

### 37. Shasta River Population

Interior Klamath Stratum

Core, Functionally Independent Population

High Risk of Extinction

Population likely below depensation threshold

4,700 Spawners Required for ESU Viability

793 mi<sup>2</sup> watershed (27% Federal ownership)

144 IP-km (90 IP-mi) (80% high)

Dominant Land Uses are Agricultural and moderate Timber Harvest

Key Limiting Stresses are ‘Impaired Water Quality’ and ‘Altered Hydrologic Function’

Key Limiting Threats are ‘Agricultural Practices’ and ‘Dams/Diversions’

#### *Highest Priority Recovery Actions*

<ul style="list-style-type: none"> <li>• Increase instream flows by securing unused water rights and establishing a water trust to benefit salmon</li> <li>• Develop a plan to increase flows out of Greenhorn Dam to enhance coho salmon rearing habitat</li> <li>• Increase cold water in the Upper Shasta basin</li> </ul>	<ul style="list-style-type: none"> <li>• Reduce water temperature, increase dissolved oxygen</li> <li>• Increase instream flows by improving the Grenada Irrigation District ditch diversion to decrease impacts on coho salmon</li> <li>• Reduce warm tailwater inputs into the stream</li> </ul>
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### 37.1 History of Habitat and Land Use

The Shasta Valley is situated on the western side of the Cascade Range in far northern California. The Shasta River basin is uniquely located at the boundary between two of California's principal geomorphic provinces: the Klamath Mountains province and the Cascade Range province. The Klamath Mountains province includes the western portions of the Shasta River watershed, where varied bedrock geologic conditions comprised principally of Paleozoic sedimentary and metamorphic rocks give rise to the Scott and Siskiyou Mountains. These contiguous mountain ranges intercept moist air originating over the Pacific Ocean, creating a pronounced rain shadow over the Shasta River basin. Due to this rain shadow, precipitation is low (i.e., 12-18 inches/year) and diminish considerably to the north and east. The majority of this precipitation falls as rain and snow between October and March, producing snowmelt and rainfall runoff along easterly draining and headwater tributaries to the Shasta River. The eastern portions of the Shasta Valley are contained within the Cascade Range geomorphic province, an area underlain by Tertiary and Quaternary volcanic and debris flows, including a large Pleistocene debris avalanche. Westerly-draining tributaries to the Shasta River originate in these Cascadian volcanic rocks along the southern and eastern watershed boundaries. Flows in these tributaries are dominated by discharge from numerous groundwater springs sourced principally from high elevation snowmelt percolation through the porous volcanic rocks. Differences in underlying lithological conditions throughout the Shasta River basin generate spatial differences in hydrological conditions and dependent geomorphic conditions. Shasta Basin geology continues to be influenced by Cascadian volcanism, particularly a massive lahar from Mt. Shasta that covered much of the southern portion of the Shasta Valley approximately 350,000 years ago (USFS 2012).

Hydrologic and dependent geomorphic conditions in the Shasta River downstream from Big Springs Creek are largely defined by spring flow from Big Springs Creek and other small springs and spring-fed tributaries. These freshwater springs provide continuous flow of cool water originating primarily from glaciers on Mt. Shasta, and this keeps the Shasta River watered throughout the year (Snyder 1931). The hydrology of the Shasta River has been and continues to be affected by Dwinnell Dam, surface water diversions, and interconnected groundwater pumping. The construction of Dwinnell Dam and the Parks Creek diversion by the Montague Water Conservation District (MWCD) in about 1926 has altered the natural flow and sediment transport regime in both the upper Shasta River and lower Parks Creek and also blocked access to about 22 percent of the available fish habitat for anadromous salmonids (National Research Council [NRC] 2004). A reduction in the frequency of large flood flows along with the elimination of sediment transport processes downstream of Dwinnell Dam have resulted in coarsening of the bed and reduction in habitat diversity immediately downstream. The loss of woody debris, pools, side channels, springs, and accessible wetlands from land use conversions, have also contributed to reduced summer and winter rearing capacity for juvenile coho salmon. Further alterations to stream channel function from agricultural practices includes a reduction in the number of beaver ponds, which provide important habitat attractive to rearing coho salmon.

