at once, grouped by land ownership and expert knowledge (Table 2).

Table 2. Advisor meeting dates and HUC 12 subwatershed groupings for the Mendocino Coast SHaRP.

Meeting Date	HUC 12 Subwatersheds
August 12, 2020	Jackass Creek, Virgin Creek, South Fork Noyo River, Hare Creek Frontal, Little River, Mallo Pass Creek, Point Arena Creek
August 19, 2020	North Fork Gualala River, South Fork Gualala River, Rockpile Creek, Buckeye Creek, House Creek, Marshall Creek, Lower Wheatfield, Upper Wheatfield
August 26, 2020	Usal Creek, Juan Creek, Wages Creek, Pudding Creek, North Fork Ten Mile River, Middle Fork Ten Mile River, South Fork Ten Mile River, Lower Noyo River
September 2, 2020	Upper Noyo River, North Fork Noyo River, Albion River, North Fork Navarro River, South Branch North Fork Navarro River, North Branch North Fork Navarro River
September 9, 2020	Cottaneva Creek, Upper Navarro River, Greenwood Creek, Brush Creek, Elk Creek, Alder Creek, Middle Garcia River, Lower Garcia River, Upper Garcia River
September 16, 2020	Indian Creek, Anderson Creek, Lower Rancheria Creek, Upper Rancheria Creek
September 23, 2020	Big Salmon River, Lower Big River, South Fork Big River, Upper Big River, North Fork Big River

The steering team presented results and facilitated discussion for each HUC 12 subwatershed, while the group collectively navigated maps and data. Participants were also asked how they thought impacts from climate change and illegal cannabis cultivation could affect the *Integrity and Risk* as well as the *Optimism and Potential* category scores. An additional meeting was held with the CDFW Habitat Conservation Program staff to review the scoring for water diversion pressure. This meeting was necessary because this dataset likely did not include the most up to date information, including illegal diversions. Through this review process, participants identified errors and shared additional information, which was assembled by the steering team and incorporated into the final scoring. General scoring adjustments post advisor review included:

- **Current distribution:** Increases or decreases were made to stream length. Confidence rating was lowered when populations were thought to be extirpated.
- **Current spawner abundance:** If no current spawning survey data was available, local expertise or adjacent watershed information was used to compensate for the absence of data.
- **Habitat condition:** When watershed assessments were absent, local knowledge or adjacent watershed data was used to adjust all metrics.
- **Water diversion pressure**: Used expert knowledge of illegal diversions to decrease confidence ratings and adjust the final score.

3.3 Watershed Scores

Final HUC 12 subwatershed scores ranged from 57 to 139.5 (median 88.5; n = 48) (Figure 9). Top scores reflected watersheds with the greatest potential for recovery, which were then selected for further habitat restoration planning. Selections were stratified by the Coho Salmon diversity strata to (1) focus limited resources on populations of relative strength, and (2) support salmon and steelhead strongholds at ecologically relevant distances. Sixteen HUC 12 subwatersheds were selected, including nine from the Lost Coast Diversity Stratum in Ten Mile River, Noyo River and Big River, and seven from the Navarro Point Diversity Stratum in the Navarro River and the Garcia River (Figure 9, Figure 10).

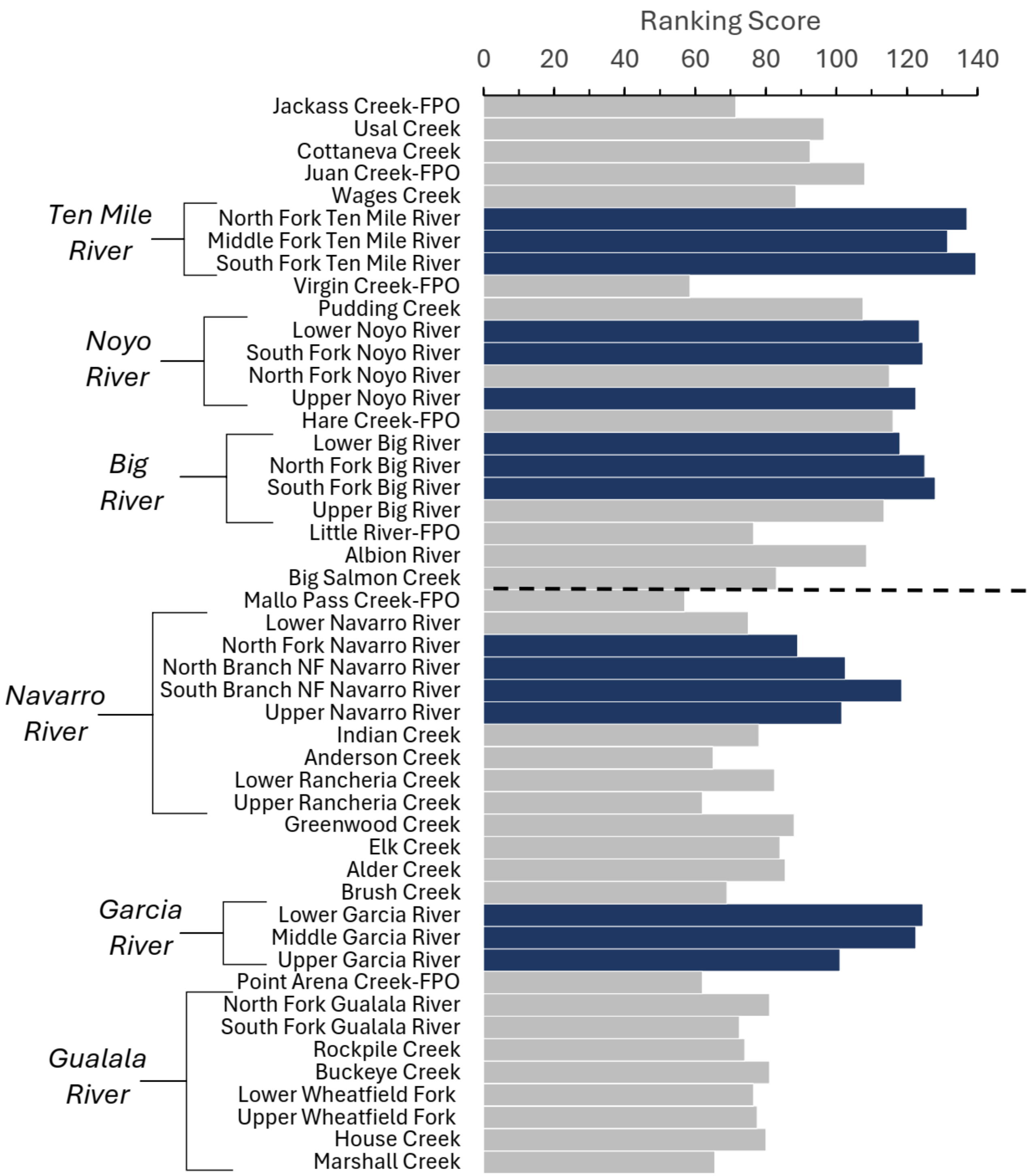


Figure 9. Ranking scores for each of the 48 HUC 12 subwatersheds for the Mendocino Coast SHaRP, organized from north (top) to south (bottom). The dashed horizontal line marks the diversity strata boundary. Solid dark blue bars represent those selected for further restoration planning (n=16). FPO = Frontal Pacific Ocean.

Figure 10. Map showing the sixteen selected HUC 12 subwatersheds for watershed restoration planning (shaded in solid green) for the Mendocino Coast SHaRP. The Coho Salmon and steelhead diversity strata boundary is shown by a red dashed line.

Chapter 4. Watershed Meetings

Five multi-day meetings were held between July 2021 and November 2022 (Table 3). Each meeting was dedicated to a subset of the selected Hydrologic Unit Code (HUC) 12 subwatersheds. Meetings were virtual due to COVID-19 restrictions. For each meeting, the objectives were to share knowledge, collectively determine the attributes limiting salmonid survival for each life stage, and to develop restoration treatments to address these attributes.

Table 3. Mendocino Coast SHaRP watershed meeting dates for individual HUC 12 subwatersheds.

Meeting	**Dates**	**HUC 12 Subwatersheds**
Ten Mile River	Jul 27–29, 2021	South Fork, North Fork, Middle Fork Ten Mile River
Big River	Nov 2–3, 2021	South Fork, North Fork, Lower Big River
Noyo River	Mar 8–9, 2022	South Fork, Upper, Lower Noyo River
Garcia River	May 23–24, 2022	Upper, Middle, Lower Garcia River
Navarro River	Nov 15–17, 2022	North Fork, North Branch North Fork, South Branch North Fork, Upper Navarro River

The invited participants included experts with salmonid habitat restoration experience or knowledge within the selected watersheds. Invitees consisted of members from federal, state, and local governmental agencies; California Native American Tribes; researchers; consultants; non-profits; restoration practitioners; private landowners; and watershed groups.

The steering team developed and distributed an agenda and relevant materials in advance of each meeting. This included SHaRP methods, HUC 12 subwatershed overviews, the life stage/attribute table, and access to an ArcGIS Online (AGOL) web map[6]. The AGOL project was developed specifically for the Mendocino Coast SHaRP, facilitating the distribution of

[6] https://arcg.is/14Dr1T1

web maps to participants and allowing them to examine and review customized datasets across various spatial scales. These publicly available interactive maps contained data layers tailored to each watershed. Appendix B. Mendocino Coast SHaRP Glossary of ArcGIS Online Data Layerslists the datasets used. To support remote collaboration, the steering team used Mural[7], a web application for shared map viewing and note-taking.

On the first meeting day, the steering team provided a guided overview of all materials and data layers. A panel of selected experts gave presentations on topics such as watershed history, restoration practices, salmonid life history and research, climate change, hydrology, and geomorphology. Collectively, these materials served as a foundation for participants to evaluate the attributes that affect salmonid survival.

4.1 Limiting Attribute Analysis

Pacific salmon and steelhead exhibit complex life histories involving distinct life stages that use nearly every portion of a watershed. This makes them especially vulnerable to altered hydrologic regimes, loss of ecologically important flows, and degraded habitats, all of which can reduce survival at each life stage. Given the wide range of habitats used and environmental conditions encountered, identifying restoration actions that will most effectively aid in species recovery presents a challenge.

The next step in each watershed meeting was completing a limiting attribute analysis to identify the most important factors and threats limiting survival of Coho Salmon, Chinook Salmon, and steelhead at each life stage. Participants completed the analysis using a life stage-attribute rating table developed for each watershed meeting. Results from this analysis were then used by the group to help develop restoration treatments.

Salmonid Life History

The steering team developed a table that defined timing, habitat needs, and potential vulnerabilities for each salmonid life stage (Table 4). During each meeting, the life stage table was presented along with watershed-specific fish and habitat data. The goal was to create a generalized conceptual life cycle model describing fish movement and habitat use for each life stage over time, from the headwaters down to the estuary. This information was used by participants to help organize hypotheses about which life stages were most susceptible to specific environmental conditions across each watershed.

[7] https://mural.co/

Table 4. Salmonid life stage table used for the limiting attribute analysis during the Mendocino Coast SHaRP.

Life Stage	Definition	Habitat Needs	Vulnerabilities
Egg/Alevin (Nov–June)	Egg incubation and alevin emergence. Embryos incubate for 1–2 months. After hatching, alevins remain nestled in the redd and feed from their yolk sac before emerging as fry.	Transition zones between pools and riffles. Adequately sized substrate and water depth to provide flow and oxygen to incubating embryos. Channel complexity and connectivity.	Redd scour, redd dewatering, excessive fine sediment that reduces oxygen or entombs alevins.
Summer Juvenile (June–Oct)	Coho Salmon and steelhead young-of-the-year and age 1+. Movement is limited; typical period of low growth.	Coho Salmon prefer slow velocity, with large wood cover. Steelhead prefer riffle habitat. Water temperature is a key driver. Riparian vegetation provides cover, shading, food sources, and instream structure.	Surface flow disconnection, habitat drying, poor water quality, high water temperatures.
Winter Juvenile (Oct–May)	Young-of-the-year that emerge in spring. Chinook Salmon typically migrate to the estuary and ocean by late spring. Spring is typically a period of high growth for rearing Coho and steelhead age 1+	Movement is influenced by hydrology and habitat availability. Alcoves, instream habitat, and floodplains provide high flow refugia and increase rearing habitat. Intact estuaries and floodplains provide high biotic productivity.	Limited access to overwinter habitat and lack of high flow refugia.
Smolt (Mar–June)	Seaward migration. Rely on endogenous and environmental cues. Ideal time for ocean entry is during upwelling.	Adequate flow and unobstructed passage. Access to floodplains and complex habitat in lower, mainstem rivers and estuaries provides cover and access to rich food sources that facilitate their transition into the ocean.	Surface flow disconnection, early estuary bar closure, lack of high flow refugia, inaccessible floodplains, high water temperatures, and poor water quality.

Life Stage	Definition	Habitat Needs	Vulnerabilities
Adult (Oct–May)	Period of migration from the ocean to spawning grounds, and steelhead kelts returning after spawning.	Peak and base flows that provide connectivity and unobstructed passage through the migration corridor, and access to spawning habitat. Complex habitat in the form of deep pools, instream structure, and undercut banks to provide cover and resting space.	Physical or flow barriers, surface flow disconnection, delayed opening or early closure of estuary bars, delayed or limited access to spawning grounds.

California watersheds rely on the natural flow regime to support salmon and steelhead life stages (Yarnell et al. 2015). Peak river flows occur during the spawning, incubation, and overwinter rearing life stages. Low base flows occur during the over summer rearing period from late spring through fall. In some watersheds, the estuary bar remains closed through the summer and reopens in the fall due to river flow and tidal influences. Migration timing, spawning distribution, and rearing may be constrained by flow alterations resulting from below normal rainfall or shifted hydrologic patterns. Shifts in climate regimes signal the importance of diverse life history strategies to maximize species' adaptive potential.

Mature Coho Salmon and Chinook Salmon typically return to the freshwater environment from November through early February in coastal Mendocino watersheds, often after significant rainfall (McGuire et al. 2021). In some locations, salmon returns are delayed until estuary sand bars break open (Moyle 2002). In coastal Mendocino watersheds, a cumulative rainfall of about 15 – 18 centimeters (6 – 7 inches) is needed to provide initial, adequate passage for migration and to spawning grounds (McGuire et al. 2021). Adult steelhead typically arrive between late December and May. They migrate both upstream and downstream, and often farther upstream than other salmon (Moyle 2002).

Most coastal Mendocino watersheds lack quality juvenile salmonid winter rearing habitat due to degraded channel condition (Gallagher et al. 2012; Stillwater Sciences 2013a). The absence of available winter habitat can limit the expression of life history strategies and reduce opportunities for foraging, growth, and survival (Sethi et al. 2022). Prior to anthropogenic modifications to the watersheds, summer rearing habitat was likely more limiting than winter rearing habitat for juvenile Coho Salmon (Stillwater Sciences 2013a). Summer rearing habitat can still be a limiting factor, particularly during drought, in watersheds with warm summer water temperatures and reduced base flows. Peak smolt outmigration typically occurs in late spring for Coho Salmon aged 1–2 years, and steelhead aged 1–3 years. Coastal Chinook Salmon typically migrate to the estuary in spring as young-of-the-year, where they rear before entering the ocean in summer. Estuaries serve as an important transition zone for juvenile salmonids (Hughes et al. 2014). The length of time juvenile salmonids spend in estuaries is variable and depends on the estuary type and the species. Figure 11 shows a juvenile Chinook Salmon observed during a snorkel survey in the Garcia River estuary in late spring.

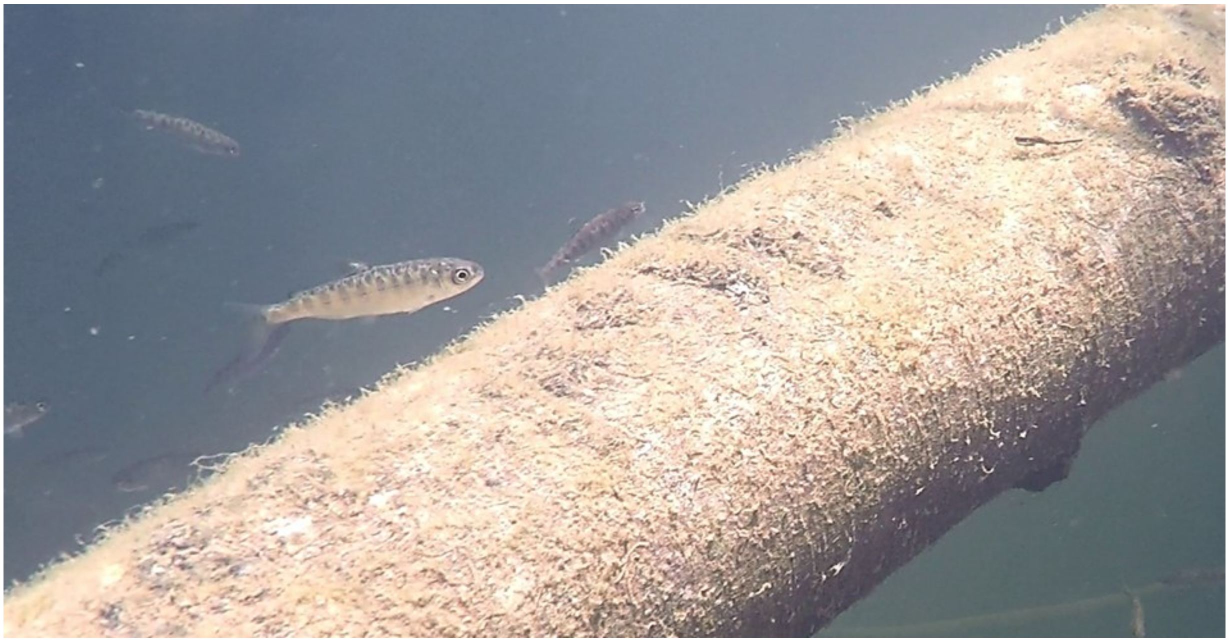


Figure 11. Chinook Salmon and steelhead young-of-the-year and steelhead using newly restored habitat in the Garcia River estuary, May 2023 (photo credit: Jen Carah, The Nature Conservancy).

Attributes

The steering team developed a list of attributes that were limiting factors or threats relevant to salmonids of the Mendocino Coast based on those identified in NOAA Fisheries recovery plans (Table 5).

Table 5. List of attributes and their associated definitions used in the limiting attribute analysis during the Mendocino Coast SHaRP to assess the influence of these attributes on one or more salmonid life stages.

Attribute	**Definition**
Anthropogenic Barriers	Insufficient quantity of habitat due to a human-caused barrier. Includes partial and ephemeral barriers.
Instream Structural Complexity	Decline of the instream habitat quality. Based on the degree of stream habitat complexity and variety, including the quantity and variability of stream depth and pools of varying sizes and depth.
Off-Channel Habitat	Loss and/or degradation of the peripheral habitat of streams and rivers, including floodplains, connected channels, and areas that are periodically inundated during high flows.
Riparian Condition	Degradation of habitat adjacent to the stream. Impairment of the near-bank environment to support plants, including large trees, that provide shade cover and terrestrial inputs to the aquatic ecosystem. This includes the supply of mature trees available as large wood to create instream habitat.
Sediment Conditions	Reduction in the quantity or quality of habitat due to changes in sediment input compared to natural rates.
Water Quality	Degraded chemical, physical, and biological characteristics of water, including water temperature, dissolved oxygen, turbidity, toxins, and pathogens.
Water Quantity	Detrimental effects that arise from deviations in the natural timing and volume of instream flow, including abnormally high or low flows.
Invasive (Non-Native) Species	An organism that causes ecological or economic harm in an environment where it is not native.

Rating

To complete the analysis, a blank life stage-attribute rating table (Figure 12) was created for each HUC 12 subwatershed and shared with participants in Mural. Life stage-attribute tables were adjusted for each watershed meeting to reflect nuances identified by the participants during discussions. Participants independently rated the impact of each attribute on each life stage as either (1) Functioning - not limiting survival; (2) Moderately Functioning - somewhat limiting survival, or (3) Not Functioning - strongly limiting survival.

Discussions were encouraged during the rating so participants could share knowledge. Participants were asked not to provide a rating if they were uncertain of a specific attribute-life stage relationship. When participants felt that a life stage- attribute rating was variable across a single HUC 12 subwatershed, they used the lowest rating to describe the broader area. During the restoration treatment discussions, participants could then specify treatments at a finer spatial scale, targeting areas where the less functioning attributes were identified.

Coho/Steelhead/Chinook					
Attribute	Egg/ Alevin	Summer Juvenile	Winter Juvenile	Smolt	Adult
Anthropogenic Barriers	N/A				
Instream Structural Complexity					
Off-Channel Habitats					
Riparian Conditions					
Sediment Conditions					
Water Quality					
Water Quantity					
Invasive/ Non-native Species					

Figure 12. Example of a blank Mendocino SHaRP life stage-attribute rating table. Participants rated the impact of each attribute on each life stage. Attributes were rated as Functioning- not limiting survival (green), Moderately Functioning- somewhat limiting survival (yellow), or Not Functioning- strongly limiting survival (red). An additional category, Not Applicable (blue), was used when the attribute did not apply to a particular life stage.

Participant ratings were automatically tallied in Mural and available for viewing. The steering team summarized the final ratings using the mean score for each attribute and life stage and combined the results into consolidated tables. Average scores were categorized as Functioning (0 – 3.3), Moderately Functioning (3.4 – 6.6), and Not Functioning (6.7 – 10). Slight adjustments were made to this scale for each watershed meeting based on participant discussion. Results were presented by the steering team, then discussed with participants. If participants believed that an attribute was incorrectly rated, adjustments were made based on a group consensus. The group moved into the next phase of the meeting to identify restoration treatments based on life stage-attribute ratings that were strongly limiting survival.

4.2 Developing Restoration Treatments

The final step for each meeting was to collectively prescribe restoration treatments to improve habitat processes, habitat diversity, and climate resilience across each HUC 12 subwatershed. Participants leveraged their knowledge of the watershed, along with ranking results and an understanding of life stage-attribute survival relationships, to identify opportunities and actions to restore or enhance the most limiting attributes to salmonid survival. Collaboratively, participants assessed each HUC 12 subwatershed in AGOL and spatially assigned site-specific treatments. After the watershed meeting concluded, the steering team distributed treatment maps to participants for review and then incorporated any edits.

Recommendations were intended to be voluntary actions achieved through outreach, education, and technical assistance. The use of regulations or laws was considered out of the scope of the SHaRP process. The following restoration treatment types were identified by participants as specific methods to improve watershed condition. More detailed guidance documents on stream restoration can be found through CDFW FRGP Guidance Tools[8].

Large Wood

The addition of large wood is a stream restoration strategy to support hydrologic and geomorphic processes that improve spawning and rearing habitat. The California Department of Fish and Wildlife Fish Bulletin 184: The Use of Large Wood in Stream Habitat Restoration provides description of large wood projects, and guidance on project implementation (Flosi et al. 2024). The Central California Coast Coho Salmon Recovery Plan developed specific targets for wood loading in streams (NMFS 2012). Targets should ideally be adjusted and selected based on data from streams with similar channel size and forest assemblages. Habitat structures are made of logs, whole trees, and/or root wads,

[8] https://wildlife.ca.gov/Grants/FRGP/Guidance#580984201-guidance-documents

that can be added within the active stream channel or off-channel areas. In small, remote streams, wood structures can be directly placed in the active channel using methods such as accelerated recruitment (Carah et al. 2014). This approach works well in remote areas with limited access, allowing for coverage of long distances of stream. While the as-built conditions create some immediate benefit for juvenile salmonid rearing, new habitat is formed over time with high winter flows, sorting of gravel, and the accumulation of new woody material through natural recruitment. When logs are placed perpendicular to the flow and span the channel, as shown in Figure 13, they are more likely to accumulate natural woody material, creating low-velocity pools for winter refugia.

Structures are usually naturally anchored using existing stream features. "For an unanchored log to remain in a stream and withstand high-flow events, it must be of sufficient length, relative to the bankfull width, and ample diameter, relative to bankfull discharge, to stay stabilized in the streambed or streambank" (Flossi et al. 2024). Some stabilizing techniques for structure logs include wedging between or bolting to live trees. "Additionally, structures can be stabilized by adding boulder ballast, keying logs into streambanks, or securing logs to piles or posts, however, these stabilization techniques require scour and stability calculations based on the results of hydrologic and hydraulic analyses" (Flosi et al. 2024). These larger multi-log structures are often designed by engineers and require heavy equipment to construct.

The function of large wood varies across watersheds to meet channel processes and fish habitat needs. Large wood can also be used in off-channel/floodplain enhancement projects. Both treatments address similar objectives:

- Scour new pools, increase the depth of existing pools, and improve complexity of cover.
- Accumulate sediment and woody debris to raise the bed elevation of incised channels.
- Create hydrologic roughness and engage natural channel processes to increase channel complexity, habitat heterogeneity, promote bar formation, disperse flow, and sort gravel.
- Increase channel migration, meanders and split channels, and backwaters that inundate during elevated stream discharge.
- Hydrologically reconnect channels with existing floodplains during winter flows to increase habitat connectivity and provide flow refugia.
- Accelerate natural recruitment of riparian trees.

Off-channel/Floodplain Enhancement

In the lower, alluvial sections of watersheds, streams grow larger, valleys widen, gradients flatten, and habitats feature multi-threaded channels and expansive floodplains. Typically, with off-channel projects, wood habitat structures are larger and contain more individual logs or whole trees. Projects can be constructed outside the active channel to reinitiate geomorphic processes and inundate floodplains during high flows. Large wood structures enhance salmonid habitat by reactivating channel processes and promoting floodplain engagement, creating features like secondary channels, alcoves, backwaters, and ponds that provide refugia during high flows. Designs often incorporate preliminary geomorphic studies, such as inundation mapping, to identify potential floodplain connections. They also include plans for wood structures and the excavation of new features. In higher-gradient reaches, small pocket alluvial areas may be suitable for off-channel habitat improvements.

Fish Passage Improvement

Fish passage improvement treatments remove partial or complete barriers for salmonids during migration. There are also barriers in saline habitats that inhibit salmonid passage. The California Salmonid Stream Habitat Restoration Manual, Volume II, Part IX; Fish Passage Evaluation at Stream Crossings (Flossi et al. 2010) provides guidance on barrier evaluation and remediation. This action can benefit migrating adults, summer and winter rearing juveniles, and smolts. Barriers are often associated with human infrastructure, including road crossings and impoundments, or result from landslides, debris, or geology. Treatments may involve culvert or tide gate upgrades, dam removal, and large wood treatment designs that improve passage at bedrock barriers by raising stream surface elevation.

Riparian Enhancement

Riparian enhancement restores riparian zones, streamside shading, and large coniferous trees that are recruited from senescence, channel avulsion, or landslides. In many places, historic riparian logging has hindered natural wood recruitment, leading to a shortage of instream large wood. Treatments may include riparian vegetation assessment and harvest management to improve natural recruitment processes.

Road Assessment/Improvement

Road assessments determine the impacts of roadways/rails on a watershed. An assessment should consider the road's purpose, whether the road surface is appropriate for its intended use, and how the road network interacts with natural hydrologic processes during runoff events (e.g., sediment, barriers, channel constriction, and access). Improvements include reducing sediment input or replacing culverts to improve fish passage. To prevent long-term impacts on a watershed, decommissioning may be the best course when roads are no longer needed.

Streamflow Enhancement

Streamflow enhancement is a treatment type that includes a broad range of techniques aimed at improving water volume, groundwater recharge, and water temperatures during the warm, dry season. This is accomplished by collaborating with landowners to reduce water diversion pressure and groundwater pumping, conserve water, and improve streamflow conditions, especially during dry years. Strategies include changing water use patterns, storage solutions, groundwater recharge, flow augmentation from off-channel storage, establishing forbearance agreements, and addressing unauthorized water diversions (Rossi et al. 2023).

In recent years, projects that increase groundwater infiltration and recharge have become increasingly important for improving dry season baseflows. Direct flow releases from storage tanks have also emerged as a key strategy to support streamflow during low-flow periods. The Collaborative Water Management report offers guidance on implementing these and other approaches to enhancing streamflow and water supply (Alford et al. 2021).

Beaver Dam Analogs

Beaver Dam Analogs (BDAs) are structures created to mimic the geomorphic processes of beaver dams. Beaver dam analogs are part of a group of treatments known as low-tech process-based restoration. California Department of Fish and Wildlife's Fish Bulletin 185 provides guidance for use for stream habitat restoration (Caisley et al. 2024). The design and installation of BDA complexes is a cost-effective, non-intrusive method that can influence hydraulic, geomorphic, and hydrologic processes in low gradient valleys. Beaver dam analogs can also be used to increase the probability of successful beaver translocation by creating immediate deep-water habitat. The Beaver Restoration Assessment Tool (BRAT)[9] can be used to further assess beaver as a restoration tool in specific locations.

Habitat Assessment

Information about specific locations important to salmonids is often limited or outdated, making assessment a critical first step before proposing restoration treatments. These assessments may include topographical surveys, large wood evaluations, habitat typing, LiDAR, and fish surveys. While not technically a restoration treatment, habitat assessments are essential for supplementing existing data and informing sound

[9] https://brat.riverscapes.net/

restoration decisions. On streams with restoration potential based on other attributes, a habitat assessment can help determine whether to proceed with treatment.

Conservation Easement

A conservation easement is a voluntary, legal agreement that permanently limits land use to protect its conservation values. Also known as a conservation restriction or agreement, a conservation easement helps safeguard a property's conservation value in the future. They can be a cost-effective tool to protect land, often providing tax benefits for landowners at a lower cost for land trusts and public agencies. In SHaRP, certain areas were recognized as having important value for the long-term protection of salmonids and their habitat.

Figure 13. Example of a newly installed large wood treatment, Gulch Seven of the North Fork Noyo River Tributary Complex - Large Wood Habitat Enhancement Project, 2022 (photo credit: Scott Monday, California Department of Fish and Wildlife).

Chapter 5. Ten Mile River

5.1 Watershed Overview

Ten Mile River is a small coastal watershed, named for its relative distance north of the Noyo River mouth in the city of Fort Bragg (Figure 14). This rugged, remote basin spans 311 square kilometers (120 square miles), flowing directly to the Pacific Ocean. Its elevation ranges from sea level at the estuary to 988 meters (3,241 feet) in the headwaters. Typically, during the summer and fall, the bar-built estuary periodically forms a sand barrier that restricts connection with the ocean. In 2012, the estuary was designated a State Marine Conservation Area under the Marine Life Protection Act (CDFW 2012).

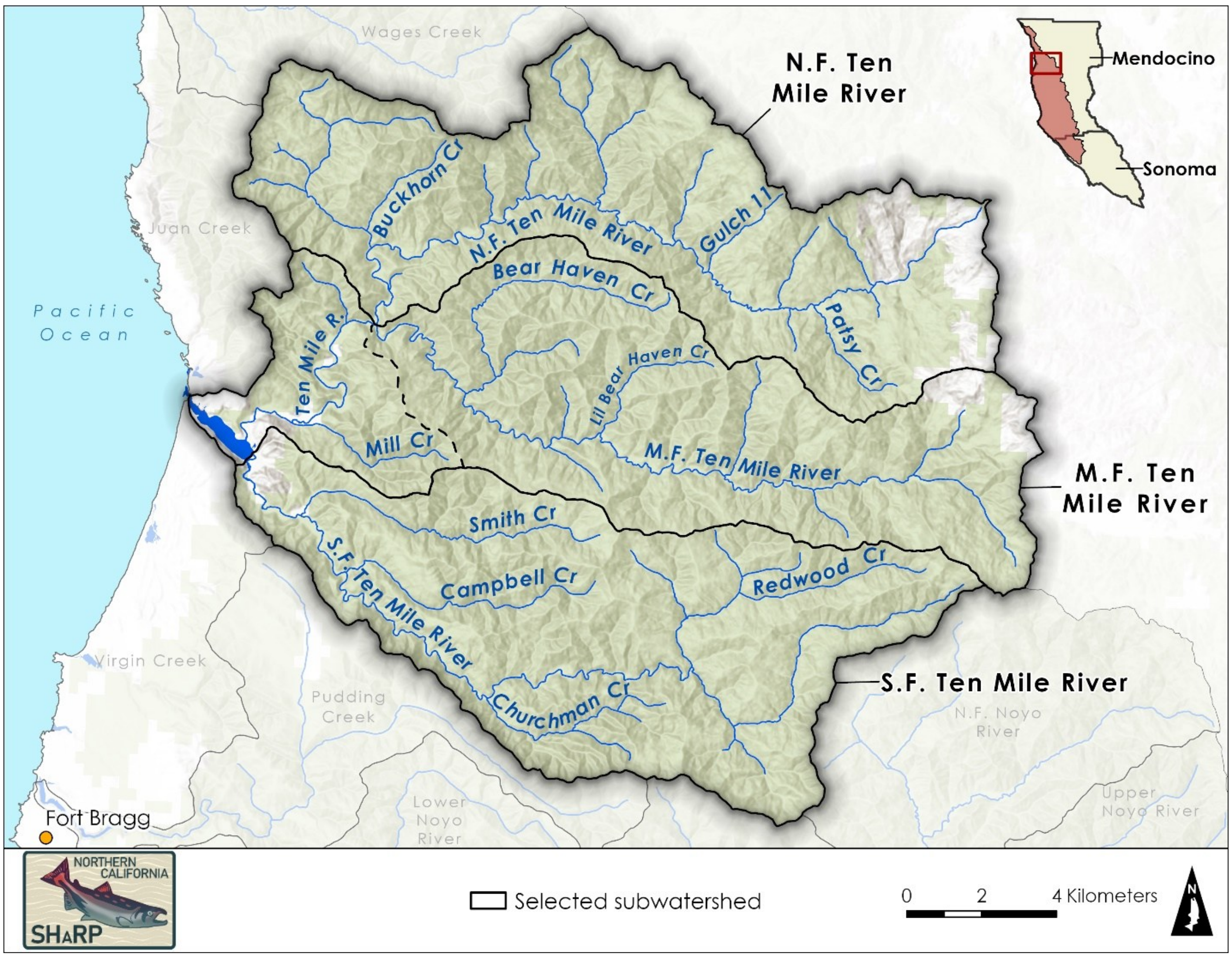


Figure 14. Overview map of the Ten Mile River, including the three HUC 12 subwatersheds selected for the Mendocino Coast SHaRP watershed planning: North Fork (N.F.) Ten Mile River, Middle Fork (M.F.) Ten Mile River, and South Fork (S.F.) Ten Mile River. The M.F. Ten Mile River was divided at the estuary ecotone (dashed line) for watershed planning.

Streamflow is unregulated by dams, with only one small impoundment located on the Little North Fork Ten Mile River. As with most remote watersheds in Mendocino County, the Ten Mile River has legal water right diversions associated with residences, ranches, and agricultural practices along with undocumented, illegal diversions.

For over a century, most of the Ten Mile River has been actively used for timber production. Since 2021, Redwood Timber Company has owned and managed approximately 90 percent of the watershed. Ranchlands occupy the coastal margins, while smaller scattered private parcels, including rural residences and ranches, are found in the northeastern interior. Ten Mile River is mostly undeveloped and managed by cooperative landowners, both of which are key to salmonid recovery.

5.2 Historical and Current Restoration

Like many coastal watersheds, past timber harvest practices have degraded salmonid habitat in the Ten Mile River, leading to its listing as impaired due to sediment and temperature in the late 1990s (US EPA 2000). Decades of effective forestry management under forest practice rules, along with extensive road improvements and salmonid habitat restoration, are gradually helping to restore the watershed. These actions have reduced excessive sediment input, improved fish passage, increased instream habitat complexity, and allowed riparian forests to mature, thereby enhancing natural recruitment. However, legacy effects of logging remain. Large wood volumes are low instream, particularly on the mainstem channels. Landslide deposits persist throughout the watershed, creating incised, low-gradient valley floors that store upslope sediment and are disconnected from floodplain habitats (Matthews 2000). Post restoration stream assessments have shown that instream wood volumes remain low compared to non-harvested old growth watersheds, emphasizing the need to revisit previous large-wood restoration projects.

In the 1970s and 1980s, instream habitat restoration in the Ten Mile River focused on removal of log jams and barriers from the stream channel to improve fish passage (Nielsen et al. 1991). During this same period, hatchery supplementation was also used to bolster populations of steelhead, Coho Salmon, and Chinook Salmon (Nielsen et al. 1991). Beginning in the early 1990s, restoration techniques shifted to incorporating large wood to create complex habitat features, enhance fish passage, and stabilize stream banks. Since 2005, Trout Unlimited (TU) has implemented dozens of projects in the tributaries of the Ten Mile River, adding at least 1,638 pieces of large wood and covering nearly 68.4 kilometers (42.5 miles) (Trout Unlimited, personal communication).

Starting in 2014, The Nature Conservancy (TNC) began protecting large properties in the lower watershed through conservation easements and fee title acquisition. This enabled large-scale instream habitat enhancement and restoration projects through associated leases. The Ten Mile River Coho Salmon Habitat Restoration and Enhancement Project is a multi-phase, multi-year project developed by TNC that focuses on floodplain reconnection following concepts from the stream evolution model from Cluer and Thorne (2014). This project enhances winter rearing habitat for juvenile Coho Salmon in the lower mainstem and lower South Fork Ten Mile River (Stillwater Sciences 2013a; 2013b). Between 2018 and 2024, four phases of this project were completed, including the installation of engineered large wood structures and the creation of over two hectares (five acres) of off-channel and side-channel habitat (Figure 15). This project also included effectiveness and validation monitoring to determine fish response to restoration (Stillwater Sciences 2023). Future phases are expected to implement all concept sites identified in the project.

Figure 15. South Fork Ten Mile River Restoration Project Site SF 17 (photo credit: David Wright, The Nature Conservancy).

5.3 Salmonid Populations

One of the first attempts to bolster salmon and steelhead populations in the basin began in 1975 with the operation of a small hatchery facility by the Salmon Restoration Association of California. The facility primarily supported Chinook Salmon while also supplementing steelhead and Coho Salmon. Chinook Salmon enhancement involved obtaining eggs from the Sacramento and Trinity River stocks for on-site incubation, rearing, and release as yearlings (Nielsen et al. 1991; Bjorkstedt et al. 2005). Hatchery operations ceased in December 1996.

By the early 1990s, some of the first population monitoring surveys were initiated. Both juvenile and adult surveys revealed low abundance and sparse distribution of Coho Salmon across the basin, with steelhead being only slightly more prevalent (Nielsen et al. 1991; Maahs 1992; Ambrose & Hines 1998). Low numbers of adult Chinook Salmon were detected during spawning surveys while smolts were captured at an outmigrant trap on the South Fork Ten Mile River (Nielsen et al. 1991; Maahs 1992). While these surveys confirmed the presence of all three salmonid species in the Ten Mile River, populations appeared to be in very low abundance.

Since 2008, spawning ground surveys have been conducted annually in the Ten Mile River under the California Monitoring Plan (CMP) to assess population status and trends. Coho Salmon and steelhead populations are low but stable, with no significant trends (McGuire et al. 2021; SWFSC 2022). In recent years, adult returns of Coho Salmon in the Ten Mile River were some of the strongest within the Central California Coast (CCC) ESU, exceeding National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries) recovery target in spawning season 2023/24 (Figure 16). The Ten Mile River also supports one of the more consistent runs of Chinook Salmon on the Mendocino Coast with an average escapement estimate of 62 (range 0 – 662) from 2008/09 to 2023/24 (n = 16).

