24. Mad River Population

Central Coastal Stratum

Non-Core 1, Functionally Independent Population

High Extinction Risk

Population likely below depensation threshold

540 Spawners Required for ESU Viability

494 mi^2 watershed (36% Federal ownership)

136 IP-km (85 IP-mi) (52% High)

Dominant Land Uses are Timber Harvest, Gravel Mining

Key Limiting Stresses are 'Altered Sediment Supply' and 'Lack of Floodplain and Channel Structure'

Key Limiting Threats are 'Roads' and 'Mining/Gravel Extraction'

Highest Priority Recovery Actions

• Increase large woody debris (LWD), boulders, or other instream structure • Construct off channel ponds, alcoves, backwater ponds, and old stream oxbows • Reduce erosion	• Reduce road-stream hydrologic connection • Improve regulatory mechanisms • Restore natural channel form and function

24.1 History of Habitat and Land Use

Timber harvest, road building, gravel mining, grazing and water diversion/impoundment are the land and water uses that have had the most pronounced effect on coho salmon habitat in the Mad River basin. Much of the North Fork watershed and the lower and middle portions of the Mad River basin are owned by Green Diamond Resource Company (GDRC) and are used for timber production. Grazing occurs on large ranches throughout the Mad River basin, as well as more concentrated grazing along the reaches of the lower river and its tributaries. Most of the upper basin is part of the Six Rivers National Forest and is managed using an ecosystem-based approach that provides for resource protection under the Northwest Forest Plan (Forest Ecosystem Management Assessment Team 1993). The Humboldt Bay Municipal Water District (HBMWD) constructed Matthews Dam in 1961 at river mile (RM) 84 in the upper basin, well upstream of historic coho salmon habitat. The HBMWD also pumps groundwater and diverts surface water for municipal and industrial use at its Essex facility in the lower Mad River.

Extensive instream gravel mining occurs throughout the lower Mad River; mining practices have greatly improved since the 1970s. The majority of large gravel bars on the lower mainstem Mad River between Blue Lake and Highway 299 are mined each year, and annual mining typically removes the estimated mean annual recruitment of gravel coming into the mining reach. Although the Army Corps of Engineers permits gravel mining with numerous mitigation measures, such as a head-of-bar buffer to maintain river flow around the gravel bar and a skim floor elevation that maintains low to moderate channel confinement, gravel mining reduces the availability of complex rearing habitat in the lower Mad River (NMFS 2004). The communities of Arcata, Blue Lake and McKinleyville are located along the lowermost reach of the Mad River, near the mouth. Many of the impacts of urbanization are in the form of development and associated road construction and land clearing, resulting in increased run-off and sedimentation.

The land uses described above have reduced available coho salmon habitat throughout the basin. Increased sediment production from logged hill slopes and roads especially that which occurred during the 1955 and 1964 flood events, have filled the Mad River with sediment, creating chronically high turbidity levels. Although the Mad River basin has naturally high rates of sediment delivery due to unstable hill slopes prone to landslides and high rates of surface erosion, the U.S. Environmental Protection Agency (USEPA) estimated that 64 percent of total sediment delivered to streams was attributed to human and land management related activities, with roads being the dominant sediment source (USEPA 2007a). In the lower Mad River and North Fork areas, total sediment loading is currently five times greater than natural sediment loading (USEPA 2007a).

Compounding the increase in sediment delivery, loss of riparian vegetation has reduced shading and created a lack of instream large wood. These land uses have resulted in warm, shallow and wide instream habitat conditions that have severely impacted coho salmon. Most of the basin is now comprised of forest stands of smaller diameter trees, with a greater percentage of hardwoods that provide different ecological functions than those found historically (GDRC 2006). Improved coho salmon access to lower river tributaries, such as Lindsay Creek, is occurring through culvert upgrades and removal, but some of the lower river tributaries still have habitat blocked by road-stream crossings. Water impoundment has resulted in greater than naturally occurring summer flows in the middle and lower sections of the river, potentially increasing

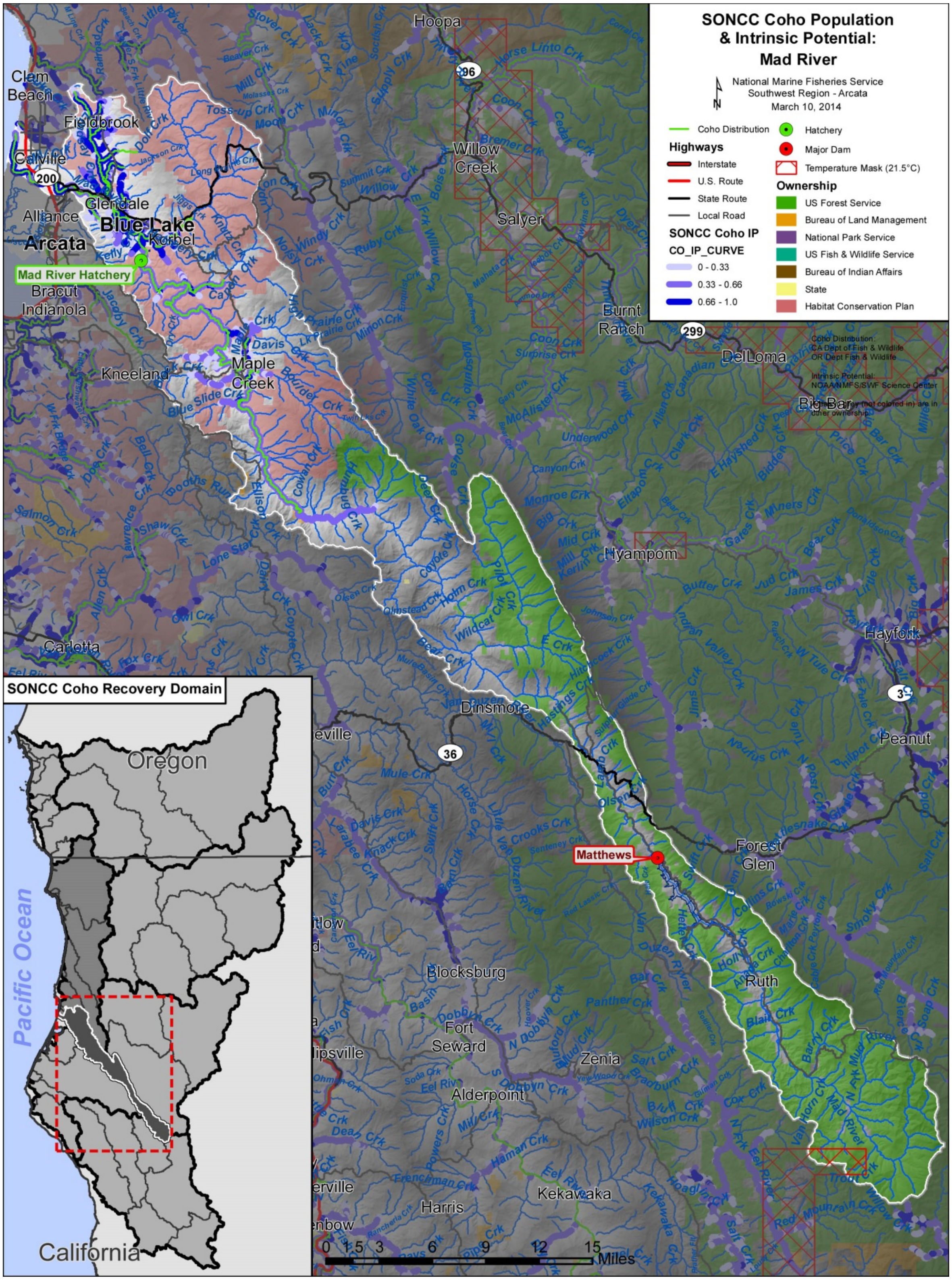

Figure 24-1. The geographic boundaries of the Mad River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2012a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

habitat availability during summer and early fall months. Screened water diversions at Essex in the lower river create fluctuations in the rate of flows in the summer and early fall. The impacts of this diversion are negligible in most instances, however peak flows in the fall are dampened and this may make adult migration more difficult.