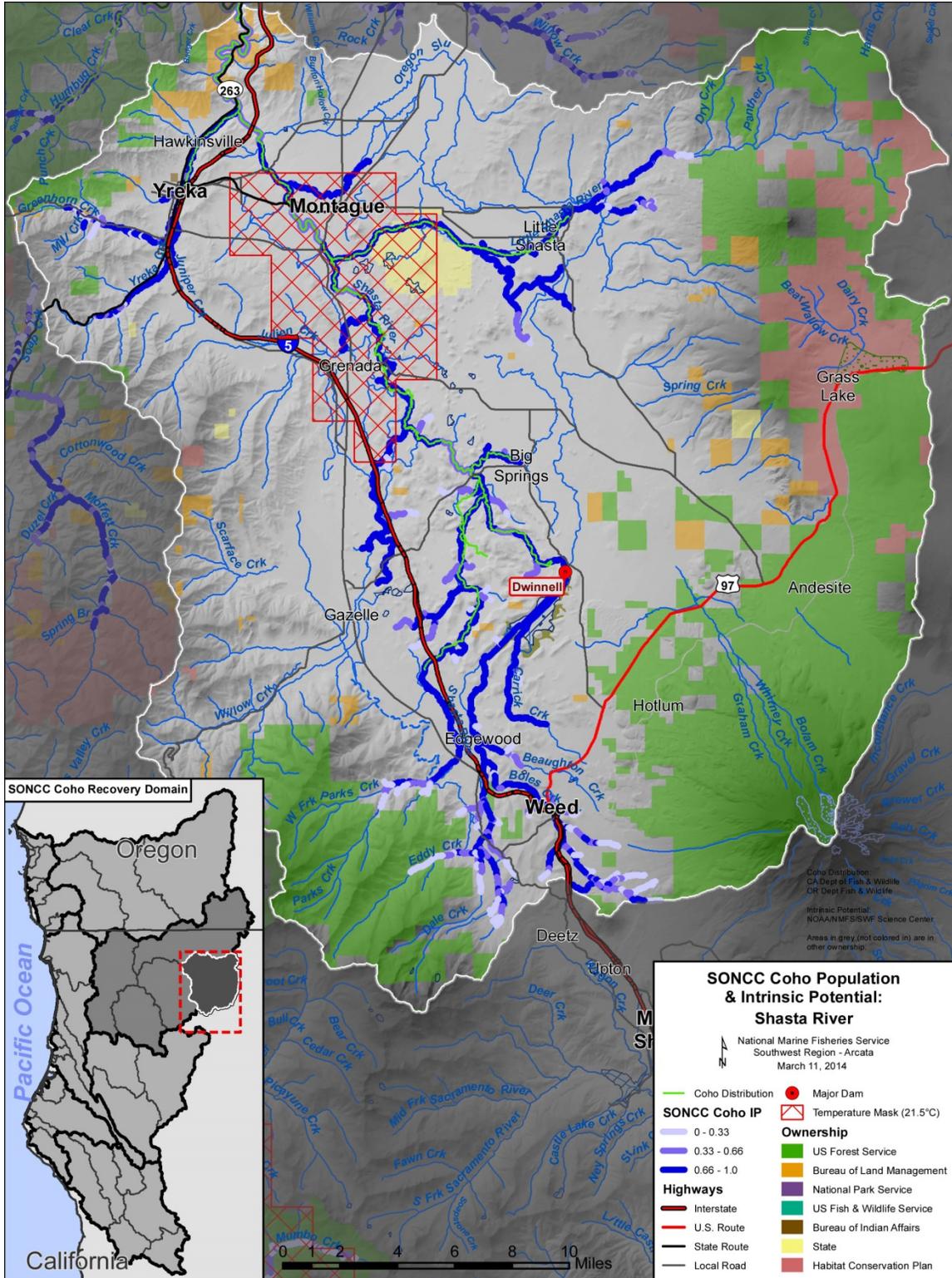


Figure 37-1. The geographic boundaries of the Shasta River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), a temperature mask (indicating areas that are inherently too warm for rearing coho salmon), land ownership, coho salmon distribution (CDFG 2012a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Interior Klamath River diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

Historic gold mining along Yreka Creek and the lower seven miles of the Shasta River occurred from the 1850s through the 1930s. Early mining activities were dependent on the development of water diversion systems to meet mining needs and gravel extraction was focused along the mainstem Shasta River. Large dredge mining activities ended around 1950 in the Shasta River basin, including Yreka Creek, but riparian areas remain poorly vegetated and erodible in these sites (Shasta Valley Resource Conservation District 2005). These past operations continue to be a threat for coho salmon along the west side of the Shasta River basin through legacy effects of remnant tailing piles, altered channel morphology, and potential remaining gold mining-associated pollution inputs.

Intensive timber harvest of the region surrounding the Shasta River watershed began in the 1850s, reached a peak in the 1950s (Klamath River Basin Fisheries Task Force 1991) and is currently occurring at a much reduced harvest rate and intensity. Extensive road networks were built to facilitate the intensive timber harvest, and many of them are on steep, naturally fragile terrain. Increased sediment loads resulting from these roads and upslope timber harvesting (e.g., Parks Creek drainage) have accumulated in the Shasta Valley. This, along with hydraulic conditions characterized by unvarying spring-fed base flows, have resulted in the covering of substrate, decreased availability of spawning gravel, and simplified pool and riffle habitats. This sediment has not been thoroughly flushed since construction of the Dwinnell Dam in 1926 and continues to be a threat to the Shasta River coho salmon population.