Since 2016, salmon and steelhead have been more intensively monitored on the South Fork Ten Mile River as part of a study to evaluate the effectiveness of habitat restoration (Stillwater Sciences 2023). This effort not only confirmed that Coho Salmon are using the newly restored habitat but also provided valuable insights into juvenile production and movement. During outmigrant trapping between 2016 and 2022, Coho Salmon smolt production estimates ranged from 14,817 – 88,203, with outmigration occurring from March to early June, typically peaking in May (Stillwater Sciences 2023).

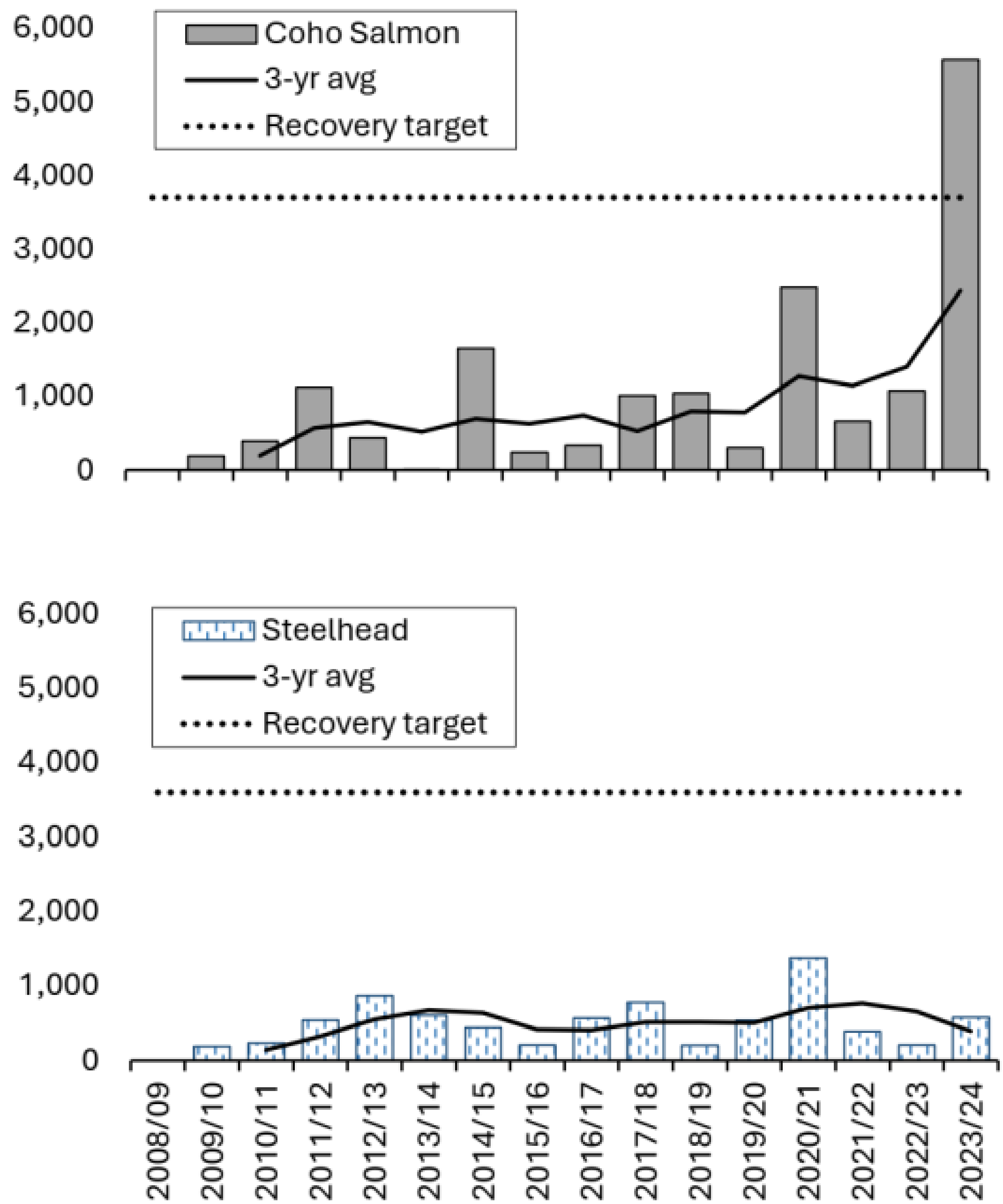


Figure 16. Ten Mile River, Mendocino County, CA Coho Salmon (top) and steelhead (bottom) annual adult escapement estimates from 2008/09 to 2023/24 (n = 16). The zero estimate in 2008/09 was due to limited survey reaches being sampled. The three-year rolling average (3-yr avg) and NOAA Fisheries recovery target are shown for each species.

5.4 Ranking Summary

The Ten Mile River Hydrologic Unit Code (HUC) 12 subwatersheds received the highest overall scores during the watershed selection process (see Chapter 3. Watershed Selection). These top rankings were largely attributed to the high scores in *Biological Importance*, with all three salmonid species present and distributed throughout the basin.

Habitat Condition scored slightly better on the South Fork Ten Mile River compared to the Middle Fork Ten Mile River and North Fork Ten Mile River (Figure 17). The South Fork Ten Mile River and Middle Fork Ten Mile River had top scores in *Optimism and Potential* due to the high percentage of timber ownership and the strong, continued support for salmon recovery and habitat restoration. The North Fork Ten Mile River scored slightly lower in *Optimism and Potential* due to lower *Intrinsic Potential* (IP) scores for both Coho Salmon and Chinook Salmon compared to the Middle Fork Ten Mile River and South Fork Ten Mile River.

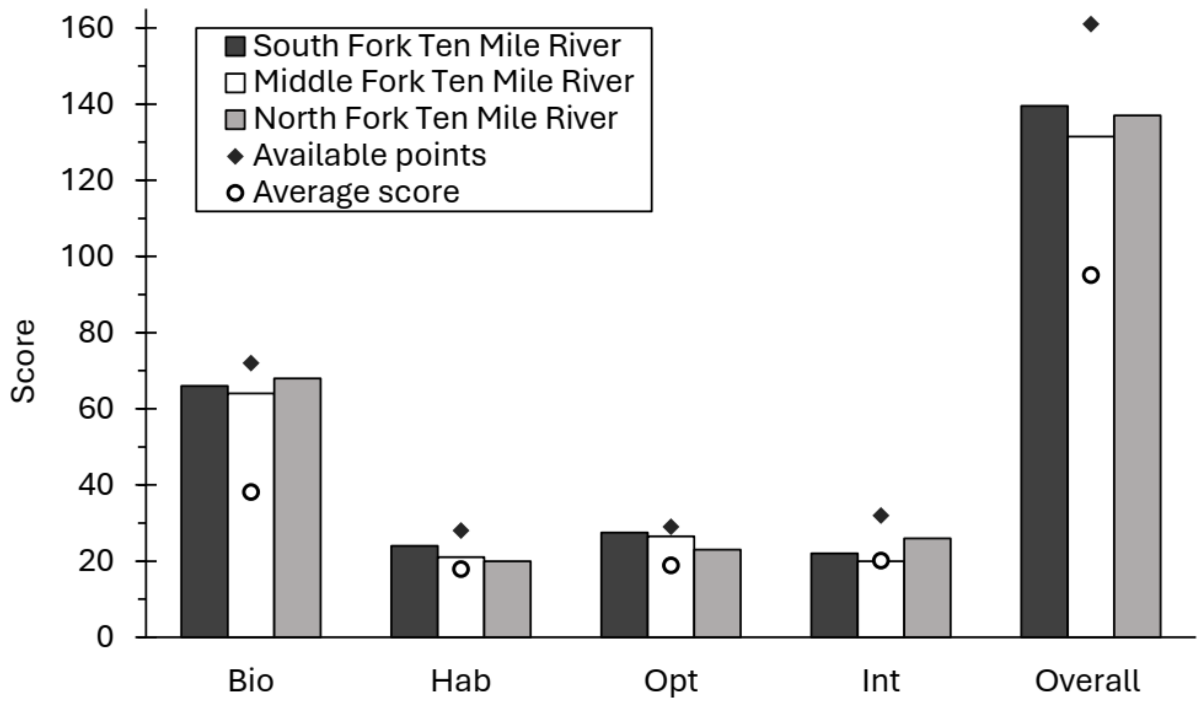


Figure 17. Ranking scores for the three selected Ten Mile River HUC 12 subwatersheds. Scores also broken down by Biological Importance (Bio), Habitat Condition (Hab), Optimism and Potential (Opt), and Integrity and Risk (Int) categories. For comparison, the average score for all 48 HUC 12 subwatersheds evaluated for the Mendocino Coast is shown by an open circle. Total available points available for each category are depicted by a diamond.

5.5 Watershed Meeting

The Salmonid Habitat Restoration Priorities (SHaRP) meeting for the Ten Mile River watershed occurred on July 27 – 29, 2021, following methods described in Chapter 4. Watershed Meetings. On the first day, the steering team introduced the SHaRP process along with life stag-attribute information specific to the Ten Mile River. A panel of practitioners presented watershed history, geomorphic processes, restoration, forestry practices, and salmon response to habitat restoration. These presentations provided participants with context important for attribute rating and identifying restoration treatments (Table 6).

Table 6. Presentations during the Ten Mile River SHaRP watershed meeting.

Title	Presenter
Ten Mile River Overview	David Wright, Fish Biologist, The Nature Conservancy
Hydrogeomorphic Processes in the Ten Mile River	Lauren Hammack, Principal Geomorphologist, Prunuske Chatham
Hydrologic Change in the Coast Redwood Forest	Liz Keppler, Hydrologist, US Forest Service
Overview of Current Fish Habitat Conditions in the Ten Mile River	Shaun Thompson, Environmental Scientist, California Department of Fish and Wildlife
Timberland Ownership and Restoration	Emily Lang, Fish Biologist, Lyme Redwood Forest Company
Non-industrial Forest Management in the Lower Ten Mile River	Linwood Gill, Forester, Usal Redwood Forest Company
South Fork Ten Mile River Coho Salmon Restoration Project: Fish Monitoring	Abel Brumo, Fish Biologist, Stillwater Sciences
Movement, Growth, and Habitat Use of Coho Salmon in the Ten Mile River	Ellory Loughridge, Fish Biologist, Pacific States Marine Fisheries Commission
Restoration Design and Effectiveness Monitoring	Lauren Hammack, Principal Geomorphologist, Prunuske Chatham and Marjorie Caisley, Engineer, California Department of Fish and Wildlife

Highlights from the panelist presentations included:

- The Ten Mile River is recovering from significant degradation caused by intensive timber harvest, as indicated by the resurgence of salmonid populations and increased channel complexity.
- Hydrogeomorphic processes in the watershed should serve as the foundation to guide restoration. There are three important zones of the watershed: (1) canyons and headwaters, which form within the bedrock and water, providing sediment and wood delivery; (2) alluvial valleys, consisting of spring-fed floodplains that provide sediment storage and transfer, riparian vegetation, and wood jams; and (3) estuary habitats, which consist of tidal and freshwater wetlands, lagoon conditions, and fine sediment deposition.
- Several drivers affect channel functionality in the lower alluvial reaches of the Ten Mile River, including channel simplification, legacy sediment, insufficient large wood, and crossings that block large wood.
- "Go big" with restoration projects in the lower watershed. Installing large wood jams to increase snags and using excavation to induce geomorphic changes will improve habitat quality.
- Mendocino coastal watersheds are experiencing similar hydrologic patterns to what was observed in a recent study on Caspar Creek. Long-term records from Caspar Creek experimental watershed in Jackson State Demonstration Forest have shown a significant decline in November precipitation; a one-third decrease in flows during November and December since the mid-1980s, accompanied by a one-month delay in the watershed's wet-up period; and slightly higher spring flows compared to pre-1985 levels.
- Significant progress has been made in addressing road and fish passage issues on timberlands, although some legacy impacts persist. Restoration should focus on areas where salmon are present, particularly in mainstem streams, and maintaining good forest practices that help retain water and decrease sediment.
- Improved grazing practices and regrowth of riparian canopy have yielded noticeable benefits.
- Fisheries monitoring has been an integral part of evaluating the effectiveness of the South Fork Ten Mile River restoration project. Preliminary findings from monitoring juvenile Coho Salmon have shown (1) interannual variability in distribution, highlighting the importance of lower mainstem habitat during drought years, (2) higher use of off-channel habitat compared to main channel, and (3) the use of restored off-channel habitat by Coho Salmon juveniles from outside the South Fork Ten Mile River.

After the presentations, participants rated the impact of attributes for each life stage. On the second day, participants leveraged their personal knowledge and the results of the limiting attribute analysis to identify specific restoration treatments in each HUC 12 subwatershed. This step was done collaboratively in ArcGIS Online.

5.6 Life Stage-Attribute Results

For life stage-attribute rating and restoration planning, the Middle Fork Ten Mile HUC 12 subwatershed was divided into two planning areas at the estuary ecotone (Figure 18, Figure 19). There were two rating scenarios in the Ten Mile River that were not used during subsequent meetings. First, Chinook Salmon were rated separately from Coho Salmon and steelhead since they do not typically overwinter as juveniles, instead rearing in the estuary during late spring and summer of their first year before entering the ocean. The steering team also oversaw two rounds of rating for each life stage-attribute relationship: (1) under current climate conditions and (2) considering future climate change impacts.

Since results under these scenarios were not substantially different, the steering team combined all species and removed the climate change scenario in future meetings. Life stage-attribute rating results are summarized below and shown in Table 7 for Chinook Salmon and Table 8 for Coho Salmon and steelhead.

Attributes strongly limiting survival

- *Instream Structural Complexity* and *Off-Channel Habitat* for Chinook Salmon at the juvenile and smolt life stages, except for in the South Fork Ten Mile River.
- *Instream Structural Complexity* and *Off-Channel Habitat* for Coho Salmon and steelhead, at the winter juvenile life stage across all planning areas. This was also true for the summer juvenile life stage in the North Fork Ten Mile River and Middle Fork Ten Mile River. At the smolt stage, this was limiting in the North Fork Ten Mile River, Middle Fork Ten Mile River, and South Fork Ten Mile River.

Attributes least limiting survival

- *Water Quantity, Barriers, Sediment Conditions, Riparian Condition, and Water Quality* were mostly not a concern across watersheds and life stages. However, under the climate change scenario (results not shown in table) *Water Quantity* became more limiting for adults, summer parr, and smolt life stages.

Table 7. Chinook Salmon life stage-attribute rating for selected Ten Mile River HUC 12 subwatersheds for the Mendocino Coast SHaRP. Note ‘Estuary’ is not a HUC 12 but was separated from the Middle Fork for rating. Life stages are EA = Egg/Alevin; SJ = Summer Juvenile; SM = Smolt; AD = Adult. N/A = Not Applicable. Average scores were binned as Functioning/not limiting survival (0 – 3.3) green, Moderately Functioning/somewhat limiting survival (3.4 – 6.6) yellow, or Not Functioning/strongly limiting survival (6.7 – 10) red.

HUC 12	Attribute	EA	SJ	SM	AD
Estuary	Barriers	N/A	2.3	2.3	2.5
Estuary	Instream Complexity	4.8	6.8	5.2	5.2
Estuary	Off-Channel	4.1	6.1	4.9	3.0
Estuary	Riparian	3.0	3.5	2.6	2.7
Estuary	Sediment	5.2	3.0	2.3	3.1
Estuary	Water Quality	2.2	1.9	2.7	2.9
Estuary	Water Quantity	2.7	2.6	5.1	5.3
North Fork	Barriers	N/A	2.0	1.8	3.4
North Fork	Instream Complexity	4.2	6.7	6.7	4.3
North Fork	Off-Channel	3.0	8.8	6.2	1.8
North Fork	Riparian	2.0	4.0	2.6	2.6
North Fork	Sediment	3.4	3.0	1.8	2.3
North Fork	Water Quality	2.6	1.0	1.0	1.8
North Fork	Water Quantity	4.4	3.3	4.4	6.0
Middle Fork	Barriers	N/A	2.0	2.3	3.0
Middle Fork	Instream Complexity	5.2	6.4	6.9	5.0
Middle Fork	Off-Channel	3.0	7.5	6.4	3.0
Middle Fork	Riparian	3.0	3.4	3.0	2.3
Middle Fork	Sediment	3.4	1.8	1.0	2.1
Middle Fork	Water Quality	2.3	1.0	1.0	1.6
Middle Fork	Water Quantity	4.7	2.5	2.9	4.8
South Fork	Barriers	N/A	1.7	1.7	2.5
South Fork	Instream Complexity	5.2	6.2	6.2	5.7
South Fork	Off-Channel	2.7	6.1	4.7	3.3
South Fork	Riparian	3.2	3.5	2.5	2.7
South Fork	Sediment	3.9	2.7	2.3	2.5
South Fork	Water Quality	1.5	2.1	1.6	1.5
South Fork	Water Quantity	3.1	2.9	3.1	4.9

Table 8. Coho Salmon and steelhead life stage-attribute rating for selected Ten Mile River HUC 12 subwatersheds for the Mendocino Coast SHaRP. Note 'Estuary' is not a HUC 12 but separated from the Middle Fork for rating purposes. Life stages are EA = Egg/Alevin; SJ = Summer Juvenile; WJ = Winter Juvenile; SM = Smolt; AD = Adult. N/A = Not Applicable. Average scores were binned as Functioning/not limiting survival (0 – 3.3) green, Moderately Functioning/somewhat limiting survival (3.4 – 6.6) yellow, or Not Functioning/strongly limiting survival (6.7 – 10) red.

HUC 12	Attribute	EA	SJ	WJ	SM	AD
Estuary	Barriers	N/A	1.9	1.8	1.4	2.3
Estuary	Instream Complexity	4.5	6.3	7.8	5.9	5.7
Estuary	Off-Channel	3.4	6.5	7.5	5.7	4.4
Estuary	Riparian	2.3	3.5	5.3	3.9	3
Estuary	Sediment	3.9	1.9	2.8	1.9	3.8
Estuary	Water Quality	1.9	3.7	1.8	1.7	1.9
Estuary	Water Quantity	2.9	3.6	2.2	3.4	4.2
North Fork	Barriers	N/A	2.5	3.2	3.8	3.3
North Fork	Instream Complexity	5	9.2	8.8	8.6	5.9
North Fork	Off-Channel	3.4	7.5	9.4	8.6	3.3
North Fork	Riparian	2.6	3.3	3.8	3.9	1.8
North Fork	Sediment	4.3	1.8	3	1.8	2
North Fork	Water Quality	2.6	1.7	1.7	1	1.8
North Fork	Water Quantity	4.7	5.3	3.2	6.2	6.4
Middle Fork	Barriers	N/A	2.3	2.3	1.7	3
Middle Fork	Instream Complexity	3.7	8.6	8.1	7.1	5.7
Middle Fork	Off-Channel	3.4	8	8.6	7.7	2.3
Middle Fork	Riparian	2.6	2.7	2.6	3.3	1.8
Middle Fork	Sediment	4.3	1.8	3.4	2.3	3
Middle Fork	Water Quality	2	1.6	2.7	2.1	2.1
Middle Fork	Water Quantity	4.7	5.3	4.5	6	5.2
South Fork	Barriers	N/A	2.1	1.8	1.4	2.5
South Fork	Instream Complexity	5.2	6	7.6	6.0	5.7
South Fork	Off-Channel	3	5.3	8.2	8	3.5
South Fork	Riparian	3	2.9	3	3.2	2.3
South Fork	Sediment	3.8	3.3	3	2.8	2.5
South Fork	Water Quality	1.8	2.1	1.4	1.4	1.9
South Fork	Water Quantity	3.2	4.9	3.3	4.0	4

5.7 Restoration Treatments

Restoration treatments are summarized by type (defined in Chapter 4.2 Developing Restoration Treatments) for the Ten Mile River selected HUC 12 subwatersheds in Table 9. Individual treatments are listed and described in Table 10-Table 12 and shown geographically in Figure 18-Figure 21.

In general, the upstream treatment boundaries coincided with the upper extent of medium steelhead IP. Most recommended treatments focused on increasing instream complexity and off-channel habitat to support rearing juveniles and smolts. Large wood was the most frequently selected treatment type, primarily to be applied in the upper mainstems and tributaries, as well as to enhance off-channel habitats in the low-gradient mainstems (Table 9, Figure 18). Adding large wood to meet targets refers to those set in the CCC Coho Salmon Recovery Plan (NMFS 2012). Given that many sections of the Ten Mile River have already undergone large wood treatments, participants emphasized the importance of considering riparian recruitment when planning future instream large wood projects. There were two road assessment/improvement treatments recommended along the mainstem North Fork Ten Mile River (Table 11, Figure 20) and South Fork Ten Mile River (Table 12, Figure 21), while the remaining treatments included riparian enhancement and streamflow enhancement in the South Fork Ten Mile River (Table 12, Figure 21), and habitat assessments in two tributaries in the North Fork Ten Mile River (Table 11, Figure 20).

Table 9. Restoration treatment summary for the Ten Mile River HUC 12 subwatersheds for the Mendocino SHaRP. MFT = Middle Fork Ten Mile River; NFT = North Fork Ten Mile River; SFT = South Fork Ten Mile River. Includes number of projects (n) and stream kilometers (km). Treatment types include LW = Large wood; OC = Off- channel/floodplain enhancement; RA = Road assessment/improvement; RE = Riparian enhancement; HA = Habitat assessment; SE = Streamflow enhancement. N/A = Not applicable.

Type	**LW**	**OC**	**RA**	**RE**	**HA**	**SE**	***Total***
MFT (km)	37.5	21.5	4.0	3.8	0.0	N/A	*66.7*
MFT (n)	7	5	1	1	0	0	*14*
NFT (km)	33.0	8.1	26.6	0.0	3.1	N/A	*70.8*
NFT (n)	8	1	2	0	2	0	*13*
SFT (km)	26.1	21.8	10.4	18.2	0.0	N/A	*76.5*
SFT (n)	4	1	2	2	0	1	*10*
Total (km)	*96.6*	*51.4*	*41.0*	*22.0*	*3.1*	*N/A*	***214.0***
Total (n)	*19*	*7*	*5*	*3*	*2*	*1*	***37***

Table 10. Middle Fork Ten Mile River (MFT) HUC 12 subwatershed restoration treatments for the Mendocino SHaRP. Each restoration treatment includes a unique identification code (ID), treatment type (type), general project location and description, and length in kilometers (km). OC = Off-channel/floodplain enhancement; LW = Large wood; RA = Road assessment/improvement; FP = Fish passage improvement; HA = Habitat assessment; RE = Riparian enhancement. See Figure 18 and Figure 19 for maps of treatment locations.

ID	Location	Type	Details	Length (km)
MFT01	Estuary	OC	Add engineered wood habitat structures to reduce predation. Investigate berm removal to increase connectivity to the floodplain.	2.45
MFT02	Mainstem from South Fork upstream to North Fork	OC	Develop projects using existing conceptual designs by TNC Conservancy to increase connectivity to floodplain and abandoned agricultural lands. Techniques may include excavation and engineered wood habitat structures. Important rearing location for Chinook Salmon.	8.67
MFT03	Middle Fork from North Fork upstream to Bear Haven	OC	Add engineered wood habitat structures. Whole-tree projects would work well in the most downstream section due to stream size.	5.41
MFT04	Middle Fork from Bear Haven upstream to Horsetail Gulch	OC	Add engineered wood habitat structures in conjunction with MFT05. Reach was treated in 2012 with large wood.	3.78
MFT05	Middle Fork from Bear Haven upstream to Horsetail Gulch	RE	Evaluate the natural or managed recruitment potential and retreatment type in MFT04. Tree stand condition may provide harvest opportunities to enhance instream wood recruitment.	3.78
MFT06	Middle Fork from Horsetail Gulch upstream to barrier near Gulch 27	LW	Add large wood to meet targets. Area upstream of Booth Gulch confluence would focus on steelhead habitat enhancement.	13.02

ID	Location	Type	Details	Length (km)
MFT07	Mill Creek	LW	Investigate habitat conditions to determine if large wood is needed to meet targets. In conjunction with MFT08. Provides habitat opportunities in the lower Ten Mile River basin.	6.10
MFT08	Mill Creek	OC	Breach berm that confines channel and deepens adjacent field using excavation to remove aggradation and allow floodplain connection. In conjunction with MFT07. TNC developed designs and completed project construction in 2025.	1.14
MFT09	Gulch 3	LW	Investigate fish use and habitat condition. If needed, add large wood to meet targets. Recent culvert upgrade improved fish passage into Gulch 3. Provides habitat opportunities in the lower Ten Mile River basin.	1.88
MFT10	Bear Haven Creek mouth upstream to South Fork Bear Haven Creek	LW	Add large wood to meet targets upstream of the 2024 Bear Haven large wood project.	1.11
MFT11	Bear Haven Creek from South Fork Bear Haven to headwaters	LW	Add large wood using accelerated recruitment methods with a chainsaw due to limited access. Focus on the lower 4.8 kilometers (3 miles) as wood levels are sufficient upstream. In 2023 and 2024, the lower 2 kilometers (1.25 miles) were treated with large wood by TU.	8.79
MFT12	South Fork Bear Haven Creek	LW	Add large wood but assess needs first. Previous assessments showed high amounts of wood, however, this may have been transported downstream during high flow events.	2.62
MFT13	Little Bear Haven Creek	LW	Conduct habitat condition assessments. If needed, treat with large wood to meet targets. Perform in conjunction with a road assessment in MFT14. Supports Coho Salmon but exhibits channel incision within the bedrock, likely caused by road degradation.	3.99

ID	Location	Type	Details	Length (km)
MFT14	Little Bear Haven Creek	RA	Road assessment in 2001. Prescriptions are likely outdated for current conditions and may be contributing to incision or sedimentation. Perform concurrently with habitat assessment in MFT13.	3.99

Table 11. North Fork Ten Mile River (NFT) HUC 12 subwatershed restoration treatments for the Mendocino SHaRP. Each restoration treatment includes a unique identification code (ID), treatment type (type), general project location and description, and length in kilometers (km). OC = Off-channel/floodplain enhancement; LW = Large wood; RA = Road assessment/improvement; FP = Fish passage improvement; HA = Habitat assessment; RE = Riparian enhancement. See Figure 18 and Figure 20 for maps of treatment locations.

ID	Location	Type	Details	Length (km)
NFT01	North Fork upstream of Cavanough Gulch	LW	Previously treated with 21 kilometers (13 miles) instream large wood project in 2010 from confluence to Gulch 19. Perform site accessibility and habitat evaluation. Add large wood to meet targets. Channel incised and disconnected from floodplain. More boulders with narrower floodplain compared to NFT02. Beneficial for Chinook Salmon in North Fork.	16.85
NFT02	North Fork mouth upstream to Cavanough Gulch	OC	Build engineered large wood habitat structures to restore habitat forming processes. Channel incised and disconnected from floodplain. Site accessibility evaluation needed. Beneficial for Chinook Salmon due to their use of the North Fork. In conjunction with NFT13.	8.06
NFT03	Little North Fork from mouth upstream to impoundment	LW	Add large wood to meet targets. Instream wood is currently present, and additions could improve habitat forming processes. Hot spot for Coho Salmon spawning. Engage with private landowners for treatment strategy in the upper watershed. Planning should incorporate measures to prevent road damage during treatment.	5.76
NFT04	Buckhorn Creek on Little North Fork	LW	The channel is incised. Investigate habitat to determine wood treatment needs then implement the project. Integrate treatment with road decommission in NFT05. Good potential for improving habitat for Coho Salmon.	1.64

ID	Location	Type	Details	Length (km)
NFT05	Buckhorn Creek on Little North Fork	RA	Evaluate for decommission. Abandoned road runs along the creek and falls into the river in places. To be carried out in conjunction with NFT04.	1.69
NFT06	McGuire Creek on Little North Fork	HA	Evaluate to determine restoration needs. Potential for large wood enhancement.	1.74
NFT07	Bald Hill Creek	LW	Retreat the 2.7-kilometer wood project completed in 2013 to meet targets. Good amount of Coho Salmon spawning present.	2.77
NFT08	Gulch 8	LW	Steep, incised bedrock channel that makes salmonid access difficult. Roads may be adding sediment. Investigate methods for adding wood to repair incision, increase coarse sediment, and improve water storage. Habitat enhancement would provide important tributary rearing and steelhead spawning habitat in the upper North Fork.	1.54
NFT09	Gulch 11	LW	Steep, incised bedrock channel that makes salmonid access difficult. Roads may be adding sediment. Investigate methods for adding wood to repair incision, increase coarse sediment, and improve water storage. Habitat enhancement would provide important tributary rearing and steelhead spawning habitat in the upper North Fork.	1.85
NFT10	Gulch 19	LW	Steep, incised bedrock channel that makes salmonid access difficult. Roads may be adding sediment. Investigate methods for adding wood to repair incision, increase coarse sediment, and improve water storage. Habitat enhancement would provide important tributary rearing and steelhead spawning habitat in the upper North Fork.	1.64

ID	Location	Type	Details	Length (km)
NFT11	Patsy Creek	HA	Conduct assessment to determine if large wood levels are sufficient. Very steep in the upper portion of the watershed. Most upstream Coho Salmon tributary in the North Fork.	1.32
NFT12	Gulch 23	LW	Steep, incised bedrock channel that makes salmonid access difficult. Roads may be adding sediment. Investigate methods for increasing wood to repair incision, increase coarse sediment, and improve water storage. Habitat enhancement would provide important tributary rearing and steelhead spawning habitat in the upper North Fork.	0.98
NFT13	North Fork mouth upstream to Cavanough Gulch	RA	Assess and determine options for road improvement. Road may be contributing to incision or sedimentation. In conjunction with NFT01 and NFT02.	24.93

Table 12. South Fork Ten Mile River (SFT) HUC 12 subwatershed restoration treatments for the Mendocino SHaRP. Each restoration treatment includes a unique identification code (ID), treatment type (type), general project location and description, and length in kilometers (km). OC = Off-channel/floodplain enhancement; LW = Large wood; RA = Road assessment/improvement; FP = Fish passage improvement; HA = Habitat assessment; RE = Riparian enhancement; SE = Streamflow enhancement. See Figure 18 and Figure 21 for maps of treatment locations.

ID	Location	Type	Details	Length (km)
SFT01	South Fork mouth upstream to Redwood Creek	OC	Previously treated with large wood. Retreat upstream of Campbell Creek confluence with engineered designs due to proximity to houses and roads. In 2023 and 2024, TU retreated 3.5 kilometers (2.2 miles) with large wood. Some cattle grazing occurs in this reach. In the downstream portion of this reach, continue to develop projects using existing TNC conceptual designs to increase connectivity to floodplain.	21.84
SFT02	South Fork upstream of Redwood Creek	LW	Add large wood to meet targets. Projects may need an engineered design, and access is challenging. Scope may be limited by landowner access permission. Steelhead are prevalent.	9.19
SFT03	Lower Smith Creek	LW	Investigate habitat and add large wood to meet targets if needed.	9.12
SFT04	Lower South Fork	SE	Investigate impacts of water use on streamflow and habitat during summer period. Determine streamflow enhancement strategy and implement.	point
SFT05	Upper Smith Creek	RA	Consider decommissioning abandoned road in the upper half of the watershed. Wood targets most likely have been met and confirmed by TNC observations. Coho Salmon consistently present.	4.31
SFT06	Lower Campbell Creek	LW	Previously treated. Add large wood to meet targets. This reach also has good potential for floodplain reconnection through treatment.	3.54

ID	Location	Type	Details	Length (km)
SFT07	Campbell Creek	LW	Investigate habitat and add large wood to meet targets upstream of the 2017 large wood project. Previous habitat assessment results showed good conditions. TNC observations confirm high density of wood and Coho Salmon juveniles in 2025.	4.20
SFT08	Lower Churchman Creek	RE	Previously treated with large wood. Investigate habitat to determine wood levels. If targets are met, use forest management and accelerated recruitment to maintain wood levels.	3.65
SFT09	Redwood Creek	RE	Previously treated with large wood in 2017 and 2018 with direct falling. Investigate habitat to determine wood levels. If targets are met, use forest management and accelerated recruitment to maintain wood levels.	14.52
SFT10	South Fork mouth upstream to Campbell Creek	RA	Work with the landowner to improve the road conditions. Road is muddy and may create water quality issues. Significant road improvements were made to Smith Ranch Road (mouth to Camp 1 Ten Mile Rd) in summer 2024 to help address this recommendation.	6.12

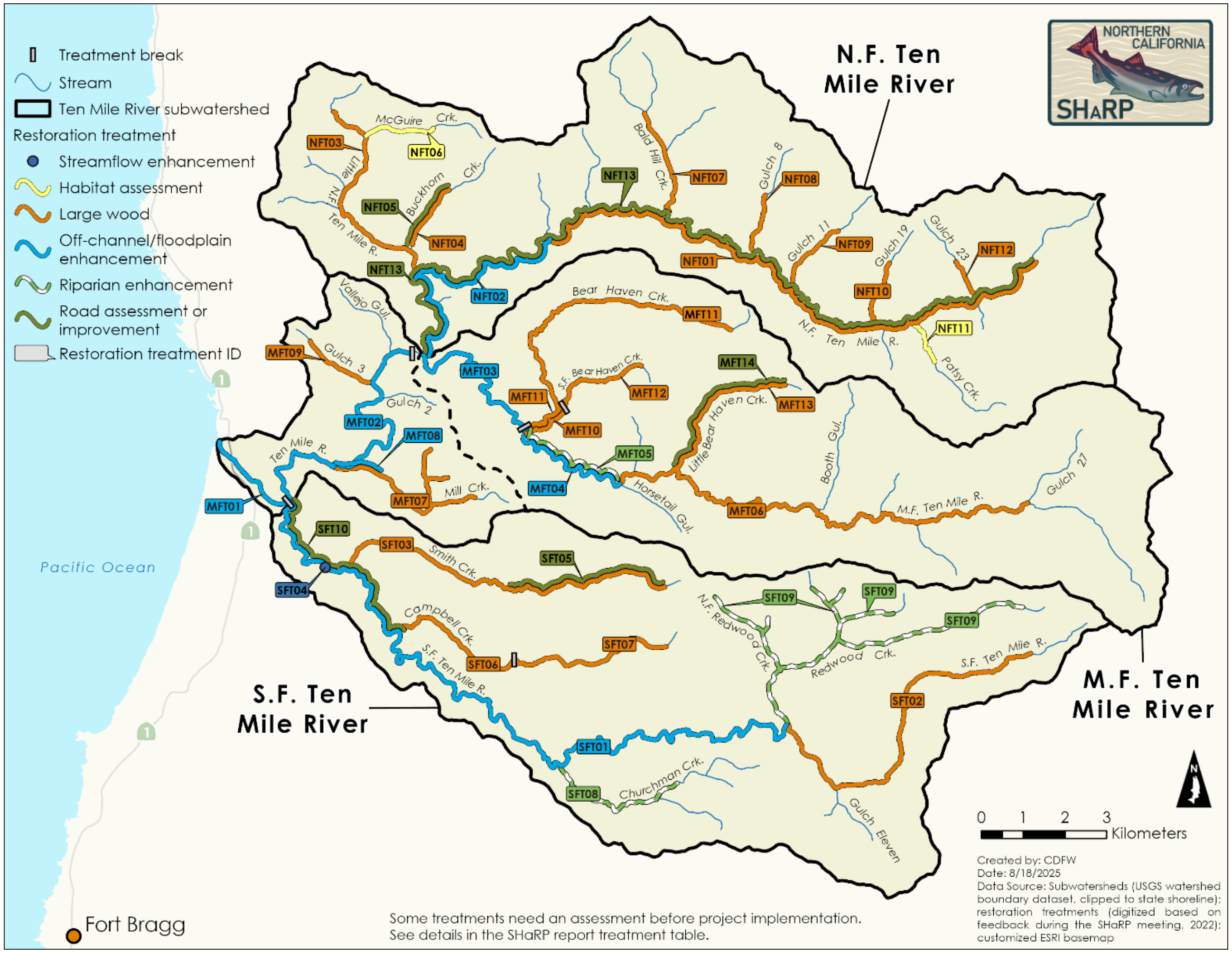


Figure 18. Restoration treatment map for the North Fork (N.F.) Ten Mile River, South Fork (S.F) Ten Mile River, and Middle Fork (M.F) Ten Mile River HUC 12 subwatersheds for the Mendocino SHaRP. The M.F Ten Mile River was divided into two planning areas at the estuary ecotone represented by the dashed line. Treatment breaks delineate individual treatment extents when those adjacent were the same type. See Tables 10–12 for treatment details.

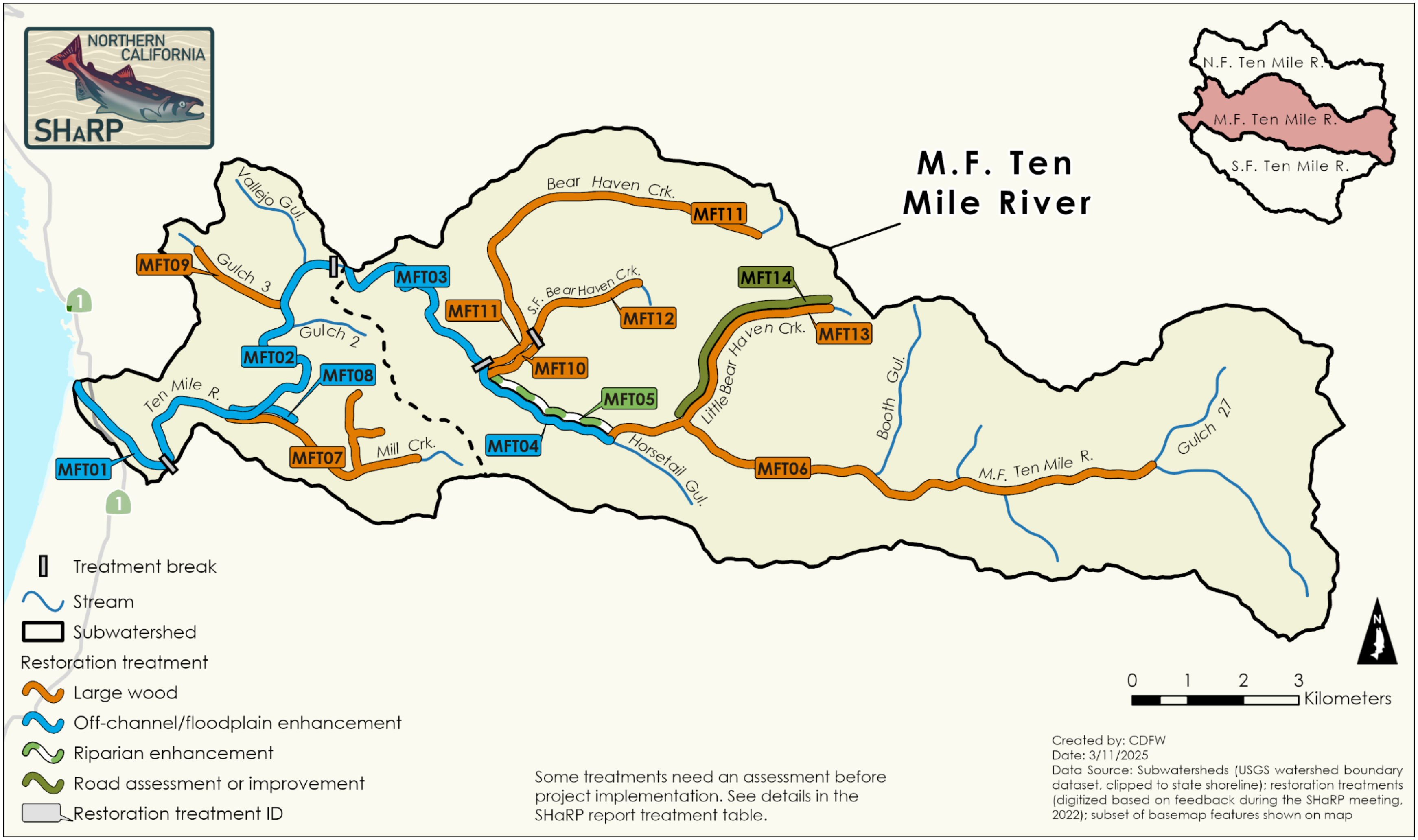


Figure 19. Restoration treatment map for the Middle Fork (M.F.) Ten Mile River HUC 12 subwatershed for the Mendocino SHaRP. The M.F. Ten Mile River was divided into two planning areas at the estuary ecotone, represented by the dashed line. Treatment breaks delineate individual treatment extents when those adjacent were the same type. See Table 10 for treatment details.