24.2 Historic Fish Distribution and Abundance

There is limited data about the historic coho salmon population in the Mad River. Potential coho salmon habitat is primarily distributed in the downstream 40 percent of the basin. The area downstream of Matthews Dam is typically not accessible to coho salmon due to a series of boulder and bedrock falls (known as "the roughs") that begin at Blue Slide Creek, RM 43, and extend to Deer Creek at RM 53 (D. Halligan, Stillwater Sciences, personal communication 2008). Since 1961, access to the upper basin has been blocked at Matthews Dam. The IP model shows the highest IP values (IP > 0.66) on private lands in the lower mainstem Mad River and its tributaries, such as Lindsay, Noisy, Hall and Mill creeks, and in the North Fork Mad River watershed. Table 24-1 shows the areas with high IP values.

Table 24-1. Tributaries with high IP reaches (IP > 0.66) (Williams et al. 2006).

Stream Name	Stream Name	Stream Name
Mad River (lower)	Squaw Creek	Warren Creek
Lindsay Creek	Leggit Creek	Powers Creek
Mill Creek	Hatchery Creek	Dry Creek
Hall Creek	Sullivan Gulch	Leggett Creek
Noisy Creek	Grassy Creek	North Fork Mad River
Quarry Creek	Mather Creek	Maple Creek
Palmer Creek	Essex Gulch	Cañon Creek
Boulder Creek		

From 1938 to 1964, the California Department of Fish and Wildlife (CDFW; previously CDFG) counted coho salmon migrating above Sweasey Dam at RM 22 in the middle portion of the basin (Sweasey Dam was built in 1938 and demolished in 1970). On average, 474 adult coho salmon passed the dam each year with a high of 3,580 adults in 1962 and a low of 3 adults in 1958 (CDFG 1968). In 1958, the California Department of Water Resources (DWR) determined the number of fish migrating above Sweasey Dam represented approximately 16 percent of the total Mad River population. DWR assumed that most coho salmon used the lower basin and its tributaries (e.g., Lindsay Creek). From the early 1970s to 1999 (the last year of artificial coho salmon propagation in the Mad River), the number of coho salmon adults returning to the Mad River hatchery declined. It should be noted, however, that in the early 1990s, the weir that directed fish into the hatchery ceased to operate, allowing adults to pass the facility. From 1995 to 2013, adult coho salmon counted in spawner survey index reaches in Cañon Creek averaged less than two and in the North Fork Mad River averaged less than one. The highest count of adult coho salmon occurred in Sullivan Gulch during this time period with an average of six (Bourque 2014).

24.3 Status of Mad River Coho Salmon

Spatial Structure and Diversity

Coho salmon have access to the most downstream 43 miles of the basin; approximately 60 percent of the basin may be naturally inaccessible to coho salmon because a collection of large boulders in the channel may prohibit upstream migration at RM 43 to 53 (Halligan 2008). Most of the population is limited to the lower Mad River and its tributaries, such as Lindsay Creek, and the most downstream 5 miles of the North Fork Mad River (CDFG 2000). Distribution has been reduced by road-stream crossing barriers in the lower portion of the basin, and access had been limited in much of the lower river tributary habitat until an intensive program of barrier removal began approximately 5 years ago, improving access to important low gradient tributary habitat.

Non-natal rearing of coho salmon in the estuary and lower Mad River results in increased survival and productivity of the Mad River population that primarily spawns and rears in tributaries (Halligan 2003, 2007). In general, non-natal rearing in the lower Mad River bolsters rearing success and increases the population's resiliency to disturbance and habitat degradation in the tributaries.

The more restricted and fragmented the distribution of individuals within a population, and the more spatial distribution and habitat access diverge from historical conditions, the greater the extinction risk. Williams et al. (2008) estimated that a minimum of 32 coho salmon per-IP-km of habitat are needed (4,900 spawners total) for the Mad River coho salmon population to approximate the historical abundance and distribution. The current distribution of spawning adults is mostly limited to the lower river tributaries.

Population Size and Productivity

There is little information on the current population size of coho salmon in the Mad River. Data from 1981 to 2013 indicate low abundance within index reaches, averaging less than one adult coho salmon in the mainstem or North Fork Mad River, less than two in Cañon Creek, and less than seven in Sullivan Gulch (GDRC 2006, Bourque 2014) (Figure 24-2). Information from the Mad River Hatchery shows that between 1991 and 1999, adult coho salmon returns declined to an average of 38. However, only a fraction of all fish ascending the Mad River entered the fish ladder at the hatchery. All available information indicates low numbers of returning adult coho salmon in the Mad River basin and suggests that the overall number of coho salmon in the basin is extremely low compared to historic conditions.

The population growth rate in the Mad River has not been quantified, although information from CDFG (2000) and GDRC (2006) suggests negative trends in population growth rate, as does the apparent long-term declines of coho salmon observed in the Mad River. Therefore, the Mad River coho salmon population is at high risk of extinction given its very low population size.

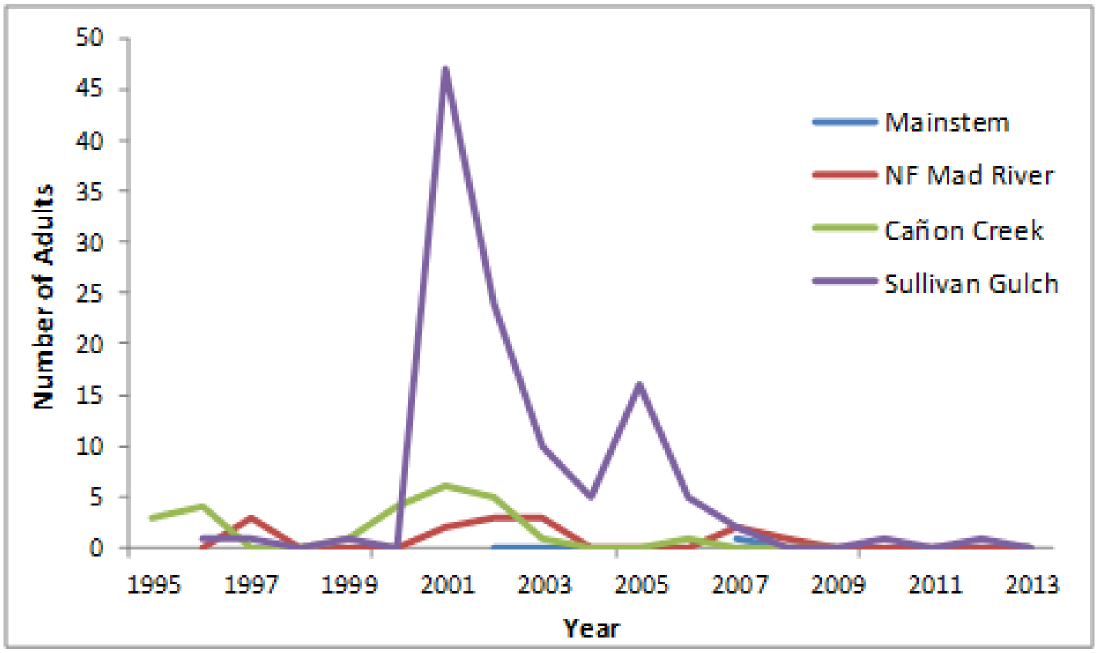

Figure 24-2. Coho salmon spawning surveys in index reaches for the Mad River. Source: Bourque 2014 and Mikus, I., pers. comm. 2014).

