33. Middle Klamath River Population

- Interior Klamath Diversity Stratum
- Non-Core Potentially Independent Population
- Moderate Extinction Risk
- 450 Spawners Required for ESU Viability
- 1038 mi^2
- 113 IP km (70 mi) (4% High)
- Dominant Land Use is Forest Service Public Land
- Principal Stresses are 'Impaired Water Quality' and 'Lack of Floodplain and Channel Structure'
- Principal Threats are 'High Intensity Fire' and 'Climate Change'

33.1 History of Habitat and Land Use

Historical mining, excessive logging, and road building activities have contributed to environmental degradation in the Middle Klamath River subbasin. Throughout the 1850's, hydraulic and placer mining methods were used to remove gravel and filter out gold in sections of the mainstem Klamath River. Piles of gravel tailings remain along the mainstem river and tributaries as remnants of these historic practices, continuing to create stress and alter channel structure throughout the watershed. Timber harvesting was prevalent in the late 1940's to the 1990's, but has rapidly declined largely due to recent Forest Service policy on maintaining ecosystem health. Today, most timber management projects on Six Rivers and Klamath NF include hazard tree removal, fuel reductions, salvage logging, and promoting the development and maintenance of diverse stand structures and species composition. Existing roads used for past timber harvesting remain in the watershed and in many places continue to contribute sediment to tributary and mainstem channels.

Hydropower dams were constructed upstream in the early to mid-1900s, and continue to alter mainstem flows. Although there are no notable dams in the Middle Klamath, the operations of upstream Iron Gate, Copco 1 and 2, JC Boyle and Keno dams reduce fall and winter flow variability, which create instream conditions that favor disease proliferation and facilitate increased fish infection rates (*Ceratomyxa Shasta*, *Icthyopthirius multifilis* (Ich), *Flavobacterium columnare* (columnaris), Aeromonid bacteria, *Nanophyetus salmonicola*, *Parvicapsula minibicornis*) (NMFS 2010; Stocking and Bartholomew 2007).

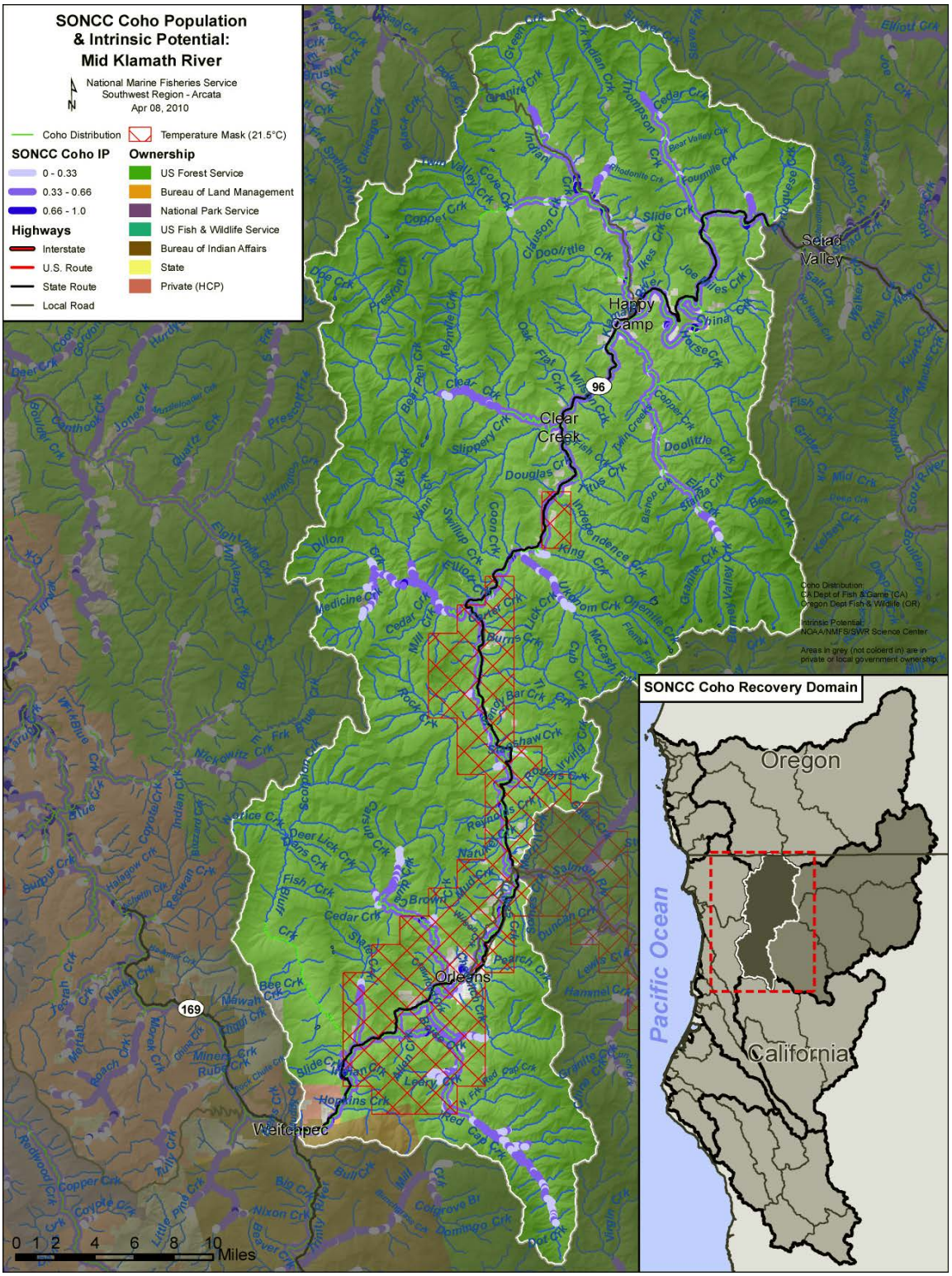

Figure 33-1. The geographic boundaries of the Middle Klamath River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership).

Low dissolved oxygen, altered water temperature regimes, and high nutrient levels are some of the water quality issues exacerbated by these upstream dams and upper basin agricultural practices (NMFS 2010). More information about how agricultural practices impact water quality can be found in the Upper Klamath population profile. Further upstream, water is diverted from the Klamath River for the Bureau of Reclamation's Klamath Project. This has altered the historic hydrologic regime of the mainstem Klamath, as well as reducing the total volume of water available for instream flows, which contributes to water quality degradation and directly affects critical periods of the life history of SONCC coho salmon (NMFS 2010). Significant volumes of water are also diverted to other non-Project irrigators from many tributaries in the Klamath River Basin, further reducing cold water inputs into the mainstem.

33.2 Historic Fish Distribution and Abundance

Very little historic data exists on coho salmon in the Middle Klamath region. Within the larger Klamath River basin we know that reports of early gill net catches were on the order of 11,000 for coho salmon in 1919 (Snyder 1931). Large declines in the basin were thought to occur between 1940 and 1960 due to large-scale timber harvest, mining, and associated habitat loss (Weitkamp et al. 1995). By the 1980's the annual escapement of coho salmon in the basin was down to around 15,000 to 20,000 fish and this estimate included a large portion of hatchery fish (Leidy and Leidy 1984). Some have concluded that salmon runs across the ESU declined by over 90 percent between the 1940's and 1980's (Weitkamp et al. 1995, California Department of Fish and Game (CDFG) 2004c). It is thought that since many tributaries in the Middle Klamath were affected by land use activities over this same time period it is likely that the Middle Klamath population was part of this decline. Historic runs in this population were likely never as large as in some tributaries such as the Scott or Shasta populations. The IP model shows that there are approximately 113 IP km of suitable juvenile rearing habitat spread throughout the mainstem Klamath River and tributaries in the Middle Klamath region. Most of this habitat is of moderate IP value (0.33 to 0.66) with a few very isolated patches of high IP value (>0.66). Historic use of Middle Klamath River tributaries by coho salmon has been documented in Aikens, Bluff, Slate, Red Cap, Boise, Camp, Irving, Dillon, Swillup, Ukonom, Independence Clear, Oak Flat, Elk, Little Grider, Indian, China, Thompson, Fort Goff, and Portuguese creeks (Brownell et al. 1999). Many other tributaries also likely supported natal and non-natal coho salmon spawning and rearing historically, as evidenced by current juvenile presence in most tributaries of the Middle Klamath River.