Wildland fire risk has increased in the Shasta River during the recent past due to fire suppression activities that have resulted in a buildup of understory fuels. These understory fuels were historically reduced by low-intensity fires that occurred every 12 to 19 years (Taylor and Skinner 1998). Fire suppression activities over the past 50 years have inadvertently created a new fire regime around the margins of the Shasta Basin, which can be characterized by frequent high severity, stand replacing fires.

### **37.2 Historical Fish Distribution and Abundance**

Information suggests that coho salmon abundance is depressed relative to historical population numbers. Until recently, coho salmon abundance could not be accurately estimated. Coho salmon runs in the Shasta Valley probably averaged a little more than 1,000 fish annually in the late 1950s (CDFG 1959), which already suggests a depressed population. In the early 1960s, the runs were estimated to average 600 fish (CDFG 1979). More recently, data suggest (Figure 37-2) the 2004 adult returning brood year class is the strongest, although still lower than historical numbers. Returns for the 2002 and 2003 brood classes have been extremely depressed.

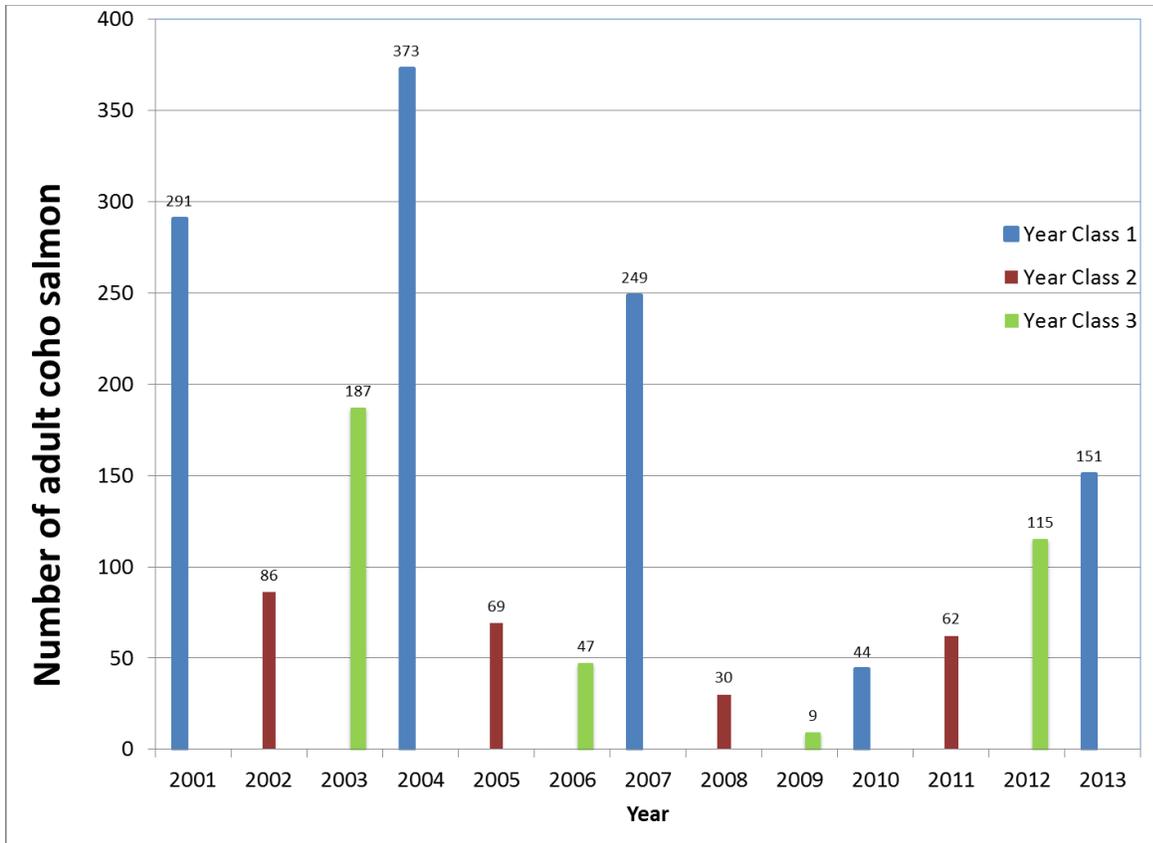


Figure 37-2. Estimates of adult coho salmon in the Shasta River from 2001 to 2013 (Knechtle 2014).