If a spawning population is too small, the survival and production of eggs or offspring may suffer because it may be difficult for spawners to find mates, or predation pressure may be too great. This situation accelerates a decline toward extinction. Williams et al. (2008) determined at least 153 coho salmon must spawn in the Mad River basin each year to avoid such effects of extremely low population sizes.

Extinction Risk

The Mad River population is at high risk of extinction because NMFS estimates the ratio of the three consecutive years of lowest abundance within the last twelve years to the amount of IP-km in a watershed is less than one, the criterion described by Williams et al. (2008). NMFS' determination of population extinction risk is based on the viability criteria provided by Williams et al. 2008 (Table 3, pg. 17). These viability criteria reflect population size and rate of decline. As Williams et al. (2008) provided no viability criteria for assessing moderate and high risk based on spatial structure and diversity, spatial structure and diversity were not considered in NMFS' determination of population extinction risk.

Role of Population in SONCC Coho Salmon ESU Viability

The Mad River population is a non-core, Functionally Independent population within the Central Coastal diversity stratum; historically having had a high likelihood of persisting in isolation over 100-year time scales, and with population dynamics or extinction risk over a 100-year time period that are not substantially altered by exchanges of individuals with other populations (Williams et al. 2006). To contribute to stratum and ESU viability, the Mad River non-core population should have at least 540 spawners. Sufficient spawner densities are needed to maintain connectivity and diversity within the stratum and continue to represent critical components of the evolutionary legacy of the ESU.

24.4 Plans and Assessments

State of California

Mad River Total Maximum Daily Load
http://www.swrcb.ca.gov/northcoast/

The North Coast Regional Water Quality Control Board (RWQCB) identified the Mad River as water quality limited due to excessive sediment loads, high levels of turbidity, and high water temperatures. The Total Maximum Daily Load (TMDL) was developed for sediment and turbidity in accordance with Section 303(d) of the Clean Water Act (CWA) in 2007.

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The Recovery Strategy for California Coho Salmon was adopted by the California Fish & Game Commission in February 2004. Priority actions in the Recovery Strategy for the Mad River hydrologic unit include minimizing sediment delivery to the river, protecting riparian vegetation, restoring floodplain and channel structure as well as estuarine sloughs and wetlands, and assessing impacts of Mad River Hatchery steelhead production on coho salmon (CDFG 2004b).

Humboldt Bay Municipal Water District (HBMWD)

HBMWD Habitat Conservation Plan (HCP)
http://www.hbmwd.com/site_documents/hcp.pdf

The HBMWD HCP (HBMWD 2004) describes plans for diversion operations for 50 years, covering listed salmonids including the coho salmon. The geographic range of the HCP includes the mouth of the Mad River upstream to the Matthews Dam. Some of the activities covered under the HCP include releasing flows at Matthews Dam, diverting water in the Essex Reach, bypassing flows below Essex, dredging, and maintaining adequate water surface elevation during low flow months. The HCP includes regular monitoring activities related to the operations of HBMWD and mitigation measures. Mitigation measures include providing minimum flows year-round downstream of Matthews Dam, retrofit of fish screens to minimize take of salmonids, and minimization of turbidity during construction.

Green Diamond Resource Company (GDRC)

Green Diamond Aquatic Habitat Conservation Plan (AHCP)

The GDRC AHCP (GDRC 2006) contains measures that will aid in conservation of aquatic species in select watersheds of the Mad River basin. The majority of the roughly 65 percent of private land in the Mad River basin is owned by the GDRC, and therefore managed according to the provisions of the AHCP. The plan has a number of provisions designed to protect coho salmon and salmon habitat on GDRC land in the Mad River basin. The plan was developed in accordance with section 10(a)(1)(B) of the ESA and contains a conservation strategy to minimize and mitigate the potential adverse effects of any authorized take of aquatic species that may occur incidental to GDRC's activities. The authorized take and its probable impacts will not appreciably reduce the likelihood of survival and recovery in the wild of covered listed aquatic species. Elements of the AHCP are expected to contribute to efforts to reduce the need to list currently unlisted species in the future under the ESA by providing early conservation benefits to those species. More information about the GDRC AHCP can be found in Section 3.2.5.

Redwood Community Action Agency (RCAA)

Mad River Watershed Assessment and Management Plan
http://www.waterboards.ca.gov/northcoast/water_issues/programs/tmdls/mad_river/pdf/120329/FINAL_PDF_MRWA.PDF

The RCAA, funded by a grant from the SWRCB, in conjunction with landowners and agency representatives, developed an assessment for the Mad River basin *(Stillwater Sciences 2010)*. The assessment focuses on identification of sediment sources within the basin and will be used to help develop an implementation plan that will assist public and private landowners in addressing water quality impairments and identifying basin-wide sediment source reduction opportunities for beneficial uses such as recovery of anadromous salmonids. The assessment was completed in July 2010 and work began on the implementation plan during summer 2010.

Lindsay Creek Community and Watershed-Based Land Use Assessment
http://www.naturalresourcesservices.org/lindsay-creek-community-and-watershed-based-land-use-assessment.html

RCAA led an innovative strategy to base land use decision-making on a new method of watershed assessment, including a strong component of community participation and Geographic Information System (GIS) Analysis. The assessment process culminated in the Strategy for the Lindsay Creek Watershed and Community, which includes GIS analyses that integrate information on riparian vegetation characteristics, salmonid habitat quality, sediment sources, landslide hazard, and land ownership. The strategy will help guide decision making and inform the Lindsay Creek Watershed Group of opportunities for sediment source reduction, riparian habitat improvement, and other salmonid habitat improvement efforts.

Mad River Stakeholders Group

http://www.naturalresourcesservices.org

The RCAA has begun to bring together stakeholders in the Mad River watershed with the intent of helping private and public landowners meet total maximum daily load (TMDL) implementation targets through sediment reduction activities. RCAA is developing an implementation plan for sediment reduction in the Mad River. The stakeholder group includes landowners and local, state and federal agencies that may be able to assist landowners with sediment reduction and high stream temperature alleviation projects.

Lindsay Creek Watershed Group

http://www.nrsrcaa.org/nrs/lindsaycreek/strategy/appendix/appC/FinalAppendixC3_05.pdf

Lindsay Creek Watershed Group is a watershed stakeholder group focused on community-based watershed improvement for the Lindsay Creek sub-watershed of the Mad River. The group seeks to integrate community land-use planning and watershed restoration opportunities through grant-funded projects.