Figure 20. Restoration treatment map for the North Fork (N.F.) Ten Mile River HUC 12 subwatershed for the Mendocino SHaRP. See Table 11 for treatment details.

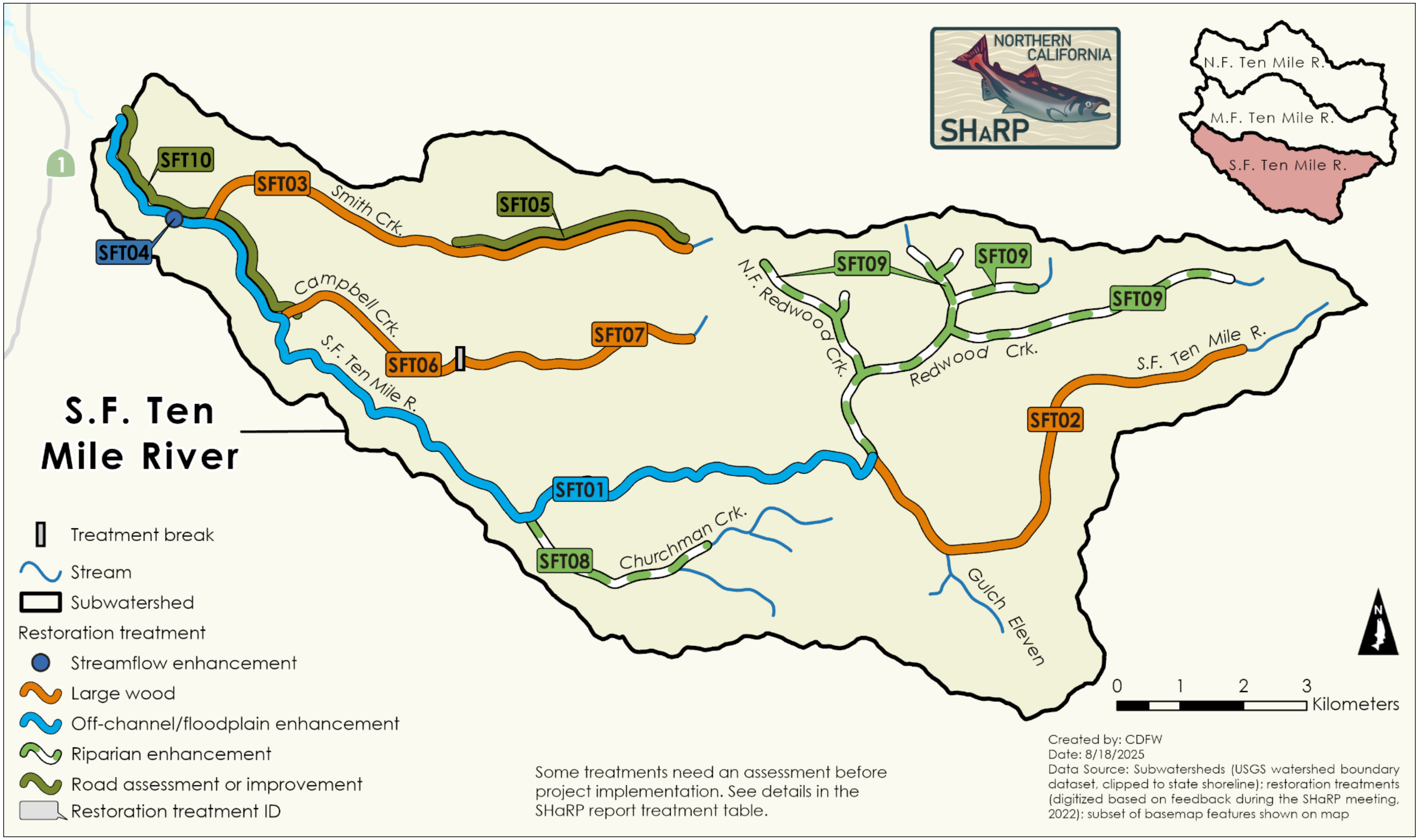


Figure 21. Restoration treatment map for the South Fork (S.F.) Ten Mile River HUC 12 subwatershed. Treatment breaks delineate individual treatment extents when those adjacent were the same type. See Table 12 for treatment details.

Chapter 6. Big River

6.1 Watershed Overview

The Big River watershed encompasses 469 square kilometers (181 square miles) and includes four Hydrologic Unit Code (HUC) 12 subwatersheds. It flows directly into the Pacific Ocean near the village of Mendocino (Figure 22). Elevation ranges from sea level at the estuary up to 864 meters (2,835 feet) in the Coast Range mountains in the eastern part of the basin.

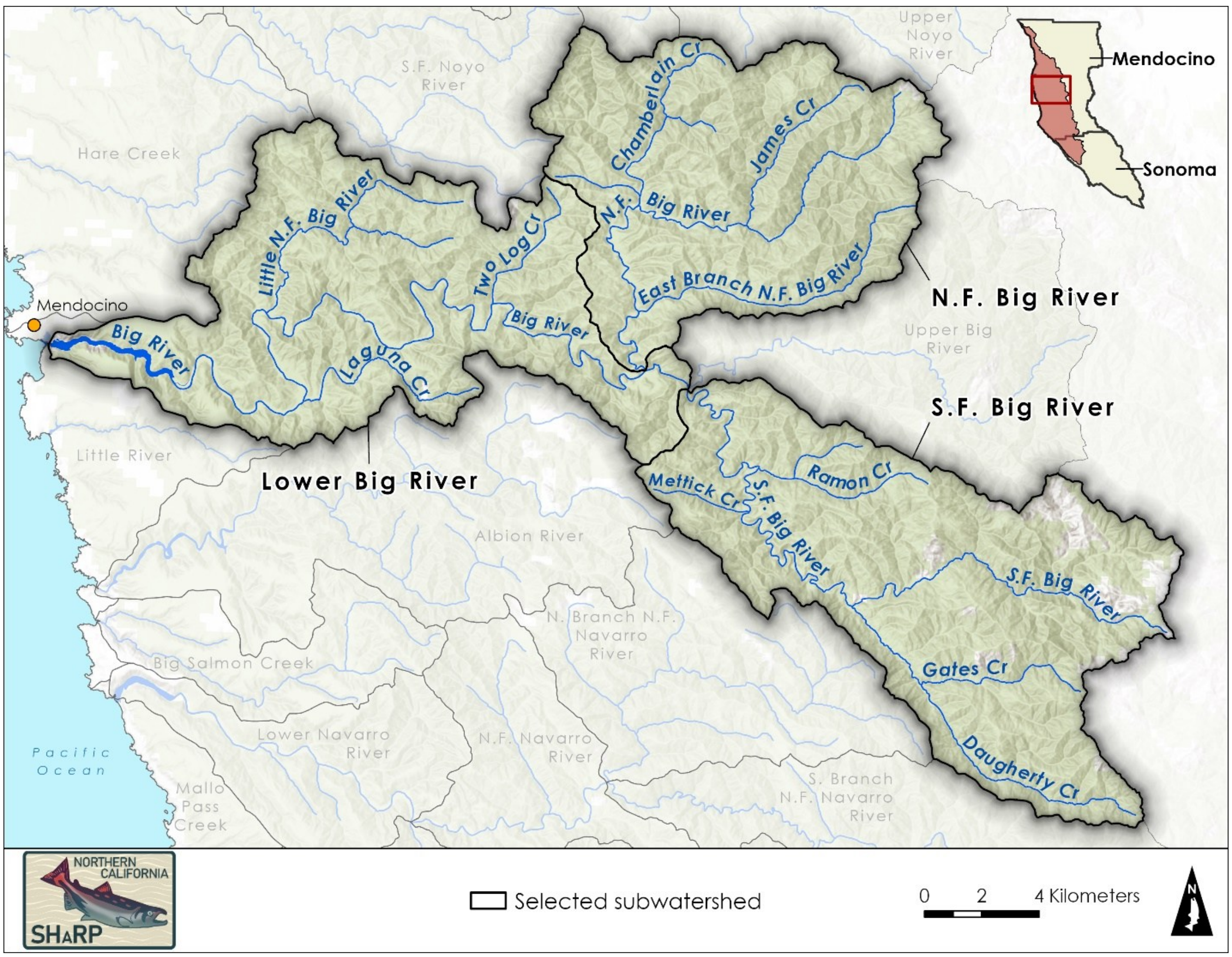


Figure 22. Overview map of Big River highlighting the three HUC 12 subwatersheds selected for the Mendocino Coast SHaRP watershed planning: Lower Big River, North Fork (N.F.) Big River, and South Fork (S.F.) Big River.

Big River flows freely with no major impoundments; however, both legal and illegal water diversions exist, predominantly in North Fork Big River and South Fork Big River. The riverine estuary remains open to the ocean year-round, featuring tidal flats, coastal marshes, and eelgrass beds. It lacks a wide lagoon characteristic of some coastal estuaries, instead featuring a long, linear channel that extends upstream 4.8 kilometers (3 miles) in the winter, and up to 12.9 kilometers (8 miles) during high spring tides. In 2012, the lower estuary was designated as a State Marine Conservation Area (CDFW 2016).

Outside of protected state lands and small residential properties, most of the Big River watershed is actively managed for timber production. Approximately 24 kilometers (14.9 miles) of the lower portion of the Big River watershed is owned and managed by California State Parks, including Mendocino Headlands State Park and Mendocino Woodlands State Park on the Little North Fork. The Conservation Fund (TCF) owns and manages the Big River Forest, which includes portions of the Lower Big River mainstem and tributaries. Under TCF ownership, land is protected from development and managed to improve habitat and provide sustainably harvested forest products (TCF 2019). North Fork Big River is mostly timberlands managed by Jackson State Demonstration Forest and Mendocino Redwood Company (MRC). South Fork Big River is primarily owned by MRC, with the upper portion of the watershed consisting of smaller, residential parcels and Montgomery Woods State Natural Reserve encompassing the headwaters.

6.2 Historical and Recent Restoration

Past logging practices in Big River have left long-term effects on salmonid habitat. In the mid to late 1800s, a railroad was constructed along the estuary to transport logs to the mill, accompanied by the construction of at least 27 splash dams in the upper watershed. This greatly accelerated erosion and removed large amounts of instream large wood (Jackson 1991; Downie et al. 2006; TCF 2019). As a result, the estuary experienced extensive sedimentation and the loss of salt marshes (Marcus & Reneau 1981). The United States Environmental Protection Agency listed Big River as having impaired water quality due to sediment and temperature, and in 2001, a Total Maximum Daily Load (TMDL) limit for sediment was developed (US EPA 2001). Some of the natural stream processes affected by past land use in Big River include entrenched channels, lack of functional floodplains, reduced instream habitat complexity, shortage of large wood, and fish passage barriers (Downie et al. 2006). Logging in the region has left an extensive network of roads throughout much of the watershed.

For decades, habitat restoration has been implemented in Big River, with past projects focusing on removing barriers to improve fish passage, road decommissioning to reduce sediment input, and adding large wood to enhance instream habitat. Since 2000, at least 18 projects have focused on road decommissioning, large wood structure placement, and tributary culvert upgrades in Lower Big River. In North Fork Big River, at least 11 large wood projects have been completed, along with several restoration projects targeting road decommissioning. An assessment of road-related erosion and watershed conditions in

Chamberlain Creek and Gulch 16 within Jackson Demonstration State Forest identified sedimentation sources and recommended large wood loading treatments (PWA 2016). Recently, three important fish passage improvement projects were completed in North Fork Big River with funding from FRGP. In 2017, Trout Unlimited (TU) remediated a fish passage barrier on Manly Gulch, a tributary to North Fork Big River. This project restored 1.2 kilometers (0.75 miles) of stream habitat and added 13 large wood structures to treat channel incision. In 2018, 11 kilometers (6.8 miles) of habitat were opened on James Creek by improving fish passage at a bedrock cascade and a road culvert barrier. Shortly after the project was completed, Coho Salmon were documented upstream of the former barrier. In 2023, TU remediated a culvert to allow passage into Dry Dock Gulch, a small tributary located approximately 8 kilometers (5 miles) upstream from the ocean. This project was identified as a recommendation in the SHaRP planning phase (Table 15; Treatment ID LB11) and restored access to approximately 0.30 hectares (0.75 acres) of off-channel rearing habitat in the lower mainstem river (Figure 23).

Figure 23. Culvert remediation and off-channel restoration project at Dry Dock Gulch in the Big River Estuary. Project completed by Trout Unlimited in 2023 (photo credit: Sarah Gallagher, California Department of Fish and Wildlife).

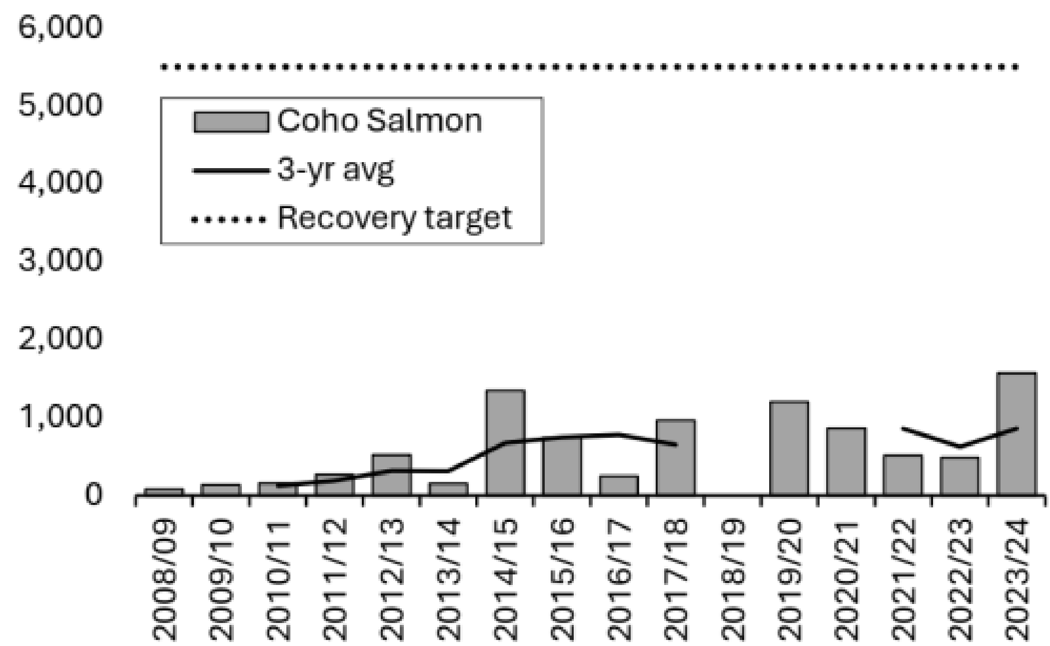
In South Fork Big River, projects have primarily focused on passage barriers. There have also been several notable road decommissioning projects on Ramon Creek and South Daugherty Creek, in addition to dozens of instream habitat enhancement projects.

6.3 Salmonid Populations

Prior to status and trend population monitoring, there was little data to determine historical estimates of salmon and steelhead in Big River. Stream survey assessments conducted by the California Department of Fish and Game (CDFG) in the 1950s and 1960s documented stream conditions, as well as species presence and densities based on juvenile observations. From the late 1950s through 1983, Big River was supplemented with out-of-basin, hatchery-reared Coho Salmon juveniles to increase population abundances (Bjorkstedt et al. 2005). Between 1949 and 1952, Chinook Salmon juveniles from the Mad

River were also released into Big River to supplement and improve the ocean fishery catch (Bjorkstedt et al. 2005; Downie et al. 2006). By the 1980s, Coho Salmon were present in only 69% of streams within their historic distribution, with an annual population of 280 adults or fewer (Brown et al. 1994). After Coho Salmon were listed under Endangered Species Act (ESA), timber companies, non-governmental organizations, and California Department of Fish and Wildlife (CDFW) have conducted various habitat and biological assessments throughout Big River, providing valuable information on juvenile salmonid occurrence and spatial distribution.

Since 2008, spawning ground surveys have been conducted almost annually in Big River (McGuire et al. 2021). From 2008/09 through 2023/24, the average Coho Salmon population estimate was 641 (range 80 – 1,572; n = 15), and steelhead was 695 (range 52 – 1,820; n = 15) (Figure 24). The annual Chinook Salmon population estimate ranged from 0 – 60 during this same period. While most years the Chinook Salmon estimate is zero, a small number of adults and redds are typically observed during surveys but too few are detected to obtain a population estimate. Smolts have been observed seasonally in the estuary (Shaughnessy et al. 2017; Osborn et al. 2021) and juveniles have been observed during CDFW summer snorkel surveys in recent years in the upper mainstem and tributaries.



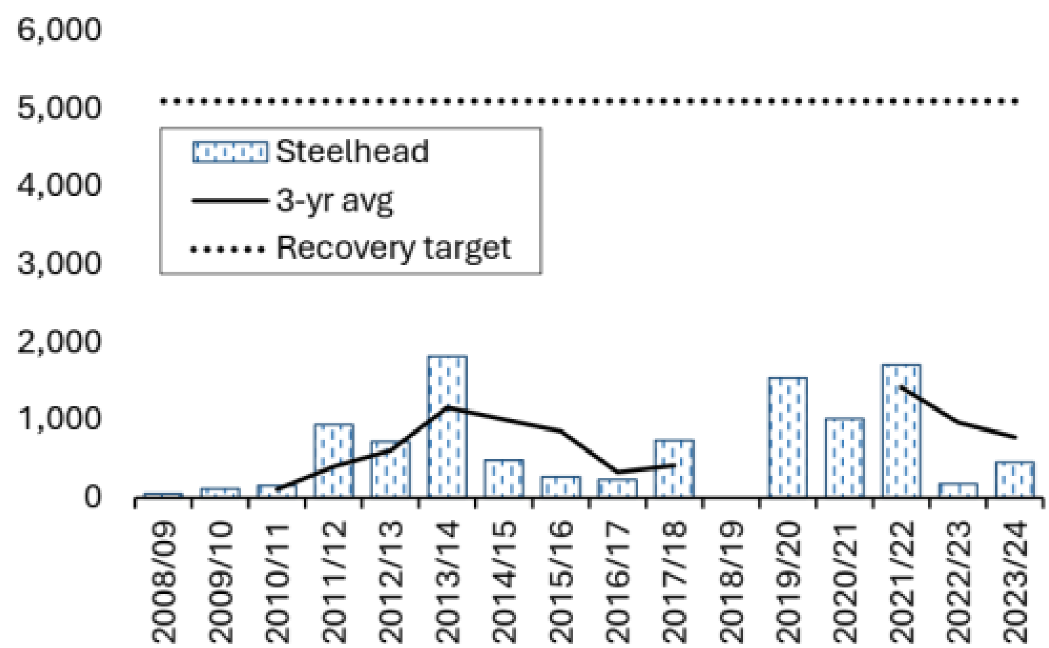


Figure 24. Big River, Mendocino County, CA Coho Salmon (top) and steelhead (bottom) annual escapement estimates from 2008/09 to 2023/24 (n = 15). No survey was conducted in 2018/19. The three-year rolling average (3-yr avg) and NOAA Fisheries recovery target are shown for each species.

6.4 Ranking Summary

Three of the four Big River HUC 12 subwatersheds (Lower Big River, North Fork Big River, and South Fork Big River) were selected during the ranking process (see Chapter 3. Watershed Selection) for further restoration planning. Lower Big River scored lower than both North Fork and South Fork primarily in the *Integrity and Risk* category, due to higher population density, roads, and warmer summer water temperatures (Figure 25).

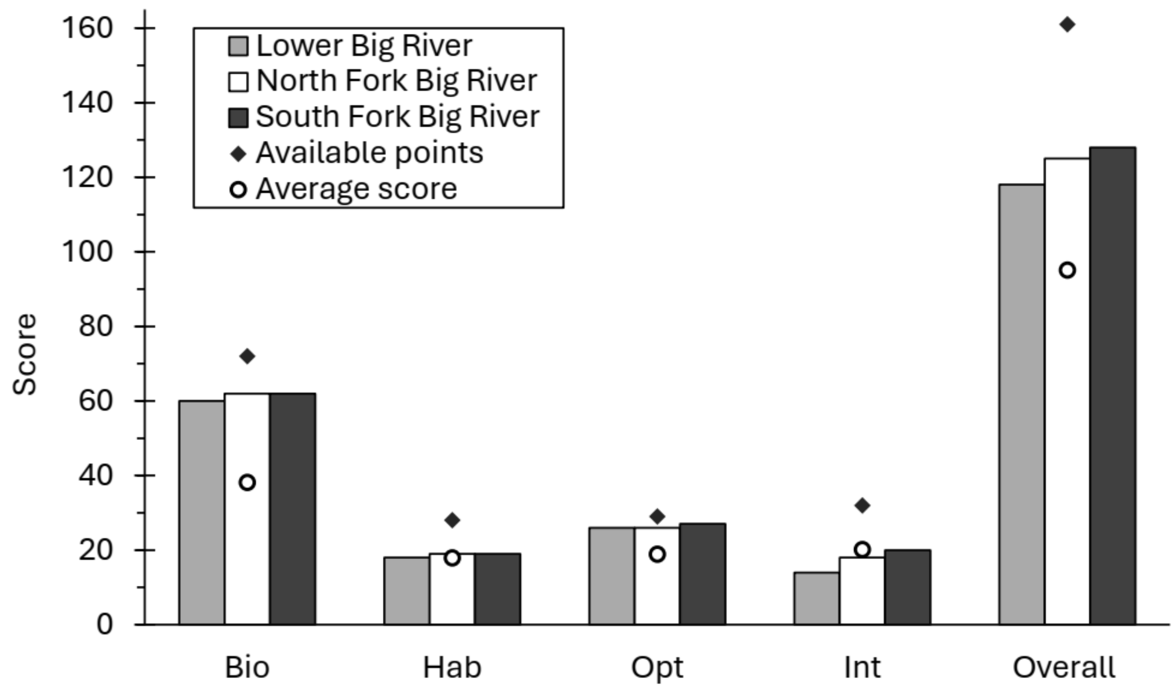


Figure 25. Ranking scores for the three selected Big River HUC 12 subwatersheds. Scores also broken down by Biological Importance (Bio), Habitat Condition (Hab), Optimism and Potential (Opt), and Integrity and Risk (Int) categories. For comparison, the average score for all 48 HUC 12 subwatersheds evaluated for the Mendocino Coast is shown by an open circle. Total available points available for each category are depicted by a diamond.

6.5 Watershed Meeting

The Big River SHaRP meeting occurred virtually on November 2–3, 2021, following methods outlined in Chapter 4. Watershed Meetings. On the first day, the steering team provided background information on the SHaRP process and facilitated expert presentations.

The keynote speaker was Dr. William Lemos, a long-term resident and local Big River expert. He co-founded the Mendocino High School of Natural Resources (SONaR) program, which provides students with an opportunity to conduct scientific surveys in Big River with mentorship from teachers and local scientists. Dr. Lemos provided a historical overview of the watershed and discussed logging impacts. His presentation provided a rich account of his experiences living and working in the watershed, including adventures flying underneath the Highway 1 bridge (Figure 26).

Figure 26. Photograph of Big River estuary salt flats taken by Dr. William Lemos from his plane.

After the presentations, participants rated the impact of attributes for each life stage. On the second day, participants leveraged their personal knowledge and the results of the limiting attribute analysis to identify specific restoration treatments in each HUC 12 subwatershed. This step was done collaboratively in ArcGIS Online.

6.6 Life Stage-Attribute Results

The steering team slightly modified the life stage-attribute rating process from the Ten Mile River meeting (Chapter 5. Ten Mile River). A spring fry category was added to represent the juvenile life stage from emergence through late spring, covering the period of fry redistribution prior to over summer rearing. The steering team also removed climate change as a separate category, instead asking participants to consider impacts of climate change for each life stage and attribute when rating. Life stage-attribute rating results are summarized below and shown in Table 13.

Attributes strongly limiting survival

- *Instream Complexity* for adults in Lower Big River.
- *Instream Complexity* and *Off-Channel Habitat* for most juvenile life stages in all HUC 12 subwatersheds.
- *Off-Channel Habitat* for smolts in all HUC 12 subwatersheds.
- *Water Quantity* in the South Fork Big River for summer juveniles.

Attributes least limiting survival

- *Riparian Condition* and *Barriers* for all life stages in all watersheds.

Table 13. Coho Salmon, Chinook Salmon, and steelhead life stage-attribute rating for selected Big River HUC 12 subwatersheds for the Mendocino Coast SHaRP. Life stages are EA = Egg/Alevin; SF = Spring Fry; SJ = Summer Juvenile; WJ = Winter Juvenile; SM = Smolt; AD = Adult. N/A = Not Applicable. Average scores were binned as: Functioning/not limiting survival (0 – 3.3) green, Moderately Functioning/somewhat limiting survival (3.4 – 6.6) yellow, or Not Functioning/strongly limiting survival (6.7 – 10) red.

HUC 12	Attribute	EA	SF	SJ	WJ	SM	AD
Lower	Barriers	N/A	3.1	3.0	4.0	3.1	4.0
Lower	Instream Complexity	5.5	7.5	7.6	7.6	6.0	6.9
Lower	Off-Channel	4.7	6.9	6.4	8.0	7.0	4.9
Lower	Riparian	2.3	2.3	4.0	3.0	2.7	3.0
Lower	Sediment	5.2	5.2	4.1	5.6	3.9	3.4
Lower	Water Quality	3.4	2.7	3.8	1.7	1.7	2.3
Lower	Water Quantity	3.4	3.9	6.0	3.9	4.2	4.3
North Fork	Barriers	N/A	1.8	2.2	2.2	2.2	3.4
North Fork	Instream Complexity	6.3	6.7	8.3	7.9	6.0	5.2
North Fork	Off-Channel	4.9	6.9	6.7	8.2	8.0	5.7
North Fork	Riparian	1.7	1.4	2.8	1.7	1.4	1.4
North Fork	Sediment	5.6	4.7	4.1	4.3	3.8	2.8
North Fork	Water Quality	2.2	3.2	4.4	2.5	1.7	1.7
North Fork	Water Quantity	3.5	4.8	6.0	3.7	3.0	2.9
South Fork	Barriers	N/A	2.3	3.1	2.8	2.0	3.2
South Fork	Instream Complexity	6.1	7.0	9.0	7.5	6.5	4.7
South Fork	Off-Channel	4.7	7.5	6.2	8.3	7.8	4.9
South Fork	Riparian	3.0	3.0	4.2	2.8	3.0	2.2
South Fork	Sediment	6.1	4.7	3.0	3.8	3.8	2.6
South Fork	Water Quality	4.2	3.7	6.1	2.2	3.3	2.8
South Fork	Water Quantity	4.2	5.2	8.5	3.9	4.0	3.9

6.7 Restoration Treatments

Restoration treatments are summarized by type (defined in 4.2 Developing Restoration Treatments) for the Big River selected HUC 12 subwatersheds in Table 14. Individual restoration treatments are described and listed in Table 15-Table 17 and shown geographically in Figure 27-Figure 30.

There were four types of restoration treatments selected for Big River (Table 14; Figure 27). In Lower Big River, off-channel/floodplain enhancement was identified for the entire length of the mainstem (Table 15; Figure 28). This also included recommendations for planning, design, and assessment to determine the specific needs for this large section. Fish passage and habitat improvement projects were identified in the lower mainstem tributaries impacted by the M1 Road Table 15; Figure 28). A combination of large wood treatments, passage improvement, and road assessment were selected throughout Little North Fork. In the North Fork Big River, large wood projects were selected mostly in the upper mainstem and tributaries, with off-channel and floodplain enhancement in the mainstem (Table 16; Figure 29). Road and fish passage improvements were recommended for Chamberlain Creek and East End Branch (Table 16; Figure 29). In South Fork Big River, participants primarily recommended large wood treatments, and the remediation of several culverts and other fish passage barriers (Table 17; Figure 30). During the life stage-attribute rating, *Anthropogenic Barriers* scored low, likely because several known barriers had been treated in the past. However, when discussing restoration treatments, participants identified multiple barriers and recommended specific treatments, especially in response to ongoing drought and climate change. Adding large wood to meet targets refers to those set in the CCC Coho Salmon Recovery Plan (NMFS 2012).

Table 14. Restoration treatment summary for the selected Big River HUC 12 subwatersheds for the Mendocino SHaRP. LB = Lower Big River; NFB = North Fork Big River; SFB = South Fork Big River. Includes number of projects (n) and stream kilometers (km). LW = Large wood; OC = Off-channel/floodplain enhancement; RA = Road assessment/improvement; FP = Fish passage improvement. N/A = Not applicable.

Type	LW	OC	RA	FP	Total
LB (km)	16.0	50.3	7.4	N/A	73.7
LB (n)	4	3	2	5	14
NFB (km)	27.5	14.3	12.8	N/A	54.6
NFB (n)	6	1	2	3	12
SFB (km)	70.0	0.0	0.0	N/A	70.0
SFB (n)	8	0	0	7	15
Total (km)	*113.5*	*64.6*	*20.1*	*N/A*	**198.2**
Total (n)	*18*	*4*	*4*	*15*	**41**

Table 15. Lower Big River HUC 12 subwatershed restoration treatments for the Mendocino SHaRP. Each restoration treatment includes a unique identification code (ID), treatment type (type), general project location and description, and length in kilometers (km). OC = Off-channel/floodplain enhancement; LW = Large wood; RA = Road assessment/improvement; FP = Fish passage improvement. See Figure 27 and Figure 28 for maps of treatment locations.

ID	Location	Type	Details	Length (km)
LB01	Estuary upstream to South Fork confluence	OC	The channel is simplified and disconnected from the historic floodplain. Conduct planning and feasibility study to determine the best restoration treatments. Tidal influence occurs 14.5 kilometers (9 miles) upstream.	45.43
LB02	Dry Dock Gulch	OC	Create alcoves in conjunction with culvert improvement on LB12 to open upstream passage and provide off-channel rearing in lower mainstem. Project completed in summer 2023.	0.89
LB03	Railroad Gulch	RA	Decommission road that is contributing to channel incision and restricting floodplain connectivity. Assessment is done. Complete in conjunction with LB04 wood treatment. Access would provide important tributary habitat for spawning and off-channel juvenile rearing in the lower mainstem.	3.35
LB04	Railroad Gulch	LW	Add large wood to meet targets. Complete in conjunction with LB03 road decommission to reduce incision. Use wood available onsite during road decommission. Access would provide important tributary habitat for spawning and off-channel juvenile rearing in the lower mainstem.	3.36
LB05	Little North Fork upstream to Thompson Gulch	RA	The road is in the floodplain and hydrologically connected to the stream. Decommission road. In conjunction with LB06 to improve instream habitat and connectivity.	4.01
LB06	Little North Fork upstream to Thompson Gulch	OC	Develop projects in conjunction with road decommission in LB05 to improve connectivity to adjacent tributaries.	4.01

ID	Location	Type	Details	Length (km)
LB07	Little North Fork from Thompson Gulch confluence upstream	LW	Add large wood to meet recruitment targets and decrease incision upstream of Mendocino Woodlands. Low natural recruitment potential.	8.08
LB08	East Branch (tributary to Little Nork Fork)	LW	Previously treated. Add large wood to meet targets.	3.33
LB09	Berry Gulch (tributary to Little North Fork)	LW	Previously treated. Add large wood to meet targets.	1.21
LB10	Rail Dump Gulch	FP	Replace culvert on M1 Road to provide 548.64 meters (1,800 feet) of habitat upstream of culvert for lower mainstem tributary habitat. Design and implement habitat restoration at log dump downstream of culvert.	point
LB11	Dry Dock Gulch	FP	Replace culvert on M1 Road in conjunction with habitat restoration in LB02. Completed in 2023.	point
LB12	Railroad Gulch	FP	Replace culvert or add bridge at M1 Road crossing to improve access to Railroad Gulch and provide lower mainstem tributary habitat. Assess pond upstream for restoration opportunities. In conjunction with LB03 and LB04.	point
LB13	Cookhouse (tributary to Little North Fork)	FP	Upgrade or replace culvert that is frequently blocked and needs regular clearing. Removal will provide access to marsh habitat for rearing.	point
LB14	Thompson Gulch tributary to Little North Fork	FP	Assess the status of a collapsed bridge that may be a partial barrier. Just upstream of the current bridge crossing.	point

Table 16. North Fork Big River (NFB) HUC 12 subwatershed restoration treatments for the Mendocino SHaRP. Each restoration treatment includes a unique identification code (ID), treatment type (type), general project location and description, and length in kilometers (km). OC = Off-channel/floodplain enhancement; LW = Large wood; RA = Road assessment/improvement; FP = Fish passage improvement. See Figure 27 and Figure 29 for maps of treatment locations.

ID	Location	Type	Details	Length (km)
NFB01	North Fork mouth upstream to James Creek	OC	Add engineered wood habitat structures. Require larger structures due to the river channel. Risk assessment needed where the river runs along Highway 20.	14.31
NFB02	North Fork upstream of James Creek	LW	Add large wood to meet targets.	9.12
NFB03	Chamberlain Creek	LW	Add large wood to meet targets. Project proposal was submitted for review in 2025.	8.67
NFB04	Water Gulch (tributary of Chamberlain Creek)	LW	Add large wood to meet targets. Potential for a beaver analog type project.	1.00
NFB05	East Branch downstream of Bull Team Gulch	LW	Add wood to the low gradient section. The implementation of a project began in 2025.	1.32
NFB06	East Branch (upper)	LW	Add wood to meet targets. In conjunction with NFB07 road decommission/improvements.	5.44

ID	Location	Type	Details	Length (km)
NFB07	East Branch (upper)	RA	Area heavily logged and abandoned road impacting stream channel. Outdated watershed/road assessment. Conduct a new assessment and implement improvements if needed.	5.44
NFB08	James Creek from Sindel Gulch to North Fork	LW	Previously treated. Add large wood to meet targets.	1.96
NFB09	Chamberlain Creek (from Water Gulch mouth upstream)	RA	Roads run on both sides of the creek near or within the channel. Perform assessment with options to improve conditions on east road. The road on the west side of Chamberlain has already been assessed.	7.32
NFB10	Bull Team Gulch (tributary of East Branch)	FP	Culvert is a partial barrier. Create design plans and upgrade to improve passage. Limited habitat upstream made it more difficult to get funding for improvements in the past.	point
NFB11	Chamberlain Creek	FP	Replace culvert. Long perched culvert is creating a partial barrier. Project is in implementation phase.	point
NFB12	Arvola Gulch (tributary of Chamberlain Creek)	FP	Partial barrier. Assess to determine options for improvement. Limited habitat upstream so lower priority.	point

Table 17. South Fork Big River (SFB) HUC 12 subwatershed restoration treatments for the Mendocino SHaRP. Each restoration treatment includes a unique identification code (ID), treatment type (type), general project location and description, and length in kilometers (km). LW = Large wood; FP = Fish passage improvement. See Figure 27 and Figure 30 for maps of treatment locations.

ID	Location	Type	Details	Length (km)
SFB01	South Fork mouth upstream to end of anadromy	LW	Add large wood to meet targets. Develop designs to determine placement locations and structure type. Engineered or anchored structures are needed along Comptche Ukiah Road in the upper watershed. Previously installed LW features were unanchored and failed during high flows.	31.04
SFB02	Ramon Creek	LW	Previously treated. Add large wood to meet targets.	6.10
SFB03	Mettick Creek	LW	Add LW features from confluence upstream to ~4000 feet (1,219 meters) to improve quantity and quality of pools and improve passage over bedrock cascades. In conjunction with SFB09 to assess passage at confluence.	2.99
SFB04	Dark Gulch	LW	Add large wood in conjunction with treating barrier on SFB11. Limited log jams are present currently. Target treatments in low gradient sections.	3.14
SFB05	Pruitt Creek	LW	Investigate potential large wood treatment. Access is difficult but may be an opportunity to cut second growth stand on State Park land. Utilize live riparian conifers to design large wood features to meet targets within the lower 3,000 feet (914 meters). The area is dense upland oak habitat with warmer temperatures. Steelhead habitat.	3.72

ID	Location	Type	Details	Length (km)
SFB06	Daugherty Creek	LW	Previously treated. Add large wood to meet targets. Road was previously decommissioned.	13.20
SFB07	Johnson Creek & Gates Creek	LW	Add large wood to meet targets.	5.97
SFB08	Upper Gates Creek	LW	Add large wood to meet targets.	3.80
SFB09	Mettick Creek	FP	Investigate passage at weirs near Mettick Creek at confluence with mainstem. Weirs were put in place to improve passage in bedrock.	point
SFB10	Johnson Creek	FP	Investigate baffles added to improve passage at the confluence with mainstem. Determine if it functions properly and if adjustments are needed.	point
SFB11	Dark Gulch	FP	Develop design to upgrade Comptche Ukiah Road crossing, which is a total barrier.	point
SFB12	Pruitt Creek	FP	Upgrade Comptche Ukiah Road crossing for passage of all life stages of salmonids. Investigate baffles that were added to improve low flow partial passage barrier at the confluence with mainstem. Determine if it functions properly and if adjustments are needed.	point
SFB13	South Fork	FP	Landowners are concerned with the impact of wood projects on several private bridge crossings. Work with the landowner to replace the bridge or find alternative solutions.	point
SFB14	Pruitt Creek	FP	Assess bedrock falls and develop recommendations for passage improvement.	point

ID	Location	Type	Details	Length (km)
SFB15	Soda Creek	FP	Investigate weirs located at confluence to determine status of passage.	point

Figure 27. Restoration treatment map for the Lower Big River, North Fork (N.F.) Big River, and South Fork (S.F.) Big River HUC 12 subwatersheds for the Mendocino Coast SHaRP. See Tables 15–17 for treatment details.