Adult coho salmon have been observed spawning in the Shasta River Canyon, lower Yreka Creek, throughout the Big Springs Complex area, and in lower Parks Creek. Juvenile coho salmon have been observed rearing in these same areas, continuing further upstream (Mount et al. 2008), and in the upper Little Shasta River. Potential coho salmon habitat is distributed throughout the Shasta River basin and IP model shows the highest values (IP > 0.66) are throughout the Shasta Valley, in low gradient reaches, and near cool spring fed tributaries to the Shasta River and Parks Creek.

Table 37-1. Tributaries in the Shasta River with high IP reaches (IP > 0.66) (Williams et al. 2006).

Stream Name	Stream Name
Shasta River <sup>1</sup>	Yreka Creek <sup>1</sup>
Big Springs Creek <sup>1</sup>	Little Shasta River <sup>1</sup>
Parks Creek <sup>1</sup>	Willow Creek <sup>1</sup>
Oregon Slough	Juniper Creek
Dale Creek	Boles Creek

<sup>1</sup> Denotes a “Key Stream” as identified in the State of California’s Coho Recovery Strategy

### 37.3 Status of Shasta River Coho Salmon

#### Spatial Structure and Diversity

The diversity and complexity of the physical and environmental conditions found within the Shasta River basin created unique life history strategies and diverse coho salmon habitat. The Shasta River population is considered a Functionally Independent population within the SONCC coho salmon ESU (Williams et al. 2006). Historical instream river conditions, fostered by unique cold spring complexes, created abundant summer rearing and off channel overwintering habitat that were favorable for production of coho salmon in the Shasta River basin.

The current distribution of coho salmon spawners is concentrated in the mainstem Shasta River from river mile 32 to about river mile 36, Big Springs Creek, lower Parks Creek, and in the Shasta River Canyon (river mile 0 to 7). Juvenile rearing is also occurring in these same areas, and occasionally in lower Yreka Creek ((Garwood 2012) and the upper Little Shasta River (Whelan, J., pers. comm. 2006). Coho salmon have also been observed utilizing aquatic macrophyte habitat in the Big Springs Creek area that is both complex and productive. This distribution is both a small fragment of the current Shasta River stream network and of the modeled IP in the basin..

Another important consideration in regards to SONCC coho salmon ESU diversity, spatial structure, and productivity is how coho salmon populations from tributaries, such as the Shasta River, are affected by straying of hatchery fish. The average annual percentage of hatchery coho salmon in the Shasta River from 2001 to 2010 was 23, with a high of 73 in 2008 (Chesney and Knechtle 2013, Ackerman et al. 2006). A high number of hatchery strays has the potential to reduce the reproductive success of the natural population (Chilcote 2003, Mclean et al. 2003, Araki et al. 2007, Chilcote et al. 2011) and negatively affect the diversity of the interior Klamath populations via outbreeding depression (Reisenbichler and Rubin 1999, HSRG 2004). However, recent preliminary findings by NMFS Southwest Fisheries Science Center suggest that hatchery and natural fish have already interbred in the upper Klamath Basin tributaries near Iron Gate Hatchery (CDFW 2013a). The total impacts of hatchery strays on Klamath River populations are not well understood. However, known straying data and preliminary genetic typing indicate that hatchery releases have negatively impacted natural populations, particularly in the upper basin.

Negative effects potentially increase over time due to climate change. For example, freshwater habitat availability for juvenile coho salmon rearing and migration is expected to decrease in the future due to climate warming (Mote et al. 2003, Battin et al. 2007); therefore, competition for limited thermal refuge areas will increase. Bartholow (2005) found a warming trend of 0.5 °C/decade in the Klamath River and a decrease in average length of river with temperatures below 15 °C (8.2 km/decade), underscoring the importance of thermal refugia areas. However, hatchery releases are expected to remain constant during this period of shrinking freshwater habitat availability, which makes the detrimental impact from density-dependent mechanisms in the freshwater environment to naturally produced coho salmon populations increase through time under a climate warming scenario. In this way, hatcheries likely continue to have an adverse impact in the effective use of habitats by naturally produced coho salmon in the future, if shared use of these habitats by natural and hatchery stocks exceed capacity limitations and food

supplies. Although there are risks to Klamath coho salmon populations from continued releases of coho salmon smolts from the Iron Gate Hatchery, due to the significantly depressed status of the Upper Klamath, Scott, and Shasta populations, releases of coho salmon could continue to contribute towards coho salmon abundance, one of the VSP criteria (NMFS and USFWS 2013).