33.3 Current Status of Middle Klamath River Coho Salmon

Spatial Structure and Diversity

There are several monitoring efforts in the Middle Klamath including: 1) fish populations, 2) stream flow, 3) water quality, 4) physical habitat, and 5) restoration sites. Monitoring is conducted by state and federal agencies, tribes and community groups. These groups include: the Karuk Tribe, the U.S. Forest Service (USFS), the U.S Fish and Wildlife Service (USFWS), CDFG, the North Coast Regional Water Quality Control Board (NCRWQCB), the U.S. Geological Survey (USGS), and the Mid-Klamath Watershed Council (MKWC). These efforts have taken place in many tributaries of the Klamath over the past decade and have provided

information on coho salmon distribution and abundance as well as habitat condition and restoration effectiveness.

Juvenile surveys have been conducted over the past several decades by various parties including the Karuk Tribe, the Mid-Klamath Watershed Council (MKWC), and the U.S. Forest Service (USFS). These surveys have found coho salmon juveniles rearing in Hopkins, Aikens, Bluff, Slate, Red Cap, Boise, Camp, Pearch, Whitmore, Irving, Stanshaw, Sandy Bar, Rock, Dillon, Swillup, Coon, Kings, Independence, Titus, Clear, Elk, Little Grider, Cade, Tom Martin, China, Thompson, Fort Goff, and Portuguese creeks (Corum 2010; Soto et al. 2008; Karuk Tribe 2009; USFS 2009b). Surveys conducted between 2002 and 2009 indicate that juvenile coho are most abundant in Aikens, Bluff, Boise, Camp, Red Cap, Sandy Bar, Slate, and Stanshaw Creeks (USFS and Karuk Tribe 2009). Most of the observations are of juveniles using the lower parts of the tributaries and it is likely that many of these fish are non-natal rearing in these refugial areas. Natal rearing is likely confined to those tributaries where spawning is occurring and where sufficient rearing habitat exists (Boise, Bluff, Slate, Thompson, Red Cap, Elk, Indian, Clear, and Camp Creeks).

Coho salmon spawning surveys have been limited in the Middle Klamath and therefore information on adult distribution is meager. Spawning adult coho salmon have been documented in Bluff, Red Cap, Camp, Boise, South Fork Clear, and Indian creeks (Soto et al. 2008) and spawning surveys by the Karuk Tribe found adults spawning in Aikens, China, Elk, and the South Fork of Clear Creek. A total of 13 streams in 2007 and 20 streams in 2008 were surveyed (Corum 2010). Outmigrant trapping between 2002 and 2008 on Red Cap and Camp Creeks found juveniles less than 40 mm, indicating that there was likely natal rearing occurring (USFS 2009b, Cyr 2010). In addition, coho salmon have been observed spawning in side channels, tributary mouths, and shoreline margins of the mainstem Klamath River between Beaver Creek (RM 161) and Independence Creek (RM 94) (Magneson and Gough 2006).

Williams et al. (2008) determined that at least 34 coho salmon per-IP km of habitat are needed (3,900 spawners total) for the Middle Klamath coho salmon population to be at low risk of extinction. Adults and juveniles appear to be well distributed throughout the Middle Klamath; however use of some spawning and rearing areas is restricted by water quality, flow, and sediment issues. Little is known about the genetic and life history diversity of the population, but it is expected to be limited because of the depressed population size and the influx of hatchery strays that is likely occurring. The Middle Klamath River coho salmon population is likely at an increased risk of extinction because its diversity is very limited compared to historical conditions. Its spatial distribution appears to be good, but since many of the Middle Klamath tributaries are used for non-natal rearing, too little is known to infer its extinction risk based on spatial structure.

Population Size and Productivity

Little data exists on the Middle Klamath coho salmon population, but runs are thought to be extremely reduced compared to historic levels. Regional biologists estimate that the total population size is around 1,000 to 1,500 in strong run years and less than 100 in weaker run years (Ackerman et al. 2006). A few tributaries in the Middle Klamath (e.g., Slate, Boise, Red Cap, Clear, Camp, and Indian Creeks) support significant returns of coho salmon, however total

spawner abundance and population productivity is unknown. Spawning surveys by the Karuk tribe in 2003, 2004, 2007, and 2008 found a handful of redds and adult coho salmon each year. In 2003, nine tributaries were surveyed, two redds were found in South Fork Clear Creek and two were found in Elk Creek. In 2004, 17 tributaries were surveyed and 36 live adult coho, 3 dead coho, and 33 redds were found in Stanshaw, S.F. Clear, Independence, Cade, Titus, and Aikens Creeks (Karuk Tribe 2009). A total of two redds and three live coho adults were found in 2007 for a total of approximately 0.4 adult coho salmon per surveyed kilometer. During the 2008/2009 spawning season, a total of 8 redds were found for a total of 0.5 fish/km (Corum 2010).

Juvenile counts indicate that productivity is relatively low with less than 12,000 juvenile coho salmon found between 2002 and 2009 during surveys of Middle Klamath tributaries (USFS 2009b). Outmigrant trapping on Red Cap and Camp Creeks by the USFS exhibited consistent use of these Middle Klamath tributaries by young-of-the-year (YOY) and age-1 coho. Every year sampled (2002 to 2003 and 2007 to 2009) found YOY and age-1 outmigration from these streams during the late spring and early summer, although the number of outmigrating age-1 smolts was generally less than 100 during most years (USFS 2009b). Based on the returns of other Klamath populations, it is likely that the 2004/2007/2010 brood year is a relatively stronger year class than the other two (re: 2003/2006/2009 and 2002/2005/2008) (Ackerman et al. 2006). Generally the returns are more consistent between years in Middle Klamath tributaries than in other populations such as the Scott or Shasta, which have very weak year classes every year (Karuk Tribe 2009, Chesney and Knechtle 2008).

Based on the available data, it appears that the Middle Klamath River coho salmon population has an average spawner abundance of 500 individuals, and is at moderate risk of extinction given the low population size and negative population growth rate. Williams et al. (2008) determined at least 113 coho salmon must spawn in the Middle Klamath each year to avoid the effects of extremely low population sizes. Based on current estimates of the population, it is likely that the population is above depensation, but well below the low-risk threshold of 3,900 spawners.

Extinction Risk

Based on the criteria set forth by Williams et al. (2008), the Middle Klamath River coho salmon population is not viable and likely at moderate risk of extinction. The estimated number of spawners likely exceeds the depensation threshold, but does not meet the low-risk threshold (Table ES-1 in Williams et al. 2008).

Role in SONCC Coho Salmon ESU Viability

The Middle Klamath River population is considered to be a non-core, Potentially Independent population within the Klamath diversity stratum; historically having had a high likelihood of persisting in isolation over 100-year time scales, but strongly influenced by immigration from other populations such that they did not exhibit independent dynamics (Williams et al. 2008). The Middle Klamath population is strongly influenced by upstream populations such as the Upper Klamath, Shasta, Scott, and Salmon River populations. Adult strays from these populations spawn and interact with coho salmon in the middle Klamath. For the stratum and ESU to be viable, the Middle Klamath non-core population needs to be above its moderate risk

threshold of 450 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. Furthermore, the Middle Klamath population will contribute toward stratum and ESU viability by providing rearing, migratory, and refugial habitat to other Klamath populations.