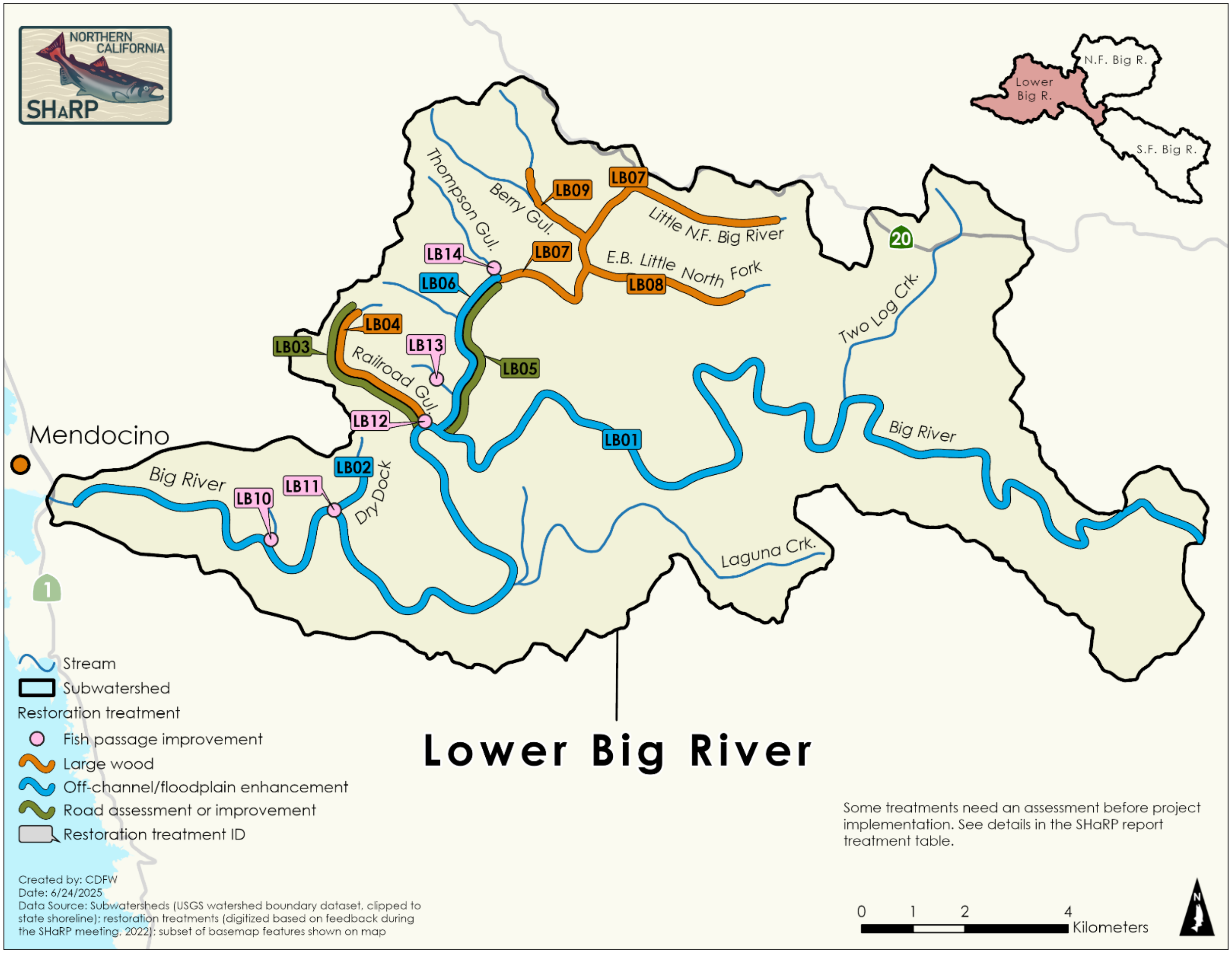


Figure 28. Restoration treatment map for the Lower Big River HUC 12 subwatershed for the Mendocino Coast SHaRP. See Table 15 for treatment details.

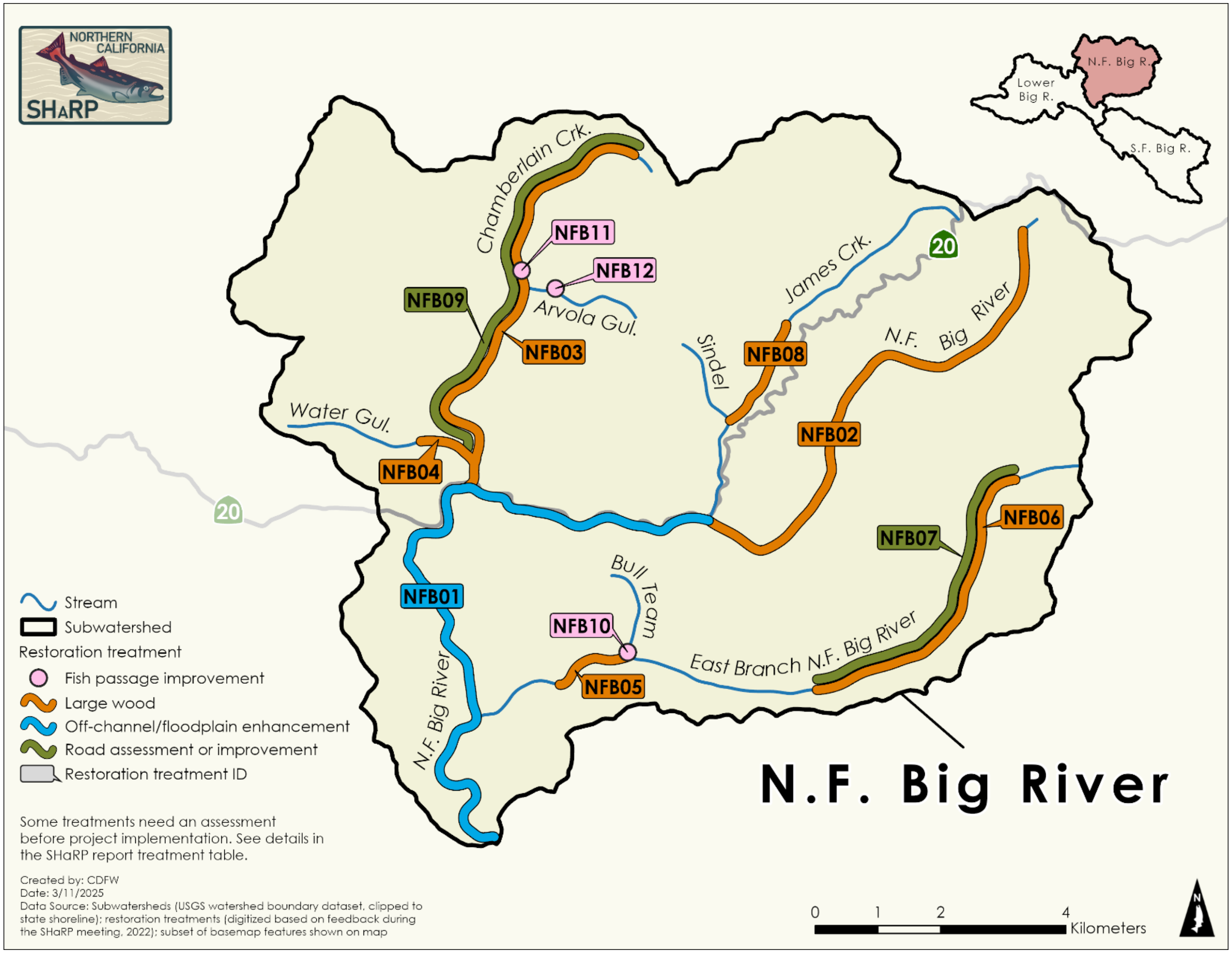


Figure 29. Restoration treatment map for the North Fork (N.F.) Big River HUC 12 subwatershed for the Mendocino Coast SHaRP. See Table 16 for treatment details.

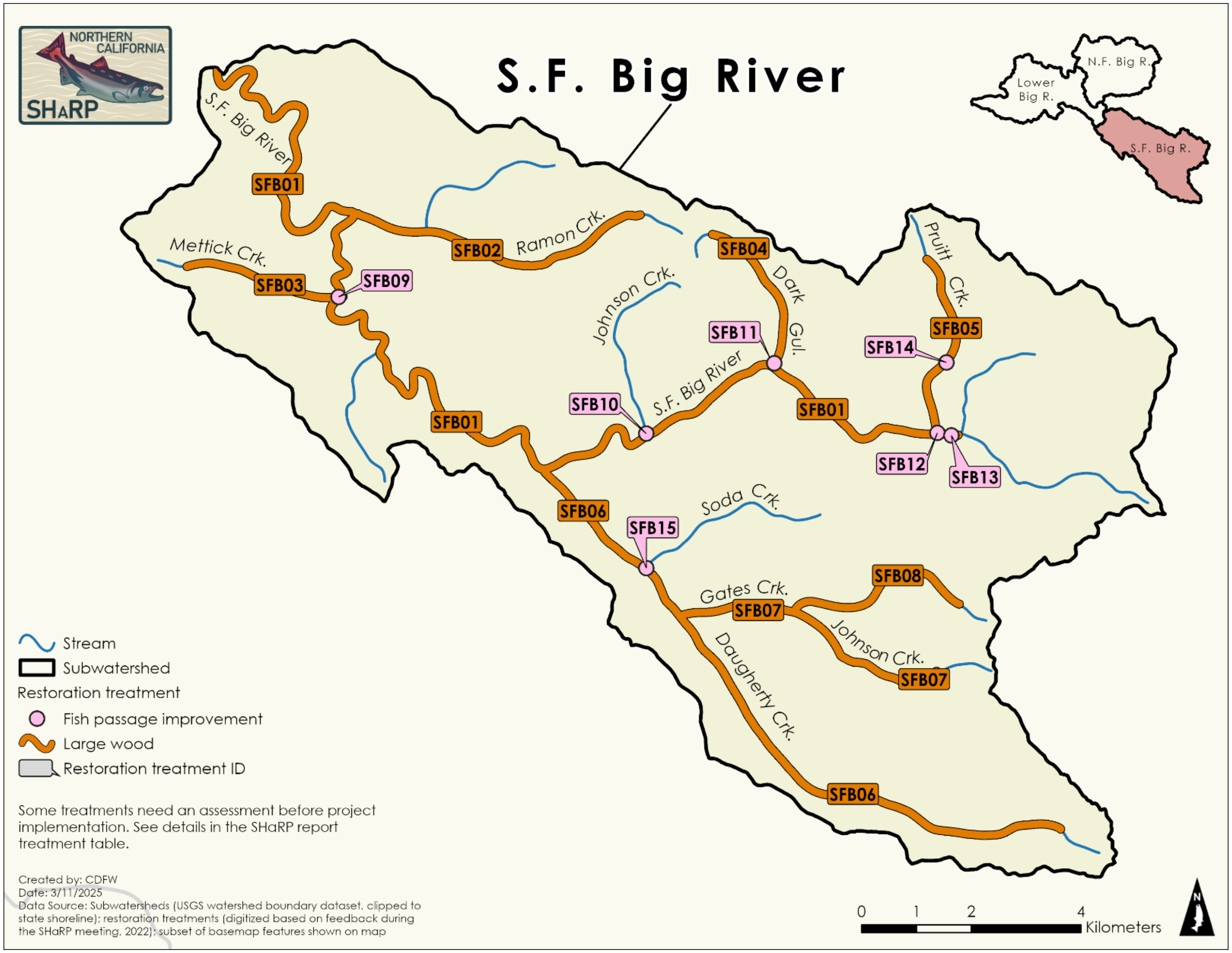


Figure 30. Restoration treatment map for the South Fork (S.F.) Big River HUC 12 subwatershed for the Mendocino Coast SHaRP. See Table 17 for treatment details.

Chapter 7. Noyo River

7.1 Watershed Overview

The Noyo River enters the Pacific Ocean through the Noyo Harbor in the city of Fort Bragg (Figure 31). The mostly forested watershed encompasses 293 square kilometers (113.1 square miles) of second-growth redwood and mixed conifer species, with low-elevation marine terraces in the western portion of the basin. Elevations within the basin range from sea level at the outlet to 977 meters (3207 feet) at Sherwood Peak.

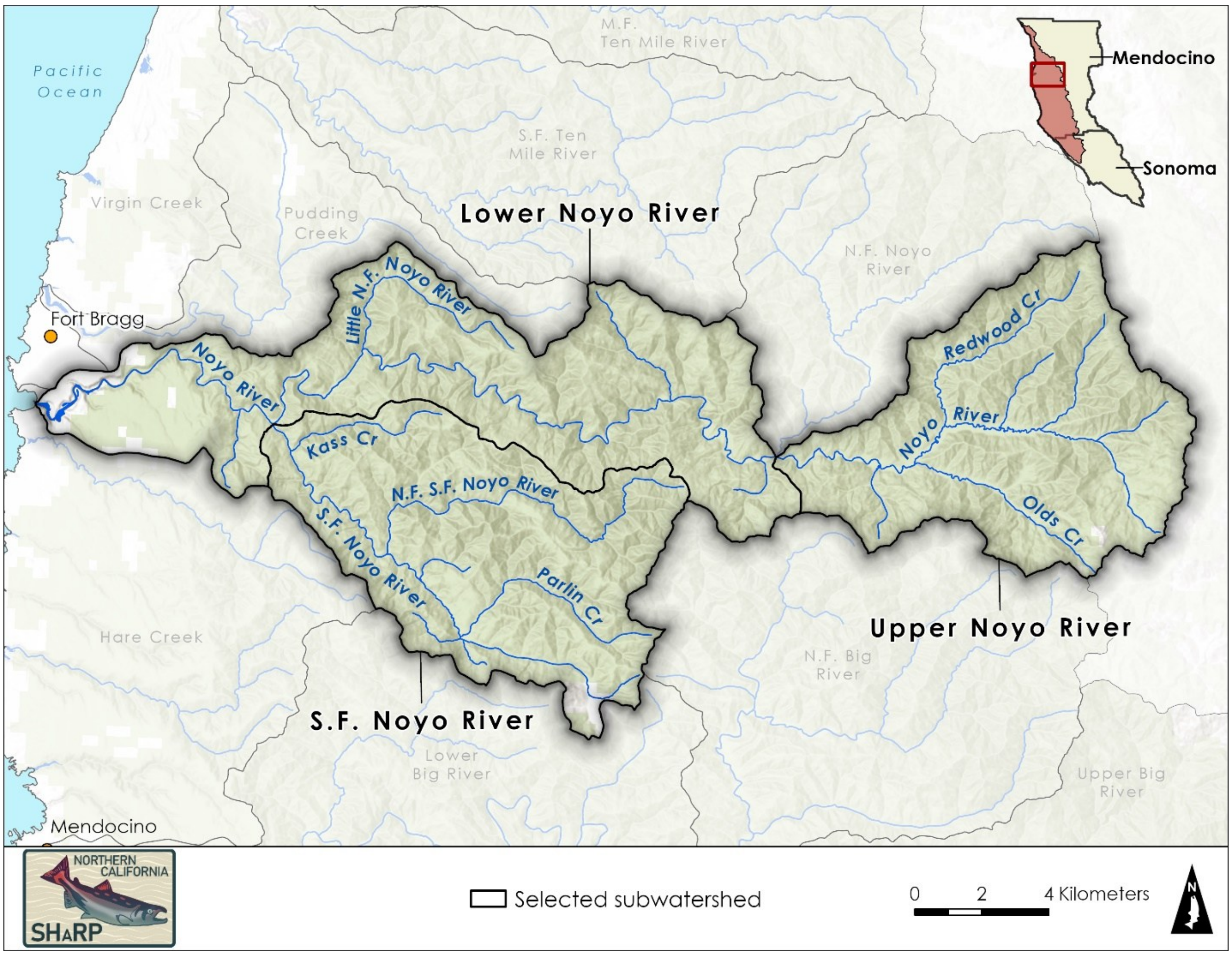


Figure 31. Overview map of the Noyo River, highlighting the HUC 12 subwatersheds selected for the Mendocino Coast SHaRP watershed planning: Lower Noyo River, South Fork (S.F.) Noyo River, and Upper Noyo River.

Streamflow in the Noyo River is largely unregulated, except for a few dams and diversions. The city of Fort Bragg withdraws most of its drinking water from surface water at the upper extent of tidal influence. On the mainstem, Camp Noyo seasonally impounds water for recreation while providing fish passage. In contrast, McGuire Dam on the South Fork Noyo River permanently impounds the upper portion of the river, creating a barrier to fish passage. The California Department of Fish and Wildlife (CDFW) Egg Collection Station (ECS) on the South Fork Noyo River includes a permanent dam and fish ladder, which is now operated exclusively for monitoring salmonid populations. Within the Jackson Demonstration State Forest, the Parlin Fork Conservation Camp seasonally impounds the South Fork Noyo River to source potable water.

In 1885, a railroad was constructed along the lower Noyo River to transport redwoods to the mill and the log loading facility in the harbor. In the early 1900s, the rail was expanded east to Willits to provide passenger service. Today, the Mendocino Railway/Skunk Train owns the rail and operates it for recreational excursions. However, collapsed sections prevent the rail from connecting through to Willits.

Until around 1900, the estuary was a tidal floodplain, before being altered by the timber industry and later by the development of the harbor for commercial fishing (Noyo River Watershed Enhancement Plan 2007). In 1950, the Noyo Harbor District was established as a port, governed by elected commissioners who oversee harbor operations, docks, and long-term strategies for operation and economic development (Pomeroy et al. 2010). In 1961, the river mouth was permanently modified with the construction of a jetty (Lin et al. 2013). Today, the harbor includes the United States Coast Guard station, a private marina, fish processing facilities, and restaurants, while supporting both commercial and recreational fishing and boating. The United States Army Corps of Engineers maintains the jetty and performs periodic channel dredging to ensure passage for large vessels, keeping the estuary open to the ocean year-round (Lin et al. 2013).

The Noyo River watershed is predominantly managed for timber production. Redwood Timber Company owns and manages most of the forest in the Lower Noyo River. CalFire manages the Jackson Demonstration State Forest, which encompasses most of the South Fork Noyo River. In the Upper Noyo River and North Fork Noyo River, the largest parcels are owned by Mendocino Redwood Company (MRC), with smaller parcels of rural residential and timber company land interspersed throughout.

7.2 Historical and Recent Restoration

Historic logging practices created large-scale disturbances throughout the Noyo River watershed, resulting in the degradation of freshwater habitats that are crucial for salmon and steelhead spawning and rearing. These practices resulted in channel incision, lack of instream large wood, and ongoing legacy sediment deposition, which continue to affect the basin’s geomorphology and ecology. The existing network of roads and rail continues to add sediment, restrict channel movement, and impede lateral fish movement into floodplains and some tributaries. The Noyo River estuary has experienced habitat loss and pollution due to harbor infrastructure (bank armoring, docks) and boating. In 1998, the Noyo River was listed as impaired under the Clean Water Act by the State of California due to excessive fine sediment from timber harvests. As a result, the United States Environmental Protection Agency developed a Total Maximum Daily Load (TMDL) to set targets for improving water quality (US EPA 1999).

For decades, sustainable forestry management practices, conservation and land protection, road improvements, and habitat restoration projects have been implemented to improve watershed health. In the late 1950s, stream clearance was piloted in the Noyo River as an early restoration practice to rehabilitate streams damaged by logging (Holman et al. 1964). This approach was later applied to other coastal watersheds in the state until the 1980s, when restoration methods shifted toward adding wood. In 1988, some of the first large wood additions in the Noyo River were implemented through a series of projects aimed at creating summer rearing habitat by installing logs and modifying existing barriers.

From 2002–2022, approximately 35 habitat restoration projects were completed in the Noyo River. In the Upper Noyo River mainstem and tributaries, at least 13 projects have added large wood and opened fish passage barriers. Two notable projects by Trout Unlimited (TU) were culvert upgrades on the Mendocino Railway in the Upper Noyo River on Gulch C (Figure 32). In the South Fork Noyo River, at least seven projects have focused on instream habitat enhancement and fish passage improvement, including the removal of two small dams in Parlin Creek in 2015. The North Fork Noyo River has had at least ten projects focusing on large wood addition and road assessment with upgrades to decrease erosion. There have been a few restoration projects in the Lower Noyo River, with a focus on large wood additions and upland habitat restoration to control sediment input in the Little North Fork Noyo River. A single project was completed in the lower estuary on Newman Gulch, where an undersized culvert was replaced to provide access to spawning and juvenile rearing habitat.

A recent FRGP grant (grant number – Q2010529) funded a basin-wide Light Detection and Ranging (LiDAR) based modeling assessment to characterize watershed channel condition and prioritize restoration efforts. This restoration planning effort complements Salmonid Habitat Restoration Priorities (SHaRP) recommendations in the Noyo River.

Figure 32. Mendocino Railway culvert upgrade on Gulch C in the Upper Noyo River (photo credit: Trout Unlimited).

7.3 Salmonid Populations

Salmon hatchery supplementation efforts were initiated around the same time as the first habitat improvement efforts in the Noyo River. The South Fork Noyo River CDFW ECS was established in 1962 and became a central location for the collection of Coho Salmon eggs for hatchery production of juvenile Coho Salmon in California. The eggs were transferred to different hatchery facilities for incubation and juvenile rearing until they were released back into the Noyo River or into other coastal watersheds ranging from the Smith River to the San Lorenzo River (Brown et al. 1991). Egg collection and stocking ceased in 2003; the trap is currently used to conduct salmon and steelhead population monitoring.

Compared to other Mendocino watersheds, the Noyo River has a longer historical dataset on adult Coho Salmon populations. During its early years of operation, annual counts of adult Coho Salmon at the South Fork Noyo CDFW ECS fish trap ranged from 1,500 – 3,000 adults annually (Brown et al. 1991). In the 1980s, annual returns of adult Coho Salmon to the Noyo River were estimated at around 3,740 adults, including hatchery-origin fish (Brown et al. 1994). Juvenile Coho Salmon were found across 84% of streams in their historic range (Brown et al. 1994).

Since 2005, spawning ground surveys have been conducted annually in the Noyo River under the California Monitoring Plan (CMP) to assess status and trends of salmon and steelhead. The South Fork Noyo River serves as a life cycle monitoring station to calibrate regionwide redd counts and to produce survival estimates, which are used for evaluating trends (McGuire et al. 2021). From 2005/06 through 2023/24, the average adult Coho Salmon estimate was 1,464 (range 228 – 5,280), and the average adult steelhead estimate was 522 (range 79 – 987) (Figure 33). The Noyo River Coho Salmon adult population was the first within the Central California Coast (CCC) ESU to exceed the National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries) recovery target in 2015/16, and then again in 2023/24. A small number of Chinook Salmon are observed annually during spawning surveys, although in some years there are too few observations to produce an estimate. Chinook Salmon adult estimates ranged from 0 – 98 from 2008/09 through 2023/24.

Life cycle monitoring on the South Fork Noyo River has provided annual estimates of Coho Salmon and steelhead smolt production, survival indices, and information on migration timing since 2000. The average Coho Salmon smolt estimate was 8,691 (range 313 – 63,063) from 2000 to 2024 (n = 25). The average steelhead smolt estimate was 4,732 (range 1,445 – 13,667) from 2000 to 2024 (n = 22).

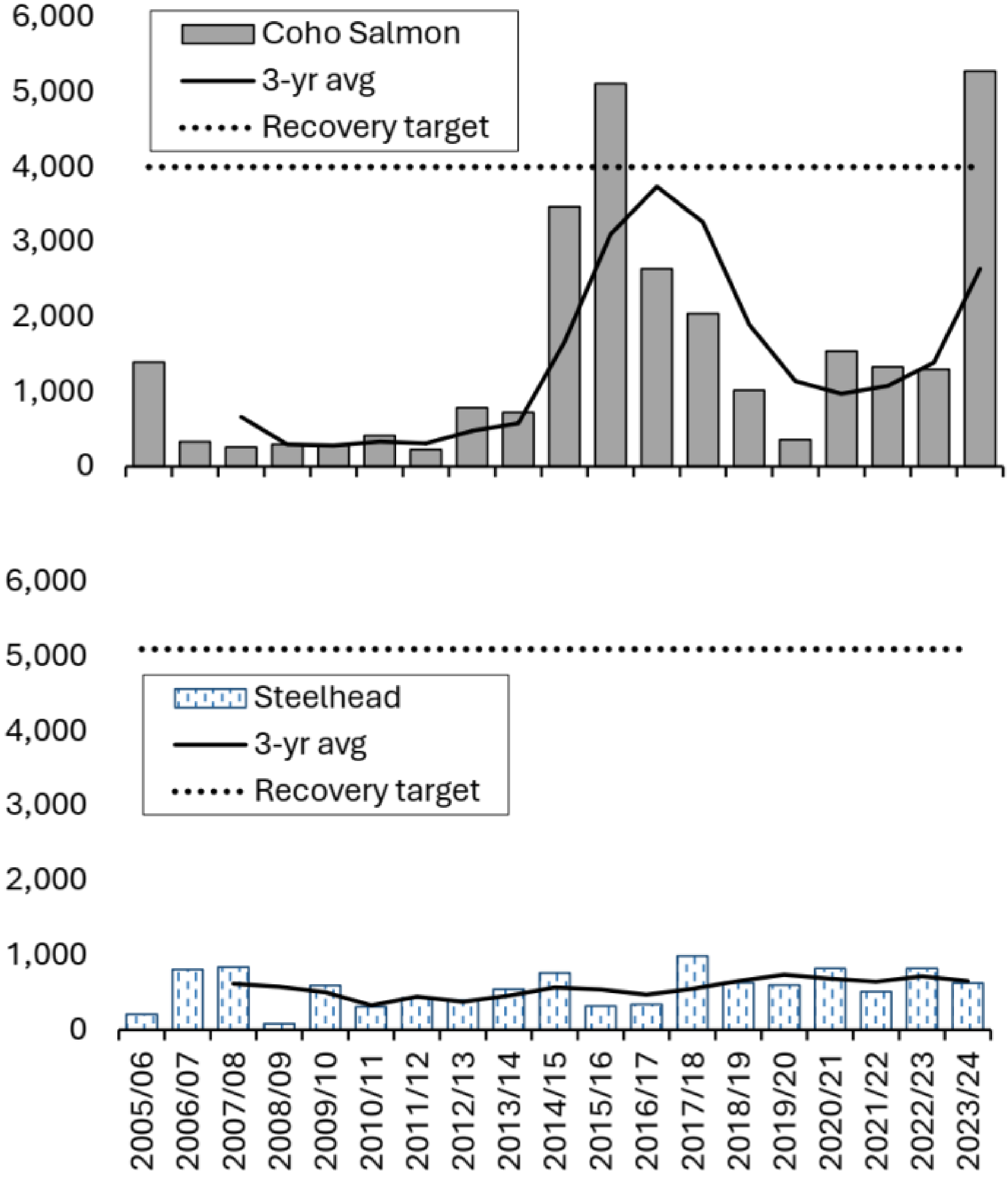


Figure 33. Noyo River, Mendocino County, CA Coho Salmon (top) and steelhead (bottom) annual adult abundance estimates from 2005/06 to 2023/24 (n = 18). The three-year rolling average (3-yr avg) and NOAA Fisheries recovery target are shown for each species.

7.4 Ranking Summary

Three of the four Noyo River Hydrologic Unit Code (HUC) 12 subwatersheds (South Fork Noyo River, Lower Noyo River, and Upper Noyo River) were selected during the ranking process (see Chapter 3. Watershed Selection) for further restoration planning. North Fork Noyo River scored slightly lower overall than the other Noyo River HUC 12 subwatersheds, mainly due to the *Habitat Condition*. The Lower Noyo River is more densely populated near the city center, which gave it a lower score in *Integrity and Risk* compared to Upper Noyo River and South Fork Noyo River (Figure 34).

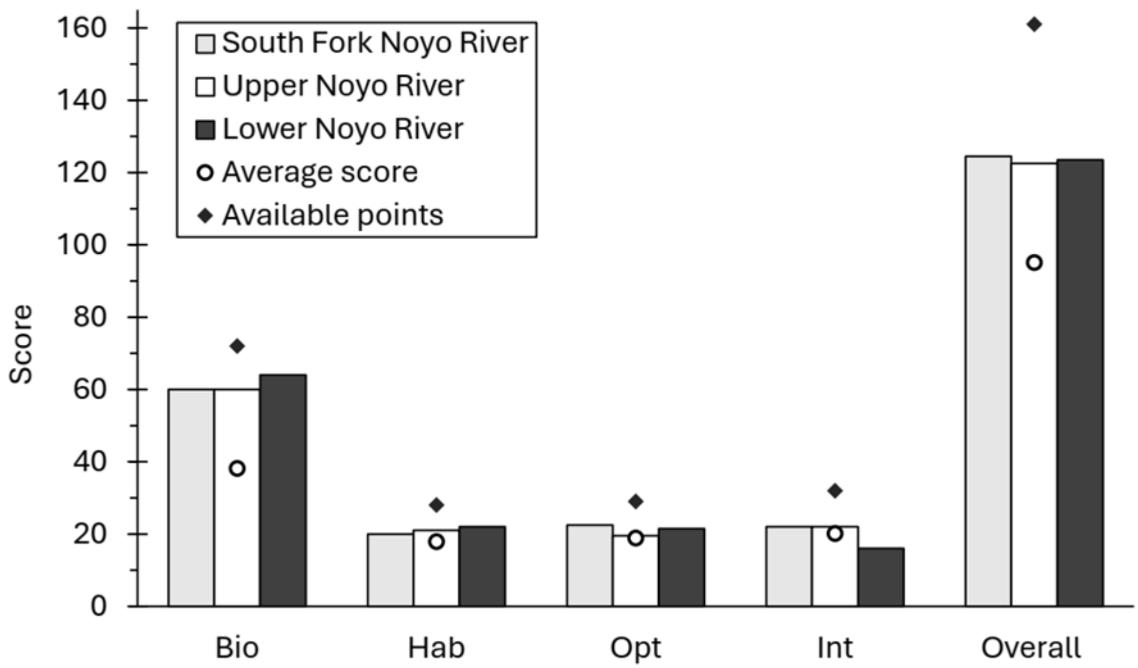


Figure 34. Ranking scores for the three selected Noyo River HUC 12 subwatersheds. Scores also broken down by *Biological Importance (Bio), Habitat Condition (Hab), Optimism and Potential (Opt), and Integrity and Risk (Int)* categories. For comparison, the average score for all 48 HUC 12 subwatersheds evaluated for the Mendocino Coast is shown by an open circle. Total available points available for each category are depicted by a diamond.

7.5 Watershed Meeting

The SHaRP meeting for the Noyo River watershed occurred on March 8 – 9, 2022, following methods outlined in Chapter 4. Watershed Meetings. On the first day, the steering team introduced the SHaRP process and presented life stage-attribute information specific to the Noyo River. Next, a panel of practitioners who work in the Noyo River shared their restoration experiences and perspectives on the next steps, providing participants with important considerations for life stage-attribute rating and identifying restoration treatments (Table 18).

Table 18. Noyo River SHaRP watershed meeting presenters.

Panelist	**Organization**
Anna Halligan, Restoration Practitioner	North Coast Coho Project, Trout Unlimited
Brett Leonard, Restoration Practitioner	California Conservation Corps
Dave Ulrich, Biologist	Mendocino Redwood Company
Emily Lang, Biologist	Redwood Timber Company
Scott Monday, Environmental Scientist	California Department of Fish and Wildlife

Highlights of the panelist presentations include:

- Trout Unlimited (TU) has been active in removing barriers and adding wood treatments in the Noyo River. Large wood treatments prior to 2017 may not have been aggressive enough to meet wood loading targets. They have a strong interest in doing more projects for the Jackson Demonstration State Forest and other private landowners.
- Since 2005, the California Conservation Corps has implemented wood projects in the Noyo River. Many projects may be below wood loading targets. They recommended retreatment of previous projects, particularly those in the Upper Noyo River watershed.
- MRC has partnered with the California Conservation Corps, TU, and others, to complete instream habitat restoration projects, including crossing upgrades, dam removal, and road decommissioning in the Upper Noyo River HUC 12 subwatershed and North Fork Noyo River. They observed that these projects have benefited summer juvenile rearing and recommended adding more structures to improve summer habitat, summer flows, and winter refugia, as well as conducting a groundwater feasibility study. In addition, they noted that timber harvest regulations

have benefited salmonids and riparian areas by protecting trees in the stream corridor which provide shade, cover, and habitat through natural recruitment.

- Redwood Timber Company has completed stream habitat restoration, road decommissioning, and barrier removals on their property. They are working with TU on strategies to further enhance habitat. They recommended enhancing habitat in the lower mainstem tributaries where access is restricted, to improve overwinter rearing habitat.
- In the Noyo River, the FRGP program has worked mostly on instream wood projects, barriers, road decommissioning, and habitat restoration assessments. They emphasized the importance of technical working groups for sharing information on restoration projects. Recommendations included increasing the scale of project treatments, which typically requires a design process. They also recommended streamflow enhancement, particularly for the Upper Noyo River HUC 12 subwatershed, and improving passage at McGuire Dam in the South Fork Noyo River HUC 12 subwatershed.

Following the panelist talks, Dr. Brian Cluer presented *'Geomorphic Perspectives and Restoration Considerations for the Noyo* River', focusing on watershed geomorphology, the stream evolution model (Cluer et al. 2014), and its applications for restoration planning in the Noyo River. Some key takeaways for restoration planning included:

- Watersheds have suffered significant landscape impacts, some of which may not be recognizable because of shifting baselines.
- Historical logging practices transformed some of the largest and most optimal spawning and rearing habitats into some of the worst, resulting from splash dams, skid roads within channels, and accumulated legacy sediment.
- Alluvial reaches offer the greatest restoration potential for reconnecting floodplains, restoring floodplain processes, and increasing rearing and spawning habitat.
- Strategic placement of large wood to restore habitat-forming processes can reduce the need for constructing additional habitat features. The wood can 'work' for us to create the habitat we need, not just 'be' the habitat.

Valley type and channel incision are important considerations when determining where to do restoration. As an example, a simple GIS analysis with LiDAR was used to measure channel morphology and incision at a series of cross sections at two locations in the Noyo River. The Upper Noyo River mainstem site is a wide alluvial valley where the channel incision measured 3.05 – 4.57 meters (10 – 15 feet), resulting in a disconnection from the floodplain (Figure 35). With stage-zero type restoration, this site could expand juvenile salmonid habitat by 56.7 hectares (140 acres) through floodplain reconnection. It would also enhance the quality of spawning habitat and improve water storage and retention. In comparison, the site on the Little North Fork in the Lower Noyo River is situated in a steep valley with a narrow channel, no visible floodplain, and encroachment from roads (Figure 36). While adding structure can improve habitat, it may not significantly increase productivity for juveniles.

The Upper Noyo River mainstem site also demonstrated how the *Intrinsic Potential* (IP) model can overestimate habitat scores when the channel is incised due to land use disturbances. This should be considered when selecting restoration treatments.

After the presentations, participants rated the impact of attributes on each salmonid life stage. On the second day, participants leveraged their personal knowledge and the results of the limiting attribute analysis to identify specific restoration treatments in each HUC 12 subwatershed. This step was done collaboratively in ArcGIS Online.

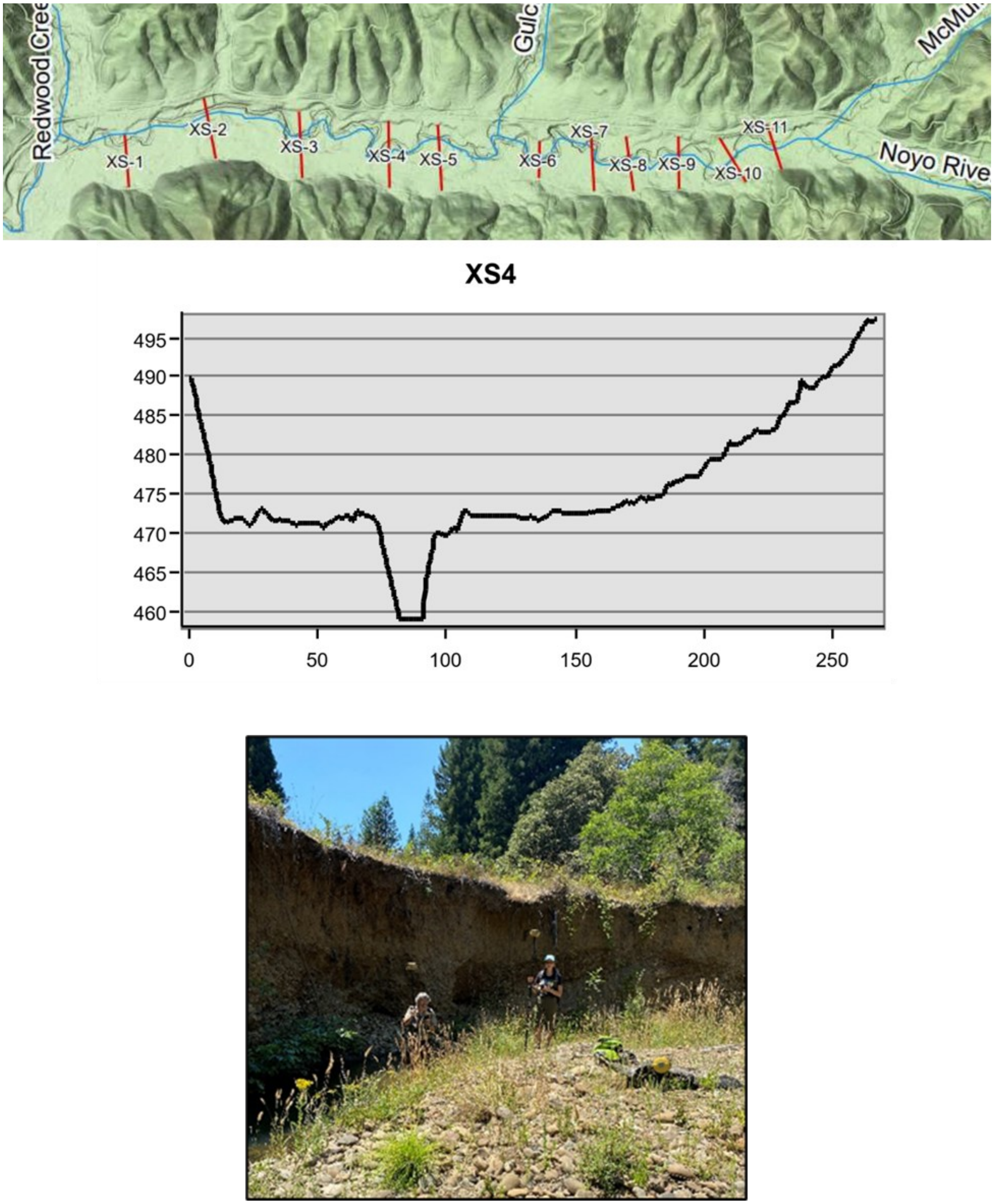


Figure 35. Map of the upper mainstem Noyo River showing individual channel cross sections (XS) where channel morphology and incision were measured in GIS (top). Chart of channel cross section XS4 with floodplain distance (*x* axis) and elevation (*y* axis) in meters (middle). Photo of incision (bottom). UN05 recommends developing a large floodplain project to reconnect floodplain habitat and address incision (photo credit: Sarah Gallagher, California Department of Fish and Wildlife).