U.S. Forest Service-Six Rivers National Forest

Although most of the USFS land is located upstream of the major coho salmon production areas, the management of these lands to minimize sediment and maintain and promote healthy riparian vegetation is important to downstream reaches occupied by coho salmon. The USFS has adopted a Watershed Condition Framework (WCF) assessment and planning approach (USFS and BLM 2011). The WCF is a comprehensive approach for proactively implementing integrated restoration on priority watersheds on national forests and grasslands. The WCF provides the Forest Service with an outcome-based performance measure for documenting improvement to watershed condition at forest, regional, and national scales. As part of the WCF, the Mad River was identified as a high priority 6th field sub-watershed in the Six Rivers National Forest (USFS and BLM 2011).

24.5 Stresses

Table 24-2. Severity of stresses affecting each life stage of coho salmon in the Mad River population. Stress rank categories, assessment methods, and data used to assess stresses are described in Appendix B.

	Stresses	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Lack of Floodplain and Channel Structure[1]	High	Very High	Very High[1]	High	Very High	Very High
2	Altered Sediment Supply[1]	High	Very High	Very High[1]	Very High	Medium	Very High
3	Impaired Water Quality	Low	Very High	Very High	Very High	Medium	Very High
4	Impaired Estuary/Mainstem Function	-	High	Very High	Very High	Medium	Very High
5	Degraded Riparian Forest Conditions	-	High	High	High	High	High
6	Altered Hydrologic Function	Medium	Medium	Medium	Medium	Low	Medium
7	Adverse Hatchery-Related Effects	Medium	Medium	Medium	Medium	Medium	Medium
8	Increased Disease/Predation/Competition	Medium	Medium	Medium	Low	Low	Medium
9	Barriers	-	Low	Low	Medium	Medium	Medium
10	Adverse Fishery- and Collection-Related Effects	-	-	Low	Low	Medium	Low

[1]Key limiting stresses and limited life stage.

Key Limiting Stresses and Life Stages

Lack of floodplain and channel structure and altered sediment supply are the stresses that limit juvenile rearing success for the Mad River coho salmon population. While many of the barriers to migration have been removed from the tributaries to the lower Mad River, many of these high IP tributaries have high sediment input, lack of channel structure, and lack of large woody debris, which adversely affects both summer and winter tributary rearing conditions. In the middle and lower portions of the mainstem Mad River, high summer water temperatures, increased sediment supply, and insufficient channel structure also adversely affect summer and winter rearing habitat. Off-channel rearing habitat, especially in the lower river and estuary, also likely limits the success of winter rearing.

The Recovery Strategy for California Coho Salmon (CDFG 2004b) identified tributaries that provide refugia value based on current habitat conditions (Table 24-3).

Table 24-3. Potential refugia areas in the geographic boundary of the Mad River population area.

Watershed	Stream Name	Watershed	Stream Name
Blue Lake	Warren Creek Lindsay Creek Grassy Creek Squaw Creek Mather Creek	Blue Lake	Hall Creek Noisy Creek Leggit Creek Hatchery Creek (Camp Bauer Creek) Powers Creek
North Fork	North Fork Mad River Sullivan Gulch	Butler Valley	Dry Creek Canon Creek Maple Creek Boulder Creek

Lack of Floodplain and Channel Structure

The lack of floodplain and channel structure poses a very high stress to fry, juvenile and adult life stages, and a high stress to smolt and eggs. In general, the lower to middle mainstem Mad River and the lower North Fork Mad River contain the poorest habitat conditions, and the tributaries that enter the lower Mad River, such as Lindsay Creek, provide relatively better habitat conditions. The mainstem channel is severely aggraded, and pool frequency and depth are likely poor throughout the mainstem. Halligan (2007) found few pools and riffles in the lower mainstem Mad River and the lower North Fork channel. Data on instream large wood structures is limited; however, given the poor riparian canopy conditions that likely exist in the lower to middle portions of the basin, a lack of instream wood is likely limiting the development of complex habitat. Some short sections of the lower North Fork and the lower Mad River are confined by flood control levees. These levees disconnect the channel from its floodplain and limit the formation of off-channel habitat, which is critical for juvenile winter rearing.

Altered Sediment Supply

Altered sediment supply is a very high stress for fry, juvenile and smolt life stages, a high stress eggs, and a medium stress for adult coho salmon in the Mad River. Increased sediment delivery has aggraded and widened channels, filled pools, and simplified stream habitat throughout the basin, especially within the mainstem Mad River and its lower tributaries, particularly the North Fork Mad River. Data from the Six Rivers National Forest suggest that sediment supply may be less of an issue in the upper basin. For example, some pools between RM 43 and RM 53 have low fine sediment accumulation; however, coho salmon are rarely able to access this portion of the basin due to boulder and bedrock falls. Data collected on the sediment budget during TMDL development (USEPA 2007a) indicate that both stored sediment within the channels and continued sediment delivery are critical stresses affecting the population. The USEPA (2007a) found that the middle Mad River area produces the greatest sediment relative to other areas of the basin, due to active landslides and active land management (e.g., timber harvest). The lower Mad/North Fork areas produce the greatest proportion of land management-related sediment. Sediment accumulation at the mouths of tributaries, such as the North Fork Mad River, may inhibit access.

Very high turbidity levels in the Mad River occur more frequently, with greater magnitude, and persist longer than turbidity levels in nearby basins that were used for comparisons (USEPA 2007a). The USEPA measured turbidity values at numerous locations during development of the TMDL, and found elevated turbidity from many sediment sources, such as legacy roads, naturally occurring and human-influenced landslides, past timber harvest, and first and second year adjustments of recently implemented road and barrier removal projects. Elevated turbidity levels result in a reduced ability of coho salmon to find food, gill abrasion, smothering of eggs, fine sediment accumulation in pools, and food assemblage changes which can result in decreased growth rate.

Impaired Water Quality

Impaired water quality is a very high stress to fry, juvenile and smolt life stages, a medium stress for adult coho salmon, and a low stress for eggs. These levels of stress coincide with high water temperature in the summer and early fall when the most affected life stages are present. Temperature data indicates that most of the lower to middle mainstem river, and the lower portions of the North Fork Mad River, have very high temperatures (greater than 17 °C) compared to tributaries. These data are consistent with the listing of the Mad River for temperature under Clean Water Act Section 303(d). High stream temperatures may limit coho salmon distribution and production in the basin. Water temperatures are cooler in lower reaches of the Mad River (Jensen 2000); however, temperature values still fall within the stressful to potentially lethal range for juvenile coho salmon. Halligan (2007) found hundreds of coho salmon rearing in the lower mainstem Mad River during summer months, but presence of juveniles was strongly correlated with undercut banks, overhanging vegetation, large wood recruitment, and thermal refugia provided by cool seeps and springs, intragravel water flow, groundwater or confluence with small tributaries.