33.4 Plans and Assessments

Karuk Tribal Fisheries Department and Restoration Division

Mid-Klamath Sub-basin Fisheries Resource Recovery Plan

In 2003, the Karuk Tribe developed this fisheries resource plan (Soto and Hentz 2003) to identify core variables pertaining to ecological function in the subbasin, and to provide management priorities and objectives to guide efforts to improve conditions in the subbasin. The Tribe will administer the long-range plan, in cooperation with federal and state management agencies, private landowners, and local communities. The resource plan focuses on active restoration of those processes most degraded by historic and current land uses and passive restoration for protection of currently functioning subbasin processes.

State of California

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 and is a guide for recovering coho salmon on the north and central coasts of California, including the Middle Klamath River. The Recovery Strategy emphasizes cooperation and collaboration at many levels, and recognizes the need for funding, public and private support for restorative actions, and maintaining a balance between regulatory and voluntary efforts.

Klamath River TMDL

The purpose of the Klamath River TMDLs are to estimate the assimilative capacity of the system with respect to the total loads of nutrients and organic matter that can be delivered to the Klamath River without causing an exceedance of the water quality objectives for nutrients and dissolved oxygen. The TMDLs also establish the amount of protection from solar radiation and cold water withdrawals necessary to meet water quality objectives for water temperature. The current TMDLs for the Klamath River in California address temperature, dissolved oxygen, nutrient, and *microcystin* water quality impairments for the Klamath River Hydrologic Unit, Middle HA (Oregon to Trinity River) and Lower HA, Klamath Glen HSA (Trinity River to Pacific Ocean).

U.S. Forest Service

Watershed Condition Framework

The USFS has adopted a Watershed Condition Framework assessment and planning approach (USFS and BLM 2011). The Watershed Condition Framework (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, Bluff Creek was identified as a high priority 6th field subwatershed in the Six Rivers National Forest (USFS and BLM 2011).

The Klamath (KNF) and Six Rivers National (SRNF) Forests have also conducted various other watershed assessments for National Forest lands within the Middle Klamath region.

33.5 Stresses

Table 33-1. Severity of stresses affecting each life stage of coho salmon in the Middle Klamath River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

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

[1] Key limiting factor(s) and limited life stage(s).

Limiting Stresses, life Stages, and Habitat

Several factors limit the function of habitat for certain life stages in the Middle Klamath and therefore limit productivity of this population. The lack of quality summer and winter rearing habitat that is protected from warm temperatures and high winter flows is one of the most likely factors limiting productivity (Soto et al. 2008). Summer rearing occurs in cold-water tributaries and other thermal refugia along the mainstem. This type of rearing habitat is limited in terms of its quality, quantity and connectivity within the Middle Klamath. In the summer, the diversion

of water leads to poor hydrologic function, disconnection and diminishment of thermal refugia, and poor water quality. Accretion of sediment at creek mouths also continues to limit access to important thermal refugia and summer rearing habitat. Winter rearing occurs primarily in confluence and tributary habitat where off-channel ponds and wetlands have formed. Winter rearing habitat has been primarily impacted by past mining activities in many tributaries, which has led to the loss and degradation of floodplain and channel structure. The majority of winter habitat that does exist is small, of poor quality, and is poorly connected. In addition to juvenile rearing habitat, it is likely that mainstem disease issues may be limiting the productivity of the population during certain years.

Looking at the overall productivity of the population, the juvenile life stage is most limited due to the degradation of summer and winter rearing habitat and the issues associated with disease and water quality that affect survival and growth in the mainstem river during migration. In order to improve the viability of this population, it will be imperative to address these limiting stressors and to improve habitat and conditions for the juvenile life stage. Addressing other stresses and threats and improving habitat for all life stages and life history strategies will also be an important component of recovery for this population.

Thermal refugia are one of the most important vital habitat types in the Middle Klamath due to their importance for rearing and migration in the Klamath River. USFS biologists in the Orleans and Happy Camp RD have been monitoring Klamath mainstem and tributary stream temperatures since 1996 (Cyr 2010). Results from this data and other studies along the Middle Klamath River have shown that once water temperatures in the mainstem become warm they typically remain warm, except for stream reaches gaining significant groundwater inflow. The additive nature of cold water from these tributaries plays a vital role in reducing salmonid thermal stress and mortality. Cool water from smaller tributaries is as critical as larger tributaries in maintaining water quality in the Klamath and providing thermal refugia for coho. The Mid-Klamath Watershed Council and Yurok Tribe have also collected temperature data in tributaries and the mainstem Middle Klamath River (MKWC 2006) and surveyed potential refugia areas to asses where refugial areas are available and used by juvenile coho salmon. These data indicate that many tributaries may serve as thermal refugia because of their cooler water temperatures relative to the warm mainstem Klamath River (Table 33-2). The presence of juveniles in these tributaries, especially when water temperatures in the mainstem Klamath River are high, supports the conclusion that they are used as refugia areas. Other important tributaries for juvenile rearing include Sandy Bar, Stanshaw, China, Little Horse, Pearch, and Boise (Harling 2009). Intact, high quality rearing and spawning tributary habitat is also vital to the recovery of this population. Habitat in Indian, Elk, Camp, Boise, Red Cap, Clear, Thompson, Dillon, Slate, and Bluff Creeks provide the highest quality spawning and rearing habitat for coho salmon in the Middle Klamath (Mid-Klamath Restoration Partnership (MKRP) 2010).

Table 33-2. Thermal refugia areas known to exist within the geographic boundaries of the Middle Klamath River subbasin (NCRWQCB 2010; MKWC 2006).

Stream Name	Stream Name
Aikens Creek	Swillup Creek
Bluff Creek	Ukonom Creek
Slate Creek	Independence Creek

Red Cap Creek	Little Grider Creek
Boise Creek	Elk Creek
Camp Creek	Indian Creek
Pearch Creek	Little Horse Creek
Stanshaw Creek	China Creek
Sandy Bar Creek	Thompson Creek
Ti Creek	Ft. Goff Creek
Dillon Creek	Portuguese Creek

Altered Sediment Supply

Altered sediment supply poses a high or very high stress to all of the life stages of coho salmon. Access to tributary rearing habitat and refugia during some parts of the summer is also blocked at times by alluvial barriers. Many of these hydrologic and connectivity issues increase the risk of infections from C. *shasta* and/or Parvicapsula *minibicornis*. Soils in this area are highly erodible and in combination with the steep terrain, recent intense fires, and a legacy of past timber harvest and road-building, fine sediment loading has contributed to impaired conditions throughout the Middle Klamath. Excessive sedimentation reduces habitat diversity, embeds spawning gravel, and reduces channel stability. Changes in the natural structure of the river and water flow cause alluvial sills to form at many tributary confluences and can either physically block fish or force flows subsurface, thereby limiting or eliminating access to important refugia and spawning/rearing habitat. Habitat complexity in many tributaries has been reduced by fine sediment filling of pools, off-channel ponds and wetlands.