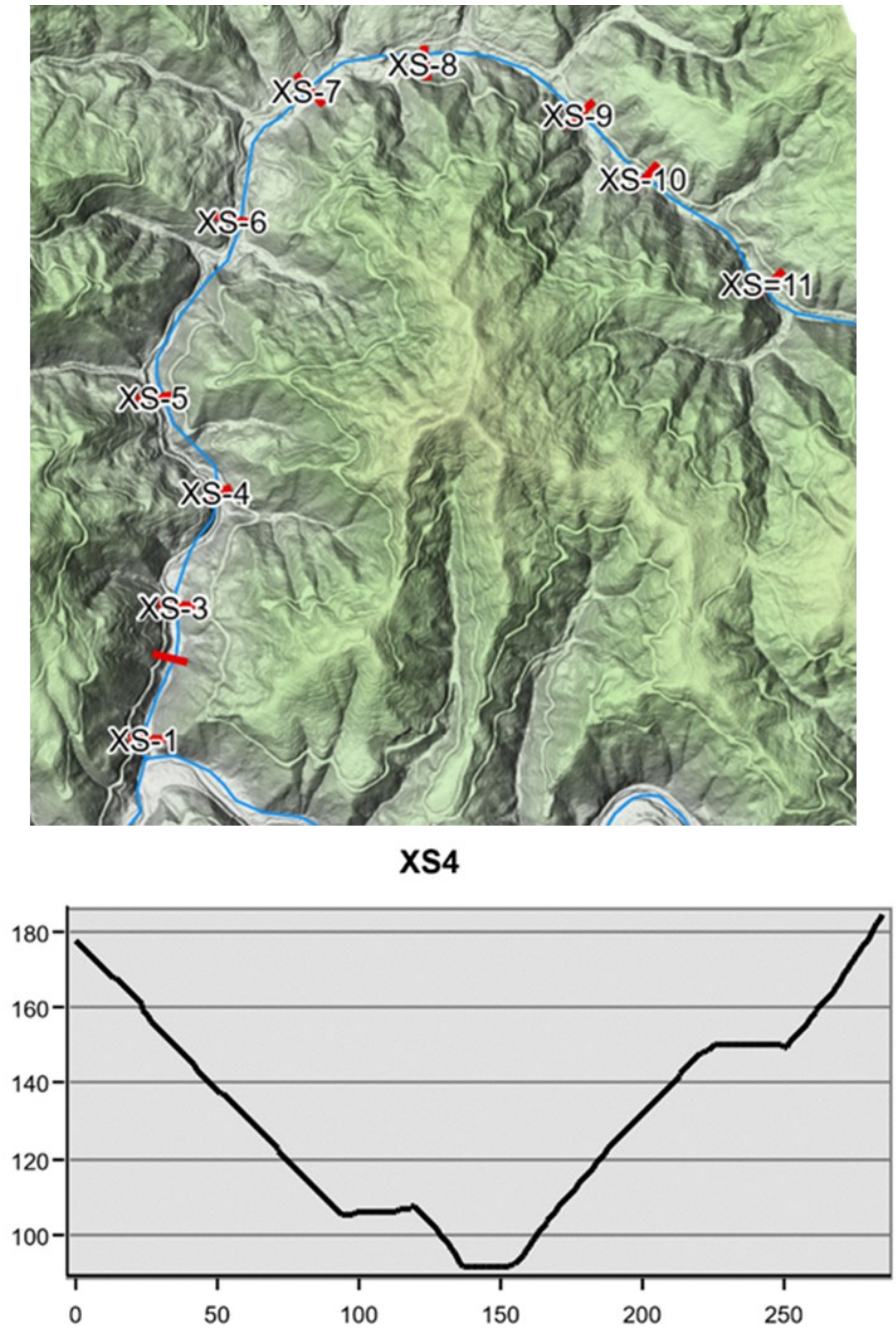


Figure 36. Map of the Little North Fork Noyo River showing individual channel cross sections (XS) where channel morphology and incision were measured in GIS (top). Chart of channel cross section XS4 with floodplain distance (*x* axis) and elevation (*y* axis) in meters (bottom).

7.6 Life Stage-Attribute Results

Participants made several adjustments to the life stage-attribute categories from those used in the Ten Mile River and Big River watershed planning areas to reflect the unique characteristics of the Noyo River watershed. This included (1) removing *Off-Channel Habitat*/summer juvenile rearing, *Sediment Conditions*/summer juvenile, *Sediment Conditions*/winter juvenile, and *Sediment Conditions*/smolt, and (2) adding *Redd scour*/egg-alevin life stage. Life stage-attribute rating results are summarized below and shown in Table 19.

Attributes strongly limiting survival

- *Instream Structural Complexity* and *Off-Channel Habitat* for most juvenile life stages in all HUC 12 subwatersheds. Only *Instream Structural Complexity* for adults in the Lower Noyo River.
- *Redd Scour* in all HUC 12 subwatersheds.
- *Water Quantity* for summer and winter juveniles throughout the watershed, except in the Lower Noyo River where concerns were limited to summer juveniles and egg/alevin life stages.

Attributes least limiting survival

- *Riparian Condition* in all HUC 12 subwatersheds.
- *Barriers* in the Upper Noyo River.
- *Water Quality* in the Upper Noyo River and South Fork Noyo River. It was moderate in the Lower Noyo River.
- All attributes for the adult life stage except for *Instream Complexity* in the Lower Noyo River.

Table 19. Coho Salmon, Chinook Salmon, and steelhead life stage-attribute rating for selected Noyo River HUC 12 subwatersheds for the Mendocino Coast SHaRP. Life stages are EA = Egg/Alevin; SJ = Summer Juvenile; WJ = Winter Juvenile; SM = Smolt; AD = Adult. N/A = Not Applicable. Average scores were binned as: Functioning/not limiting survival (0 – 3.3) green, Moderately Functioning/somewhat limiting survival (3.4 – 6.6) yellow, or Not Functioning/strongly limiting survival (6.7 – 10) red.

HUC 12	Attribute	EA	SJ	WJ	SM	AD
Lower Noyo	Barriers	N/A	3.8	3.5	4.0	3.7
Lower Noyo	Instream Complexity	7.1	8.3	9.2	7.5	6.9
Lower Noyo	Off-Channel	8.0	N/A	10.0	8.8	6.4
Lower Noyo	Riparian	3.8	5.3	3.8	3.2	2.0
Lower Noyo	Sediment	6.5	N/A	N/A	N/A	4.8
Lower Noyo	Water Quality	5.1	6.8	3.8	4.7	3.5
Lower Noyo	Water Quantity	7.1	8.8	5.9	6.3	5.3
Lower Noyo	Redd Scour	7.1	N/A	N/A	N/A	N/A
South Fork Noyo	Barriers	N/A	3.8	4.7	4.4	5.2
South Fork Noyo	Instream Complexity	5.5	8.1	9.2	7.1	5.8
South Fork Noyo	Off-Channel	7.0	N/A	9.6	8.3	6.2
South Fork Noyo	Riparian	2.3	4.2	2.1	2.3	2.2
South Fork Noyo	Sediment	5.1	N/A	N/A	N/A	4.4
South Fork Noyo	Water Quality	3.4	5.3	4.1	3.0	2.6
South Fork Noyo	Water Quantity	6.4	7.7	6.8	5.5	5.2
South Fork Noyo	Redd Scour	7.1	N/A	N/A	N/A	N/A
Upper Noyo	Barriers	N/A	3.0	3.2	2.5	4.4
Upper Noyo	Instream Complexity	6.2	8.8	9.2	7.3	6.3
Upper Noyo	Off-Channel	7.0	N/A	9.6	6.2	6.3
Upper Noyo	Riparian	2.7	4.8	3.2	3.0	2.8
Upper Noyo	Sediment	5.5	N/A	N/A	N/A	6.0
Upper Noyo	Water Quality	3.0	5.5	3.0	3.5	3.0
Upper Noyo	Water Quantity	6.6	9.6	7.1	6.1	6.5
Upper Noyo	Redd Scour	7.1	N/A	N/A	N/A	N/A

7.7 Restoration Treatments

Restoration treatments are summarized by type (defined in 4.2 Developing Restoration Treatments) for the Noyo River selected HUC 12 subwatersheds in Table 20. Individual treatments are listed and detailed in Table 21–Table 23 and shown geographically in Figure 37-Figure 40.

Most treatments focused on improving off-channel habitat in mainstem channels and floodplains, as well as placing large wood in smaller tributaries like the North Fork South Fork Noyo River, Parlin Creek, and Redwood Creek (Table 22; Figure 39). Adding large wood to meet targets refers to those set in the CCC Coho Salmon Recovery Plan (NMFS 2012). Six fish passage treatments were identified, which included upgrading or replacing railroad culverts and (Table 22; Figure 39). This also included the low flow barrier on the South Fork Noyo River near Parlin Camp (Figure 41). Road assessment or improvement was recommended for the entire mainstem Noyo River, and near Gulch C and McMullen Creek (Table 21; Table 23; Figure 38; Figure 40).

Table 20. Restoration treatment summary for the selected Noyo River HUC 12 subwatersheds for the Mendocino SHaRP. LN = Lower Noyo River; SFN = South Fork Noyo River; UN = Upper Noyo River. Includes number of projects (n) and stream kilometers (km). LW = Large wood; OC = Off-channel/floodplain enhancement; RA = Road assessment/improvement; HA = Habitat assessment; FP = Fish passage improvement. N/A = Not applicable.

Type	LW	OC	RA	HA	FP	*Total*
LN (km)	4.9	35.2	32.4	7.1	N/A	*79.5*
LN(n)	3	2	1	2	2	*10*
SFN (km)	42.7	20.3	0	0	N/A	*63.1*
SFN (n)	5	2	0	0	3	*10*
UN (km)	17.4	11.9	5.5	2.8	N/A	*37.6*
UN (n)	6	2	2	1	2	*13*
Total (km)	*65*	*67.4*	*37.9*	*9.9*	*N/A*	***180.2***
Total (n)	*14*	*6*	*3*	*3*	*7*	***33***

Table 21. Lower Noyo River (LN) HUC 12 subwatershed restoration treatments for the Mendocino SHaRP. Each restoration treatment includes a unique identification code (ID), treatment type (type), general project location and description, and length in kilometers (km). OC = Off-channel/floodplain enhancement; LW = Large wood; RA = Road assessment/improvement; HA = Habitat assessment; FP = Fish passage improvement; RE = Riparian enhancement; SE = Streamflow enhancement. See Figure 37 and Figure 38 for maps of treatment locations.

ID	Location	Type	Details	Length (km)
LN01	Estuary	HA	Remove marine debris associated with the harbor. Make improvements to existing infrastructure by increasing shading and decreasing flat surfaces to increase channel complexity and protect migrating salmonids. This would require assessment and development of multiple partnerships.	point
LN02	Upper Estuary	OC	Channel incised. Good opportunities to work with landowners to reconnect floodplains. Up to tidal influence at Newman Gulch.	2.82
LN03	Top of estuary upstream to North Fork mouth	OC	Mainstem lacks structure. Railroad runs along the river channel, decreasing floodplain connectivity and natural recruitment. Railroad culverts create fish passage barriers into tributaries. Use the FRGP-funded LiDAR hydrologic modeling project to determine project locations.	32.36
LN04	Top of estuary upstream to North Fork mouth	RA	Assess riparian conditions and impacts of the railway on sediment and channel confinement. Identify opportunities to restore hydrologic function along roads. In conjunction with LN03.	32.36
LN05	Noyo Trib #8	LW	Tributary has low amounts of large wood with good potential for improvement due to low gradient. Add large wood in conjunction with passage assessment/remediation in LN06.	point

ID	Location	Type	Details	Length (km)
LN06	Noyo Trib #8	FP	Assess the redwood log crossing that may be impeding fish passage. Additionally, there is a pinch point further upstream at Company Ranch Road.	0.93
LN07	Little North Fork	HA	Assess habitat and develop a plan for removing roads and adding large wood projects to reduce channel incision and sedimentation. Wood projects may only be needed outside Redwood Timber Company and need to be engineered. Haul road decommission requires finding an alternate route. Abandoned roads in smaller drainages contribute sediment and could be removed.	7.08
LN08	Duffy Gulch	FP	Remove highest ranking barrier in railroad fish passage assessment to allow access to spawning and rearing habitat. Designs were completed, and 2023 FRGP funds were awarded to TU to implement the project.	point
LN09	Duffy Gulch	LW	Add large wood to meet targets in conjunction with barrier removal on LN08.	2.06
LN10	Unnamed tributary	LW	Known Coho Salmon stream on Mendocino Redwood Property. Add large wood to meet targets.	1.92

Table 22. South Fork Noyo River (SFN) HUC 12 subwatershed restoration treatments for the Mendocino SHaRP. Each restoration treatment includes a unique identification code (ID), treatment type (type), general project location and description, and length in kilometers (km). OC = Off-channel/floodplain enhancement; LW = Large wood; RA = Road assessment/improvement; HA = Habitat assessment; FP = Fish passage improvement; RE = Riparian enhancement; SE = Streamflow enhancement. See Figure 37 and Figure 39 for maps of treatment locations.

ID	Location	Type	Details	Length (km)
SFN01	South Fork	LW	Add large wood to meet targets.	16.19
SFN02	South Fork	OC	Assess potential off-channel project opportunities and develop projects. Use engineered designs.	16.19
SFN03	Kass Creek	OC	Assess current wood densities and retreat if needed to meet targets.	4.12
SFN04	Kass Creek	LW	Assess current wood densities and retreat if needed to meet targets.	4.12
SFN05	North Fork South Fork	LW	Previously treated. Add large wood to meet targets. In 2024, TU treated the lowest 2.6 kilometers (1.6 miles).	12.91
SFN06	Brandon Gulch (North Fork South Fork)	LW	Add large wood to meet targets. Project was funded and implemented by Mendocino Land Trust in 2025.	2.78
SFN07	Parlin Creek	LW	Previously treated. Add large wood to meet targets. Use accelerated wood recruitment method due to access.	6.74

ID	Location	Type	Details	Length (km)
SFN08	Brandon Gulch (North Fork South Fork)	FP	Design treatments in the NFSF below the Brandon G confluence to improve passage over bedrock cascade more frequently.	point
SFN09	South Fork	FP	Low flow barrier associated with Parlin Fork Conservation Camp water intake dam. Identified in the California Fish Passage Assessment Database (PAD) as PAD ID 758253. 7.2 kilometers (4.5 miles) of available habitat on Parlin and 4.8 kilometers (3 miles) on SF Noyo upstream of the dam.	point
SFN10	South Fork	FP	Replace the screen at McGuire Pond to prevent non-native fish species from moving downstream. Investigate removal of the dam to allow upstream passage.	point

Table 23. Upper Noyo River (UN) HUC 12 subwatershed restoration treatments for the Mendocino SHaRP. Each restoration treatment includes a unique identification code (ID), treatment type (type), general project location and description, and length in kilometers (km). OC = Off-channel/floodplain enhancement; LW = Large wood; RA = Road assessment/improvement; HA = Habitat assessment; FP = Fish passage improvement; RE = Riparian enhancement; SE = Streamflow enhancement. See Figure 37 and Figure 40 for maps of treatment locations.

ID	Location	Type	Details	Length (km)
UN01	Mongomery Creek- tributary west of Olds Creek	LW	Investigate opportunities to add large wood. Combine with mainstem project in UN13. Cold water tributary that supports Coho Salmon. Road decommissioning/upgrades done in 2007. The lower half is a private ranch.	2.04
UN02	Olds Creek	LW	Retreat to meet large wood targets. Creek tends to go dry in sections and wood may improve conditions. Sensitive cultural resources in the area so special needs for using heavy equipment.	2.49
UN03	Olds Creek	HA	Assess habitat and determine potential treatment needs. The landowner was not open to partnership in the past. Develop relationships with landowner.	2.85
UN04	Redwood Creek	LW	Numerous past large wood projects on MRC property. Wood loading targets are good but retreatment with larger structures would be beneficial to reactive natural processes and engage floodplain. Retreat previous projects and add wood upstream of MRC property.	7.26
UN05	Mainstem between Olds Creek and McMullen Creek	OC	Develop a large floodplain/stage 0 project to restore habitat forming processes, reconnect floodplain, and reduce incision. Use LiDAR and hydrological modeling.	6.07

ID	Location	Type	Details	Length (km)
UN06	Gulch C	LW	Railroad crossing barrier remediated. Investigate wood loading and add large wood to meet targets if needed. Potential landslide in upper watershed contributing sediment.	2.25
UN07	Gulch C	RA	Perform assessment of road network to determine options for remediation or removal.	2.22
UN08	McMullen Creek	LW	Previously treated. Add large wood to meet targets. Previous treatments did not include direct falling and therefore are smaller in size. Project was funded with implementation beginning in 2025 by the California Conservation Corps.	2.06
UN09	McMullen Creek	RA	Roads are along both sides of the creek. Perform assessment of the road network to determine options for removal on one or both sides.	3.27
UN10	Redwood Creek	FP	Pursue a design to upgrade the railroad crossing. Box culvert crossing is a partial barrier.	point
UN11	Burbeck Creek	FP	Replace culvert at rail. Culvert failing and unstable in 2022. Completely failed and created a temporary barrier in 2023. This caused excessive sedimentation and blew out previous.	point
UN12	Mainstem upstream of Burbeck Creek	LW	Treat with large wood to the rail crossing. Skip section with boulder cascade.	1.29
UN13	Mainstem upstream to Olds Creek	OC	Investigate and develop projects using LiDAR assessment. Section is steep and gorgy so projects may be limited in type. Multiple, private landowners so assessment and projects would need partnership development.	5.84

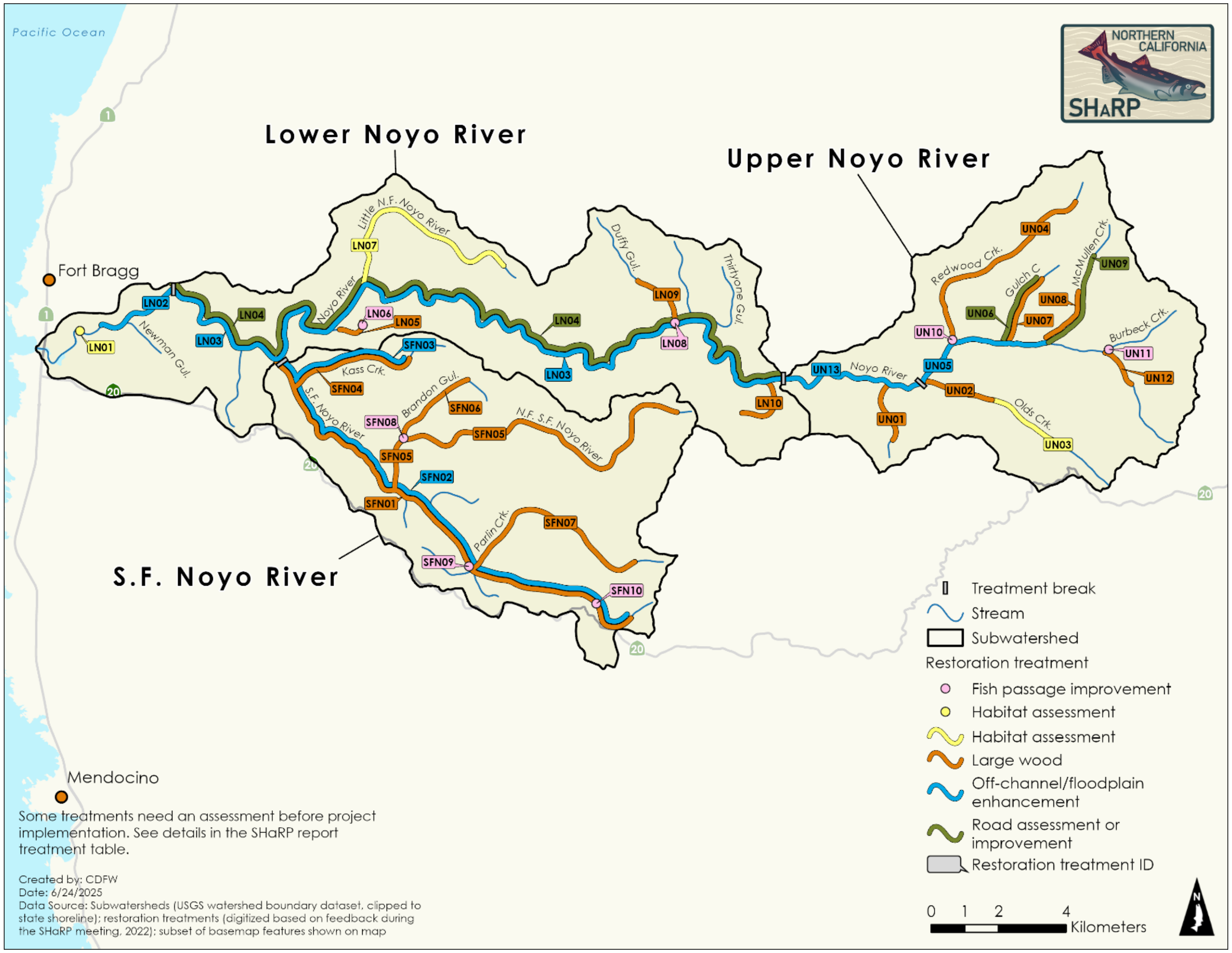


Figure 37. Restoration treatment map for the Lower Noyo River (LN), South Fork (S.F.) Noyo River (SFN), and Upper Noyo River (UN) HUC 12 subwatersheds for the Mendocino SHaRP. Treatment breaks delineate individual treatment extents when those adjacent were the same type. See Tables 21–23 for treatment details.

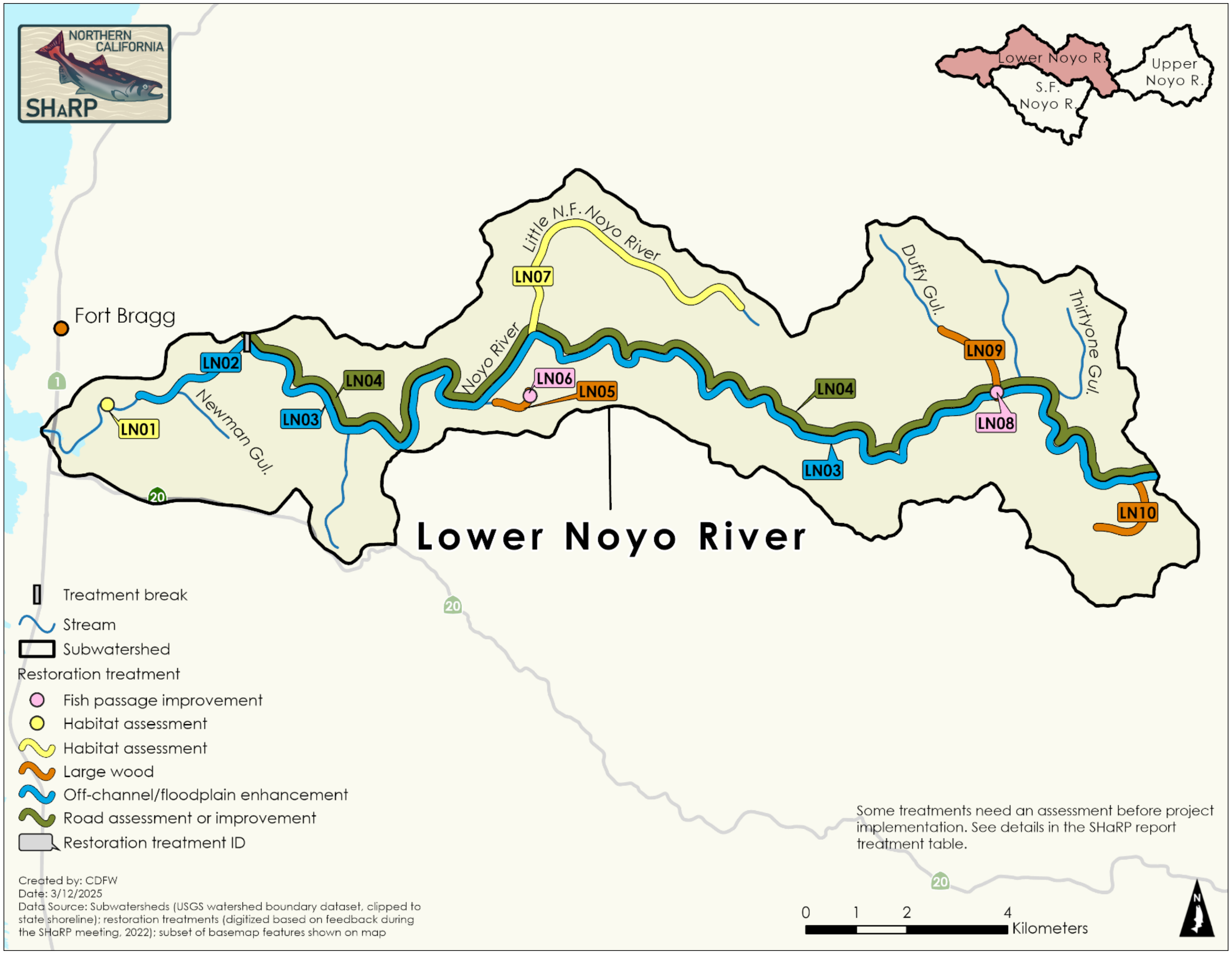


Figure 38. Restoration treatment map for the Lower Noyo River (LN) HUC 12 subwatershed for the Mendocino SHaRP. Treatment breaks delineate individual treatment extents when those adjacent were the same type. See Table 21 for treatment details.

Figure 39. Restoration treatment map for the South Fork (S.F.) Noyo River (SFN) HUC 12 subwatershed for the Mendocino SHaRP. See Table 22 for treatment details.

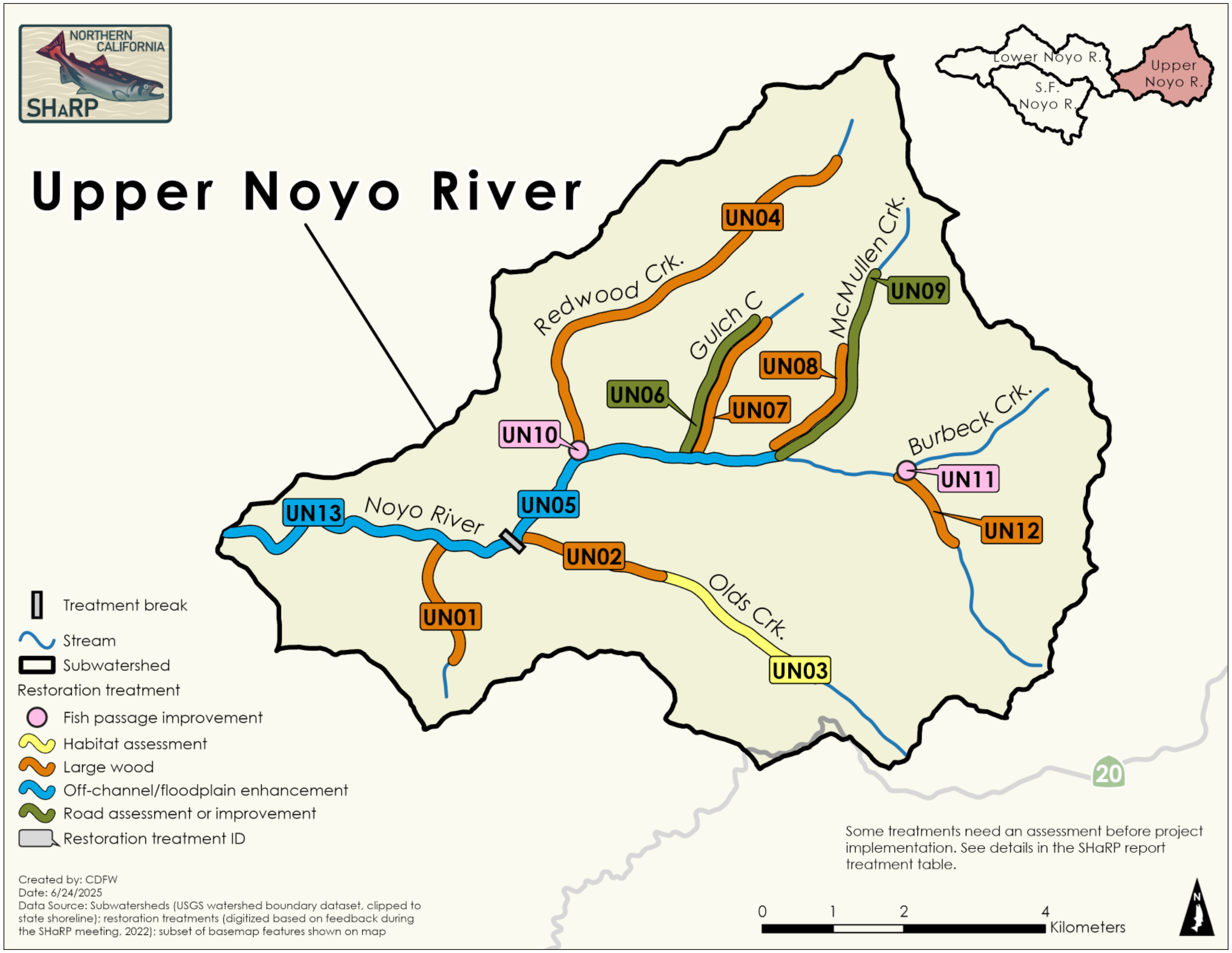


Figure 40. Restoration treatment map for the Upper Noyo River (UN) HUC 12 subwatershed for the Mendocino SHaRP. Treatment breaks delineate individual treatment extents when those adjacent were the same type. See Table 23 for treatment details.

Figure 41. Small dam on the South Fork Noyo River used for Parlin Fork Conservation Camp water source, 2013 (photo credit: Scott Monday, California Department of Fish and Wildlife). SFN09 recommends potential treatments to address fish passage

Chapter 8. Garcia River

8.1 Watershed Overview

The Garcia River watershed encompasses approximately 295 square kilometers (114 square miles) and enters the Pacific Ocean north of the city of Point Arena in southern Mendocino County (Figure 42). Elevations range from sea level at the mouth to approximately 625 meters (2,050 feet) at the headwaters (CDFG 2005).

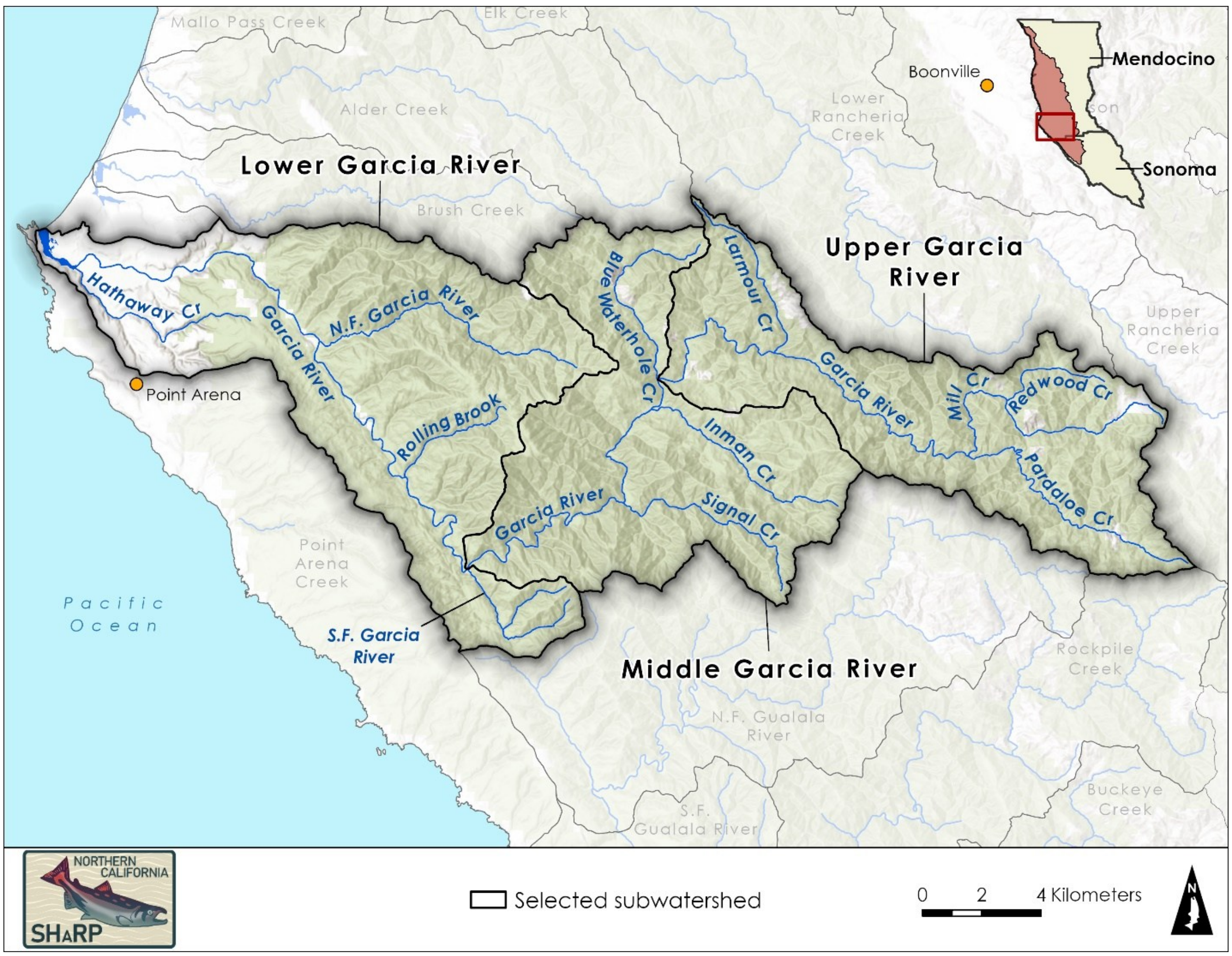


Figure 42. Overview map of the Garcia River, including the three HUC 12 subwatersheds selected for the Mendocino Coast SHaRP watershed planning: Lower Garcia River, Middle Garcia River, and Upper Garcia River.

The estuary covers approximately 0.3 square kilometers (0.1 square miles) of tidal mud flats, sloughs, and wetlands. It remains predominantly marine, staying open to the ocean throughout the summer, with brief closures only during extreme droughts. The lower watershed is characterized by coastal terraces and alluvial floodplains. Approximately 13 kilometers (8 miles) of the mainstem river runs directly along the San Andreas fault, giving this reach unique characteristics, including a particularly wide valley and channel zone. The middle and upper watershed is steep, rugged, and dominated by forestland.

Much of the watershed consists of large land parcels managed for timber. Land use also includes rural residences, agriculture, and former gravel extraction. Mendocino Redwood Company (MRC) has a large holding surrounding most of the South Fork Garcia River and adjacent mainstem. Conservation easements cover much of the North Fork Garcia River, middle and upper Garcia River mainstem, and tributaries. The Conservation Fund (TCF) acquired 96.3 square kilometers (37.2 square miles) of the Garcia River Forest in 2004 (TCF 2017) that is currently managed under a conservation easement with The Nature Conservancy (TNC).

The Manchester-Point Arena Rancheria lies in the lower portion of the Garcia River watershed, which has a combined area of 147 hectares (364 acres), and spans two parcels divided by the Garcia River. One parcel is located on Manchester Tribal lands and the other on Point Arena Tribal lands (Manchester-Point Arena Band of Pomo Indians 2025). In the upper watershed, the Maillard Ranch property has 6,070 hectares (15,000 acres) under a conservation easement with Save the Redwoods League. The remaining upper watershed consists of large, mostly undeveloped parcels. The estuary is encompassed by Manchester State Park, the Bureau of Land Management Point Arena-Stornetta Unit of the California Coastal National Monument, and the Stornetta Ranch. Legal and illegal water diversions associated with residential and agricultural use are sparsely distributed and mainly located in the lower watershed. There is a single small impoundment located on upper Pardaloe Creek.

Upstream, beyond the influence of coastal air temperatures, water temperatures in the mainstem river can become very warm in the summer, making it unsuitable for juvenile salmonid rearing (Stillwater Sciences 2016). However, nearby cold-water seeps and springs provide thermal refuge in the mainstem river, and tributaries such as Inman Creek, Signal Creek and Blue Waterhole provide suitable water temperatures for summer rearing. Some stream channels are prone to seasonal drying; for example, the lower 2.4 kilometers (1.5 miles) of the North Fork Garcia River typically dries out completely during the summer, most likely due to geomorphic processes and landform. In the coastal summer fog zone, small tributaries may provide important refuges for Coho Salmon, especially as climate change drives increases in water temperatures (Stillwater Sciences 2016).

8.2 Historical and Recent Restoration

Logging and lumber milling began in the 1840s, with the most intensive timber harvesting occurring in the 1950s. Splash dams and crib dams were built to temporarily store logs before they were flushed into mills located downstream. Farming and livestock production was established in the early 1900s (Monschke et al. 1992) , and instream and floodplain gravel extraction began in the 1930s (Garcia River Gravel Management Plan 1996). The lower alluvial floodplains were converted to agricultural fields, while the river and estuary were simplified, constricted, and altered by excessive sedimentation and the loss of large wood from land use in the upper watershed. Gravel mining further modified channel morphology and riparian vegetation. The cumulative effects of land use are evident today in the form of aggraded stream channels (Figure 43), increased sediment input, decreased large wood volumes, depleted riparian forests, and elevated water temperatures.

Figure 43. A perched floodplain along the Garcia River, where sediment deposition has resulted in channel incision, causing the floodplain to disconnect from the main river channel (photo credit: Shaun Thompson, California Department of Fish and Wildlife).

In the early 1980s, riparian planting and stream protection efforts were initiated by local conservation groups. The Garcia River Watershed Enhancement Plan was developed to guide the restoration of natural resources and improve fish habitat (Monschke et al. 1992). The comprehensive road and sediment assessment completed by Pacific Watershed Associates helped identify restoration needs to improve water quality in the Garcia River (PWA 1997). In 2002, the Garcia River watershed sediment Total Maximum Daily Load

(TMDL) was adopted into the North Coast Basin Plan. The implementation of the Garcia River TMDL has been successful due to strong partnerships and large private and public investments. The acquisition of large tracts of land has provided protection and created opportunities for improved logging practices and habitat restoration.

The Garcia River Monitoring Program was jointly established by the Regional Water Quality Control Board and The Nature Conservancy (TNC) to assess watershed conditions for TMDL and inform the development of management strategies for the Garcia River Forest. A basin-wide assessment was carried out from 2007 to 2013 to collect baseline data important for tracking watershed recovery.