Impaired Estuary/Mainstem Function

The loss and degradation of estuarine habitat in the Mad River is a high to very high stress for fry, juvenile and smolt coho salmon due to the loss of rearing habitat and refugia. Levees have been constructed in most of the historic estuary for agriculture or floodplain development. Limited estuary rearing habitat remains. Historically, the potential for estuarine rearing and the amount of refugia habitat were likely significant given the size of the floodplain in the estuary. The estuary was also once connected to sloughs and other off-channel rearing habitat, such as overflow channels and cut-off meanders. The mouth of the Mad River was previously located further south than its current location, and entered the ocean closer to Arcata. The Mad River now turns north and enters the ocean near McKinleyville (Figure 24-1). The relocation of the mouth has increased the size of the estuary, but available estuarine rearing habitat is simplified, with little instream structure or diversity, very little off-channel habitat, and a highly altered estuarine function.

Degraded Riparian Forest Conditions

Degraded riparian forest conditions exist across the basin, and are a high stress to all coho salmon life stages. Streamside canopy data are lacking; however, based on the extensive timber harvest that has occurred in the lower to middle portion of the basin, including the North Fork, poor cover and shade conditions likely exist through much of the lower to middle basin. In addition, open and hardwood-dominated riparian forest conditions have likely replaced riparian forests that once contained large confers for large wood recruitment. Hardwood- and small conifer-dominated riparian forests provide limited wood recruitment into the Mad River.

Altered Hydrologic Function

Altered hydrologic function is a medium stress for the egg, fry, juvenile and smolt life stages of coho salmon and low stress for adults. Low summer stream flows are especially problematic where increased stored sediment has reduced the amount of available rearing habitat through aggraded channels, contributing to subsurface flows. Operations of the water district, which are managed under an HCP, include an upstream impoundment at RM 84 and groundwater pumping and surface water diversions at the Essex facility on RM 9 to 10. The water district operations affect the quantity and timing of water availability in the Mad River. The construction of Matthews Dam increased summer and early fall stream flows throughout the middle and lower mainstem Mad River downstream to the Essex facility, likely increasing availability of summer rearing habitat. However, groundwater pumping and surface water diversions at Essex result in minor daily flow fluctuations during the summer and fall. Smaller agricultural diversions exist in various locations throughout the basin reducing summer base flows.

Adverse Hatchery-Related Effects

The Mad River Hatchery produced coho salmon from 1971 to 1999. The original broodstock was from the Noyo River, and at other times coho salmon from other watersheds within and outside the ESU were released into the Mad River. Coho salmon production ceased after the 1999 brood year, but it is unclear if this has reduced genetic effects of hatchery-reared fish on wild fish within the Mad River basin, and if the reproductive ability of naturally spawned Mad River coho salmon is reduced due to past intermingling of hatchery-raised and wild fish. The Mad River Hatchery still produces steelhead, which are stocked into the Mad River. Adverse hatchery-related effects pose a medium risk to all life stages of coho salmon in the Mad River, because the Mad River is stocked with steelhead from the Mad River Hatchery (Appendix B).

Increased Disease/Predation/Competition

Disease, predation, and competition are a medium threat to eggs, fry, and juveniles, and a low threat to smolts and adult coho salmon. The primary source of this stress is the Mad River Hatchery, located in the lower Mad River near the town of Blue Lake at RM 12, which currently produces 150,000-1+ steelhead smolts annually. These smolts are released into the lower mainstem Mad River during the spring, when coho salmon juveniles are hatching and rearing in the same section of the river. While the Mad River Hatchery attempts to reduce predation effects by releasing steelhead during high turbidity, and by releasing fewer steelhead than historically, coho salmon fry and juveniles are likely eaten by and compete with the hatchery-reared steelhead. Juvenile coho salmon abundance and overall population size is negatively affected as a result.

Barriers

Barriers are a medium stress for the fry and juvenile coho salmon, and a low stress for smolts and adult coho salmon. Humboldt County and Caltrans have documented road related barriers or partial barriers within the basin, mostly within the lower river tributaries. Many of these road-stream crossing barriers have been removed (e.g., Lindsay, Mill, Anker, Grassy, Mather and Hall creeks and Sullivan Gulch) or are planned for removal. Barriers on Powers Creek, Essex Creek, and Quarry Creek in the lower Mad River also require improvements to allow for unimpeded juvenile and adult coho salmon passage. Green Diamond has been documenting and addressing fish passage barriers at road-stream crossings throughout their property. Green Diamond Resource Company has a policy to install bridges on fish-bearing watercourses wherever feasible or other fish friendly structures where bridges are not feasible. GDRC has also been working collaboratively with restoration groups to address known road related fish passage barriers. A recent example within the Mad River watershed is a road decommissioning project that included a culvert removal on Vincent Creek and opened up coho habitat formally blocked by the crossing barrier.

Adverse Fishery- and Collection Related Effects

Based on estimates of the fishing exploitation rate, as well as the status of the population relative to depensation and the status of NMFS approval for any scientific collection (Appendix B), these activities pose a medium stress to adults and a low stress to juveniles and smolts.

24.6 Threats

Table 24-4. Severity of threats affecting each life stage of coho salmon in the Mad River population. Threat rank categories, assessment methods, and data used to assess threats are described in Appendix B.

	Threats[2]	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Threat Rank
1	Roads[1]	High	Very High	Very High[1]	Very High	High	Very High
2	Mining/Gravel Extraction[1]	Low	High	High[1]	High	Medium	High
3	Channelization/Diking	Low	High	High	High	Low	High
4	Timber Harvest	Medium	Medium	Medium	Medium	Low	Medium
5	Hatcheries	Medium	Medium	Medium	Medium	Medium	Medium
6	Dams/Diversion	Medium	Medium	Medium	Medium	Low	Medium
7	Agricultural Practices	Low	Medium	Medium	Medium	Low	Medium
8	High Severity Fire	Low	Medium	Medium	Medium	Low	Medium
9	Climate Change	Low	Low	Medium	Medium	Medium	Medium
10	Urban/Residential/Industrial Dev.	Low	Medium	Medium	Medium	Low	Medium
11	Fishing and Collecting	-	-	Low	Low	Medium	Low
12	Road-Stream Crossing Barriers	-	Low	Low	Low	Low	Low

[1] Key limiting threats and limited life stage
[2] Invasive Non-Native/Alien Species is not considered a threat to this population

Key Limiting Threats

The two key limiting threats, those which most affect recovery of the population by influencing stresses, are roads and mining/gravel extraction.

Roads

Roads are a very high threat to the fry, juveniles and smolts, and a high threat to eggs and adults. Road density is very high throughout the basin, ranging from 4.4 to 6.3 miles of road per square mile in the lower Mad River and North Fork areas (USEPA 2007a). Roads are a significant source of both chronic and catastrophic sediment input to streams in the basin, affecting the quality and quantity of available coho salmon habitat in the Mad River and its tributaries. In 2007, the USEPA developed the TMDL for sediment and turbidity for the Mad River (USEPA 2007a). An estimated 64 percent of the total sediment delivered to streams was attributed to human and land management-related activities, and road-related sediment contributes approximately 62 to 73 percent of the anthropogenic sediment in the basin (USEPA 2007a).