Impaired Water Quality

Coho salmon in the Middle Klamath River watershed have numerous interacting stresses. High water temperatures, exacerbated by water diversions and seasonal low flows restrict juvenile rearing in the mainstem Klamath River, and lessen the quality of tributary rearing habitat. The water quality issues are a primary concern due to issues of elevated water temperatures, low dissolved oxygen, and high nutrient levels. Water quality conditions in the Middle Klamath are impaired by seasonal high temperature, low DO, and high pH (NMFS 2007b). Seasonal decreases in water quality can be a very high stress for juveniles and a high stress for smolts due to poor rearing and migratory conditions. Although benthic macroinvertebrate indicators of water quality (via the IBI and EPT metrics) were ranked as good for the watershed, other water quality parameters were either poor or fair. Water quality conditions including pH and temperature (>17 ºC MWAT) are rated as poor in the mainstem Klamath and several key tributaries were found to have fair water temperatures (16.1 to 17 ºC). Grider, Indian, Elk, sandy Bar, and Whitmore Creeks all had water temperatures found to be above the 17º MWAT as recommended as suitable for juvenile fish. Dissolved oxygen (DO) was found to be fair (6 to 6.75 mg/l 7 DA-min) in the upper Middle Klamath, while the lower Middle Klamath had good (6.75- 7 mg/l) to very good (>7 mg/l) DO levels. Overall, the water quality in the Klamath River is impaired and is on the 303(d) Clean Water Act list.

Use of mainstem habitat is most limited by water quality during the summer months (June through September) when water temperatures are high throughout the day. Juveniles must utilize tributaries and other off-channel areas where cooler water can be found. Juvenile foraging and

migration during early summer is most affected by poor mainstem conditions which force individuals into cold water tributaries, and in some years adult migration in the fall may be impacted as well (NMFS 2007b). Dissolved oxygen is also impaired in areas during this same time period and can reach as low as 5.5 mg/L in the mainstem (NCRWQCB 2010), effectively making these areas unusable for rearing or foraging. Highly fluctuating DO concentrations are common throughout the mainstem and pH tends to rise throughout the summer, peaking in late August and fluctuating widely between day and night (NMFS 2007b). This fluctuating condition further likely limits use of mainstem areas for juveniles and restricts rearing to tributary and confluence habitat where water quality is better. The impacts of disease may also be affected by water quality with recent increased documented incidences of sub-lethal and lethal effects on juveniles, smolts, and adults with elevated temperatures (Bartholomew and Courter 2007). MKWC (2006) documented mainstem and tributary temperatures in the summer of 2006 and showed that while mainstem temperatures are often higher than the range of coho salmon suitability (>19 ºC), most tributary temperatures were suitable (<19 ºC) for coho salmon.

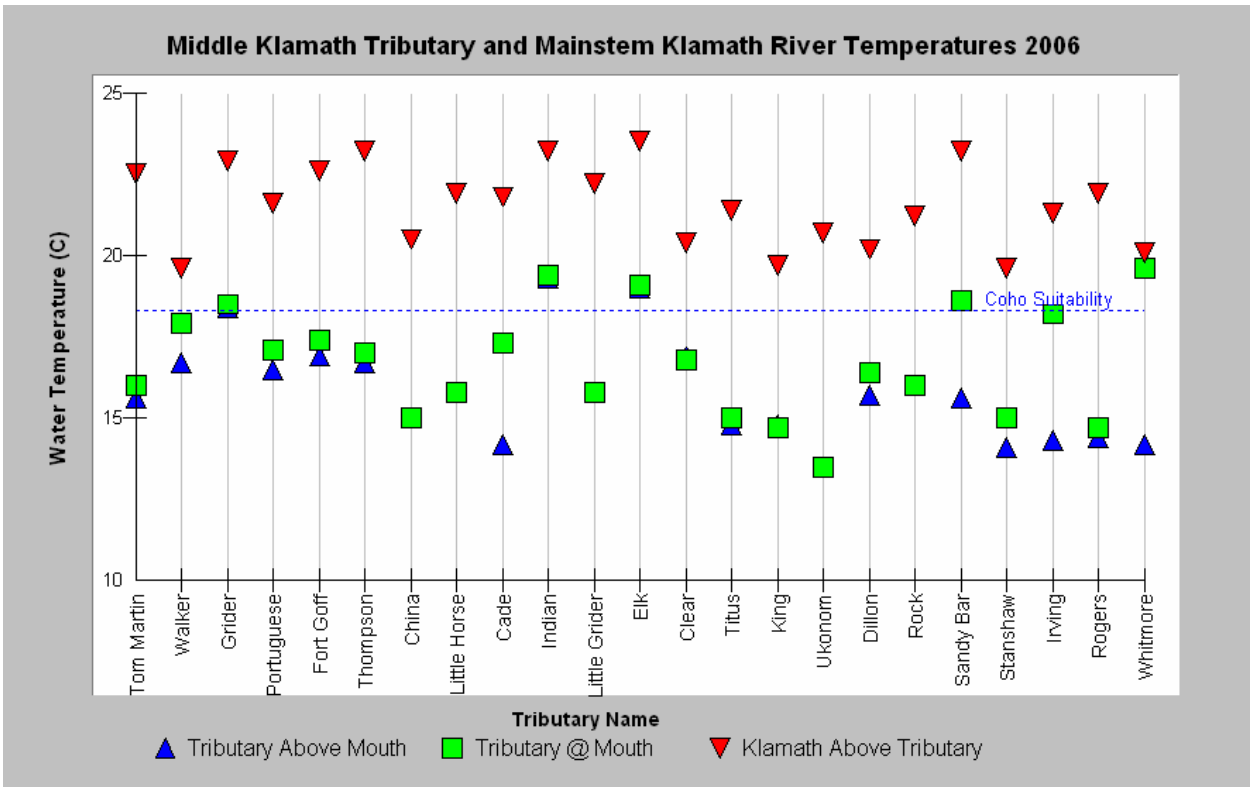

Figure 33-2. Temperature data collected during 2006 surveys (mid-June through mid-October). The data show that most tributaries were cool enough at the time of survey to support coho salmon, while mainstem Klamath River water temperatures were in the highly stressful range (MKWC 2006).

Lack of Floodplain and Channel Structure

The lack of floodplain and channel structure is also a high stressor given the need for juvenile coho salmon to rear in tributaries and utilize thermal refugia during summer. Habitat complexity in the form of pools, LWD cover, and off-channel floodplains, is essential for juvenile rearing to optimize prey availability, avoid predation, and access thermal and velocity refugia; and in general the Middle Klamath subbasin lacks these characteristics. The lack of floodplain and

channel structure is a high stress for most life stages in this population. Fry, juveniles and smolts have been shown to often utilize floodplains, side channels, and slow water habitats where available, especially in winter when high flows inhibit use of mainstem channel habitat. Generally, floodplain structure is not available in many Middle Klamath tributaries due to the steeper gradients and channel confinement in these areas, as well as the remnant dredge tailings on the floodplain in many areas. Floodplain connectivity is believed to be poor in the Indian Creek sub-watershed and the area between Dillon Creek and the Salmon River confluence. CAP data on large wood are lacking, but NMFS (2007b) noted that wood was inadequate in many Middle Klamath tributaries and therefore contributes stress to certain life stages that utilize more complex habitats. Sediment loading in some tributaries has affected the quality and availability of off-channel habitat as well. Fine sediment has filled many off-channel ponds and wetlands and the lack of flushing flows on the mainstem Klamath prevents the creation and maintenance of side and off-channel habitat. Adults are impacted through the lack of suitable spawning habitat as a result of poor gravel recruitment and retention.

Barriers

Alluvial dams, low flow conditions, road-crossings, and diversions cause many seasonal and permanent barriers in the Middle Klamath. Of these, alluvial dams at the mouths of many tributaries present the greatest number of barriers. In total, there are almost 50 known seasonal or permanent barriers in the Middle Klamath blocking or impairing access to over 170 miles of coho salmon habitat (MKRP 2010). Hwy 96 has several poorly designed culverts that block upstream and downstream migration in key watersheds (Portuguese, Fort Goff, and Cade Creeks) and unscreened diversions in streams are likely an issue. Overall, barriers pose a low stress for fry and a high stress for juveniles, smolts, and adults due to the numerous barriers that exist throughout the tributaries of the Klamath. Barriers throughout the Middle Klamath are especially important because they may block access for juvenile coho salmon to summer and winter refugia and rearing areas, as well as blocking spawning grounds for returning adults.