**Population Size and Productivity**

The number of spawners in all three year classes is low, well below the depensation threshold. Productivity may also be impaired. Recent comparisons of estimated Shasta River yearling coho salmon production to returning adult Shasta River coho salmon have ranged from 4.4 to 46.6 (Chesney and Knechtle 2013, Table 37-2). By brood year, the number of yearlings produced per returning adult has been trending downwards, suggesting that in-river conditions have not improved sufficiently to initiate recovery of the Shasta River coho salmon population. The number of yearlings produced per adult will continue to be tracked, as it is a useful measure to infer habitat condition and trend between years, for coho salmon in the Shasta Basin when redd and juvenile abundance is below carrying capacity (Knechtle and Chesney 2013).

Adult spawning surveys and fish counting weir information started in 1934, and are conducted by the California Department of Fish and Wildlife (formerly California Department of Fish and Game [CDFG]). These weir counts indicate that the minimum number of adult spawning coho salmon have varied between 0 to 400 for most years, with a high of approximately 900 returning adults in 1978 (Chesney and Knechtle 2013; note: These data may not account for entire adult coho salmon brood year numbers, as weirs were sometimes removed [due to high flows] before all coho salmon spawners had entered the Shasta River). These brood year population estimates are low, and have not trended upward over time. Therefore, the Shasta River coho salmon population is at high risk of extinction given the unstable and low population size and presumed negative population growth rate.

Table 37-2 Adult coho salmon estimates. Yearling coho salmon production point estimates, and ratio of yearling coho salmon produced per adult return for the Shasta River population, brood years 2001-2008 (Chesney and Knechtle 2013)

Adult Brood Year	Adult Estimate	Yearling Year	Yearling Point Estimate	Yearlings Produced Per Adult
2001	291	2003	11,052	38
2002	86	2004	1,799	20.9
2003	187	2005	2,054	11
2004	373	2006	10,833	29
2005	69	2007	1,178	17.1
2006	47	2008	208	4.4
2007	255	2009	5,396	21.2
2008	31	2010	169	5.6
2009	9	2011	19	2.1
2010	44	2012	2049	46.6
<b>Average</b>				<b>19.62</b>

## **Extinction Risk**

The Shasta River population is at high risk of extinction because the ratio of the three consecutive years of lowest abundance within the last twelve years to the amount of IP-km in the 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 in SONCC Coho Salmon ESU Viability**

The Shasta River population is a core, Functionally Independent population within the Interior Klamath River 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 Shasta River core population should have at least 4,700 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. Besides its role in achieving demographic goals and objectives for recovery, as a core population the Shasta River population may serve as a source of spawner strays for nearby coastal populations. At present, the capacity of the Shasta River coho salmon population to provide recruits to adjacent independent populations is limited due to its low spawner abundance. Conversely, recruits straying from the nearby Scott River and Upper Klamath River may enhance recovery of the Shasta River population.

## **37.4 Plans and Assessments**

### **Shasta Valley Resource Conservation District**

The Shasta Valley Resource Conservation District was formed in July of 1953 and reached its present boundaries in 1957. The Shasta Valley RCD manages soil, water, and fish and wildlife resources for conservation purposes. Currently, the District manages 44 open funding contracts and employs 5 permanent staff members. In addition to permanent staff, the Shasta Valley RCD also employs 2 temporary staff members. Additional information about the Shasta Valley RCD is available on their web site, <http://svrcd.org/wordpress/>.

*Study Plan to Assess Shasta River Salmon and Steelhead Recovery Needs (Shasta Valley RCD and McBain & Trush 2013)*

This Study Plan focuses on fish ecology, geomorphology, hydrology, water quality (including temperature), and the habitat needs for salmonid life history stages. The plan emphasizes coordination of basin-wide research and monitoring, to guide and enhance the Shasta Valley RCD's ability to assist the recovery of Shasta Basin salmonid populations. Developing the Study Plan required: review of relevant Shasta Basin documents and information; characterization of historical streamflow and habitat conditions in the Shasta Basin, to help guide recovery planning efforts; description of the geographical distribution of different life stages of

salmonids (migration, spawning, rearing, etc.) to form life history tactics and the physical and biological constraints each life stage experiences; anticipation of key restoration and management issues that will foster rapid salmonid population recovery; and evaluation of modeling, monitoring, and planning efforts to help synchronize future data collection for model input, calibration, and testing.

<http://www.fws.gov/arcata/fisheries/reports/dataSeries/SVRCD%20Shasta%20River%20Final%20Study%20Plan.pdf>

### *Shasta Valley Coordinated Resources Management and Planning*

The decline in anadromous salmon populations, particularly fall-run Chinook salmon, by the late 1980s, prompted ranchers and other water users in the Shasta Valley to form the Shasta River Coordinated Resources Management and Planning committee in 1991. Their desire was to examine and understand the local factors that might be responsible for declines in anadromous fish which could then lead to identification of effective ways to reverse those declines. Since that time, the Shasta Coordinated Resources Management and Planning committee has been working on a variety of approaches to improving survival of salmon and steelhead in the Shasta River.