Most habitat restoration projects in the Garcia River have been implemented in the tributaries of the Middle Garcia River HUC 12 subwatershed. In the early 1990s, at least 16 projects focused on modifying log jams and streambank stabilization in Inman Creek, Signal Creek, and Blue Waterhole. Restoration projects in the lower Garcia River focused on modification of log jams to improve passage in the North Fork Garcia River and Olsen Gulch, treatment of erosion sources along roads in the South Fork Garcia River, and fencing in the lower mainstem to restore riparian vegetation. Between 2008 to 2019, 14 additional restoration projects focused on reducing sediment delivery from roads and adding instream wood to increase habitat complexity were completed.

In recent years, TNC, with funding from CDFW’s Prop 1 and FRGP, has worked on two large-scale projects to improve the estuary and lower mainstem Garcia River. The Garcia River Estuary Enhancement Plan was created with a multiphase project design to increase habitat for salmonids within the lower Garcia River and estuary below Highway 1 (PCI 2018). The first phase of the project was completed in 2022, with additional modifications in 2023 (Table 27; Treatment ID LG01).

In 2023, TNC received a National Oceanic Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries) grant to assess the Garcia River, spanning ~19.3 kilometers (12 miles) from the Highway 1 bridge to the confluence with the South Fork Garcia River. The goal is to develop a restoration plan that identifies high-priority opportunities to create winter flow refugia. This will be achieved by improving instream and floodplain habitats and developing a suite of concept designs for restoration on willing landowner properties.

8.3 Salmonid Populations

Prior to the current California Monitoring Plan (CMP) status and trend monitoring, salmonid population estimates were mostly anecdotal. A remnant Coho Salmon population was thought to persist in the basin based on observations by local biologists before the California Endangered Species Act (CESA) listing (Brown et al. 1991). In the 1950s and 1960s, biological and stream habitat surveys were conducted sparsely throughout the

Garcia River. These surveys mainly documented habitat conditions and species presence only. Creel surveys conducted in the early 1970s documented angler catch of Chinook Salmon, Coho Salmon, and steelhead (CDFG 1975; CDFG 1976).

The first spawning surveys occurred in the South Fork Garcia River in spawning years 1989/90, 1990/91, and in Signal, Inman, Mill, and Pardaloe creeks in 1995/96 (Maahs 1996). The primary objectives of the 1995/96 survey were to (1) evaluate the success of Coho Salmon yearlings planted in 1992 and (2) assess fish use of habitat structures that were placed in summer 1995 (Maahs 1996). Adult steelhead, redds, and carcasses were observed in all survey years, but no Chinook Salmon or Coho Salmon were observed. The first expansive spawning surveys occurred in winter 1998/99 where approximately 29 kilometers (18 miles) of river were surveyed for redds on multiple occasions during the salmon and steelhead spawning season (Maahs 1999). There was no evidence of Coho Salmon or Chinook Salmon, but steelhead adults, redds and carcasses were observed in most survey reaches (Maahs 1999).

Since 2008, spawning ground surveys have been conducted almost annually in the Garcia River to assess status and trends of salmon and steelhead (McGuire et al. 2021). Adult Coho Salmon population estimates have ranged from 0 – 515 and adult steelhead population estimates have ranged from 65 – 2,238 from spawning years 2008/09 to 2022/24 (n = 15) (Figure 44). As part of the pilot Coho Salmon conservation rearing project (Chapter 2.3), adult fish were released into the Garcia River during four spawning seasons: 2019/20 (3 jacks), 2020/21 (121 adults), 2021/22 (92 adults), and 2022/23 (87 adults). Observations of project fish on redds during spawning surveys indicated that they likely contributed to the redd counts, increasing population estimates in the years that they were released. In addition, preliminary results of parentage analysis through genetic testing of juveniles collected from the Garcia River showed successful reproduction of some of the released project fish.

The Garcia River supports one of the most consistent Chinook Salmon populations within the Mendocino Coast watersheds, with estimates ranging from 0 – 148 annually from spawning years 2008/09 to 2022/24. During the summers of 2022 and 2023, juvenile Chinook Salmon were documented upstream of previously documented ranges in the upper mainstem Garcia River, and as far upstream as lower Mill Creek and Pardaloe Creek (Sarah Gallagher, personal communication). In 2023, 2024, and 2025, TNC and California Department of Fish and Wildlife (CDFW) conducted snorkel surveys to evaluate newly constructed habitat in the Garcia River estuary and consistently observed hundreds of young-of-the-year Chinook Salmon rearing during the spring and early summer (Sarah Gallagher, personal communication).

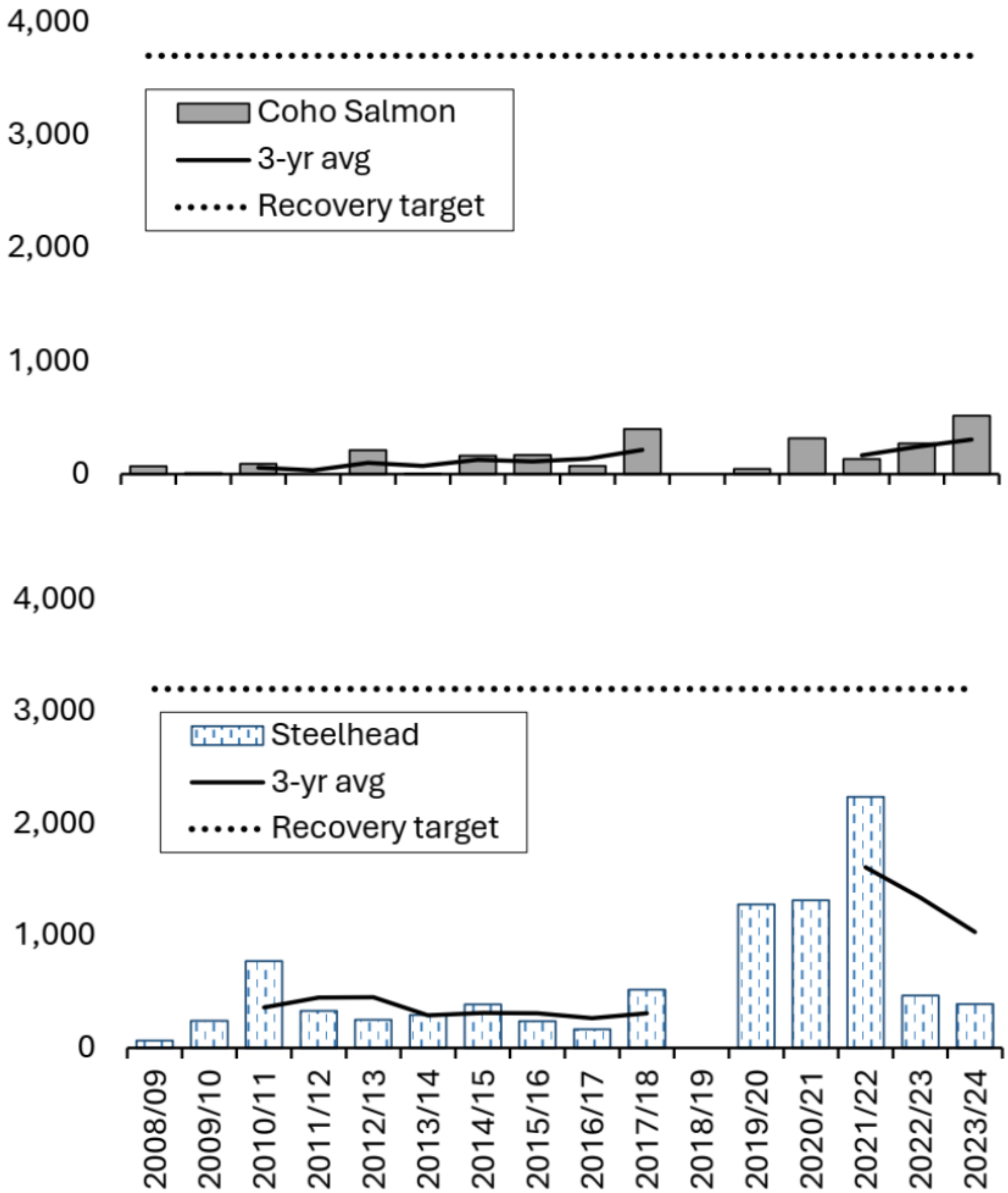


Figure 44. Garcia River, Mendocino County, CA Coho Salmon (top) and steelhead (bottom) annual escapement estimates from 2008/09 to 2023/24 (n =15). The Garcia River was not surveyed in 2018/19. The three-year rolling average (3-yr avg) and NOAA Fisheries recovery target are shown for each species.

8.4 Ranking Summary

All three Garcia River HUC 12 subwatersheds were selected during the ranking process (see Chapter 3. Watershed Selection) for further restoration planning. The Upper Garcia River overall score was lower relative to the Lower Garcia River and Middle Garcia River, mostly due to its lower score in *Biological Importance* (Figure 45). The Upper Garcia River has comparatively lower densities of salmonid redds and more limited distributions of Coho Salmon and Chinook Salmon. The Upper Garcia River scored relatively better in *Integrity and Risk* primarily due to its low population density and minimal water diversions.

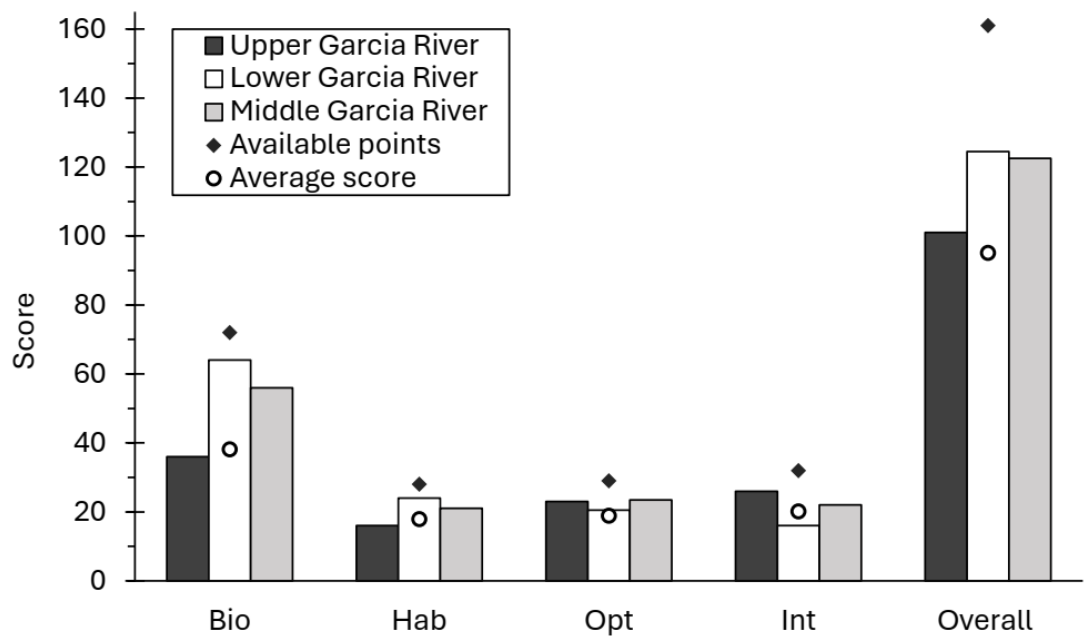


Figure 45. Ranking scores for each of the selected Garcia River HUC 12 subwatersheds. Scores also broken down by *Biological Importance (Bio)*, *Habitat Condition (Hab)*, *Optimism and Potential (Opt)*, and *Integrity and Risk (Int)* categories. For comparison, the average score for all 48 HUC 12 subwatersheds evaluated for the Mendocino Coast is shown by an open circle. Total available points available for each category are depicted by a diamond.

8.5 Watershed Meeting

The SHaRP meeting for the Garcia River watershed occurred on May 23–24, 2022, following methods described in Chapter 4. Watershed Meetings. On the first day, the steering team introduced the SHaRP process and presented life stage-attribute information specific to the Garcia River. Next, practitioners with experience working in the Garcia River presented their expertise on watershed history, land use, and restoration efforts, which provided participants with context important for life stage-attribute rating and identifying restoration treatments (Table 24).

Table 24. Presentations during the Garcia River SHaRP watershed meeting.

Title	Presenter
Garcia River Watershed and Monitoring Program	Jonathan Warmerdam, Environmental Program Manager (Supervisor), North Coast Water Board Jen Carah, Senior Freshwater Ecologist, The Nature Conservancy
Garcia Estuary Habitat Enhancement Project	Peter Van De Burgt, North Coast Project Manager, The Nature Conservancy
Collaborative Efforts to Address TMDL Goals in the Middle and Upper Garcia River	Colin Hughes, Senior Engineering Geologist, California Department of Fish and Wildlife
Garcia River Panel Discussion	Scott Kelly, North Coast Timberland Manager, The Conservation Fund Dave Ulrich, Aquatic Biologist, Mendocino Redwood Company Anna Halligan, North Coast Coho Project Coordinator, Trout Unlimited

Highlights from the panelist presentations include:

- In 2002, the Action Plan for the Garcia River Watershed Sediment Total Maximum Daily Load (Garcia TMDL) was adopted into the Water Quality Control Plan for the North Coast Region and became law. The Garcia River TMDL requires the treatment of controllable sediment discharge sources across the watershed, primarily associated with roads and landings. By 2016, approximately 80% of the land ownerships in the watershed had developed erosion control plans and were implementing management plans to address their erosion sources.
- From 2007 through 2012, the North Coast Regional Water Quality Control Board partnered with TNC to conduct a basin-wide assessment to monitor and assess the effectiveness of management activities. Findings showed that tributaries exhibited some improvement in complexity, depth, and fine sediment, but the mainstem river remains sediment impaired with fine sand exceeding recommendations.
- Impairment from land use impacts took decades to occur, and recovery will take time. Conservation actions are improving conditions for salmonids, particularly in the tributaries. Watershed recovery strategies should include pollution controls, riparian protections, and habitat restoration.
- The TNC Garcia River Estuary Salmonid Habitat Enhancement Project was designed to reconnect floodplains and create complex instream habitat. This would provide velocity refuge and feeding opportunities in the middle estuary. The project was in the implementation phase during the meeting. The Nature Conservancy highlighted important resources needed for this large estuary restoration project, including multiple sources of funding and support, land acquisition and protection of the estuary, permitting, and support of private ranchers.
- Trout Unlimited has treated 24.1 kilometers (15 miles) of road and numerous landslides in the South Fork Garcia River, while TNC completed large wood projects in Signal Creek, Olsen Gulch, and the North Fork Garcia River using accelerated recruitment. They recommend retreating to meet density targets.
- Mendocino Redwood Company has actively storm-proofed logging roads during timber harvest and documented Coho Salmon distribution throughout their property on the South Fork Garcia River, and smaller tributaries like Rolling Brook.
- The Conservation Fund recommended continuing focus on ecosystem function and highlighted their acquisition of the Garcia River Forest, completed road assessments, investments in road improvements, and numerous large wood projects. They highlighted the success of the TMDL contributing to road-related erosion control but noted that there are still legacy roads that may require reconstruction, rerouting to upslope, or decommissioning over time.
- Overall recommendations included continuing upgrades or decommissioning of roads; evaluating opportunities to add large wood to the mainstem; retreating tributaries with large wood, as initial treatments were below NOAA Fisheries' recommended wood loading rates; implementing off-channel and winter velocity

refuge habitat in the mainstem downstream of the South Fork Garcia River confluence; and evaluating fish response to restoration efforts.

After the presentations, participants rated the impact of attributes for each life stage. On the second day, participants leveraged their personal knowledge and the results of the limiting attribute analysis to identify specific restoration treatments in each HUC 12 subwatershed. This step was done collaboratively in ArcGIS Online.

8.6 Life Stage-Attribute Results

The steering team added *Invasive Species* as an attribute due to the presence of New Zealand mudsnails in the Lower Garcia River. Life stage-attribute rating results are summarized below and shown in Table 25.

Attributes strongly limiting survival

- *Instream Structural Complexity* and *Off-Channel Habitat* for juveniles and smolts
- *Water Quality and Water Quantity* for summer juveniles in the Upper and Middle HUC 12 subwatersheds.
- *Sediment Conditions* in the Lower Garcia River. While this attribute was rated as functioning to moderately functioning for all life stages, historically, sediment has been known to be an issue. Participants discussed whether issues had been addressed through the large number of road improvements. Because aggradation of gravel may be limiting channel and floodplain function, participants decided that it should be addressed through restoration.

Attributes least limiting survival

- *Barriers* for all life stages.
- *Invasive Species* for all life stages.
- All attributes for the eggs/alevin and adult life stages.

For some life stage-attribute relationships, there were an equal number of ratings by participants for functioning and not functioning. Reasons for differences were discussed and resolved. These included:

- *Instream Structural Complexity* for eggs in the Lower and Upper Garcia River.
- *Water Quality* for adults, eggs, smolts in the Middle Garcia River.
- *Water Quantity* for egg/alevin in the Middle Garcia River.

Participants noted that illegal water diversions have decreased as trespass grow operations declined following the legalization of marijuana.

While *Invasive Species* did not rate high as a factor limiting survival for any life stage, the presence of New Zealand mudsnails in the Lower Garcia River and estuary and may impact food availability for juveniles and smolts. The exact impacts and magnitude of those impacts on salmonids are not well understood. Participants noted that further study is warranted.

Table 25. Coho Salmon, Chinook Salmon, and steelhead life stage-attribute rating for selected Garcia River HUC 12 subwatersheds for the Mendocino Coast SHaRP. Life stages are EA = Egg/Alevin; SJ = Summer Juvenile; WJ = Winter Juvenile; SM = Smolt; AD = Adult. N/A = Not Applicable. Average scores were binned as: Functioning/not limiting survival (0 – 3.3) green, Moderately Functioning/somewhat limiting survival (3.4 – 6.6) yellow, or Not Functioning/strongly limiting survival (6.7 – 10) red.

HUC 12	Life Stage	EA	SJ	WJ	SM	AD
Lower	Barriers	N/A	1.6	1.7	1.7	2.7
Lower	Instream Complexity	6.0	8.8	8.9	7.8	5.8
Lower	Off-Channel	4.6	7.0	8.8	7.5	4.6
Lower	Riparian	3.5	5.6	4.6	3.3	2.7
Lower	Sediment	5.6	4.5	4.0	2.7	3.3
Lower	Water Quality	5.1	6.4	3.4	3.4	3.2
Lower	Water Quantity	5.3	6.7	3.8	2.6	3.2
Lower	Invasive Species	2.3	6.6	5.2	5.9	1.7
Middle	Barriers	N/A	1.8	1.8	2.2	2.3
Middle	Instream Complexity	6.0	7.7	9.1	8.2	6.8
Middle	Off-Channel	6.8	6.6	9.5	8.2	5.6
Middle	Riparian	3.0	5.9	4.0	4.3	4.1
Middle	Sediment	5.5	4.6	4.3	3.5	4.6
Middle	Water Quality	5.2	9.1	3.5	6.0	3.0
Middle	Water Quantity	5.7	9.0	4.3	5.6	5.3
Middle	Invasive Species	2.7	2.7	2.7	2.3	1.7
Upper	Barriers	N/A	2.7	2.3	2.3	3.0
Upper	Instream Complexity	6.0	8.1	8.8	7.9	5.8
Upper	Off-Channel	4.6	6.4	8.1	8.3	5.1
Upper	Riparian	3.0	5.1	3.0	3.7	3.0
Upper	Sediment	4.4	4.5	4.5	3.7	2.7
Upper	Water Quality	5.8	7.2	3.1	3.2	3.1
Upper	Water Quantity	5.9	7.2	4.0	4.0	3.0
Upper	Invasive Species	1.8	3.4	2.0	2.0	1.8

8.7 Restoration Treatments

Restoration treatments are summarized by type (defined in 4.2 Developing Restoration Treatments) for the Garcia River selected HUC 12 subwatersheds in Table 26. Individual treatments are listed and detailed in Table 27–29 and are shown geographically in Figure 46–Figure 49.

The addition of large wood was the most applied treatment and primarily treatment recommendation in the mainstem Lower Garcia River, portions of the Upper Garcia River, and within several tributaries. Adding large wood to meet targets refers to those set in the CCC Coho Salmon Recovery Plan (NMFS 2012). Off-channel/floodplain enhancement was primarily recommended in the mainstem Lower Garcia River. Road assessments, riparian enhancement, and habitat assessments were recommended mainly in the mainstem Upper Garcia River. No fish passage improvements were recommended, however there were barriers identified to investigate further.

Table 26. Restoration treatment summary for the selected Garcia River HUC 12 subwatersheds for the Mendocino SHaRP. LG = Lower Garcia River; MG = Middle Garcia River; UG = Upper Garcia River. Includes number of projects (n) and stream kilometers (km). LW = Large wood; OC = Off-channel/floodplain enhancement; RA = Road assessment/ improvement; RE = Riparian enhancement; HA = Habitat assessment; FP = Fish passage improvement. N/A = Not applicable.

Type	**LW**	**OC**	**RA**	**RE**	**HA**	**FP**	***Total***
LG (km)	16.2	16.2	0.8	0	N/A	N/A	*33.3*
LG (n)	5	3	2	0	1	0	*11*
MG (km)	20	0	0	0	0	N/A	*28.6*
MG (n)	4	0	0	0	0	1	*5*
UG (km)	19.7	0	5.0	5.8	12.4	N/A	*34.8*
UG (n)	4	0	1	1	2	0	*8*
Total (km)	*54.4*	*16.2*	*5.8*	5.8	*12.4*	*N/A*	***94.6***
Total (n)	*13*	*3*	*3*	*1*	*3*	*1*	***24***

Table 27. Lower Garcia River (LG) HUC 12 subwatershed restoration treatments for the Mendocino SHaRP. Each restoration treatment includes a unique identification code (ID), treatment type (type), general project location and description, and length in kilometers (km). HA = Habitat assessment; OC = Off-channel/floodplain enhancement; LW = Large wood; RA = Road assessment/improvement. See Figures 46 and 47 for maps of treatment locations.

ID	Location	Type	Details	Length (km)
LG01	Estuary	OC	Estuary is simplified and disconnected from the historic floodplain. Implement recommendations from the Estuary Enhancement Plan (PCI 2018). Designs include engineered log jams and excavated floodplain features. The first phase of construction occurred in summer 2022. There are future phases that can and should be constructed.	4.22
LG02	Lower Hathaway Creek	OC	Hathaway Creek was rerouted and functions as a ditch disconnected from the historic floodplain. Implement conceptual designs in Estuary Enhancement Plan (PCI 2018). Establish a multi-threaded channel network through wetland. Landownership changes will be needed to fully implement the project.	2.50
LG03	Mainstem from Highway 1 bridge upstream to South Fork	LW	In some sections, channel is simplified and disconnected from the historic floodplain. Assess to determine current condition, develop design plans, and implement projects. Good access for projects near confluence with South Fork. TNC's assessment is nearly complete in 2025, and early conceptual design work is underway. In conjunction with LG04.	9.51

ID	Location	Type	Details	Length (km)
LG04	Mainstem from Highway 1 bridge upstream to South Fork	OC	Channel is simplified and disconnected from the historic floodplain. Assess current conditions, develop design plans, and implement projects. Good access for projects near confluence with South Fork. TNC's assessment is nearly complete in 2025, and early conceptual design work is underway. In conjunction with LG03. While the investigation of beaver reintroduction/analogs was recommended by participants, TNC's subsequent watershed assessment has shown that the channel is likely too wide and flashy for this type of treatment.	9.52
LG05	North Fork	LW	Add large wood to the 1.6-kilometer (~ 1 mile) section upstream of Bridge 9. Opportunity to move large wood used in previous projects back into the channel by hand.	2.66
LG06	Rolling Brook	LW	Assess habitat condition. Design and implement large wood projects. In conjunction with road assessment/removal in LG07. Location has good access for equipment.	0.79
LG07	Rolling Brook	RA	Assess for potential road removal in conjunction with LG06 addition of large wood. Old road in floodplain and channel incision. Used consistently by Coho Salmon. Provides rearing habitat in the lower basin.	0.79
LG08	South Fork upstream into lower Flemming Creek	LW	Inventory previous large wood treatments and add new ones if needed to meet targets. In lower alluvial habitat, use engineered jams, and create side channels to interact with the mainstem river. Designs should incorporate equipment access restrictions. Coho Salmon use the entire South Fork up into Flemming Creek.	3.12

ID	Location	Type	Details	Length (km)
LG09	Garcia River at Highway 1 crossing	RA	Redesign Caltrans Highway 1 bridge to facilitate more natural flows. Bridge is low and narrow, and flows are causing erosion at the bridge site. Caltrans began assessment of the bridge in 2025.	point
LG10	Garcia River	HA	Motorists access the river and drive upstream, crossing the river at multiple points. Redds and juvenile fish are vulnerable at crossings. Driving on gravel bars also likely compacts them, further locking the channel into a degraded state, inhibiting the development of complex flow paths. Determine ways to prevent access around Voorhees Grove. Identify off-road vehicle river access points throughout the mainstem and develop solutions to prevent access.	point
LG 11	Olsen Gulch	LW	Add large wood to previous treatment area.	0.15

Table 28. Middle Garcia River (MG) HUC 12 subwatershed restoration treatments for the Mendocino SHaRP. Each restoration treatment includes a unique identification code (ID), treatment type (type), general project location and description, and length in kilometers (km). HA = Habitat assessment; OC = Off-channel/floodplain enhancement; LW = Large wood; RA = Road assessment/improvement; FP = Fish passage improvement. See Figure 46 and Figure 48 for maps of treatment locations.

ID	Location	Type	Details	Length (km)
MG01	Signal Creek	LW	Previously treated. Add large wood to meet targets.	7.59
MG02	Inman Creek	LW	Previously treated. Add large wood to meet targets.	7.76
MG03	North Fork Inman Creek	LW	After assessing the barrier on MG05, investigate opportunities for habitat improvement projects upstream.	1.30
MG04	Blue Waterhole Creek	LW	Assess habitat to determine design plan. Previous large wood projects and road decommissioning were completed. Add wood structures to sites with gravel bars and easier access. Due to steep gradient and boulder substrate, large structures will be needed. Treatment may help to route and sort gravel and increase habitat complexity. Mostly steelhead habitat with Coho Salmon found in lower creek.	3.33
MG05	North Fork Inman Creek	FP	Cascade barrier to anadromy most years. Investigate barrier status and treat if necessary to open access to salmonid habitat upstream.	point

Table 29. Upper Garcia River (UG) HUC 12 subwatershed restoration treatments for the Mendocino SHaRP. Each restoration treatment includes a unique identification code (ID), treatment type (type), general project location and description, and length in kilometers (km). HA = Habitat assessment; LW = Large wood; RA = Road assessment/improvement; RE = Riparian enhancement. See Figure 46 and Figure 49 for maps of treatment locations.

ID	Location	Type	Details	Length (km)
UG01	Mainstem between BWH Creek and East End Creek	HA	Assess habitat needs and restoration opportunities including options for engineered wood structures.	8.63
UG02	Mainstem between Blue Waterhole Creek and East End Creek	RA	Follow storm-proofing guidelines to reduce sediment input from nearby unimproved roads. Many gullies on the road in slide prone areas.	5.03
UG03	Mainstem between East End Creek and Pardaloe Creek	LW	Add large wood to meet targets. Investigate to determine if engineered designs are required.	5.79
UG04	Mainstem between East End Creek and Pardaloe Creek	RE	Landslides are common along Hollow Tree Road. Impacts riparian vegetation. Evaluate the potential for riparian plantings. In conjunction with large wood treatments in UG03.	5.79
UG05	Pardaloe Creek upstream to Fish Rock Road crossing	LW	The channel is incised. Add large wood to meet targets. Engineered structures are needed due to the proximity of the road. Investigate suitable treatment locations due to bedrock outcroppings and equipment access issues.	3.02

ID	Location	Type	Details	Length (km)
UG06	Pardaloe Creek upstream to Monahan Creek	HA	Incised, confined valley with suitable gravel substrate for spawning. Perform assessment to determine habitat treatment needs and plan. May need engineered log structures due to the proximity of the road. Existing logging debris could be put in the creek.	3.73
UG07	Mill Creek	LW	The section between Cabin Creek and North Mill Creek has good water temperatures and is low gradient. Add large wood structures to increase connectivity. Engineered designs are needed to protect roads and critical culverts. Conduct an assessment to determine how much farther upstream treatments should extend.	8.44
UG08	Redwood Creek upstream to Corral Creek	LW	Channel incised. Assess habitat to determine wood treatment design plan, then implement projects.	2.43

Figure 46. Restoration treatment map for the Lower Garcia River, Middle Garcia River, and Upper Garcia River HUC 12 subwatersheds for the Mendocino SHaRP. Treatment breaks delineate individual treatment extents when those adjacent were the same type. See Tables 27–29 for treatment details.

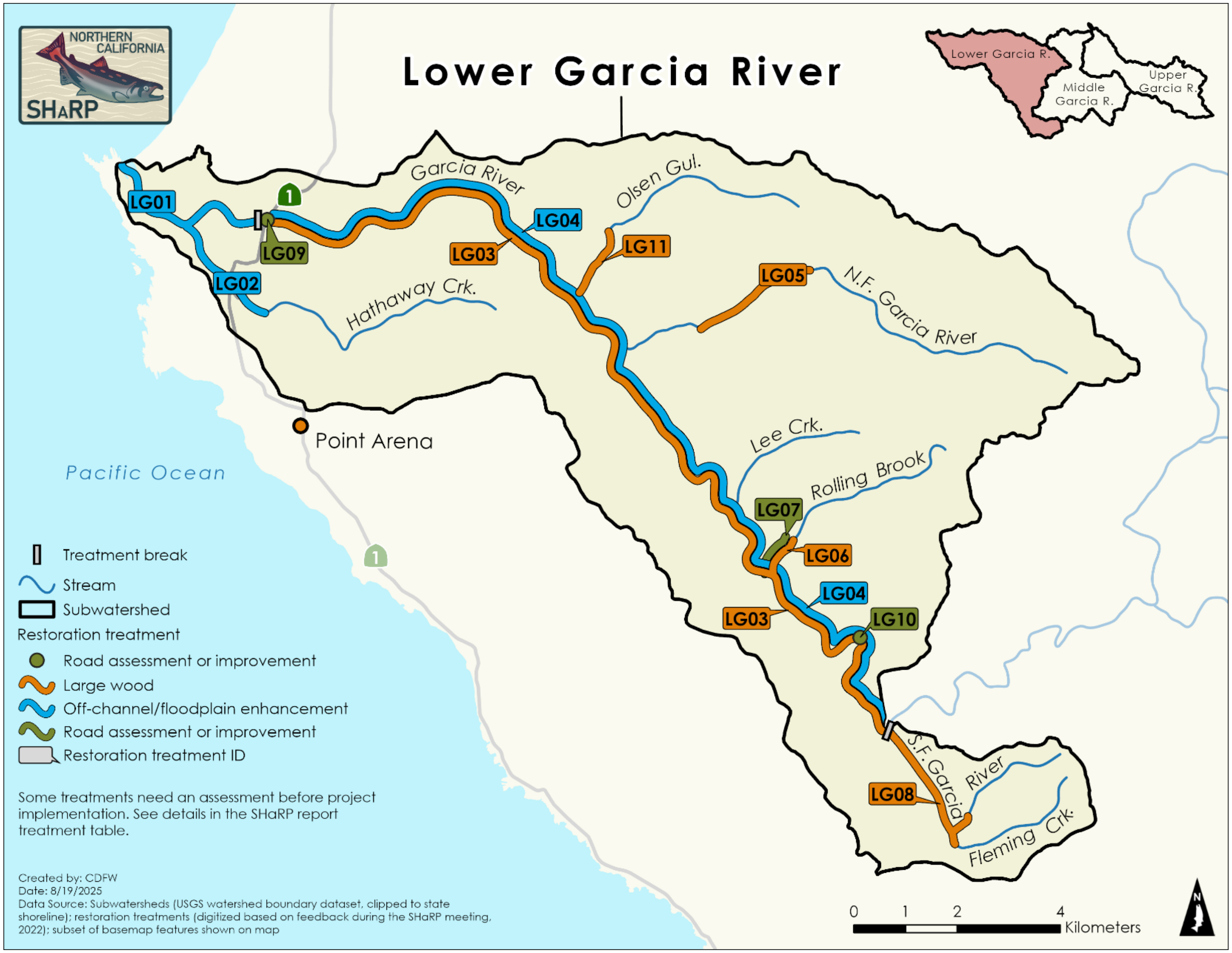


Figure 47. Restoration treatment map for the Lower Garcia River HUC 12 subwatershed for the Mendocino SHaRP. Treatment breaks delineate individual treatment extents when those adjacent were the same type. See Table 27 for treatment details.

Figure 48. Restoration treatment map for the Middle Garcia River HUC 12 subwatershed for the Mendocino SHaRP. See Table 28 for treatment details.

Figure 49. Restoration treatment map for the Upper Garcia River HUC 12 subwatershed for the Mendocino SHaRP. Treatment breaks delineate individual treatment extents when those adjacent were the same type. See Table 29 for treatment details.

Chapter 9. Navarro River

9.1 Watershed Overview

The Navarro River watershed is the largest watershed on the Mendocino Coast, encompassing over 809.4 square kilometers (312.5 square miles) (Figure 50). Its elevation ranges from sea level at the estuary to over 915 meters (3,000 feet) in the coastal mountains. The bar-built estuary forms a sand barrier that restricts connection with the ocean, typically during the summer and fall but also can close during periods of low flow year-round. The timing of the estuary mouth's opening and closing can delay adult migration and smolt emigration. The estuary was designated as a State Marine Conservation Area as part of California's Network of Marine Protected Areas (California State Parks n.d.). A large portion of the estuary is surrounded by Navarro River Redwoods State Park.

Land use is predominantly timber production (70%), followed by rangeland (25%) and agriculture (5%). Additionally, a small portion of the watershed includes rural residential development, primarily around the towns of Navarro, Philo, and Boonville (Navarro Watershed Restoration Plan 1998). Some inland protected lands include Hendy Woods State Park, Galbreath Wildlands Preserve, and land protected by the Anderson Valley Land Trust. The Anderson Valley Land Trust, established in 1991, works with landowners to create conservation easements to protect the land and promote sustainable use practices in the Anderson Valley and Navarro River.

The Navarro River watershed is considered an impaired watershed under Section 303(d) of the Clean Water Act due to excessive sediment yields and high stream temperatures (US EPA 2000). The United States Environmental Protection Agency, with assistance from the North Coast Regional Water Quality Control Board, established Total Maximum Daily Loads (TMDLs) to improve water quality within the Navarro River watershed (US EPA 2000). Although sparsely populated, water demand within the watershed stems from small diversions used for range cattle, vineyards, orchards, and other agricultural uses. Streamflow is further depleted by residential ground water extraction, while sediment erosion from a dense network of roads further contributes to the watershed's impaired status (Navarro Watershed Restoration Plan 1998).

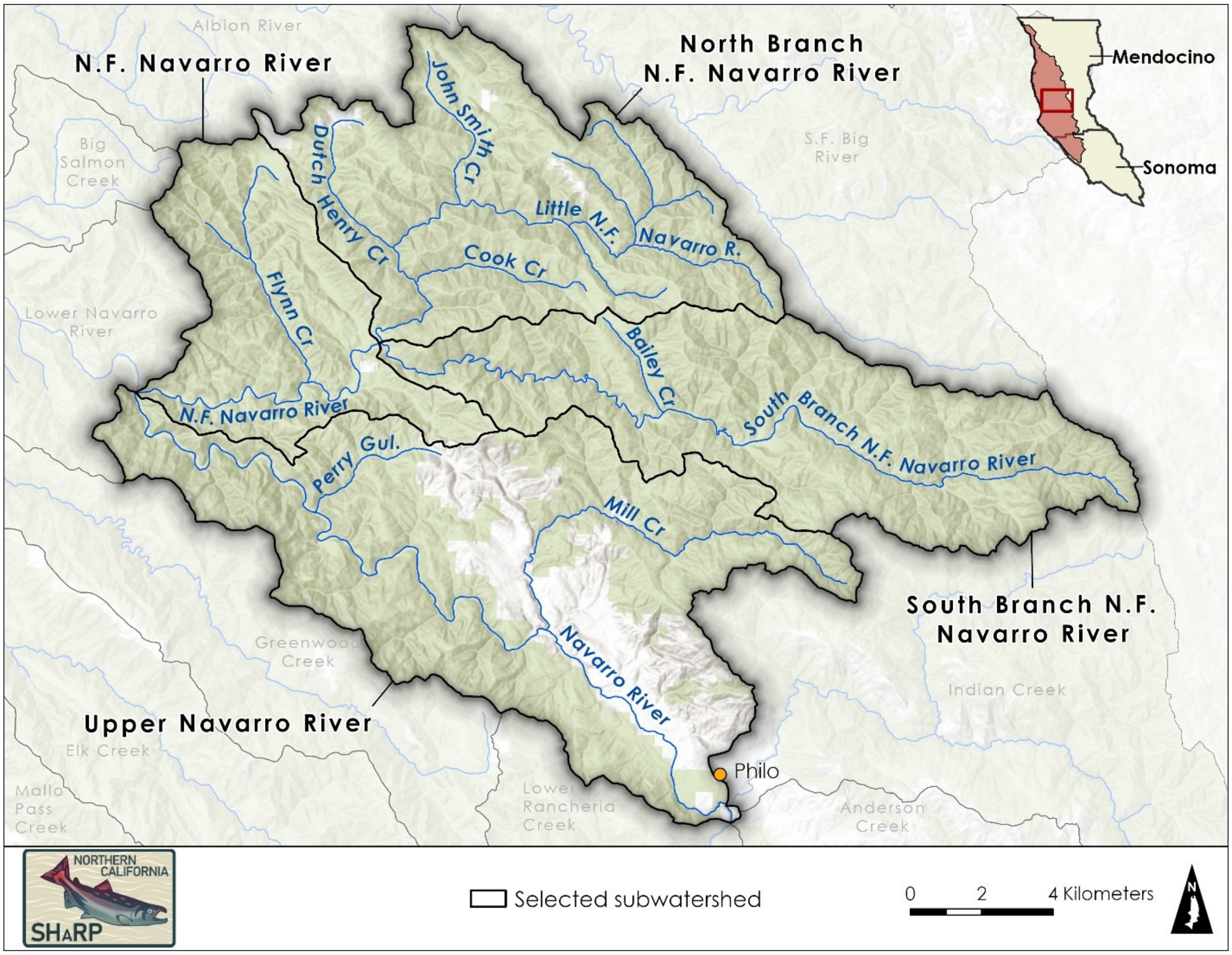


Figure 50. Overview map of selected HUC 12 subwatersheds within the Navarro River for Mendocino Coast SHaRP watershed planning: North Branch North Fork (N.F.) Navarro River, N.F. Navarro River, Upper Navarro River, and South Branch N.F. Navarro River.

Groundwater extraction for cannabis cultivation and residential development has likely led to reduced streamflow in late summer. During this period, groundwater serves as the primary source of base flows, which are vital for supporting fish and other aquatic organisms. Notably, Zipper et al. (2019) found that residential use depletes five times as much streamflow as cannabis cultivation. In 2009, total surface water withdrawals within the Navarro River watershed were estimated at 2 x 10^6 m^3 per year for traditional agriculture (McGourty et al. 2013), which exceeds the combined surface extraction from both cannabis and residential groundwater extractions by a factor of four (McGourty et al. 2020).