Mining/Gravel Extraction

Mining/gravel extraction presents a high threat to the fry, juvenile and smolt life stages, a medium threat to the adults, and a low threat to the egg life stage, as coho salmon do not typically spawn in the gravel extraction area. Historic gravel extraction was very damaging to the habitat in the lower Mad River until 1994. Current instream mining practices are much improved over past practices. The current mining is permitted by the Army Corps of Engineers and the permit contains numerous minimization measures to reduce the effects of gravel extraction on fish habitat, such as a head-of-bar buffer to provide for channel steering around skimmed gravel bars, provisions to provide low to moderate flow channel confinement, mining volumes that are scaled to annual water yield, and annual estimates of sediment recruitment to the lower Mad River. However, even with minimization measures, gravel extraction reduces overall habitat complexity and reduces the quality and quantity of available pool habitat. Given the sensitivity of the channel to disturbance (i.e., current lack of floodplain and channel structure; low levels of instream wood), and the use of the gravel extraction reach by coho salmon juveniles for summer rearing, gravel extraction is a high threat to rearing juveniles and a moderate threat to adults who require resting habitat in pools during upstream migration.

Channelization/Diking

Channelization and diking presents a high threat to the Mad River population. Levees confine some of the lower mainstem river and the lower North Fork and disconnect the lower river channel from its floodplain and wetlands, reducing the availability of off-channel winter rearing habitat in the lower basin.

Timber Harvest

Timber harvest is a medium threat to the coho salmon population in the Mad River. Many of the changes that have occurred to instream and riparian conditions in the basin reflect legacy effects of more intensive harvest from previous decades. Such legacy effects are addressed under the appropriate stresses earlier in this profile. Although current timber harvest practices are more protective of coho salmon habitat than before, timber harvest likely threatens the persistence of the coho salmon population by increasing sediment yield and reducing streamside shading and potential large wood recruitment. The majority of the private timberland in the Mad River basin is owned by Green Diamond and will continue to be harvested for timber. Within Green Diamond property, harvest occurs at a moderate level and under the direction of the company's AHCP (GDRC 2006). This plan lays out goals and objectives to minimize and mitigate effects from timber harvest through measures related to road and riparian management, slope stability, and harvesting activities. Although the private timberland is managed under an AHCP that reduces the effects of timber harvest, increased sediment yield, decreased sources of instream wood, and decreased stream shading are still expected to occur.

Hatcheries

Hatcheries pose a medium threat to all life stages of coho salmon in the Mad River. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress.

Dams/Diversions

Dams and diversions are a medium threat to the Mad River population. Diversions and groundwater pumping at the HBMWD Essex facility (RM 9 to 10) cause daily flow fluctuations during summer and fall months; however observations by NMFS staff and analysis of gage data (NMFS 2005c) show negligible impacts to juvenile salmonids, with water level never dropping more than 0.3 feet. Due to riffle grade control, it is unlikely that the amount of available habitat is decreased for rearing coho salmon and stranding has never been documented (HBMWD and Trinity Associates 2004). Changes in flows, however, may affect migration of adults during the fall. The impoundment of the Mad River at Matthews Dam has also increased summer and fall flows throughout most of the mainstem Mad River and increased habitat availability from RM 84 to RM 10.

Marijuana cultivation has become abundant in many areas of the SONCC coho salmon recovery domain. Although the number of plants grown each year is unknown, the water diversion required to support these plants is placing a high demand on a limited supply of water (Bauer 2013a). Most diversions for marijuana cultivation occur at headwater springs and streams, thereby removing the coldest, cleanest water at the most stressful time of the year for coho salmon (Bauer 2013b). Based on an estimate from the medical marijuana industry, each marijuana plant may consume 900 gallons of water per growing season (HGA 2010).

Other water diversions for agriculture, some of which may be unauthorized, occur throughout the basin.

Agricultural Practices

Agricultural practices pose an overall medium threat to coho salmon. Grazing occurs throughout the basin and may contribute to increased sediment generation and delivery and to decreased riparian vegetation. Other agriculture, such as the cultivation of hay, also occurs in the lower basin. Marijuana cultivation has become abundant in many areas of the SONCC coho salmon recovery domain. Although the number of plants grown each year is unknown, the herbicides, pesticides, and fertilizers used to support these plants are likely impairing water quality in coho salmon streams. Specific information on the magnitude of these activities is limited.

High Severity Fire

Altered vegetation characteristics throughout the basin pose a medium threat to coho salmon from high severity fires. Most of the basin contains forests of small diameter trees that are close together. These types of previously logged forests burn with greater intensity than late seral forest stands, and high severity forest fires create an erosion hazard. The increased sediment yield from high severity fires would likely deliver sediment to coho salmon habitat in the basin, filling pools and reducing habitat complexity. Riparian vegetation would also be reduced or eliminated, and issues associated with inadequate riparian cover, including increased water temperatures and decreased macroinvertebrate abundance would be aggravated.

Climate Change

Climate change poses a medium threat to this population. The impacts of climate change in this region will have the greatest impact on juveniles and adult coho salmon. Although the current climate is generally cool, modeled regional average temperature shows a relatively large increase over the next 50 years (see Appendix B for modeling methods). Average air temperature could increase by up to 2 °C in the summer and by 1 °C in winter. Annual precipitation in this area is predicted to change little over the next century. The vulnerability of the estuary and coast to sea level rise is moderate in this population. Juvenile and smolt rearing are most at risk due to increasing temperatures and changes in the amount and timing of precipitation, which will affect water quality and hydrologic function in the summer. The range and degree of temperature and precipitation is likely to increase in all populations in the ESU, and adult coho salmon will be negatively affected by ocean acidification and changes in ocean conditions and prey availability (Independent Science Advisory Board 2007, Portner and Knust 2007, Feely et al. 2008).

Urban/Residential/Industrial Development

Population growth and development, especially in the Arcata and McKinleyville area, will continue to present a moderate threat to coho salmon in the Mad River because it results in removal of vegetation, increased sediment delivery, introduction of exotic species, and increased landscape coverage with impervious surfaces that alters water transport on land and subsequently affects instream flows. Most of the growth within Humboldt County is in the Arcata and McKinleyville area (projected at 0.6 percent annually), resulting in more water diverted from the lower Mad River.

Fishing and Collecting

Based on estimates of the fishing exploitation rate, as well as the status of the population relative to depensation and the status of NMFS approval for any scientific collection (Appendix B), these activities pose a medium threat to adults and a low stress to juveniles and smolts.

Road-Stream Crossing Barriers

Road-stream crossing barriers are a low threat to the population. Many of the road-stream crossing barriers in the lower Mad River and its tributaries have been removed or treated during the past 5 years.

24.7 Recovery Strategy

Abundance of coho salmon in the Mad River basin is severely depressed, and consequently, their spatial distribution is restricted. Recovery activities in the basin should promote increased spatial distribution, particularly in the tributaries of the lower Mad River, as well as increased productivity and abundance. Efforts to increase distribution may also yield increases in diversity, abundance and productivity. Preservation of observed life history traits (i.e., mainstem juvenile rearing) is necessary to ensure long-term viability. Activities to improve habitat conditions should focus on the low gradient tributaries that enter the lower Mad River, all with high IP values, and the mainstem Mad River from the mouth upstream to the boulder and bedrock falls that begin at RM 43.