With support provided by the Shasta Valley RCD, the Coordinated Resources Management and Planning committee began monitoring Shasta River water temperature, air temperature, and flow in the mid-1990s, and dissolved oxygen in the late 1990s. The Shasta Valley RCD has recently begun stream flow monitoring in support of the nascent Shasta Water Trust managed by The Nature Conservancy. The Shasta Valley RCD began a groundwater study in 2004, completed Phase One in 2007, and is continuing with Phase Two. The Shasta Valley RCD continues its streambank protection program, has revived its riparian planting program, and is implementing prioritized irrigation tailwater reduction strategies. The Shasta Valley RCD continues to support efforts to fund the lease/purchase of cold water for dedication to the Shasta River and Parks Creek. Efforts are also underway to expand accessible coho salmon habitat, especially in the Big Springs Complex area, Little Shasta River, and Upper Parks Creek. Approximately six miles of habitat is being restored along Big Springs Creek and the adjacent reach of the Shasta River. This restored area is already being used by coho salmon and other salmonids. The Shasta River Coho Salmon Working Group is exploring alternatives to supplement the coho salmon population in the Shasta River Basin, working with a wide range of stakeholders and agencies.

### **Montague Water Conservation District (MWCD)**

The MWCD is an irrigation district located within the Shasta River watershed, (for history see: <http://freepages.genealogy.rootsweb.ancestry.com/~npmelton/sismont.htm>). MWCD operates three points of diversion in the Shasta River, including at Lake Shastina. MWCD has been working with local, state and federal agencies to improve habitat and to better understand existing conditions and opportunities to improve conditions for coho salmon and other species in the Shasta River watershed. In recent years the MWCD has worked collaboratively with fishery managers to provide pulse flows that assist juvenile salmon to either relocate to better rearing habitat or to out migrate towards the Pacific Ocean. In December 2013, the MWCD agreed to settle a lawsuit that would result in 2,250 to 11,000 acre-feet of environmental water released from Dwinnell Dam for fish benefits each year. MWCD will have to develop a long-term flow

plan and habitat restoration measures that will be subject to a formal Endangered Species Act process.

### **The Nature Conservancy**

The Nature Conservancy (TNC) purchased two large ranches along the upper Shasta River (the Nelson Ranch) and Big Springs Creek (the Busk Ranch) between 2005 and 2008. These properties, currently referred to as the Shasta Big Springs Ranch, contain 4,534 acres and include 3 miles along the upper Shasta River and another 2.2 miles of Big Springs Creek. The TNC, along with various local, state and federal partners, has already implemented several restoration actions including, but not limited to, construction of riparian fencing, riparian plantings, instream water dedications, and improved water management actions. Restoration of riverine habitats throughout this reach have already resulted in improvements to instream flow and water temperature benefitting anadromous salmonids. TNC staff have also assisted in the establishment of the Shasta River Water Trust, which leases surface water and undertakes permanent water transfers to improve instream flows in the Shasta River. For more information describing TNC's restoration of salmonid habitat in the Shasta Big Springs Ranch, please refer to their web site:

<http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/california/explore/shasta-big-springs-ranch-protected.xml>

### **State of California**

*Recovery Strategy for California Coho Salmon*

[http://www.dfg.ca.gov/fish/Resources/Coho/SAL\\_CohoRecoveryRpt.asp](http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp)

The Recovery Strategy for California Coho Salmon (CDFG 2004b) was adopted by the California Fish and Game Commission in February 2004 and is a guide for recovering coho salmon on the north and central coasts of California, including the Shasta 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. The Strategy includes improved water management/water use efficiency, water augmentation, improved habitat management, protection, assessment and monitoring, and outreach and education.

*Shasta River TMDL*

<http://www.swrcb.ca.gov/northcoast/>

Clean Water Act Section 303(d) requires each state to develop a list of impaired waters where pollution controls are not sufficient to attain or maintain applicable water quality standards and a total maximum daily load (TMDL) for each pollutant of concern in each of the listed impaired waters. In June 2006, a Total Maximum Daily Load (TMDL) was established for water temperature and dissolved oxygen in the Shasta River watershed, along with an action plan to implement it. The TMDL and Action Plan set load allocations and assigned implementation responsibilities. In September 2011, the Shasta Valley RCD provided the NCRWQCB with a five-year Shasta Valley TMDL Progress Report.

## **Natural Resources Conservation Service**

### *Klamath Basin Adaptive Management Plan (NRCS2002)*

The primary goal of the adaptive management plan in the Shasta Valley RCD service area is to achieve a reliable water supply for agriculture. The core objectives are to: decrease water demand, increase water storage, improve water quality, and develop fish and wildlife habitat. Planning, design, and implementation of on-farm projects within the Shasta River basin are ongoing, and include assistance from a variety of NRCS programs.