Increased Disease/Predation/Competition

Disease, predation, and competition are a moderate to high stress for the population. Of these three stressors, disease is the most significant. Pathogens that cause diseases in juveniles and adults include *Ceratomyxa shasta*, Ichthyopthirius *multifilis* (Ich), *Flavobacterium columnare* (columnaris), Aeromonid bacteria, *Nanophyetus salmonicola*, and the kidney myxosporean *Parvicapsula minibicornis* (Federal Regulatory Energy Commission (FERC) 2007, National Research Council (NRC) 2004). Disease occurs when conditions for the pathogen are favorable and when fish are susceptible. Ich and columnaris were responsible for the significant die-off event in the Lower Klamath River in the summer of 2002. Infection by *P. minibicornis* may occur at a prevalence of greater than 50 percent of juvenile coho salmon. It is unknown how often they cause direct mortality (Bartholomew and Courter 2007). Juvenile mortality rates from short term and longer term exposures at various locations in the Klamath River vary by location and time of year, but are consistently higher at Beaver Creek (Upper Klamath) and Seiad Valley (Table 33-3). In 2008 mortality ranged from 12.5 to 20.5 percent at the Orleans site (Bartholomew 2008).

Table 33-3. Percent loss of coho salmon exposed at various Mid-Klamath River sentinel sites. The salmon were exposed for 72 hours in May or June 2008 and subsequently held for 65 or more days at the Salmon Disease Laboratory in a 16 to 18°C water supply. ND = no fish were exposed (Bartholomew 2008).

Exposure sites	May	June
Seiad Valley (Up. Klamath Pop.)	46.0	87.5
Orleans	20.5	12.5
Young's Bar	ND	20.0

Altered Hydrologic Function

Altered hydrologic function poses a high stress for the population. The timing, magnitude and volume of flows in the mainstem Klamath River has been altered compared to historic conditions. The high stress rank for juveniles and smolts is due to the altered flow regime in the mainstem and human-induced seasonal low flows in many Middle Klamath tributaries. The altered hydrology in the mainstem has led to decreases in water quality, and thermal refugia have been lost due to lack of access to tributaries and other suitable rearing habitat. Alteration of the natural hydrograph is primarily due to diversions and water withdrawals in the Upper Basin and in upstream tributaries, and the managed flow from Iron Gate Dam. Although the impacts of the hydropower and agricultural projects decrease with distance downstream from Iron Gate, significant impacts remain to the Middle Klamath mainstem hydrograph. Generally, spring and summer flows are lower than historically unimpaired flows, and tend to peak approximately a month earlier, subsiding to summer baseflow approximately two months earlier during most years. As a result, important life history strategies/traits (e.g., smolt outmigration timing, spring juvenile/fry redistribution) have now been either modified or lost entirely due to the hydrologic shift. The earlier onset of low baseflows also precipitates poor water conditions that now coincide with a greater proportion of the smolt outmigration through the mainstem reach.

Many of the flow impairments in tributary streams are due to the diversion of water for private and municipal use. Diversions cause some tributaries to go subsurface intermittently during the summer and may eliminate or reduce thermal refugia in tributaries or tributary outlets at other times of the year. Also detrimental are the high sediment loads that have caused some reaches to flow subsurface intermittently during the summer. Refugia and off-channel rearing habitat are often cut off from mainstem and tributary streams from low flow conditions in the summer. Summer water diversions can contribute to degraded habitat and/or fish passage issues in Stanshaw, Red Cap, Boise, Camp, Elk Creek, and Fort Goff Creeks during low water years. Many of these areas lack the summer base flows needed to maintain connectivity to summer rearing habitat and refugia after diversions have been removed from streams.

Impaired Estuary/Mainstem Function

All anadromous fish natal to Middle Klamath River tributaries must migrate through the Lower Klamath River and estuary to complete its life history cycle. The Klamath River estuary plays an important role in providing holding habitat, foraging and refuge opportunities for juvenile coho salmon and smolts from the Middle Klamath. Although the estuary is short and small compared to the large size of the watershed, it does provide complex habitat as well as rearing opportunities for juvenile coho salmon. The degraded conditions that exist throughout the

Klamath Basin today may mean that the estuary must play an even greater role for all Klamath populations by providing opportunities for juvenile and smolt growth and refugia prior to entering the ocean. The estuary, although relatively intact, suffers from poor water quality, elevated sedimentation and accretion, loss of habitat, and disconnection from tributary streams and the floodplain. Additionally, diking and development on the floodplain along the Lower Klamath has led to the loss and degradation of riparian vegetation and side channel habitat in the estuary. More information about the Klamath River estuary can be found in the other population profiles concerning the Lower and Upper Klamath River.

Disease, access to and availability of thermal refugia and off-channel habitat, and lack of connectivity between tributaries and the mainstem are all issues that impact the quality of migratory habitat downstream of the Middle Klamath. Juveniles, smolts, and adults transitioning through estuarine and mainstem habitats are stressed by the degraded conditions in these migratory habitats and suffer from the lost opportunity for increased growth, and consequently, may have a lower survival rate. The loss and degradation of estuarine and mainstem habitat is considered a moderate to high stress for the population, with the most affected life stages being juveniles and smolts due to the degradation of rearing and migratory habitat.

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. No hatcheries or artificial propagation occur in the Middle Klamath population area, but there are two hatcheries in the Klamath River basin. Iron Gate Hatchery is upstream on the Klamath River, and Trinity River Hatchery is on the Trinity River, which breaks from the Klamath near the Middle Klamath population area. The proportion of spawning adults of hatchery origin in the Middle Klamath River is unknown. Adverse hatchery-related effects pose a medium risk to all life stages, due to the presence of Iron Gate Hatchery and Trinity River Hatchery in the Klamath basin (Appendix B).

Degraded Riparian Forest Conditions

Degraded riparian forest conditions pose a medium stress for all life stages. Aerial photos show that while there are areas of disturbance, the majority of riparian areas surrounding tributaries and high quality refugia contain abundant riparian vegetation and have adequate structure and diversity. The medium rating is due to areas of degraded riparian condition resulting from high intensity fires, mining, major floods (such as the 1964 flood), and past timber harvests. These disturbances create localized, short term reductions in riparian vegetation that can have major impacts depending on the degree and extent of coho salmon use of the area. Areas such as Elk Creek, where wildfire has recently denuded riparian vegetation, will experience higher water temperatures and higher sediment loads over the short term, but will slowly recover their riparian function in the long term.

Adverse Fishery Related Effects

NMFS has determined that federally-managed fisheries in California are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effects of fisheries managed by the state of California and tribal governments on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS (Appendix B).

33.6 Threats

Table 33-4. Severity of threats affecting each life stage of coho salmon in the Middle Klamath. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

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

[1] Invasive Non-Native/Alien Species and Urban/Residential/Industrial are not considered threats to this population.

High Intensity Fire

High intensity fire is a high threat to all life stages in the Middle Klamath. Because of past timber harvest practices and fire-suppression efforts, understory forest fuel loads have become excessive. High intensity fires result from these excessive forest fuel loads and are seen regularly throughout the area (e.g., Dillon, Pony, Swillup, Stanza, Titus, and Panther). Large, high intensity fires can cause chronic sediment transport from upslope sources to stream channels, particularly when coupled with salvage and other logging activities. Landscapes scorched by intense fire loosen soil integrity as plant and tree roots degrade, triggering landslides that introduce large quantities of sediment into creeks and rivers. Areas that are prone to future fire events (based on fuel loading) include important coho salmon habitat in Red Cap, Boise, Bluff, Slate, Camp, Indian, Elk, Goff, Portuguese, Clear, Dillon, and Thompson creeks.