9.2 Historical and Recent Restoration

Past restoration efforts in the Navarro River have focused on mitigating the impacts of logging and its associated road infrastructure. More recent restoration efforts have focused on fish passage improvements, instream habitat improvements, and streamflow enhancement.

In the 1950s, the California Department of Fish and Game (CDFG) identified logging operations on the North Fork Navarro River subwatershed as the greatest threat to stream conditions (CDFG 1955). These operations, including clear-cutting and the creation of logging roads, introduced large sediment loads into the stream, smothering spawning gravel and reducing habitat for invertebrates, which serve as a key food source for salmonids (CDFG 1955). At the time, CDFG recommended building streamflow maintenance dams to reduce summer stream temperatures. However, concerns were raised about eliminating important and heavily used spawning habitat in Anderson Creek and the South Branch of the North Fork. CDFG also proposed building a new jetty at the mouth of the Navarro to allow early spawning fish to enter the river immediately, rather than waiting for fall rain to break open the sandbar (CDFG 1955).

Beginning in the 1980s, restoration efforts focused on improving fish passage by removing log jams and instream barriers. By the 1990s and early 2000s, restoration techniques shifted to conducting watershed evaluations aimed at identifying and addressing sediment issues from legacy logging roads, stabilizing banks, adding stream cover, and improving instream habitat through the addition of large wood structures.

In June 1998, the Coastal Conservancy adopted a resource enhancement plan for the Navarro River watershed, outlining three primary objectives to restore salmon and steelhead habitat: increasing the frequency and depth of pool habitat, lowering summer stream temperatures, and reducing sediment production and input (Navarro Watershed Restoration Plan 1998). To achieve these goals, the plan recommended adding large wood to streams, installing instream structures, enhancing riparian shading, boosting summer base flows, and reducing sediment input from roads, gullies, and stream banks through stabilization and gully remediation (Navarro Watershed Restoration Plan 1998).

More recent restoration projects have focused on increasing large wood loading to enhance stream complexity and improve habitat for salmonids. In the upper watershed, projects have focused on upland habitat restoration to reduce sediment input and create instream habitat. In the North Fork Navarro River, projects have focused on modifying instream habitat, reducing sediment through road decommissioning and improving fish passage.

From 2010 to 2024, Trout Unlimited (TU) completed 17 habitat restoration projects in the Navarro River (Trout Unlimited, personal reference). Between 2013 and 2016, TU implemented the North Fork Navarro Instream Coho Habitat Enhancement Project where 404 pieces of large wood were placed into 17.5 kilometers (10.9 miles) of the river in collaboration with Mendocino Redwood Company (MRC). In 2022, TU received funding from FRGP for the Soda Creek Fish Passage and Winter Habitat Refugia Design Project (CDFW 2024b). This project will provide engineered designs to restore 4.2 kilometers (2.6 miles) of habitat in Soda Creek by replacing a stream crossing to ensure unobstructed passage (Table 33; NFN11; NFN17). Additionally, it will include designs to enhance approximately 1,280 meters (4,200 feet) of stream habitat upstream of the crossing (CDFW 2024). Most recently in summer 2024, TU with funding from FRGP completed the removal of the earthen barrier that formed the Rancho Navarro Pond on Neefus Gulch, a tributary of the North Fork Navarro River. The objectives of this project were to restore natural streamflow and channel function, provide upstream access to habitat for salmon and steelhead, and remove invasive aquatic organisms, including bullfrogs.

Outside of the North Fork Navarro, many restoration efforts have focused on Mill Creek, with a focus on streamflow enhancement. In 2018, the Mendocino County Resource Conservation District (MCRCD), The Nature Conservancy (TNC), and TU launched the Collaborative Water Management (CWM) Plan for Mill Creek (Mill Creek Collaborative Water Management Plan 2021). The plan aims to enhance streamflow for Coho Salmon and steelhead trout by supporting and incentivizing landowners to adopt water management practices. Specifically, CWM seeks to improve summer streamflow conditions while ensuring adequate water supply for landowners. This is achieved by reducing the need for pumping in the dry season by expanding water storage for landowners to capture water during the wet season. This will improve water efficiency and groundwater recharge among other approaches.

Additionally, CWM established a monitoring framework to assess streamflow and water conditions, allowing for the evaluation of the effectiveness of streamflow enhancement efforts (The Navarro River Flow Enhancement Partnership et al. 2021). The Navarro Flow Enhancement Partnership has completed several storage and forbearance projects with vineyards and rural residential users, and more are in development.

Between September and October 2020, MCRCD, in partnership with TU, implemented a large wood augmentation project along two reaches of Mill Creek, spanning 1.9 kilometers (1.2 miles). The project placed 37 pieces of large wood within the channel, as shown in Figure 51.

In 2022, TNC received funding from the California Department of Fish and Wildlife (CDFW) to develop large wood and groundwater infiltration projects in Mill Creek. This led to the development of a large wood enhancement plan for ~ 4.5–6.4 kilometers (3–4 miles) of reaches with high intrinsic potential, focusing on the ~ 4 kilometers (2.5 miles) where Coho Salmon presence has been recorded. A groundwater recharge feasibility study was conducted on the Little Mill Creek watershed (~ 425 hectares/1,050 acres) to evaluate opportunities for streamflow enhancement. One project incorporating both channel restoration and direct pond release was designed to 100%. In 2024, a grant from the

Wildlife Conservation Board funded projects focused on the restoration of incised channels, placement of large wood, groundwater recharge, and a pond release plan in Mill Creek (CDFW 2024). This work partially addresses recommendation UNA07 (Table 34).

Figure 51. Example of a large wood treatment structure in lower Mill Creek in 2020. Photo credit Sarah Gallagher, CDFW.

9.3 Salmonid Populations

Overall, Coho Salmon and steelhead populations are currently a fraction of their respective recovery targets in the Navarro River (Figure 52). Steelhead are distributed throughout most of the Navarro River, while Coho Salmon populations are strongest in the North Fork Navarro River, with low abundances occurring in the mainstem, Mill Creek, Indian Creek, and Rancheria Creek. Anderson Creek is not monitored under the California Monitoring Plan (CMP) because Coho Salmon were not known to be present there in recent history. However, incidental observations were made of Coho Salmon adults spawning in winter 2024/25, and of juveniles rearing in late spring 2025 (Linda MacElwee and Sarah Gallagher, personal communication).

From spawning season 2008/09 through 2023/24, adult Coho Salmon estimates ranged from 0 – 798 and adult steelhead estimates ranged from 102 – 1,926 (Figure 52). Since 2014, life cycle monitoring on the North Fork Navarro River has provided annual estimates of Coho Salmon and steelhead smolt production, indices of survival, and information on migration timing. The average Coho Salmon smolt estimate was 31,868 (range 2,527 – 96,714) from 2014 to 2024 (n = 10). The average steelhead smolt estimate was 45,018 (range 2,793 – 101,546) from 2014 to 2024 (n = 10).

As part of the pilot Coho Salmon conservation rearing project (Chapter 2.3), adult fish were released into the North Fork Navarro River during three spawning seasons: 2019/20 (6 jacks), 2020/21 (77 adults), and 2021/22 (100 adults). Observations of project fish on redds during spawning surveys indicated that they likely contributed to the redd counts, increasing population estimates in the years that they were released. In addition, preliminary results of parentage analysis through genetic testing of juveniles collected from the North Fork Navarro River showed successful reproduction of some of the released project fish.

Based on current monitoring, Chinook Salmon appear to be at very low abundances or locally extirpated, as they have not been observed during spawning surveys since CMP monitoring began. However, in 2014, several individual juveniles were captured in the North Fork Navarro River outmigrant trap, providing evidence of successful reproduction.

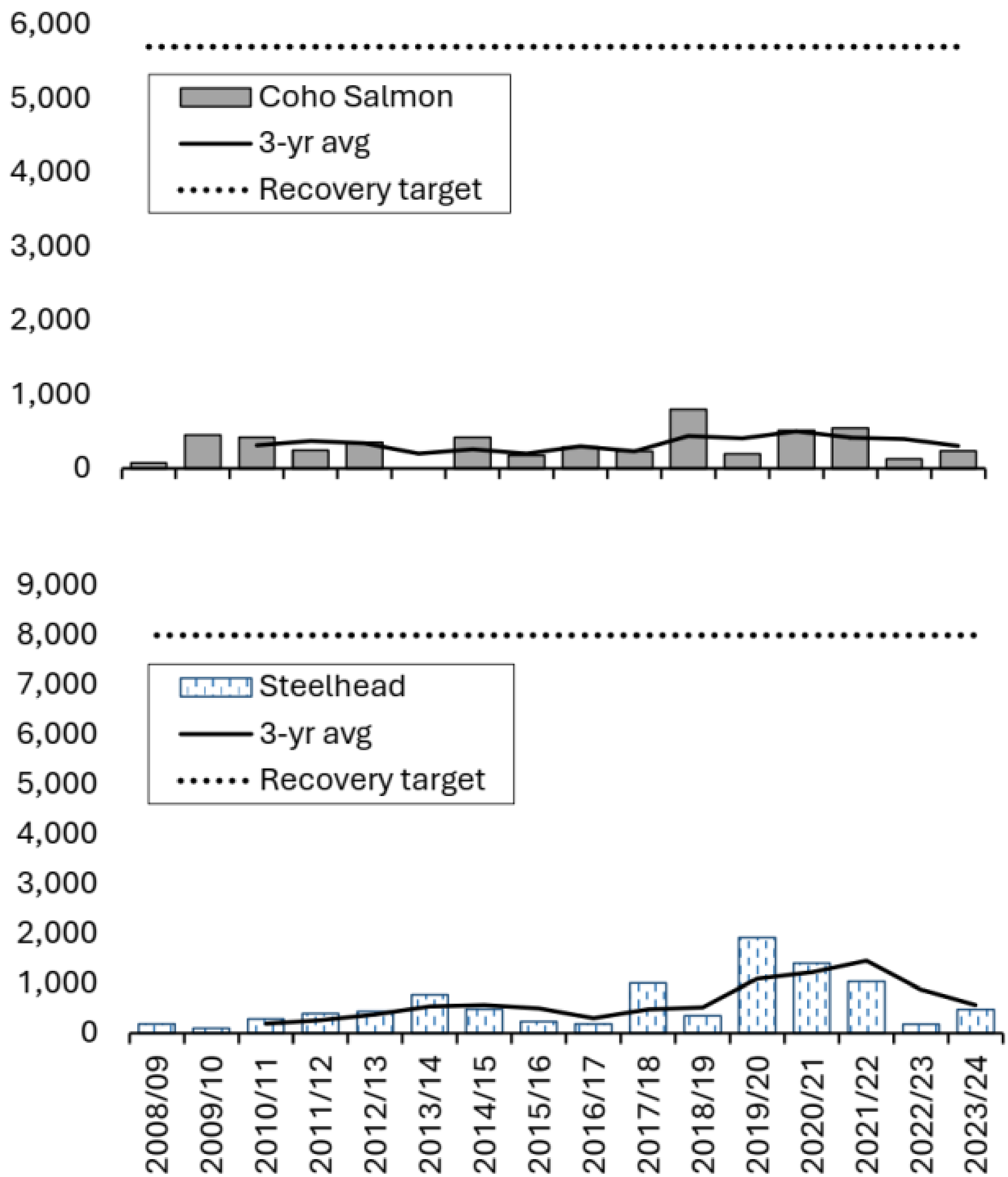


Figure 52. Navarro River, Mendocino County, CA Coho Salmon (top) and steelhead (bottom) annual escapement estimates from 2008/09 to 2023/24 (n = 14). The three-year rolling average (3-yr avg) and NOAA Fisheries recovery target are shown for each species.

9.4 Ranking Summary

Four HUC 12 subwatersheds were selected during the ranking process (see Chapter 3. Watershed Selection) for further restoration planning: North Branch North Fork Navarro River, North Fork Navarro River, Upper Navarro River, and South Branch North Fork Navarro River. South Branch North Fork Navarro River received the highest overall score (Figure 53). The Upper Navarro River and North Fork Navarro River scored lower in *Integrity and Risk* due to larger residential populations and water diversions. During the advisor review (see Chapter 3.2 Advisor Review), participants discussed whether to include the Lower Navarro River HUC 12 subwatershed as a selected watershed. Because it contains important estuarine habitat and serves as a migration corridor, it provides high value to all salmon and steelhead life stages. However, it scored lower overall compared to other HUC 12 subwatersheds and therefore was not added.

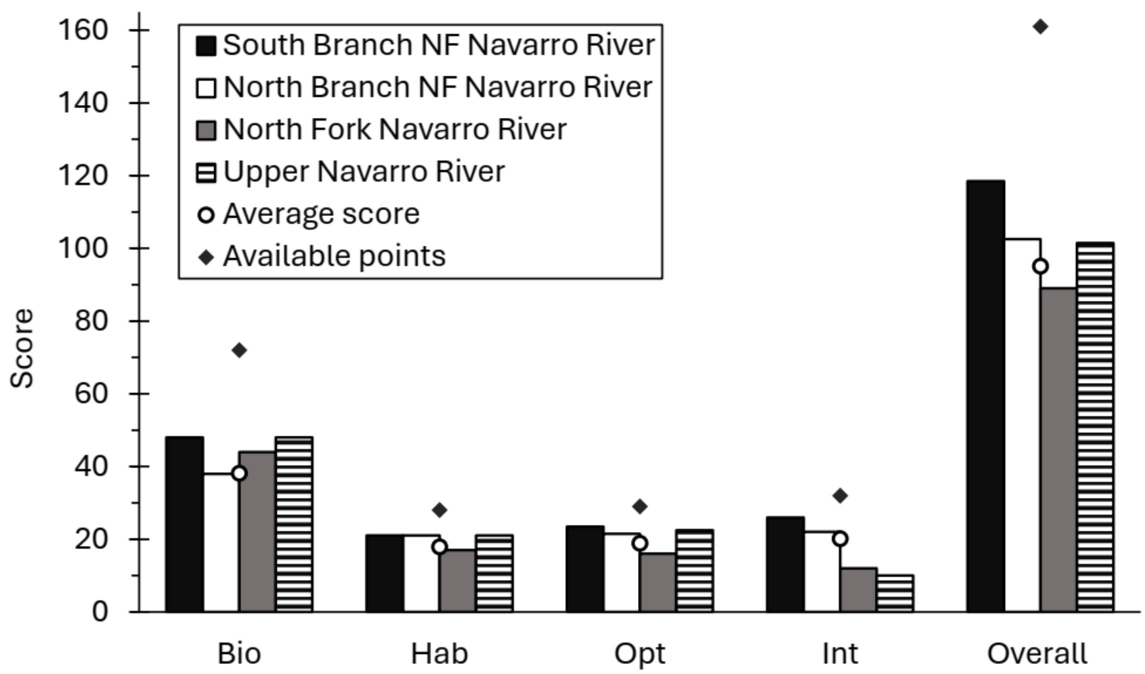


Figure 53. Ranking scores for the four selected Navarro River HUC 12 subwatersheds. Scores also broken down by *Biological Importance (Bio)*, *Habitat Condition (Hab)*, *Optimism and Potential (Opt)*, and *Integrity and Risk* (*Int*) categories. For comparison, the average score for all 48 HUC 12 subwatersheds evaluated for the Mendocino Coast is shown by an open circle. Total available points available for each category are depicted by a diamond.

9.5 Watershed Meeting

The SHaRP meeting for the Navarro River watershed occurred over four days from November 14 – 17, 2022. The first day included a field tour where participants visited restoration projects on the North Fork Navarro River, two streamflow enhancement projects on Mill Creek, and a section of the upper mainstem river at Hendy Woods State Park to observe existing habitat conditions. The second meeting day was held virtually following methods in Chapter 4. Watershed Meetings. The steering team introduced the SHaRP process and presented life stage-attribute information specific to the Navarro River. Several presentations followed, covering watershed history and overview of restoration efforts, salmonid monitoring, and a panel discussion with context important for life stage- attribute rating and identifying restoration treatments (Table 30).

Table 30. Presentations during the Navarro River SHaRP watershed meeting.

Title	**Presenter**
History and Overview of Restoration Efforts in the Navarro Watershed	Linda MacElwee, Project Coordinator, Mendocino County Resource Conservation District
Navarro River Expert Panel Discussion	Jennifer Carah, Senior Scientist, The Nature Conservancy Anna Halligan, North Coast Coho Project Coordinator, Trout Unlimited Tyler Cadwell, Fisheries Biologist, California Conservation Corps Laurel Marcus, Executive Director, California Land Stewardship Institute Bryan McFadin, Senior Water Resource Control Engineer, California Water Quality Control Board
Salmonid Life History and CMP Monitoring	David Ulrich, Aquatic Biologist, Mendocino Redwood Company

Highlights of the panelist presentations include:

- The Navarro River watershed has legacy impacts from post-settlement land development, including ranching, agriculture, and timber. In the early 1900s, there were as many as 30 operational timber mills.

- Both timber and agriculture (vineyards, farms, orchards) continue to have the largest land use impacts in the watershed. A quarter of the watershed is owned by Mendocino Redwood Company.
- There is a long history of efforts to restore and conserve the Navarro River watershed. Pacific Watershed and Associates has focused efforts on inventorying, storm proofing, and decommissioning roads to reduce sediment input. The MCRCD has completed instream and riparian enhancements, road work, and community outreach and education. TU has completed sediment reduction projects, fish passage projects, and large wood augmentation projects. The California Conservation Corps has been working in the Navarro River watershed since the 1990s, primarily focusing on completing large wood augmentation projects. In 2013, MCRCD started working with TU's Conservation Hydrology Program to install stream gauges to monitor water quantity. In 2015, MCRCD partnered with TNC and TU to enhance streamflow within priority Coho Salmon streams, forming the Navarro River Flow Enhancement Partnership, which now maintains the flow gauges and develops and implements flow enhancement projects.
- Over the last several decades, summer base flows have significantly and exponentially decreased, with stream reaches drying, even in good water years.
- While there is spawning and rearing habitat in the mainstem river, habitat suitability has declined due to fluctuations in flows caused by water withdrawals and exacerbated by climate change and drought conditions. Water temperature is also poor in the mid to upper mainstem, likely due to several factors, including water diversion, poor riparian cover, and aggradation.

After the presentations, participants rated the impact of attributes for each life stage. On meeting days three and four, SHaRP participants leveraged their personal knowledge and the results of the limiting attribute analysis to identify specific restoration treatments in each HUC 12 subwatershed. This step was done collaboratively in ArcGIS Online.

9.6 Life Stage-Attribute Results

Attribute rating was combined for North Branch North Fork and South Branch North Fork Navarro River HUC 12 subwatersheds. The steering team slightly modified the frequency bin categories from those used in other watershed meetings to capture attributes that participants discussed as most limiting. Life stage-attribute rating results are summarized below and shown in Table 31.

Attributes strongly limiting survival

- *Instream Structural Complexity* and *Off-Channel Habitat* at the juvenile life stage across all HUC 12 subwatersheds.
- *Water Quantity* in the Upper Navarro River for all life stages except winter juveniles, and in the North Fork Navarro River for the summer juvenile life stage only.
- *Riparian Condition, Sediment Conditions,* and *Water Quality* at the summer juvenile life stage in the Upper Navarro River.
- *Invasive Species* at the summer juvenile life stage in the North Fork Navarro River due to the presence of bullfrogs associated with the reservoir in Neefus Gulch.

Attributes least limiting survival

- *Anthropogenic Barriers* across all life stages and HUC 12 subwatersheds.
- *Riparian Condition* across all life stages in the North Fork Navarro River and North Branch and South Branch of the North Fork Navarro River.

Poor ratings for *Sediment Conditions* and *Riparian Condition* for summer juveniles in the Upper Navarro River primarily reflect mainstem habitat and not Mill Creek where these attributes would rate better. Much of the mainstem Navarro River has issues with warm water temperatures and low flows in the dry season due to excessive sediment, nonfunctional floodplains, lack of instream complexity and riparian habitat, and water diversions. Participants noted that low flow conditions can create barriers during adult migration to the spawning grounds, and for steelhead kelts when they return to the ocean after spawning. Although not considered during rating, participants discussed potential water quality issues in the North Fork Navarro River related to trash being dumped from Highway 128. Potential solutions included the installation of preventative signage.

Table 31. Coho Salmon, Chinook Salmon, and steelhead life stage-attribute rating for selected Navarro River HUC 12 subwatersheds for the Mendocino Coast SHaRP. NBSB = North Branch and South Branch of the North Fork Navarro River. Life stages are EA = Egg/Alevin; SJ = Summer Juvenile; WJ = Winter Juvenile; SM = Smolt; AD = Adult. N/A = Not Applicable. Average scores were binned as: Functioning/not limiting survival (0 – 3.3) green, Moderately Functioning/somewhat limiting survival (3.4 – 6.4) yellow, or Not Functioning/strongly limiting survival (6.5 – 10) red.

HUC 12	Life Stage	EA	SJ	WJ	SM	AD
Upper	Barriers	N/A	3.3	2.3	2.9	4.9
Upper	Instream Complexity	7.2	9.1	9.0	8.3	7.3
Upper	Off-Channel	6.5	7.5	9.1	8.4	7.5
Upper	Riparian	3.5	6.7	3.5	4.6	3.8
Upper	Sediment	7.8	6.7	5.5	5.4	6.5
Upper	Water Quality	5.5	9.1	5.1	5.5	4.9
Upper	Water Quantity	7.6	9.7	5.4	7.5	6.6
Upper	Invasive Species	4.0	6.3	3.8	4.7	3.0
North Fork	Barriers	N/A	3.4	3.8	3.4	4.5
North Fork	Instream Complexity	5.8	7.1	7.4	7.2	6.9
North Fork	Off-Channel	4.5	6.9	7.7	6.6	6.2
North Fork	Riparian	2.1	2.8	1.8	1.9	1.3
North Fork	Sediment	5.7	5.1	4.8	4.1	4.4
North Fork	Water Quality	4.9	6.1	3.8	3.9	3.7
North Fork	Water Quantity	4.8	8.7	4.7	5.8	5.8
North Fork	Invasive Species	6.1	6.5	3.8	3.5	3.3
NBSB North Fork	Barriers	N/A	2.6	2.1	2.7	3.4
NBSB North Fork	Instream Complexity	4.5	7.1	7.1	5.5	5.8
NBSB North Fork	Off-Channel	4.8	6.0	7.5	6.3	6.0
NBSB North Fork	Riparian	2.0	3.9	2.4	3.2	2.4
NBSB North Fork	Sediment	5.6	4.3	4.7	3.4	3.8
NBSB North Fork	Water Quality	3.4	4.8	2.9	2.9	2.5
NBSB North Fork	Water Quantity	4.0	5.8	3.8	4.4	4.4
NBSB North Fork	Invasive Species	2.6	3.4	2.2	2.6	2.2

9.7 Restoration Treatments

Restoration treatments are summarized by type(defined in 4.2 Developing Restoration Treatments) for the Navarro River selected HUC 12 subwatersheds in Table 32. Individual restoration treatments are listed and described in Table 33–36 and shown geographically in Figure 54-Figure 58.

Most treatments focused on improving instream habitat complexity, reconnecting to off-channel habitats and floodplains, and providing velocity refugia. The addition of large wood to the mainstem and tributaries was the most frequently recommended treatment. Many previous large wood project sites were recommended to be retreated to meet targets. Adding large wood to meet targets refers to those set in the CCC Coho Salmon Recovery Plan (NMFS 2012). Off-channel/floodplain enhancement was recommended for the entirety of the mainstem Upper Navarro River. Streamflow enhancement projects were the second most frequently recommended treatment, with recommendations made for selected subwatersheds except in the South Branch North Fork Navarro River. Several fish passage projects were identified, including culvert and crossing upgrades.

Table 32. Restoration treatment summary for the selected Navarro River HUC 12 subwatersheds for the Mendocino SHaRP. NFN = North Fork Navarro River; UNA = Upper Navarro River; NBNF = North Branch North Fork Navarro River; SBNF = South Branch North Fork Navarro River. Includes number of projects (n) and stream kilometers (km). LW = Large wood; OC = Off-channel/floodplain enhancement; RA = Road assessment/improvement; RE = Riparian enhancement; HA = Habitat assessment; FP = Fish passage improvement; CE = Conservation easement; SE = Streamflow enhancement. N/A = Not applicable.

Type	**LW**	**OC**	**RA**	**RE**	**HA**	**FP**	**CE**	**SE**	***Total***
NFN (km)	13.7	8.6	6.2	0	0.5	N/A	0	18.5	*47.6*
NFN (n)	3	5	1	0	1	3	0	5	*18*
UNA (km)	13.7	30.7	0	0	3.4	N/A	3.2	28.4	*79.5*
UNA (n)	3	1	0	0	2	3	1	4	*14*
NBNF (km)	30.3	1.1	0	5	1.2	0	0	8.8	*46.4*
NBNF (n)	7	1	0	1	1	0	0	2	*12*
SBNF (km)	28.4	1.7	0	0	1.9	N/A	0	0	*32*
SBNF (n)	8	3	0	0	1	1	0	0	*13*
Total (km)	*86.2*	*42.2*	*6.2*	*5*	*6.9*	*N/A*	*3.2*	*55.7*	***205.5***
Total (n)	*21*	*10*	*1*	*1*	*5*	*7*	*1*	*11*	***57***

Table 33. North Fork Navarro River (NFN) HUC 12 subwatershed restoration treatments for the Mendocino SHaRP. Each restoration treatment includes a unique identification code (ID), treatment type (type), general project location and description, and length in kilometers (km). OC = Off-channel/floodplain enhancement; LW = Large wood; SE = Streamflow enhancement; RA = Road assessment/improvement; HA = Habitat assessment; FP = Fish passage improvement. See Figure 54 and Figure 55 for maps of treatment locations.

ID	Location	Type	Details	Length (km)
NFN01	Mainstem upstream to Coon Creek	OC	Investigate and develop projects to promote back flooding to increase available off-channel rearing habitat in lower North Fork.	4.10
NFN02	Dead Horse Gulch	OC	Develop projects in low gradient sections near the mouth to increase floodplain connectivity and available off-channel rearing habitat in lower North Fork.	0.39
NFN03	Coon Creek	OC	Develop projects in low gradient sections near the mouth to increase floodplain connectivity and available off-channel rearing habitat in lower North Fork.	0.53
NFN04	Tramway Gulch	OC	Gulch is marshy with lots of wood. Road has been removed. Develop projects in low gradient sections near the mouth to increase floodplain connectivity and available off-channel rearing habitat in lower North Fork. Focus on engineered designs due to proximity to Highway 128.	1.32
NFN05	Flynn Creek	LW	Add large wood to meet targets and slow water down in high flows. Use wood from Humboldt Crossing at Tank 4 Gulch to enhance habitat.	6.23

ID	Location	Type	Details	Length (km)
NFN06	Flynn Creek and upper tributaries	SE	Major concentrations of water use in this area. Onion patch has wells and cannabis. The Navarro River Partnership has developed a Collaborative Water Management Plan, which includes the community of Rancho Navarro. Develop flow enhancement projects, including groundwater recharge (e.g. gully stuffing), water storage and forbearance, rainwater capture, and streamflow enhancement.	13.23
NFN07	Flynn Creek	RA	The creek is bound by the road on one side and a railroad grade on the other. Investigate removal of railroad grade to decrease channelization.	6.23
NFN08	Camp 16 Gulch	LW	Add large wood to meet targets. Salmon were detected in 2022. Habitat is low gradient with good potential. Railroad grade impacts channel processes. Not impacted by Rancho Navarro water withdrawals.	0.82
NFN09	Neefus Gulch	SE	The lower stretch of the drainage can run dry due to withdrawals. Develop water forbearance projects with tank storage and rainwater catchment. Off-channel water storage tanks may help summer/fall low flow conditions in lower Neefus Gulch.	2.93
NFN10	Soda Creek	HA	In conjunction with NFN18, investigate habitat conditions upstream of Highway 128 to determine why water is not coming downstream. In addition to water use, there may be other reasons the creek goes dry.	0.47

ID	Location	Type	Details	Length (km)
NFN11	Soda Creek	OC	Large floodplain has good potential for a stage-zero project and providing winter refugia in the lower North Fork. Lower reach assessment by TU in 2023. Support recommendations for large wood or floodplain enhancement. In conjunction with fish passage improvement on NFN17.	2.30
NFN12	NF Navarro River from Coon Creek to South Branch/North Branch confluence	LW	Add large wood to meet targets.	6.69
NFN13	Neefus Gulch from Appian Way to the headwaters.	SE	Address instream diversions upstream of the dam removal location. Recommend working with landowners for streamflow enhancement to improve flows. Explore use of 5–10 thousand-gallon tanks for rainwater catchment for the community of Rancho Navarro. Implement larger tanks in the lower river to reduce drafting in the summer.	0.40
NFN14	NF Navarro River from Soda Creek confluence upstream to the North Branch and South Branch confluence	SE	Major concentrations of water use in this area. Develop flow enhancement projects, including groundwater recharge (e.g. gully stuffing), water storage and forbearance, rainwater capture, and stream enhancement.	1.96
NFN15	Dead Horse Gulch	FP	Upgrade the culvert on Highway 128 to provide fish passage upstream and off-channel rearing in North Fork.	point
NFN16	Coon Creek	FP	Upgrade the culvert on Highway 128 to provide fish passage upstream and off-channel rearing in North Fork.	point

ID	Location	Type	Details	Length (km)
NFN17	Soda Creek	FP	Upgrade the culvert at the mouth of Soda Creek to provide fish passage and provide off-channel rearing in North Fork.	point
NFN18	Soda Creek	SE	Soda Creek supplies the town of Navarro with water and goes dry. Work with landowners to install rainwater catchment tanks and develop forbearance projects to eliminate dry season instream diversion and groundwater pumping.	point

Table 34. Upper Navarro River (UNA) HUC 12 subwatershed restoration treatments (n = 14). See Figure 56 for specific locations. OC = Off-channel/floodplain enhancement; SE = Streamflow enhancement; LW = Large wood; HA = Habitat assessment; CE= Conservation easement; FP = Fish passage improvement. See Figure 54 and Figure 56 for maps of treatment locations.

ID	Location	Type	Details	Length (km)
UNA01	Mainstem	OC	Channel is simplified and disconnected from the historic floodplain. Very few restoration projects have been completed in the past. Identify opportunities for instream and off-channel projects using LiDAR and field assessments and develop projects.	30.74
UNA02	Mainstem upstream of Mill Creek confluence	SE	Develop water storage and forbearance projects. Groundwater pumping and flow diversions deplete river flows. Projects would provide opportunities to increase streamflow during low flow periods.	9.41
UNA03	Perry Gulch downstream of Gulch 1	LW	The road near the creek goes through most of the property providing access for treatment. In conjunction with UNA11.	3.32
UNA04	Floodgate Creek upstream to Highway 128	LW	Add large wood to meet wood targets. Known Coho Salmon presence. Tends to run dry at confluence with mainstem. 2017 habitat assessment showed low wood densities. Since the SHaRP meeting, salmon were observed spawning in the winter of 2024/2025 (personal communication with landowner).	2.54

ID	Location	Type	Details	Length (km)
UNA05	Floodgate Creek upstream to Highway 128	SE	Develop projects for groundwater recharge (e.g. gully stuffing), water storage and forbearance, rainwater capture, and streamflow enhancement. The lower creek dries in the summer. Riparian wells and flow diversions deplete flow. Upstream of MRC property, the area is developed with agriculture and rural residences. Several water storage ponds near Pear Pasture Gulch.	2.54
UNA06	Mill Creek	LW	Add large wood to areas not previously treated to meet targets. Include channel-spanning wood and augment existing large wood projects. Component of Mill Creek Collaborative Watershed Plan.	7.85
UNA07	Mill Creek and Meyer Gulch	SE	Implement projects described in Mill Creek Collaborative Watershed Plan for water storage and forbearance, groundwater recharge, rainwater capture, and streamflow enhancement. Infiltration project is in the implementation phase by the Navarro Flow Enhancement Partners, MCRCD, TNC, and TU. Address diversions near stream wells. There are legal and illegal diversions for cannabis. Sections of the stream run dry annually and may be improved with flow augmentation strategies.	16.45

ID	Location	Type	Details	Length (km)
UNA08	Meyer Gulch	HA	Assess the stream for habitat quality and restoration potential in the section upstream of a small culvert barrier near Quail Road. Assess the value of barrier removal and subsequently improving conditions upstream. Flow predictions show drying in late summer even in wet years. Streamflow enhancement in UN07 is an important component of habitat restoration effort. Residential ponds upstream may provide potential for summer releases.	1.24
UNA09	Lazy Creek	HA	Assess for habitat restoration potential. In conjunction with the Caltrans barrier removal on UNA12. Habitat needs assessment before making recommendations. Pond on creek that could provide flow augmentation.	2.12
UNA10	Mainstem and confluence of Mill Creek	CE	To improve connectivity, develop conservation easements for floodplain and confluence restoration. Good opportunity with potential willing landowner. Land traditionally grazed with sheep. Confluence zones are ecologically important.	3.23
UNA11	Gulch 1	SE	Investigate summer water releases from the 15-hectare reservoir into Perry Gulch to support juvenile rearing. Perry Gulch runs dry in the summer. The landowner has a conservation easement with Save the Redwoods League. The reservoir is large enough (minimum 11 hectares) to provide flows to keep a smaller watershed wet during the dry season. In conjunction with UN03 to improve habitat in Perry Gulch.	point

ID	Location	Type	Details	Length (km)
UNA12	Lazy Creek	FP	Upgrade the culvert at Highway 128 to allow fish passage. Identified in the California Fish Passage Assessment Database (PAD) as PAD ID 706968)	point
UNA13	Gowan Creek	FP	Upgrade the culvert at Highway 128 to allow fish passage. Identified in PAD as PAD ID 713127.	point
UNA14	Meyer Gulch mouth at Mill Creek	FP	Culvert is currently impassible to fish under most flows and blocks access upstream in Meyer Gulch. An unsuccessful upgrade was attempted in the past with a concrete fish ladder and bedrock modification. Design for culvert replacement in place with TU. Implement project. Identified in PAD as PAD ID 706977.	point

Table 35. North Branch North Fork Navarro River (NBNFN) HUC 12 subwatershed restoration treatments for the Mendocino SHaRP. Each restoration treatment includes a unique identification code (ID), treatment type (type), general project location and description, and length in kilometers (km). LW = Large wood; RE = Riparian enhancement; OC = Off-channel/floodplain enhancement; SE = Streamflow enhancement; HA = Habitat assessment. See Figure 54 and Figure 57 for maps of treatment locations.

ID	Location	Type	Details	Length (km)
NBNFN01	North Branch mouth upstream into lower Dutch Henry Creek	LW	Retreat with large wood to meet targets. Previous large wood structures blew out during high flows. This reach tends to go dry and consists of shallow pools, limited large wood, and abundant gravel. Dutch Henry Creek contributes excessive fine sediment.	7.35
NBNFN02	Dutch Henry Creek	RE	Work with landowner to implement best management practices for grazing, including adding fencing to keep cattle out of creek and improve riparian habitat. There is potential rearing habitat for steelhead and Coho Salmon in Mud Gulch. Build landowner relationships to implement projects.	4.97
NBNFN03	Cook Creek	LW	Previously treated. Add large wood to meet targets. Limited road access. Implement chop-and-drop techniques.	3.75
NBNFN04	Little North Fork	LW	Previously treated. Add large wood to meet targets. Good spawning habitat is available for Coho Salmon.	8.50
NBNFN05	Little North Fork	OC	Investigate low gradient sections for off-channel habitat opportunities. Develop and implement projects based on findings.	1.11

ID	Location	Type	Details	Length (km)
NBNFN06	John Smith Creek and Johnson Creek	LW	Add large wood to meet targets. John Smith Creek is a Coho Salmon hotspot with good rearing and spawning. In 2023, TU treated the lowest 3.1 kilometers (1.9 miles).	4.33
NBNFN07	John Smith Creek and Lower Johnson Creek	SE	Develop water forbearance projects to increase baseflow during low-flow periods.	3.51
NBNFN08	John Smith Creek from Gulch 15 upstream into lower Johnson Creek	HA	Develop a forest management plan to help address channel incision to reconnect stream channel to floodplain. May include techniques such as upland fuel load reduction and gully stuffing. Develop a relationship with the landowner.	1.17
NBNFN09	Bottom Creek	LW	Previously treated. Add large wood to meet targets.	2.48
NBNFN10	Sawyer Creek	LW	Previously treated. Add large wood to meet targets.	2.17
NBNFN11	Spooner Creek	LW	Previously treated. Add large wood to meet targets.	1.75
NBNFN12	Dutch Henry Creek	SE	Work with landowners to reduce instream water use, including developing alternative water sources for cattle. In conjunction with NBNFN02 to implement best management practices for cattle grazing.	5.29

Table 36. South Branch North Fork Navarro River (SBNFN) HUC 12 subwatershed restoration treatments for the Mendocino SHaRP. Each restoration treatment includes a unique identification code (ID), treatment type (type), general project location and description, and length in kilometers (km). LW = Large wood; OC = Off-channel/floodplain enhancement; HA = Habitat assessment. See Figure 54 and Figure 58 for maps of treatment locations.

ID	Location	Type	Details	Length (km)
SBNFN01	South Branch downstream of Bailey Creek	LW	Retreat previous direct falling project to meet wood loading targets. Difficult access with boulders and steep banks.	12.94
SBNFN02	South Branch at mouth	OC	Reconnect floodplain terraces and opportunities for winter habitat enhancement. Road on the right bank has been decommissioned.	0.87
SBNFN03	South Branch upstream of McCarvey Creek	OC	Reconnect floodplain at confluence with McCarvey Creek.	0.42
SBNFN04	South Branch	OC	Assess for off-channel habitat around terraces shown on LiDAR and develop projects. Exclude the canyon section.	0.40
SBNFN05	South Branch downstream of Rose Creek	LW	Retreat with large wood to meet targets from Hard Scratch to Burns Gulch. Good road access.	0.46

ID	Location	Type	Details	Length (km)
SBNFN06	South Branch	HA	There is a diversion and on-stream pond with invasive fish and frogs. May be addressed through legal cannabis permitting. May be degraded conditions from previous timber harvest. Identify restoration opportunities in the upper South Branch. Perform habitat assessment for restoration potential. Potential interest from the landowner.	0.74
SBNFN07	Bailey Creek	LW	Good potential habitat for treatment. Degradation due to old mill site. Treat in conjunction with log jam fish passage barrier near mouth on SBNFN13.	1.88
SBNFN08	Bear Creek	LW	Add large wood to meet targets. Identified as a priority in the large wood technical working group.	2.25
SBNFN09	Bridge Creek	LW	Add large wood to meet targets. Has not been treated with wood to date. Good steelhead habitat with some use by Coho Salmon.	1.98
SBNFN10	Shingle Mill Creek	LW	Habitat is lower gradient with good potential to be improved with wood treatment. Good steelhead habitat with some use by Coho Salmon.	3.77
SBNFN11	McCarvey Creek	LW	Habitat is lower gradient with good potential to be improved with wood treatment. Good steelhead habitat with some use by Coho Salmon.	2.03
SBNFN12	Low Gap Creek	LW	Good access to the site. Investigation needed to determine wood treatment. Good steelhead habitat with some use by Coho Salmon.	2.61

ID	Location	Type	Details	Length (km)
SBNFN13	Bailey Creek	FP	Investigate fish passage at log jam from an old Humboldt crossing 150 feet upstream from confluence.	point

Figure 54. Restoration treatment map for the North Fork (N.F.) Navarro River, Upper Navarro River, North Branch N.F. Navarro River, and South Branch N.F. Navarro River HUC 12 subwatersheds for the Mendocino SHaRP. Treatment breaks delineate individual treatment extents when those adjacent were the same type. See Tables 33 – 36 for treatment details.