Lack of floodplain and channel structure, impaired estuary function, impaired water quality, and altered sediment supply are the key limiting factors for coho salmon production in the Mad River basin. Top recovery priorities in the basin should include improving channel structure and off-channel rearing habitat, reducing sediment delivery, and reducing summer stream temperatures in the mainstem Mad River. Additional high priority activities include increasing amounts of LWD in the tributaries and mainstem, improving estuarine function, providing adequate instream flow, removing barriers, and addressing predation by and competition with hatchery steelhead. Conservation partnerships with the Blue Lake Rancheria Indian Tribe, gravel mining and timber industries, HBMWD, and other local and state agencies will be essential to improving instream habitat for recovery of coho salmon. The effects of fishing on this population's ability to meet its viability criteria should be evaluated.

Table 24-5 on the following page lists the recovery actions for the Mad River population.

Table 24-5. Recovery action implementation schedule for the Mad River population. Recovery actions for monitoring and research are listed in tables at the end of Chapter 5.

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MadR.2.1.1	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	All streams where coho salmon would benefit immediately	2a
SONCC-MadR.2.1.1.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-MadR.2.1.1.2	*Place instream structures, guided by assessment results*					
SONCC-MadR.2.1.50	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Population wide	2b
SONCC-MadR.2.1.50.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-MadR.2.1.50.2	*Place instream structures, guided by assessment results*					
SONCC-MadR.2.2.2	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel habitats, alcoves, backwater habitat, and old stream oxbows	Lower Mad River and high IP tributaries, all streams where coho salmon would benefit immediately	2a
SONCC-MadR.2.2.2.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-MadR.2.2.2.2	*Implement restoration projects that improve off channel habitats to create refugia habitat, as guided by assessment results*					
SONCC-MadR.2.2.51	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel habitats, alcoves, backwater habitat, and old stream oxbows	Population wide	2b
SONCC-MadR.2.2.51.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-MadR.2.2.51.2	*Implement restoration projects that improve off channel habitats to create refugia habitat, as guided by assessment results*					
SONCC-MadR.8.1.16	Sediment	Yes	Reduce delivery of sediment to streams	Improve regulatory mechanisms	Population wide	2a
SONCC-MadR.8.1.16.1	*Develop grading ordinance for maintenance and building of private and County roads that minimizes the effects to coho*					
SONCC-MadR.8.1.13	Sediment	Yes	Reduce delivery of sediment to streams	Reduce erosion	Lower Mad River and all streams where coho salmon would benefit immediately	2a
SONCC-MadR.8.1.13.1	*Inventory sediment sources, and prioritize for treatment based on probability of sediment delivery and treatment feasibility*					
SONCC-MadR.8.1.13.2	*Treat sources of erosion, based on prioritization*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MadR.8.1.57	Sediment	Yes	Reduce delivery of sediment to streams	Reduce erosion	Population wide	2b
SONCC-MadR.8.1.57.1	*Inventory sediment sources, and prioritize for treatment based on probability of sediment delivery and treatment feasibility*					
SONCC-MadR.8.1.57.2	*Treat sources of erosion, based on prioritization*					
SONCC-MadR.8.1.15	Sediment	Yes	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	All areas where coho salmon would benefit immediately	2a
SONCC-MadR.8.1.15.1	*Assess and prioritize road-stream connection, and identify appropriate treatments*					
SONCC-MadR.8.1.15.2	*Decommission roads, guided by assessment*					
SONCC-MadR.8.1.15.3	*Upgrade roads, guided by assessment*					
SONCC-MadR.8.1.15.4	*Maintain roads, guided by assessment*					
SONCC-MadR.8.1.58	Sediment	Yes	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	2b
SONCC-MadR.8.1.58.1	*Assess and prioritize road-stream connection, and identify appropriate treatments*					
SONCC-MadR.8.1.58.2	*Decommission roads, guided by assessment*					
SONCC-MadR.8.1.58.3	*Upgrade roads, guided by assessment*					
SONCC-MadR.8.1.58.4	*Maintain roads, guided by assessment*					
SONCC-MadR.2.2.3	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Restore natural channel form and function	Lower Mad River	2b
SONCC-MadR.2.2.3.1	*Re-evaluate existing gravel mining permit minimization measures*					
SONCC-MadR.2.2.3.2	*Update minimization measures in existing and new gravel mining permits if necessary and possible*					
SONCC-MadR.8.1.14	Sediment	Yes	Reduce delivery of sediment to streams	Reduce risk of catastrophic fire	Population wide	2b
SONCC-MadR.8.1.14.1	*Identify forested stands for fire hazard reduction*					
SONCC-MadR.8.1.14.2	*Based on assessment, apply appropriate management techniques (e.g. thinning) to reduce risks of high severity fire*					
SONCC-MadR.5.1.37	Passage	No	Improve access	Reduce invasive species	Lindsay Creek and all streams where coho salmon would benefit immediately	2b
SONCC-MadR.5.1.37.1	*Eradicate invasive riparian species, such as reed canary grass*					
SONCC-MadR.5.1.37.2	*Plant native riparian vegetation to shade out emergent reed canary grass*					
SONCC-MadR.5.1.37.3	*Monitor success and re-treat if necessary*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MadR.5.1.54	Passage	No	Improve access	Reduce invasive species	Population wide	2d
SONCC-MadR.5.1.54.1	*Eradicate invasive riparian species, such as reed canary grass*					
SONCC-MadR.5.1.54.2	*Plant native riparian vegetation to shade out emergent reed canary grass*					
SONCC-MadR.5.1.54.3	*Monitor success and re-treat if necessary*					
SONCC-MadR.5.1.10	Passage	No	Improve access	Remove barriers	Tributaries to lower Mad river, all streams where coho salmon would benefit immediately	2b
SONCC-MadR.5.1.10.1	*Evaluate and prioritize barriers for removal*					
SONCC-MadR.5.1.10.2	*Remove barriers, based on evaluation*					
SONCC-MadR.5.1.53	Passage	No	Improve access	Remove barriers	Population wide	2d
SONCC-MadR.5.1.53.1	*Evaluate and prioritize barriers for removal*					
SONCC-MadR.5.1.53.2	*Remove barriers, based on evaluation*					
SONCC-MadR.1.1.4	Estuary	No	Improve connectivity of tidally-influenced habitat	Reconnect estuarine habitat	Lower Mad River/Estuary	2b
SONCC-MadR.1.1.4.1	*Identify opportunities in the estuary and lower river for reconnecting sloughs, tributaries and tidal and non-tidal wetlands*					
SONCC-MadR.1.1.4.2	*Re-connect sloughs and tidal wetlands to estuary*					
SONCC-MadR.7.1.6	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve regulatory mechanisms	Lower and middle Mad; North Fork Mad	2b
SONCC-MadR.7.1.6.1	*Develop regulatory mechanisms and enforce measures to protect existing LWD recruitment potential*					
SONCC-MadR.7.1.8	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Population wide	2b
SONCC-MadR.7.1.8.1	*Amend California Forest Practice Rules to include regulations which describe the specific analysis, protective measures, and procedure required by timber owners and CalFire to demonstrate timber operations described in timber harvest plans meet the requirements specified in 14 CCR 898.2(d) prior to approval by the Director (similar to a Spotted Owl Resource Plan)*					
SONCC-MadR.7.1.8.2	*Apply best management practices for timber harvest*					
SONCC-MadR.26.1.48	Low Population Dynamics	No	Increase population abundance	Rescue and relocate stranded juveniles	Population wide	2b
SONCC-MadR.26.1.48.1	*Survey coho-bearing tributaries and relocate juveniles stranded in drying pools*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID		*Step Description*				
SONCC-MadR.5.1.9	Passage	No	Improve access	Reduce sediment/flow barrier	Lower and middle Mad, North Fork, Canon Creek, Dry Creek, Lindsay Creek, Powers Creek, and other disconnected tributaries where coho salmon would benefit immediately	3b
SONCC-MadR.5.1.9.1		*Develop a plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage*				
SONCC-MadR.5.1.9.2		*Excavate, or otherwise treat, tributary mouths to restore connectivity, guided by the plan*				
SONCC-MadR.5.1.55	Passage	No	Improve access	Reduce sediment/flow barrier	Population wide	3d
SONCC-MadR.5.1.55.1		*Develop a plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage*				
SONCC-MadR.5.1.55.2		*Excavate, or otherwise treat, tributary mouths to restore connectivity, guided by the plan*				
SONCC-MadR.1.2.36	Estuary	No	Improve estuarine habitat	Assess and improve estuary and tidal wetland habitat	Estuary	3b
SONCC-MadR.1.2.36.1		*Identify parameters to assess condition of estuary and tidal wetland habitat*				
SONCC-MadR.1.2.36.2		*Determine amount of estuary and tidal wetland habitat needed for population recovery and develop a plan for restoration*				
SONCC-MadR.1.2.36.3		*Restore estuary and tidal wetland habitat guided by the plan*				
SONCC-MadR.3.1.41	Hydrology	No	Improve flow timing or volume	Determine effects of marijuana cultivation	Population wide	3b
SONCC-MadR.3.1.41.1		*Assess cumulative effects (e.g., flow, water quality) of marijuana cultivation*				
SONCC-MadR.3.1.41.2		*If needed, develop plan to reduce effects of marijuana cultivation*				
SONCC-MadR.3.1.41.3		*Implement plan*				
SONCC-MadR.3.1.18	Hydrology	No	Improve flow timing or volume	Manage flow	Population wide	3b
SONCC-MadR.3.1.18.1		*Collaborate with HBMWD to explore changes in releases, pumping and Essex diversion that will benefit coho salmon*				
SONCC-MadR.3.1.18.2		*Implement recommended changes*				
SONCC-MadR.3.1.19	Hydrology	No	Improve flow timing or volume	Reduce diversions	All areas where coho salmon would benefit immediately	3b
SONCC-MadR.3.1.19.1		*Identify diversions*				
SONCC-MadR.3.1.19.2		*Review diversions for opportunities to increase instream flow during summer low flow period*				