Climate Change

Climate change has emerged as an important threat to coho salmon in the Middle Klamath due to the predicted changes in fire regimes, snow pack, ambient temperatures, and precipitation. Climate change poses a high threat to this population. The impacts of climate change in this

region will have the greatest impact on juveniles, smolts, and adults. The current climate is generally warm and modeled regional average temperatures shows a large increase over the next 50 years (see Appendix B for modeling methods). Average ambient temperature could increase by up to 3 ^{o}C in the summer and by 1 ^{o}C in the winter, while annual precipitation in this area is predicted to trend downward over the next century. Additionally it is predicted that snowpack in upper elevations of the Klamath basin will decrease with changes in response to changes in temperature and precipitation (California Natural Resources Agency 2009). Rearing and migratory habitat are most at risk to climate change. Increasing water temperatures and changes in the amount and timing of precipitation and snowmelt will impact water quality and hydrologic function in the summer and winter. Adults will also be negatively impacted by ocean acidification and changes in ocean conditions and prey availability (Independent Science Advisory Board 2007, Feely et al. 2008, Portner and Knust 2007). Overall, the range and degree of variability in ambient temperature and precipitation are likely to increase in all populations, creating long term threats to the persistence of coho salmon in this area.

Roads

Historic logging, road building, and wildfires in the Middle Klamath have contributed to degraded instream and floodplain conditions and unnatural sediment loads in the watershed. Roads are a high threat to juveniles and a medium threat to eggs, fry, smolts and adults. Road density is high (≥2.5 to 3 mi/sq mi) or very high (>3 mi/sq mi) throughout half of the watershed, including areas where limited high IP reaches and high quality refugia areas are located. The majority of these roads are located on U.S. Forest Service public land and are being prioritized and treated (upgraded, storm-proofed, and/or decommissioned). Currently, the areas with the greatest remaining road densities and greatest risk for slope failure include the China, Cade, Dillon, Rock, Reynolds, and Slate Creek watersheds. The Klamath and Six Rivers National Forest have developed a Forest Road Analysis and a Motorized Travel Management Plan that determines much of the road work done on the Forest for natural resource benefit. Many roads have been decommissioned and storm-proofed by the Forest Service, and this threat will continue to be addressed along with other upslope threats. Because road decommissioning and road improvements are costly and there are high priority roads that still remain untreated, it is expected that the high density of roads will continue to contribute to sedimentation in the Middle Klamath over the next several decades. Excessive sedimentation leads to simplification of streams, embeds spawning gravel, decreases pool depth for rearing juveniles and reduces channel stability. Such habitat changes hinder successful spawning and emergence, limit access to rearing habitats, increase competition and predation, and affect macro-invertebrate densities.

Dams/Diversions

Dam construction on the mainstem Klamath River has resulted in severely degraded instream and floodplain conditions and unnatural sediment loads in the watershed. Dams and diversions are a high threat to juveniles and smolts, and medium threat to all other life stages other than egg. The threat from dams and diversions primarily stems from the diversion of water from tributaries of the Middle Klamath and from the influence of upstream dams and diversions on mainstem habitat, tributary access, and refugia. The diversion of water from tributaries is largely undocumented and is expected to continue to degrade habitat and refugia into the future. Within the Middle Klamath itself there are approximately 170 documented diversions (CalFish 2009).

Diversion of water from tributaries limits summer base flows, decreases the potential for summer rearing, and limits access to thermal refugia. These diversions further diminish instream flows and exacerbate water quality issues. Unscreened, undocumented diversions throughout the Middle Klamath likely act as fish passage barriers, preventing migration of juveniles. Each summer, diversion of water from Middle Klamath tributaries leads to the disconnection of rearing habitat, the impairment of water quality, and the reduction in thermal refugial area and quality.

Upstream dams including Iron Gate, Copco 2 and 1, JC Boyle, and Keno dams, create significant water quality and hydrology issues in the Middle Klamath. These water quality issues are thought to facilitate increased infection rates, disease occurrence, as well as creating low dissolved oxygen levels, altered water temperature regimes, and increased nutrient levels. The operation of these dams have changed the hydrologic regime and have resulted in an earlier onset of base flow conditions and changes in the timing and magnitude of peak flows. Fish passage or dam removal above Iron Gate dam is expected to occur within the next 10 years, thereby reducing or removing the threat posed by the hydroelectric project over the long term. In the interim period, efforts will be made to avoid, minimize, or reduce the impacts from the dams through the PacifiCorp Habitat Conservation Plan and the Klamath Basin Restoration Agreement.

In addition to the dams on the Klamath River, upstream diversions by the Klamath Project in the Upper Klamath basin and in the Scott and Shasta Rivers decrease flows required to maintain adequate water temperatures in the mainstem Klamath River, and increase the occurrence and severity of alluvial barriers at many tributary mouths. These diversions are expected to continue, however conservation efforts are attempting to reduce diversions, making them less of a threat into the future. Together, upstream dams and diversions threaten all life stages of coho salmon through their impacts on habitat quality and availability, water quality and quantity, sedimentation, and disease/infection rates.

Hatcheries

Hatcheries pose a medium threat to other life stages in the Middle Klamath River basin. The rationale for these ratings is described under the “Adverse Hatchery-Related Effects” stress. .

Road-stream Crossing Barriers

Road related barriers are a medium threat and primarily affect juveniles, smolts, and adults in this population and juveniles and smolts from upstream populations that utilize rearing and refugial habitat in the Middle Klamath. Over the past decade, the Klamath and Six Rivers National Forests have removed most of the critical anadromous fish passage barriers on Forest roads, however there are still a number of passage problems associated with Highway 96 (Table 33-5). Road-stream crossings are important not only because they block tributary habitat and access to refugia, but also because they may impact the hydrologic function of tributaries and lead to increased road failures. Some of the remaining road-stream crossing barriers have been prioritized for removal (Fort Goff Creek) and the remaining barriers are being evaluated for removal.

Table 33-5. List of important road-stream crossing barriers in the Middle Klamath area.

Barrier Treatment Ranking	Stream Name	Road Name	USFS District	County	Miles of habitat*
2	Portuguese Creek	Hwy 96	Happy Camp	Siskiyou	0.4
2	Fort Goff Creek	Hwy 96	Happy Camp	Siskiyou	0.9
2	Cade Creek	Hwy 96	Happy Camp	Siskiyou	0.5
2	Negro Creek	Private	Ukonom	Siskiyou	unknown
1	Crawford Creek	Hwy 96	Orleans	Humboldt	0.6
1	Stanshaw Creek	Hwy 96	Ukonom	Siskiyou	0.2
1	Sandy Bar Creek	Hwy 96	Ukonom	Siskiyou	0.4

*Miles of habitat and ranking is estimated by the MKRP (2010). Ranking is on a scale from 0 to 3 with 3 being the highest.

Mining/Gravel Extraction

Although suction dredging occurs in the Middle Klamath, this activity is not believed to impede adult migration and should not affect eggs since dredging only occurs during the late spring to early fall. Suction dredging mostly affects juveniles and can have both beneficial as well as detrimental effects. Degradation can deplete the entire depth of gravel on a channel bed, exposing other substrates that may underlie the gravel, which would reduce the amount of usable anadromous spawning habitat (Collins and Dunne 1990, Kondolf, 1994, Oregon Water Resources Research Institute 1995). Gravel removal not only impacts the extraction site, but may reduce gravel delivery to downstream spawning areas (Pauley et al. 1989). Beneficial effects include removing fine sediments from spawning gravel, increasing the availability of benthic macro-invertebrates, creating pools, and restoring pool depths. Adverse effects include increasing turbidity, modifying spawning channels, decreasing emergent macro-invertebrate prey, and disturbing and displacing juveniles and smolts from refugia. Past mining activities have also left heavy metal contamination (i.e., mercury, copper, arsenic, etc.) at sites on Indian and Copper creeks (a tributary of Dillon creek). The Forest Service recently capped the mill tailings with fill at the Siskon Mine superfund site, and plans are underway to revegetate the mill tailing pond and mill site area, and storm-proof and stabilize the mine road. No details of the Luther Gulch superfund site near Indian Creek are available. Overall, mining and gravel extraction are not a significant threat for coho salmon and are given a rating of low to medium in the CAP analysis.