## **U. S. Fish and Wildlife Service**

### *Long Range Plan for the Klamath River Basin Conservation Area Fishery Restoration Program*

[http://www.krisweb.com/biblio/gen\\_usfws\\_kierassoc\\_1991\\_lrp.pdf](http://www.krisweb.com/biblio/gen_usfws_kierassoc_1991_lrp.pdf)

In 1986, the Klamath River Basin Fishery Resources Restoration Act was enacted (Public Law 99-552) which authorized a 20-year long Klamath River Basin Conservation Area Restoration Program to help rebuild anadromous fish populations in the basin. The “Long Range Plan for the Klamath River Basin Conservation Area Fishery Restoration Program” was produced by Klamath River Basin Fisheries Task Force (1991) with assistance from Kier Associates. This program includes work through the Jobs in the Woods Program, the Fish Passage Program, and the Partners for Fish and Wildlife Program. The Partners program is funded through the US Fish and Wildlife Service and provides funding for fish habitat restoration activities, planning and implementation, project monitoring, and education/outreach in the Klamath basin.

### 37.5 Stresses

Table 37-3. Severity of stresses affecting each life stage of coho salmon in the Shasta River. Stress rank categories, assessment methods, and data used to assess stresses are described in Appendix B.

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

#### Key Limiting Stresses, Life Stages, and Habitat

The Shasta River coho salmon population evolved with areas of large spring complexes, which provided sustained sources of cold, clean, high quality water, and abundant areas for rearing during hot, dry summer months. With the expansion of large-scale water diversions to serve agricultural needs, the amount and extent of cold water springs accessible to coho salmon have diminished. Data indicate that impaired water quality and altered hydrologic function are the limiting stresses for the Shasta River coho salmon population, and that juveniles are the limiting life stage for the population due to poor water quality and stressful conditions encountered during hot, dry summer months.

The most vital habitat in the Shasta River basin are its cold springs, which create cold water refugia for juvenile coho salmon, decrease overall water temperatures throughout the basin, and allow for successful summer rearing of individuals in natal and non-natal creeks and mainstem areas. Yreka Creek, Julian Creek, Willow Creek, Parks Creek, Dale Creek, Eddy Creek and the Shasta River upstream from Lake Shastina receive runoff from west side mountains. Boles Creek, Carrick Creek, Beaughton Creek and Big Springs Creek are all spring creeks originating from snowmelt percolating from Mt. Shasta. Recent UC Davis investigations have indicated the

high potential productivity and capability of the Big Springs Creek to support large salmonid populations (Mount et al. 2009). Known cool water refugia are listed in Table 37-4. They are all located in reaches with high IP values.

Table 37-4. Potential refugia areas within the geographic boundaries of the Shasta River population.

Sub-basin	Stream Name	Stream Name
Shasta River	Big Springs Complex: Big Springs Creek, Little Springs Creek, Hole in the Ground Springs and Creek, Clear Springs, and other unnamed springs downstream from Dwinnell Dam	Mainstem Shasta River, river mile 32 to 38
Shasta River	upper Little Shasta River	upper Yreka Creek
Shasta River	Parks Creek, and springs flowing into the lower reaches of Parks Creek: Shasta Springs, Kettle Springs and Creek, and Bridge Field/Black Meadow Springs and Bridge Field Creek	upper Greenhorn Creek (N.B. upstream from Greenhorn Dam)

**Impaired Water Quality**

Impaired water quality is a very high stress for most coho salmon life stages. Reduced quantity of instream flows creates extremely stressful water quality conditions for rearing juveniles, and decreases the cold water input from vital cold spring complexes throughout the basin. This is primarily the result of agricultural diversion of surface water. The hydrology in the Shasta River is dominated by a large spring complex that provides the majority of the water for the Shasta River, particularly during the summer. The water that emerges from the springs is very cold, high in nutrients, and provides for exceptionally high primary and secondary productivity. The flow of the river is enhanced by snow melt from Mt. Shasta that historically maintained a consistent cold water flow of at least 103 cubic feet per second (cfs) to the Klamath River during the summer (Mack 1958). This spring-fed system was noted for producing large runs of both spring-run and fall-run Chinook salmon, coho salmon, and steelhead (Snyder 1931).