Figure 55. Restoration treatment map for the North Fork (N.F.) Navarro River HUC 12 subwatershed for the Mendocino SHaRP. Treatment breaks delineate individual treatment extents when those adjacent were the same type. See Table 33 for treatment details.

Figure 56. Restoration treatment map for the Upper Navarro River HUC 12 subwatershed for the Mendocino SHaRP. See Table 34 for treatment details.

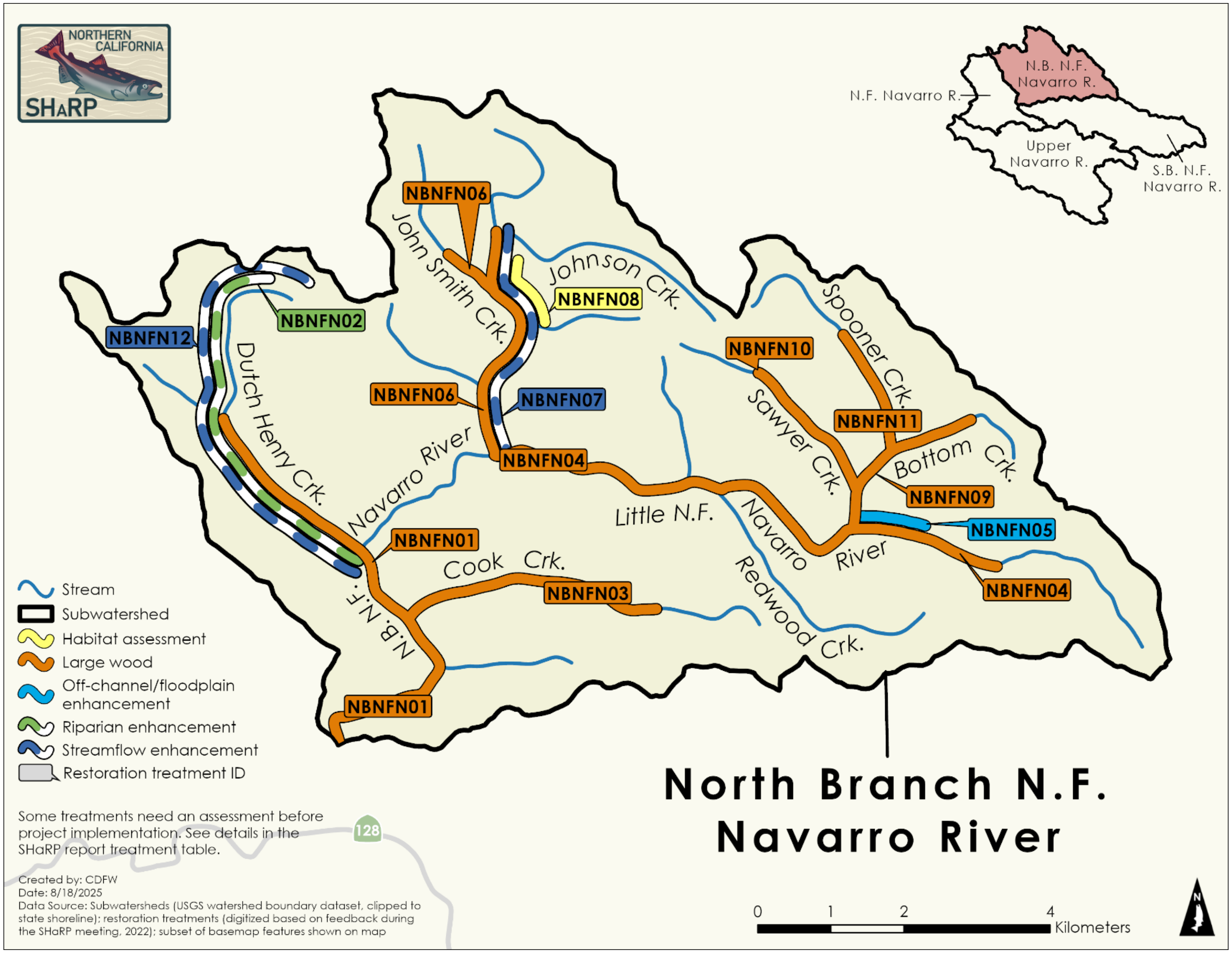


Figure 57. Restoration treatment map for the North Branch North Fork (N.F.) Navarro River HUC 12 subwatershed for the Mendocino SHaRP. See Table 35 for treatment details.

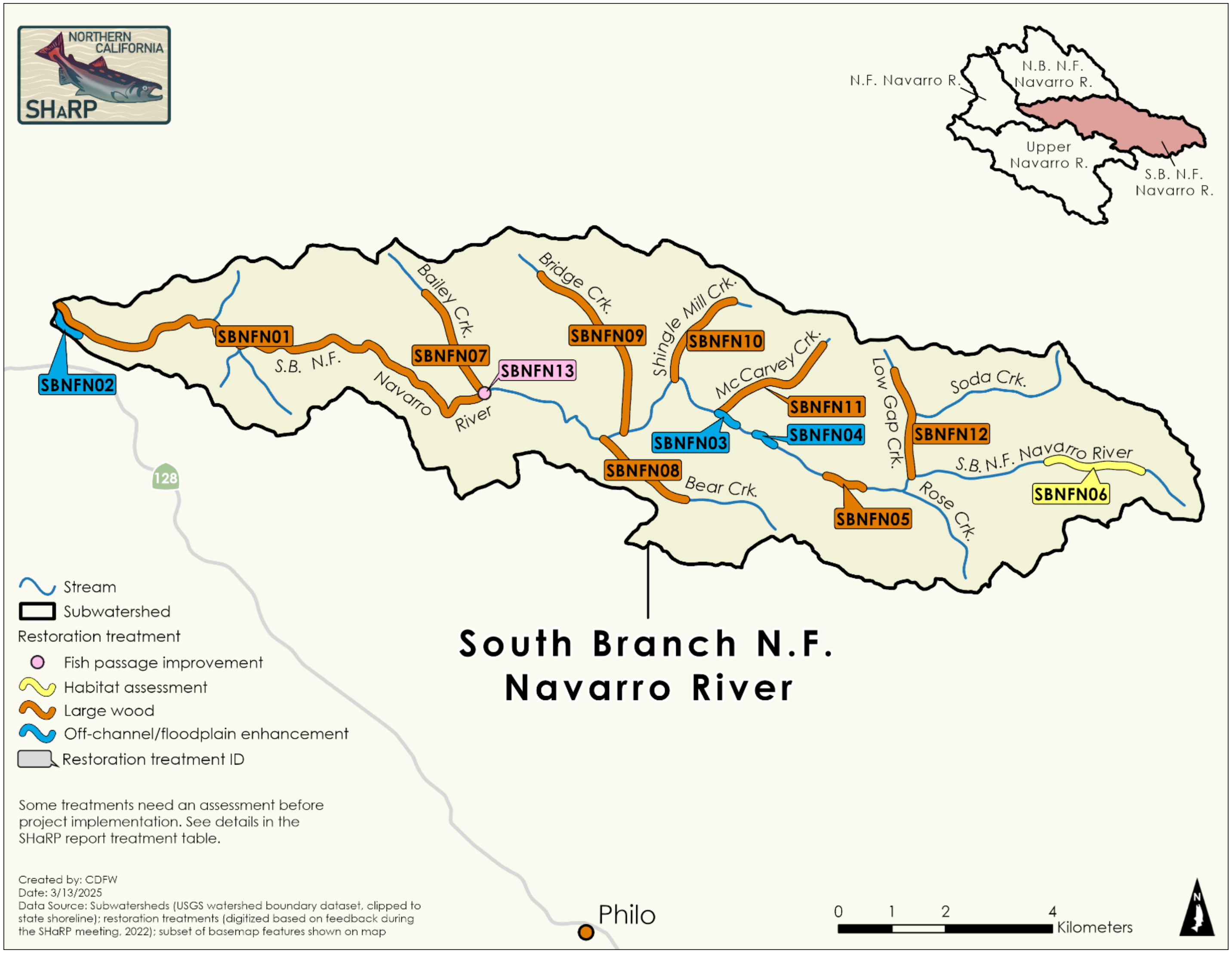


Figure 58. Restoration treatment map for the South Branch North Fork (N.F.) Navarro River HUC 12 subwatershed for the Mendocino SHaRP. See Table 36 for treatment details.

Chapter 10. Conclusions and Implementation

Through the Salmonid Habitat Restoration Priorities (SHaRP) process, agency staff, restorationists, and experts identified 16 priority HUC 12 subwatersheds in the Mendocino Coast region for restoration planning and collaboratively developed site-specific restoration treatments for those subwatersheds. This report includes 192 discrete recommendations to be carried out across salmon and steelhead strongholds in the Ten Mile River, Big River, Noyo River, Garcia River, and Navarro River watersheds (Table A1 in Appendix C. Mendocino Coast SHaRP Restoration Treatment Summary).

The primary restoration treatment type recommended across all selected HUC 12 subwatersheds was the addition of large wood to improve overwinter rearing habitat for juvenile salmonids. Large wood treatments were recommended in locations that had not previously been treated, and at sites that were previously treated where large wood targets were below those established in the Central California Coast Coho Salmon federal recovery plan (NMFS 2012). Adding more wood to existing projects may require fewer resources and less planning than starting new projects because landowner agreements, locations, and techniques were established previously. Additionally, in some cases, large wood can be placed and anchored on or adjacent to existing structures to enhance complexity and recruitment.

The next two most recommended treatment types were off-channel/floodplain enhancement and fish passage, with 30 projects each. Over 100 kilometers of road assessment/improvements within 16 individual projects were also recommended. Compared to the other selected HUC 12 subwatersheds, the Navarro River notably had the most (11) recommendations for streamflow enhancement (Table 32). Habitat assessments were typically recommended in areas that had not been assessed recently or in those thought to have high quality habitat locations so specific treatments could be determined. Riparian enhancement and conservation easements were the least recommended treatments overall.

From Planning to Action: Implementing Projects in This Report

This plan serves as a guide for restoration practitioners, helping to identify project areas, develop proposals, and apply for funding. Moving forward, recommendations in this action plan will be uploaded to an online geodatabase hosted by the California Department of Fish and Wildlife's (CDFW) North Coast Salmon Project (NCSP). This will allow participants to track completed projects and identify those still needing attention. Those looking to implement SHaRP recommendations can consult the restoration treatment maps and tables to identify project areas, develop project proposals, and use the resources listed below to secure funding and navigate the permitting process.

Sources of Funding

There are many potential grant opportunities and restoration resources that provide funding to implement SHaRP restoration recommendations.

The Salmonid Restoration Federation Funding Opportunities webpage[10] provides a comprehensive list of funding opportunities. Listed below are some of the key grant programs with additional details.

California Department of Fish and Wildlife Restoration Grants Program

This program encompasses various grants that promote biodiversity, conservation, climate resilience, and enhanced public access. This program focuses on supporting restoration efforts that foster collaboration among public agencies, Native American Tribes, and non-profit organizations. For more information, please visit the CDFW Restoration Grants webpage[11].

Granting programs include:

- Fisheries Restoration Grant Program
- Watershed Restoration Program
- Fish and Wildlife Management Grants
- Conservation Planning and Protection Grants
- Cannabis Restoration Grants Program

California State Parks Habitat Conservation Fund

A granting program that administers $2 million dollars for projects including interpretive programs, wildlife and fish species protection, and the purchase or development of wildlife corridors or trails. For more information, please visit the California State Parks Habitat Conservation Fund webpage[12].

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[10] https://www.calsalmon.org/resources/restoration-funding-opportunities

[11] https://wildlife.ca.gov/Grants/Restoration-Grants

[12] https://www.parks.ca.gov/?page_id=21361

California Wildlife Conservation Board

Authorizes and allocates funds for the purchase of land and waters suitable for recreation purposes and the preservation, protection, and restoration of wildlife habitat. The California Wildlife Conservation Board can also authorize the construction of recreational facilities on properties where it holds a proprietary interest. For more information, please visit the California Wildlife Conservation Board Grants webpage[13].

United States Fish and Wildlife Service Partners for Fish and Wildlife

The Partners for Fish and Wildlife Program consults with landowners to help them conserve and improve wildlife habitat. Program provides free technical and financial assistance to landowners, managers, tribes, corporations, schools, and non-profits interested in improving wildlife habitat on their land. For more information, please visit the US Fish and Wildlife Service Partners for Fish and Wildlife webpage[14].

California State Water Resources Control Board Financial Assistance Funding

A grant and loan funding program for water treatment, drought support, and pollution control. For more information, please visit the California State Water Resources Control Board Financial Assistance Funding - Grants and Loans webpage[15].

National Oceanic and Atmospheric Administration National Marine Fisheries Service Grants

Funding opportunity and technical assistance for habitat restoration projects across the country. These projects enhance the nation's fisheries, threatened and endangered species, and coastal communities. For more information, please visit the NOAA Fisheries Restoring Ocean and Inland Habitats webpage[16].

California Fish Passage Forum

Funds on-the-ground projects that specifically address fish passage. This may include barrier removal/construction, assessments, and monitoring related to fish passage. For more information, please visit the California Fish Passage Forum Funding and Resources Webinar webpage[17].

[13] https://wcb.ca.gov/Grants
[14] https://www.fws.gov/program/partners-fish-and-wildlife
[15] https://www.waterboards.ca.gov/water_issues/programs/grants_loans/
[16] https://www.fisheries.noaa.gov/topic/habitat-conservation/how-we-restore
[17] https://www.cafishpassageforum.org/funding/

Federal Highway Administration Aquatic Organism Passage

A grant program aimed at resolving road issues that impede aquatic organism passage. For more information, please visit the Federal Highway Administration Aquatic Organism Passage[18].

California State Coastal Conservancy

Grant funding to support resiliency of the California coast and its watersheds. Project applications must meet goals and objectives outlined in the Coastal Conservancy Strategic Plan 2023–2027. Please visit the California Coastal Conservancy Strategic Plan 2023 webpage[19].

Permitting Assistance

Permitting and regulatory processes are an integral part of implementing habitat restoration projects. Listed below are some of the permitting requirements and technical resources available.

California Department of Fish and Wildlife Cutting the Green Tape Initiative

A statewide program aimed at improving CDFW's permitting administration to accelerate the pace and scale of restoration efforts throughout the state. For more information, please see the Cutting the Green Tape - California Department of Fish and Wildlife webpage[20].

California Department of Fish and Wildlife *Habitat Restoration and Enhancement Act Approvals*

The Habitat Restoration and Enhancement Act established permitting efficiencies for any person, public agency, or non-profit organization seeking to implement a habitat restoration or enhancement project. For more information, please visit the CDFW Habitat Restoration and Enhancement Act Approvals webpage[21].

California Water Boards Permitting Restoration Projects

For information regarding water quality permitting for restoration projects, please visit the following programs and their associated webpages:

- California State Waterboards North Coast Restoration Program [22]
- Water Board Order for Small Habitat Restoration Projects[23]

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[18] https://www.fhwa.dot.gov/engineering/hydraulics/culverthyd/aquatic/culvertaop.cfm
[19] https://scc.ca.gov/grants/
[20] https://wildlife.ca.gov/Conservation/Cutting-Green-Tape
[21] https://wildlife.ca.gov/Conservation/Environmental-Review/HREA
[22] https://www.waterboards.ca.gov/northcoast/water_issues/programs/Restoration/
[23] https://acceleratingrestoration.org/permits/general-order-small-habitat-restoration-projects/

National Oceanic and Atmospheric Administration Fisheries Restoration Center

Offers technical assistance for restoration project planning and implementation, as well as streamlined Section 7 permitting for qualifying projects. For more information, please visit the NOAA Fisheries Providing Technical Support for Habitat Restoration Efforts webpage.[24]

Sustainable Conservation's Accelerating Restoration

Offers tools and resources to help restorationists in California understand and streamline permitting for aquatic and riparian restoration work. For more information please visit Sustainable Conservation's Accelerating Restoration webpage[25].

Final Considerations

The Mendocino SHaRP process used collaboration and the best available data to identify the most promising locations for salmon and steelhead habitat restoration to support species recovery. While only the highest-ranking HUC 12 subwatersheds were selected for further planning, those not selected should still be considered for restoration as opportunities arise and as projects in the selected HUC 12 subwatersheds are completed.

CDFW and NOAA Fisheries are committed to increasing tribal participation in SHaRP going forward. During the planning and participant phases of the Mendocino Coast SHaRP, outreach was conducted based on the staffing and expertise available at the time; future efforts aim to build on these foundations to broaden engagement. Since then, new procedures have been implemented to support this goal, including working with the CDFW Department Tribal Liaison to expand outreach and create a more inclusive contact list through the Native American Heritage Commission.

To support the implementation of these recommendations within a 10-year timeframe, the CDFW NCSP team will be managing a publicly available web-based database that compiles a spatial record of SHaRP recommendations and completion status. The database includes project funding sources and will help agencies and practitioners track projects to help plan and complete SHaRP recommendations. In addition, NCSP will continue to engage with restoration practitioners through watershed and technical advisory meetings to revisit recommendations, track implementation, and strengthen collaboration.

Overall, the SHaRP planning process aligns with NOAA Fisheries and CDFW recovery plans, the NOAA Fisheries' Species in the Spotlight Initiative, and Governor Newsom's 30x30 Initiative to conserve 30% of California's land and coastal habitats by 2030, through the advancement of regionally led conservation efforts (Executive Order N-82-20 2020).

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[24] https://www.fisheries.noaa.gov/national/habitat-conservation/providing-technical-support-habitat-restoration-efforts

[25] https://acceleratingrestoration.org/permits/general-order-small-habitat-restoration-projects/

Furthermore, the Mendocino SHaRP action plan is highlighted in the Governor's California Salmon Strategy for a Hotter, Drier Future (California Office of the Governor 2024), which outlines the State's approach to supporting and promoting native salmon populations amid the challenges posed by climate change. These efforts include revitalizing degraded waterways through projects focused on restoring river corridors, enhancing biodiversity, and providing climate refugia.

The 30x30 Initiative also emphasizes the importance of prioritizing partnerships with Native American Tribes in conservation planning. Moving forward, more effort will be applied to engage and incorporate the expertise and traditional knowledge of Tribal Nations in guiding salmonid habitat restoration efforts. This will include working closely with tribal liaisons to ensure effective outreach and engagement, which fosters collaborative relationships that respect and implement the cultural and ecological knowledge of tribal communities.

The Mendocino SHaRP team will continue to explore collaborative restoration opportunities along the Mendocino Coast to strengthen the protection and conservation of native salmonid populations. Additionally, the team will continue to collaborate with restoration practitioners to maintain open communication and outreach and share funding opportunities.

Contact Information

For more information on restoration ideas or questions about implementing SHaRP recommendations along the Mendocino Coast, please contact NCSP (ncsp@wildlife.ca.gov) or Joe Pecharich at the NOAA Fisheries Restoration Center (joe.pecharich@noaa.gov).

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Appendix A: Mendocino Coast SHaRP Data Categories and Metrics

Biological Importance (64 points)

As suggested in Bradbury et al. 1995, *Biological Importance* was weighted higher than the other categories to reflect the focus on salmon and steelhead. Final scores were multiplied by 2.

Current Distribution

Stream length (kilometers) of current distribution of Coho Salmon (Christy 2016), Chinook Salmon (Gavette 2005), and steelhead (Christy 2012). This data was largely compiled from CDFW's Biogeographic Information and Observation System (BIOS). The steering team extended lengths in some locations using assessments that validated the most current salmonid distribution. The rank weighted score was adjusted if a species was determined to no longer be present in the HUC 12 subwatershed. *Points: Coho Salmon 8; Chinook Salmon 4; Steelhead 4*

Current Spawner Abundance

Current spawner abundance is the estimated mean of redds per kilometer for each species (Coho Salmon, Chinook Salmon, and steelhead) annually from 2010–2019. Based on Mendocino CMP Coastal Monitoring Program (CMP) spawning survey redd counts (Adams et al. 2011; McGuire et al. 2021). Redd counts from Little River, Caspar Creek, and the South Fork Noyo River prior to 2010 were also included. The mean redd density (redds/km) for each HUC 12 subwatershed was standardized by year (z-scored) to ensure survey samples were represented by the relative strength of annual adult return. *Points: Coho Salmon 8; Chinook Salmon 4; Steelhead 4*

Fish Traffic

Fish traffic was developed by the steering team to capture the importance of spatial locations that are common to all salmonids during migration. This metric was calculated for each HUC 12 subwatershed by summing the total distribution (linear km) for each species. In watersheds that had more than one HUC 12 subwatershed, species distribution lengths were added to any HUC 12 subwatersheds located downstream. For example, Lower Big River HUC 12 subwatershed would include species distribution length from North Fork Big River, South Fork Big River, and Upper Big River. Brush Creek HUC 12 subwatershed is only one complete watershed and therefore would not have any additional distribution added. This metric gave more weight to lower watersheds and estuaries that provide habitat important for (1) adult migration, (2) multiple age-classes of salmonids that occupy the same time-space during spring outmigration, (3) spawning and rearing when upstream migration opportunities are poor due to low or delayed flows associated with drought, and (4) in good abundance years when headwater reaches are saturated with rearing juveniles. This metric also provided value for Chinook Salmon, estuarine habitat, and spatiotemporal dynamics to help balance metric scoring from other categories that are more freshwater rearing centric. Spawner Abundance, August Temperature, IP Anchors, Canopy, and Diversions focus on Coho Salmon and steelhead that generally rear in freshwater habitat for at least 1 year, compared to Chinook Salmon juveniles that migrate from freshwater before their first summer. *Points: 4*

Habitat Condition (28 points)

This category represents stream habitat suitability for salmonids using (1) habitat modeling data, and (2) stream habitat data from CDFW watershed assessments and stream inventories.

IP-NorWeST Anchor Sites

Potential Anchor Habitat (km). GIS-based analysis of potential anchor sites that could support all life stages of Coho Salmon. Datasets used for analysis included the Intrinsic Potential (IP) model (Agrawal et al. 2005) for channel gradient and floodplain width and the NorWeST stream temperature model (Chandler et al. 2016) for water temperatures. Anchor sites were classified as those with mean August temperatures greater than 17.8° C and either (a) 1–3 percent gradient with valley width of 40–100 meters or 100–500 meters, or (b) 0–1 percent gradient with valley width of 500–1,000 meters or 1,000–4,000 meters. Stream lengths that met these criteria were totaled for each HUC 12 subwatershed. *Points: 4*

Habitat Suitability Index

Ecosystem Management Decision Support (EMDS) based analysis of watershed assessments conducted between 2004 and 2020. Habitat typing data from the habitat assessments was grouped by reach (defined using the Rosgen channel type classification) and year and the following metrics were calculated for each reach. This data was input into the EMDS Factor Analysis Program with habitat suitability curves used in the South Fork Eel River Watershed Assessment (CDFW 2014). The EMDS outputs a series of summarized data by reach. Standardized score values ranged from -1 (fully unsuitable) to 1 (fully suitable). HUC 12 subwatershed scores were based on a length-weighted mean of the reach so that on average, longer reaches had more influence than shorter reaches. The outputs used for the ranking were:

- ***Canopy density:*** The average percentage of the thalweg within a stream reach that is influenced by tree canopy, measured at the center of each habitat unit with a spherical densitometer. *Points: 4*

Primary pool percent**:** Residual pool depth (calculated from maximum depth and the pool tail crest depth collected during habitat typing surveys) assigned pools as primary or secondary. Bins were defined by depth criteria according to stream order from North Coast Hydrography data. The total length of primary pools within a reach was divided by reach length and multiplied by 100 for the calculated metric. Percent of the stream reach with pools that have a maximum depth of 0.8 meters (2.5 feet; 1st and 2nd order), 0.9 meters (3 feet; 3rd order), and 1.2 meters (4 feet; 4th and 5th order) deep. *Points: 4*

- ***Pool shelter:*** Relative measure of quantity and composition of large woody debris, root wads, boulders, undercut bank, bubble curtain, and overhanging and instream vegetation. This was calculated by multiplying shelter rating (channel complexity based on the number of objects creating cover) by percent cover (an overhead view estimate of percent surface area covered by objects). *Points: 4*
- ***Pool substrate embeddedness*****:** Percent of small cobbles (6.4–12.7 centimeters; 2.5–5 inches in diameter) buried in fine sediments at a pool tail. *Points: 4*
- ***Reach habitat suitability index:*** This combines the previous four suitability scores by moving through them stepwise, assessing the extent to which each value answers "true" to the proposition that "conditions in the stream reach are suitable to sustain healthy populations of anadromous salmonids" with canopy and embeddedness assigned "critical" so that a reach fully unsuitable regarding these variables is assessed to be false for this proposition. The magnitude of the positive or negative value indicates how "true" (+1) or "false" (-1) the proposition is for this reach. *Points: 4*

Large Wood Density

Number of large wood pieces greater than 30.5 centimeters (12 inches) diameter and greater than1.8 meters (6 feet) long per stream distance. Data was collected during CDFW stream habitat surveys from 2009 to 2010 and by UC Hopland from 2002 to 2008. Pieces of large wood were summed for each reach then divided by reach length. Mean was calculated for each HUC 12 subwatershed. Large wood pieces that were added during habitat restoration projects after stream surveys occurred were appended to the large wood dataset. Data was obtained directly from plans from implemented restoration projects. This data increased the average large wood count in 21 of the HUC 12 subwatersheds from stream survey data estimates. Roughly half of the HUC 12 subwatersheds that had large wood added during restoration projects showed modest increases (less than 10%) in the average count, with the largest increases (greater than 30%) occurring in Big Salmon Creek, Middle Garcia River, Pudding Creek, and Usal Creek. *Points: 4*

Optimism and Potential (29 points)

Intrinsic Potential (IP)

IP is modeled based on mean annual discharge, channel gradient, and valley width (Agrawal et al. 2005). IP score reflects the potential for high quality habitat to occur based on the stream's intrinsic properties (e.g., geomorphology and hydrology). It is a tool used to evaluate channel reaches or watersheds for the quality of their historical salmonid habitat. The total stream length (kilometers) in each HUC 12 subwatershed that met medium and high thresholds for IP for steelhead, Chinook Salmon, and Coho Salmon was summarized. High IP was defined as greater than or equal to 0.66 for Coho Salmon and greater than or equal to 0.695 for Chinook Salmon and steelhead. Medium IP was defined as greater than or equal to 0.33 and less than 0.66 for Coho Salmon and greater than or equal to 0.345 and less than 0.695 for Chinook Salmon and steelhead. *Points: 18 total (4 for high; 2 for medium)*

Land Ownership

The conservation potential of a subwatershed was evaluated using two metrics of land ownership: (1) percentage of timber land and (2) average parcel size. The percentage of timber land was calculated by dividing the total acreage of parcels designated for timber related uses with the subwatershed total acreage. Land under public, timber, and tribal ownership typically has more conservation potential than private, non-timber lands. Average parcel size was an index of habitat fragmentation and potential for water diversions. Smaller average parcel sizes are generally less favorable. *Points: 8*

Restoration Support

Restoration potential was evaluated during the advisor review by the watershed experts (advisors) and steering team members. Using professional judgment, each HUC 12 subwatershed was rated on (1) community support for restoration, (2) investment devoted to past restoration, and (3) landowner receptiveness to restoration in the past, and/or if landowners currently have holdings in the majority of a subwatershed. Scores signified support for future collaboration on projects. *Points: 3*

Integrity and Risk (32 Points)

Integrity and risk were used to assess anthropogenic threats and disturbances to summarize watershed integrity and ecological risks. Key factors included impacts from summer water temperatures, diversion pressure, population density, and road density. Higher score = lower risk.

Water Temperature

The NorWeST stream temperature model data (Chandler et al. 2016) was used to assess the amount of suitable cold-water habitat available for salmonids. Length of stream with mean August water temperatures less than 17.8° C. *Points: 8*

Disturbance

- ***Road density:*** Miles of road per square mile of land. Road networks may contribute large amounts of sediment to Mendocino Coastal watersheds or cause large land disturbances that lead to sedimentation of waterways (Stillwater Sciences 2019). The steering committee summarized available road data to characterize this threat. Source data was compiled by CalFire from various sources, including topographic maps and timber harvest plans. *Points: 8*
- ***Population density***: Population census and parcel data were used to characterize the threats associated with increasing human population size including land development, increased water demands, and habitat fragmentation. The population density was calculated as the sum of persons within each subwatershed divided by the respective subwatershed area. *Points: 8*
- ***Water diversion pressure:*** Registered diversions per square mile for each HUC, based on spatial location of water rights throughout California in the Electronic Water Rights Information Management System (eRWRIMS). *Points: 8*

Appendix B. Mendocino Coast SHaRP Glossary of ArcGIS Online Data Layers

The steering team created an ArcGIS web map for the Mendocino SHaRP process. The web map was hosted and shared through ArcGIS Online. The web map included a set of data layers used to help participants with SHaRP planning. These data layers are listed and described below. Some of the data layers were modified for the Mendocino Coast SHaRP project and may not be appropriate in other applications.

Watersheds (HUC 12 and HUC 16): A component of the USGS Watershed Boundary Dataset (WBD) that maps the full areal extent of surface water drainage for the United States. A hierarchy of watersheds is delineated in the WBD and levels of the hierarchy are assigned a hydrologic unit code (HUC). SHaRP uses the HUC 12 or subwatershed level.

Data Mask: Mask layer to conceal watersheds outside those selected.

Water Diversions: Locations of registered surface water withdrawals (Points of Diversion) maintained within the Electronic Water Rights Information Management System (eWRIMS) by California State Water Resources Control Board, Division of Water Rights.

Past Restoration: Past restoration projects completed within the planning areas from the late 1990's to 2020. These include:

> **NOAA Fisheries PCSRF Grant Projects:** The Pacific Coastal Salmon Recovery Fund (PCSRF) was established by Congress to fund restoration and conservation of Pacific salmon and steelhead populations and their habitat. This layer provides location points and descriptions of these projects.
>
> **Fisheries Restoration Grant Program Projects:** The Fisheries Restoration Grant Program (FRGP) is a California Department of Fish and Wildlife program designed to restore anadromous salmonid habitat in coastal California. This dataset shows the locations of all FRGP funded restoration projects.
>
> **Past Restoration Projects:** The PCSRF and FRGP project datasets display projects as point features regardless of project size. This dataset, provided by CDFW staff, shows a more realistic linear extent for some projects.

Large Private Landowners: General ownership boundaries for non-public landowners owning, with a few exceptions, 121.40+ hectares (300+ acres). Parcels were clipped to the SHaRP planning area extent and dissolved into owner boundaries based on parcel owner. Some ownerships are a compilation of parcels owned by members of the same family, so it should not be assumed that management practices or access are the same for individual parcels.

Large Wood Density: Estimated density of large wood in the stream reach (pieces per linear foot). Large wood was only counted if it was at or below the elevation of bankfull discharge and divided into small and large. Red indicates low density; blue indicates high density.

LWD Small Pieces/km: The number of trees with diameters greater than ~ 30 centimeters (12 inches) and lengths 1.8–6.1 meters (6–20 feet).

LWD Large Pieces/km: The number of trees with diameters greater than ~30 centimeters (12 inches) and lengths greater than 6.1 meters (20 feet).

LWD All Pieces/km: This is small and large combined.

Habitat Suitability Index (HSI)

Standardized scores with values ranging from -1.00 (fully unsuitable) to 1.00 (fully suitable) Higher scores are shown in green and lower scores shift toward red.

HSI Reach: HSI Pool Depth, HSI Pool Shelter, HSI Canopy, and HSI embeddedness together to score the suitability of the entire reach.

HSI Pool Depth: Percent of total stream length attributed to primary pool length. Primary pools are habitat units with sufficient residual pool depth based on the stream order (stream size).

HSI Pool Shelter Complexity: Mean shelter rating within the reach. Shelter rating is an evaluation of the quantity and composition of fish cover existing in pool habitat units. Cover includes woody debris, boulders, undercut banks, and vegetation.

HSI Pool Quality: Pool Depth and Pool Shelter Complexity for the reach.

HSI Substrate Embeddedness: Percent of small cobbles in pool tail-outs buried in fine sediments. Cobbles are categorized based on the percentage of the stone buried in fines using four bins: 0–25%, 26–50%, 51–75%, and 76–100%.

HSI Canopy: Average tree canopy closure for the stream reach. Mean canopy density for each reach measured at the center of each habitat unit with a spherical densitometer. Roughly 30% of defined habitat units are measured.

Stream Inventory Landmarks & Log Debris Accumulations (LDA): Notable features encountered by survey crews conducting CDFW stream habitat inventories. Landmarks include potential fish migration problems, eroding banks, log debris accumulations (LDA), etc.

Intrinsic Potential (IP) Model Data: The IP model uses geomorphic and hydrologic attributes to score stream nodes on their expected relative production of each salmonid species. The geomorphic component includes valley width and gradient (using 10m Digital Elevation Model). The hydrologic component uses precipitation (using PRISM climatological data). The estimated length of potential Coho Salmon, Chinook Salmon, and steelhead habitat based on geomorphic and hydrologic attributes, symbolized by color with green most favorable and red least favorable.

- *IP: Mean Gradient %:* Mean gradient of stream segment from 0–20%; symbolized by color. Green colors are low gradient (0–3%); red is high gradient.
- *IP: Valley Width:* Mean valley width of stream segment from less than 5 meters to over 350 meters (blue is narrow width; red is large valley width).

Stream Habitat Reach Summary: Summary metrics for stream reaches surveyed under the salmonid stream habitat inventory framework. These data include physical attributes related to channel type and individual habitat units (e.g., pools, riffles, runs). Key metrics summarized here include channel type, bankfull width, stream width and depth, pool frequency, and bank vegetation.

Salmonid Distribution: Current known distribution of the anadromous form of steelhead trout as well as Coho Salmon and Chinook Salmon. This includes adult and juvenile observations.

California Passage Assessment Database: Locations of known and potential barriers to anadromous fish.

West Coast USA Estuarine Biotic Habitat: Current and historical extent of estuaries, classified by percent substrate cover by dominant biota (from Pacific Marine Estuarine Fish Habitat Partnership).

NorWeST Modeled Stream Temperatures: Predicted mean August stream temperature for the stream node (1 km resolution). Predicted stream temperature is available for both current conditions (1993–2011) and future scenarios (2040s and 2080s). In the AGOL map, temperatures are symbolized by color, with red indicating warmer and blue indicating cooler conditions.

CALFIRE Harvest Roads: This dataset shows road features that are related to Timber Harvest Plans approved by the California Department of Forestry and Fire Protection (CALFIRE). These do not include skid trails and tractor roads, and this data is primarily from 1997 to present. Symbolized by color indicating permanent (black), seasonal (brown), or temporary (dashed black) in the AGOL map.

Survey Stream Reaches (CA Coastal Monitoring Program Sample Frame): Stream reaches included within the CDFW CA CMP sample frame. Generally, these reaches indicate locations that are known to have Coho Salmon present and represent locations where spawning surveys are conducted.

Streams: National Hydrography Dataset depicts the water drainage network in the focus area.

Sea Level Rise: Polygons showing the predicted inundation footprint and relative depth of water given simulated changes to sea level height as modeled by the NOAA Office for Coastal Management. Darker blue indicates deeper water, green indicates areas that are not hydrologically connected that may flood. This includes six categories, ranging from 0.3 –1.8 meters (1 to 6 feet) in 0.3 meter (1 foot) increments above the current mean higher high water for the area.

Vegetation: Spatial distribution of vegetation types created by a compilation of the best available land cover data available for California. Sources of data include CALFIRE Fire and Resource Assessment Program, CDFW VegCamp, and UDSA Forest Service Remote Sensing Laboratory.

California Protected Areas Database (CPAD): Depicts boundaries of lands that are protected for open space purposes by public agencies or non-profit organizations.

California Conservation Easement Database (CCED): Depicts boundaries of private lands with easements and other restrictions to ensure land use is compatible with maintaining land as open space. Easements may be held by government agencies and jurisdictions as well as non-profit organizations and land trusts.

Soils: Map units depicting the spatial distribution of soil types. Data provided by the Natural Resources Conservation Service's Soil Survey Geographic database.

Watersheds (fill symbol): Dataset is used to highlight HUC 12 subwatersheds selected for restoration recommendations.

Geologic Map of California: A general overview of the geology and structure of the region that depicts major rock types, deposits, and geologic structures like faults and folds.

Light Detection and Ranging (LiDAR) Hillshade: Shaded relief of 1-meter Digital Elevation Model derived from LiDAR data that is depicted with a hill shading effect to help visualize topography.

Live Stream Gages: Near real-time measurements of stream stage height and discharge from gages owned and maintained by various agencies. Data is updated hourly with flow forecasts provided where available. Lower Noyo River, Navarro River, and Lower Garcia River are the only Mendocino SHaRP watersheds with a gage.

Public Lands: California Protected Areas Database (CPAD) depicts boundaries of lands that are protected for open space purposes by public agencies or non-profit organizations.

Appendix C. Mendocino Coast SHaRP Restoration Treatment Summary

Table A1: Habitat restoration treatment summary for the Mendocino Coast SHaRP. Includes number of projects (n) and total distance of stream kilometers (km) for each watershed and by treatment type. LW = Large wood; OC = Off-channel/floodplain enhancement; RA = Road assessment/improvement; RE = Riparian enhancement; HA = Habitat assessment; FP = Fish passage improvement; CE = Conservation easement; SE = Streamflow enhancement. N/A = Not applicable.

Type	CE	FP	HA	LW	OC	RA	RE	SE	*Total*
Ten Mile River (km)	0.0	N/A	3.1	79.6	51.4	41.0	22.0	0.0	*197.0*
Ten Mile River(n)	0	0	2	19	7	5	3	1	*37*
Big River (km)	0.0	N/A	0.0	113.5	64.6	20.1	0.0	0.0	*198.2*
Big River (n)	0	15	0	18	4	4	0	0	*41*
Garcia River (km)	0.0	N/A	12.4	54.4	16.2	5.8	5.8	0.0	*94.6*
Garcia River (n)	0	1	3	13	3	3	1	0	*24*
Navarro River (km)	3.2	N/A	6.9	86.2	42.2	6.2	5.0	55.7	*205.5*
Navarro River (n)	1	7	5	21	10	1	1	11	*57*
Noyo River (km)	0.0	N/A	9.9	65.0	67.4	37.9	0.0	0.0	*180.2*
Noyo River (n)	0	7	3	14	6	3	0	0	*33*
Total (km)	*3.2*	N/A	*32.2*	*398.8*	*243.1*	*111.1*	*32.7*	*55.7*	***875.5***
Total (n)	*1*	*30*	*13*	*85*	*30*	*16*	*5*	*12*	***192***