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. In addition, tribal salmonid fisheries have the potential to cause injury and death to coho salmon in the Klamath/Trinity basin. The effects of the fisheries managed by the State of California and the Yurok and Hoopa Tribes, on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. NMFS has authorized future collection of coho salmon for research purposes in the Middle Klamath River. NMFS has determined these collections are not likely to jeopardize the continued existence of the SONCC coho salmon ESU.

Channelization/Diking

According to the CAP analysis channelization and diking is not a major issue in the Middle Klamath. There is little residential and agricultural development in the Middle Klamath and therefore only small-scale channelization and diking of tributaries, except for Indian Creek.

Agricultural Practices

Other than the effects from water diversions in this part of the subbasin, agricultural practices pose a low threat to all life stages for coho salmon. Because of the small number of existing ranches and farms in this watershed, agricultural practices are a low threat to this population and are not thought to cause significant decreases in water quality, are not significantly altering streambanks or floodplains, and are not decreasing riparian habitat in the Middle Klamath subbasin. However, effects from water withdrawals are seen in these areas, and act cumulatively with withdrawals occurring upstream. Grazing does occur in the Marble Mountain Wilderness and in the Upper Bluff Creek watershed, however, the extent of grazing impacts to these watersheds is not considered to be significant. Upstream agricultural practices in the Upper Basin and the Scott and Shasta valleys are affecting water quality and flow volumes in the Middle Klamath River mainstem (See appropriate profiles for more information). In particular, upstream agricultural practices may be contributing to extended summer low flow conditions, reduction in available rearing habitats, and overall increased stress to juveniles.

Timber Harvest

Timber harvest is not a threat to coho salmon in this area due to the protective measures in place on National Forest timberlands. Timber harvesting has been low throughout this watershed the past few decades, and is not expected to increase in the near future. Under current management practices and the financial, administrative and legal restrictions on timber harvest, the USFS is unlikely to implement large timber sales. Additionally, timber practices are governed by the rigorous protective measures for water quality that are required under the Northwest Forest Plan (NWFP). There has not been a vegetation management action (such as timber harvest) on the KNF that was determined likely to have an adversely affect on SONCC coho salmon for at least a decade.

33.7 Recovery Strategy

The potential for coho salmon recovery in the Middle Klamath is very high, however the population is currently depressed in abundance and habitat is degraded in many areas. Summer and winter rearing habitat is in poor quality in many areas and is limited in its extent and connectivity. Mainstem conditions during the summer are prohibitive for migration and rearing. Recovery activities in the watershed should focus on the key limiting stressors and life stages. Restoration should include the ongoing long term reduction in sediment through road decommissioning and timber harvest management, and reduction in high intensity fire risks through fuels reduction on private and public lands.

The removal of the four mainstem hydroelectric dams will also be important to the improvement of hydrologic function, water quality, and disease conditions in the mainstem Klamath. The immediate restoration and maintenance of tributary water quality, hydrologic function, and

floodplain and channel structure for spawning and rearing will help increase productivity, abundance, and distribution of the population. Recovery actions should focus on protecting and restoring those tributaries that have been identified as being important to natal and non-natal coho salmon. Specific goals for restoration are listed below and in the table of recovery actions that follows.

The highest potential for restoring summer migratory and rearing habitat is in the mainstem Klamath River and in Slate, Elk, and Indian Creeks (MKRP 2010). Reducing stream temperatures, maintaining and improving thermal refugia, improving hydrologic function, and removing barriers will all help to increase the opportunity and capacity for summer rearing and migration in the Middle Klamath. These actions will benefit both the natal population as well as the other Interior Klamath diversity stratum populations.

The highest potential for restoring winter rearing habitat is in the mainstem Klamath River and in Elk and Indian Creeks (MKRP 2010). Improving channel and floodplain complexity and connectivity and reducing sediment supplies to tributaries will help to increase the opportunity and capacity for winter rearing. These actions will benefit both the natal population as well as the other Klamath populations in the stratum.

Table 33-6 on the following page lists the recovery actions for the Middle Klamath River population.