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID		*Step Description*				
SONCC-MadR.3.1.52	Hydrology	No	Improve flow timing or volume	Reduce diversions	Population wide	3d
SONCC-MadR.3.1.52.1		*Identify diversions*				
SONCC-MadR.3.1.52.2		*Review diversions for opportunities to increase instream flow during summer low flow period*				
SONCC-MadR.7.1.7	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	All areas where coho salmon would benefit immediately	3b
SONCC-MadR.7.1.7.1		*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*				
SONCC-MadR.7.1.7.2		*Develop and implement grazing management plans to improve water quality and coho salmon habitat*				
SONCC-MadR.7.1.7.3		*Plant vegetation to stabilize stream bank*				
SONCC-MadR.7.1.7.4		*Fence livestock out of riparian zones*				
SONCC-MadR.7.1.7.5		*Remove instream livestock watering sources*				
SONCC-MadR.7.1.56	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	Population wide	3d
SONCC-MadR.7.1.56.1		*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*				
SONCC-MadR.7.1.56.2		*Develop and implement grazing management plans to improve water quality and coho salmon habitat*				
SONCC-MadR.7.1.56.3		*Plant vegetation to stabilize stream bank*				
SONCC-MadR.7.1.56.4		*Fence livestock out of riparian zones*				
SONCC-MadR.7.1.56.5		*Remove instream livestock watering sources*				
SONCC-MadR.7.1.5	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase riparian vegetation	Population wide	3b
SONCC-MadR.7.1.5.1		*Develop an appropriate timber harvest management plan for benefits to coho salmon habitat*				
SONCC-MadR.7.1.5.2		*Thin, or release conifers, guided by the plan*				
SONCC-MadR.7.1.5.3		*Plant conifers, guided by the plan*				
SONCC-MadR.7.1.5.4		*Suppress invasives, guided by the plan*				
SONCC-MadR.7.1.5.5		*On USFS lands, continue implementation of Aquatic Conservation Strategy and follow restoration plans developed under the CWA TMDL*				
SONCC-MadR.16.1.21	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3b
SONCC-MadR.16.1.21.1		*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*				
SONCC-MadR.16.1.21.2		*Identify level of fishing impacts that does not limit attainment of population-specific viability criteria*				

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MadR.16.1.22	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Reduce fishing impacts to levels that do not limit recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3b
SONCC-MadR.16.1.22.1	*Determine actual fishing impacts*					
SONCC-MadR.16.1.22.2	*If actual fishing impacts limit attainment of population-specific viability criteria, modify management so that fishing does not limit attainment of population-specific viability criteria*					
SONCC-MadR.16.2.23	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3b
SONCC-MadR.16.2.23.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-MadR.16.2.23.2	*Identify level of scientific collection impact that does not limit attainment of population-specific viability criteria*					
SONCC-MadR.16.2.24	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Reduce impacts of scientific collection to levels that do not limit recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3b
SONCC-MadR.16.2.24.1	*Determine actual impacts of scientific collection*					
SONCC-MadR.16.2.24.2	*If actual scientific collection impacts limit attainment of population-specific viability criteria, modify collection so that impacts do not limit attainment of population-specific viability criteria*					
SONCC-MadR.17.2.12	Hatcheries	No	Reduce adverse hatchery impacts	Identify and reduce impacts of hatchery on SONCC coho salmon	Lower Mad River	3b
SONCC-MadR.17.2.12.1	*Identify means to reduce ecological interactions from hatchery-raised steelhead*					
SONCC-MadR.17.2.12.2	*Develop and implement Hatchery and Genetic Management Plan*					
SONCC-MadR.10.2.20	Water Quality	No	Reduce pollutants	Develop and implement TMDLs	Population wide	3b
SONCC-MadR.10.2.20.1	*Implement sediment TMDLs for water bodies listed under Clean Water Act Section 303(d)*					
SONCC-MadR.10.2.20.2	*Develop temperature TMDL for water bodies listed under Clean Water Act Section 303(d)*					
SONCC-MadR.10.7.47	Water Quality	No	Restore nutrients	Add marine-derived nutrients to streams	All streams where coho salmon would benefit immediately	3c
SONCC-MadR.10.7.47.1	*Develop a plan to supply appropriate amounts of marine-derived nutrients to streams (e.g. carcass placement, pellet dispersal)*					
SONCC-MadR.10.7.47.2	*Supply marine-derived nutrients to streams guided by the plan*					
SONCC-MadR.10.7.49	Water Quality	No	Restore nutrients	Add marine-derived nutrients to streams	Population wide	3d
SONCC-MadR.10.7.49.1	*Develop a plan to supply appropriate amounts of marine-derived nutrients to streams (e.g. carcass placement, pellet dispersal)*					
SONCC-MadR.10.7.49.2	*Supply marine-derived nutrients to streams guided by the plan*					