Table 33-6. Recovery action implementation schedule for the Middle Klamath River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	***Step Description***					
SONCC-MKR.2.2.1	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Population wide	2
SONCC-MKR.2.2.1.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-MKR.2.2.1.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-MKR.2.2.2	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Increase beaver abundance	Stanshaw, Red Cap, Boise, Camp, Elk, Dillon, Slate, and Fort Goff Creeks	3
SONCC-MKR.2.2.2.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					
SONCC-MKR.2.2.2.2	*Implement beaver program (may include reintroduction)*					
SONCC-MKR.2.2.3	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Improve regulatory mechanisms	Population wide	BR
SONCC-MKR.2.2.3.1	*Limit hunting or removal of beaver*					
SONCC-MKR.2.2.4	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Re-connect channel to existing off-channel ponds, wetlands, and side channels	Population wide	2
SONCC-MKR.2.2.4.1	*Assess instream flow conditions and side channel connectivity and develop a plan to obtain adequate flows for channel connectivity*					
SONCC-MKR.2.2.4.2	*Mechanically alter side channels, off channel ponds and wetlands to achieve connectivity*					
SONCC-MKR.2.2.5	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Remove, set back, or reconfigure levees and dikes	All leveed streams	3
SONCC-MKR.2.2.5.1	*Assess feasibility and develop a plan to remove or set back levees and dikes that includes restoring the natural channel form and floodplain connectivity once the levees have been removed*					
SONCC-MKR.2.2.5.2	*Remove levees and restore channel form and floodplain connectivity*					
SONCC-MKR.2.1.6	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Population wide	3
SONCC-MKR.2.1.6.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-MKR.2.1.6.2	*Place instream structures, guided by assessment results*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	***Step Description***					
SONCC-MKR.8.1.20	Sediment	Yes	Reduce delivery of sediment to streams	Minimize mass wasting	Population wide	BR
SONCC-MKR.8.1.20.1	*Assess and map mass wasting hazard, prioritize treatment of sites most susceptible to mass wasting, and determine appropriate actions to deter mass wasting*					
SONCC-MKR.8.1.20.2	*Implement plan to stabilize slopes and revegetate areas through planting and best management practices*					
SONCC-MKR.8.1.21	Sediment	Yes	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	BR
SONCC-MKR.8.1.21.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-MKR.8.1.21.2	*Decommission roads, guided by assessment*					
SONCC-MKR.8.1.21.3	*Upgrade roads, guided by assessment*					
SONCC-MKR.8.1.21.4	*Maintain roads, guided by assessment*					
SONCC-MKR.10.3.10	Water Quality	Yes	Protect cold water	Protect existing or potential cold water refugia	Population wide	2
SONCC-MKR.10.3.10.1	*Develop emergency plan to protect thermal refugia during warm periods*					
SONCC-MKR.10.3.11	Water Quality	Yes	Protect cold water	Educate stakeholders	Population wide	BR
SONCC-MKR.10.3.11.1	*Develop an educational program that teaches to reduce channel encroachment, reduce usage of toxic chemicals, maintaining septic systems, water conservation, and landscaping with native species.*					
SONCC-MKR.10.3.12	Water Quality	Yes	Protect cold water	Improve regulatory mechanisms	Population wide	2
SONCC-MKR.10.3.12.1	*Develop regulatory mechanisms that protect critical cold water refugia*					
SONCC-MKR.10.2.13	Water Quality	Yes	Reduce pollutants	Remove pollutants	Indian Creek, Copper Creek, and Luther Gulch	2
SONCC-MKR.10.2.13.1	*Assess contamination from tailing piles and develop mining activities remediation plan*					
SONCC-MKR.10.2.13.2	*Take necessary actions to ensure responsible parties remediate mine tailing piles, guided by the plan*					
SONCC-MKR.1.2.43	Estuary	No	Improve estuarine habitat	Improve estuary condition	Klamath River Estuary	3
SONCC-MKR.1.2.43.1	*Implement recovery actions to address strategy "Estuary" for Lower Klamath River population*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	***Step Description***					
SONCC-MKR.16.1.28	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	3
SONCC-MKR.16.1.28.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-MKR.16.1.28.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-MKR.16.1.29	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-MKR.16.1.29.1	*Determine actual fishing impacts*					
SONCC-MKR.16.1.29.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-MKR.16.2.30	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	3
SONCC-MKR.16.2.30.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-MKR.16.2.30.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-MKR.16.2.31	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-MKR.16.2.31.1	*Determine actual impacts of scientific collection*					
SONCC-MKR.16.2.31.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-MKR.3.1.15	Hydrology	No	Improve flow timing or volume	Increase instream flows	Population wide	2
SONCC-MKR.3.1.15.1	*Assess diversion impact and develop a program to increase flow during low flow periods*					
SONCC-MKR.3.1.15.2	*Increase flows during low flow periods, as described in the program*					
SONCC-MKR.3.1.16	Hydrology	No	Improve flow timing or volume	Educate stakeholders	Population wide	BR
SONCC-MKR.3.1.16.1	*Develop an educational program about water conservation programs and instream leasing programs*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		***Step Description***				
SONCC-MKR.3.1.17	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-MKR.3.1.17.1		*Prioritize and provide incentives for use of CA Water Code Section 1707*				
SONCC-MKR.3.1.18	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-MKR.3.1.18.1		*Establish a categorical exemption under CEQA for water leasing*				
SONCC-MKR.3.1.19	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-MKR.3.1.19.1		*Establish a comprehensive statewide groundwater permit process*				
SONCC-MKR.3.1.42	Hydrology	No	Improve flow timing or volume	Increase instream flows	Population wide	3
SONCC-MKR.3.1.42.1		*Install flow gages to ensure appropriate flows*				
SONCC-MKR.3.1.42.2		*Maintain flow gages annually*				
SONCC-MKR.27.1.32	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate survival of juvenile coho salmon	Population wide	2
SONCC-MKR.27.1.32.1		*Develop comprehensive PIT tagging and retrieval project that assesses habitat use and survival*				
SONCC-MKR.27.1.33	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-MKR.27.1.33.1		*Perform annual spawning surveys*				
SONCC-MKR.27.1.34	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-MKR.27.1.34.1		*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*				
SONCC-MKR.27.1.35	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		***Step Description***				
SONCC-MKR.27.1.35.1		*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*				
SONCC-MKR.27.1.36	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Disease'	Population wide	3
SONCC-MKR.27.1.36.1		*Annually estimate the infection and mortality rate of juvenile coho salmon from pathogens, such as Ceratomyxa shasta and Parvicapusla minibicornis*				
SONCC-MKR.27.2.37	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-MKR.27.2.37.1		*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*				
SONCC-MKR.27.2.37.2		*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*				
SONCC-MKR.27.2.38	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-MKR.27.2.38.1		*Measure the indicators, pool depth, pool frequency, D50, and LWD*				
SONCC-MKR.27.2.39	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-MKR.27.2.39.1		*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*				
SONCC-MKR.27.2.40	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-MKR.27.2.40.1		*Measure the indicators, pH, D.O., temperature, and aquatic insects*				
SONCC-MKR.27.2.41	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Hydrologic Function'	All IP habitat	3
SONCC-MKR.27.2.41.1		*Annually measure the hydrograph and identify instream flow needs*				
SONCC-MKR.27.1.44	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-MKR.27.1.44.1		*Develop supplemental or alternate means to set population types and targets*				
SONCC-MKR.27.1.44.2		*If appropriate, modify population types and targets using revised methodology*				

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		***Step Description***				
SONCC-MKR.5.1.22	Passage	No	Improve access	Reduce sediment barriers	Population wide	2
SONCC-MKR.5.1.22.1		*Inventory and prioritize barriers formed by alluvial deposits*				
SONCC-MKR.5.1.22.2		*Remove alluvial deposits, construct low flow channels, or reduce stream gradient to provide fish passage at all life stages*				
SONCC-MKR.5.1.23	Passage	No	Improve access	Remove barriers	Population wide	BR
SONCC-MKR.5.1.23.1		*Develop breaching and dam removal program to address man-made rock dams*				
SONCC-MKR.5.1.23.2		*Breach or remove man-made rock dams*				
SONCC-MKR.5.1.24	Passage	No	Improve access	Remove structural barrier	Population wide	2
SONCC-MKR.5.1.24.1		*Assess culvert barriers and prioritize for removal*				
SONCC-MKR.5.1.24.2		*Remove culvert barriers*				
SONCC-MKR.5.1.25	Passage	No	Improve access	Reduce flow barrier	Dillon Creek	BR
SONCC-MKR.5.1.25.1		*Assess low flow tributaries and their sediment sources that contribute to seasonal flow barriers. Develop a plan to alleviate sediment delivery and remove current barriers*				
SONCC-MKR.5.1.25.2		*Alleviate sediment delivery in areas with low flow conditions and seasonal flow barriers as described in the plan*				
SONCC-MKR.5.1.26	Passage	No	Improve access	Reduce flow barrier	Independence, Boise, Camp, Titus, and Thompson Creeks	BR
SONCC-MKR.5.1.26.1		*Identify areas where fish stranding occurs and develop a plan to create low flow channels, concentrate existing flows, and prevent stranding*				
SONCC-MKR.5.1.26.2		*Implement plan to prevent stranding*				
SONCC-MKR.5.2.27	Passage	No	Decrease mortality	Screen all diversions	Population wide	3
SONCC-MKR.5.2.27.1		*Assess diversions and develop a screening program*				
SONCC-MKR.5.2.27.2		*Screen all diversions*				
SONCC-MKR.7.1.7	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	Population wide	BR
SONCC-MKR.7.1.7.1		*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*				
SONCC-MKR.7.1.7.2		*Develop grazing management plan to meet objective*				

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	***Step Description***					
SONCC-MKR.7.1.7.3	*Plant vegetation to stabilize stream bank*					
SONCC-MKR.7.1.7.4	*Fence livestock out of riparian zones*					
SONCC-MKR.7.1.7.5	*Remove instream livestock watering sources*					
SONCC-MKR.7.1.8	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Mainstem	BR
SONCC-MKR.7.1.8.1	*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*					
SONCC-MKR.7.1.8.2	*Thin, or release conifers, guided by prescription*					
SONCC-MKR.7.1.8.3	*Plant conifers, guided by prescription*					
SONCC-MKR.7.1.9	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Reduce fire hazard	Private land in mid-Klamath	BR
SONCC-MKR.7.1.9.1	*Develop fire hazard reduction educational materials for landowners*					
SONCC-MKR.7.1.9.2	*Develop a plan for fire break stewardship and defensible space*					
SONCC-MKR.7.1.9.3	*Implement fire-safe community action plans in identified areas*					