The diversion of surface water has resulted in stream temperatures for summer rearing that are poor throughout the mainstem Shasta River from its mouth to the Big Springs area, and in Parks Creek further upstream. At times, water temperatures become lethal to anadromous fish (Gwynne 1993, North Coast Regional Water Quality Control Board [NCRWQCB] 2006). During summer months dissolved oxygen concentrations in the Shasta River follow a distinct diurnal pattern, with high concentrations (near or above saturation) during daylight hours and lower concentrations (near or below saturation) at night. This dissolved oxygen pattern is typical of productive river systems experiencing high photosynthesis and respiration rates of aquatic plants. During summer months, Shasta River dissolved oxygen concentrations are above the Basin Plan objective of 7.0 mg/L during daylight hours, and fall below 7.0 mg/L during nighttime and early morning hours of the day (NCRWQCB 2011). These conditions (high water

temperatures, high pH, and large fluctuations in DO) are exacerbated by low stream flows, large biomass of aquatic vegetation, high level of biological oxygen demand in sediments via organic decay, decrease in riparian cover, and increasing ambient temperatures from climate change. Impaired water quality creates a very high stress for all life stages of coho salmon, and decreases survival and fitness of juveniles throughout the Shasta River watershed.

Since 2009, livestock have been excluded from Big Springs Creek, the source of approximately 80% of the summer stream flow in the Shasta River (Jeffres et al. 2010). Livestock exclusion has facilitated a dramatic increase in submerged and emergent aquatic vegetation biomass, resulting in concomitant increases in channel depths (through increased resistance) and shade (from the vegetation canopy). Increases in shade and depth have reduced rates of heating throughout Big Springs Creek, making much of the creek thermally suitable as over-summering coho salmon rearing habitat.

### **Altered Hydrologic Function**

Altered hydrologic function presents a very high stress to fry, juvenile, and smolt life stages, and a medium stress to the egg and adult stages. Dwinnell Dam and over 100 other adjudicated irrigation diversions either store or divert from the Shasta River from April 1 to October 1, providing irrigation for approximately 52,000 acres of land (about 10 percent of the watershed) during the growing season. Water diversions have been estimated to exceed 110 cfs (NRC 2004) and consumptive use of irrigation water is approximately 150,000 acre feet per year (KRBFTF 1991).

Shasta River surface water is over-appropriated during the irrigation season, leaving inadequate summer instream flows of approximately 15 to 20 cfs in the lower Shasta River, sometimes dropping to 5 cfs in dry years (Hampton 2009; CDWR 2014). In response, the Shasta TMDL Implementation Plan set a target summer flow of 45 cfs of water cool enough to sustain salmonids at the DWR Montague gage (NCRWQCB 2011). Water quantity/flow regime is generally good (fully functional) in the southern portion of the Shasta Valley including upper Parks Creek, the upper Shasta River, and tributaries originating from the flanks of Mt. Shasta: Dale, Boles, Broughton and Carrick creeks, but poor in other key areas from over appropriated water diversions and Dwinnell Dam.

Hydrologic function is severely altered by a rapid decrease in flows beginning with the onset of the irrigation season, when large numbers of Shasta Valley irrigators begin diverting water simultaneously. The reduced discharge along the mainstem Shasta River, Parks Creek, and tributaries to the Shasta River forces rearing juvenile coho salmon to move either upstream towards spring-fed habitat, or downstream to the Klamath River. Reduced flows during the spring often result in decreases in summer rearing habitat and reduced opportunities for juvenile fish movement within the basin.

In undertaking annual Shasta River downstream migrant trapping studies, CDFW observed a relationship between reduced base flows, increasing water temperatures, and early outmigration of young-of-the-year (YOY) coho salmon (Chesney and Yokel 2003). In years when spring base flows were reduced early due to drought conditions and the onset of agricultural water deliveries, YOY coho salmon outmigration to the mainstem Klamath River occurred earlier than in years

when Shasta River base flows were sustained at a higher level through the spring (Chesney and Yokel 2003). This suggests that juvenile coho salmon, while known to naturally exhibit non-natal rearing in the Klamath River, are prematurely forced to redistribute within the basin in response to diminishing spring flows. Note that the mainstem Klamath River below Iron Gate Dam is impaired by elevated nutrient levels, organic enrichment/low dissolved oxygen levels, elevated water temperatures (NCRWQCB 2010), and fish diseases (Stocking et al. 2006, Nichols and True 2007). Thermal impairment of lower Shasta River water in late summer/early fall can also result in morbidity and mortality of in-migrating adult coho salmon. This impairment therefore reduces the health and survival of both out-migrating and in-migrating Shasta River coho salmon.

### **Impaired Estuary/Mainstem Function**

This stress refers to the estuary and mainstem conditions in the Klamath River since this population is part of a larger basin containing multiple populations. Conditions in the Klamath River mainstem and estuary are important to this population since all salmon and steelhead that originate from the Shasta River migrate to and from the ocean through the mainstem Klamath River and the Klamath River estuary. The Klamath River estuary plays an important role in providing holding habitat, foraging and refuge opportunities for outmigrating juvenile coho salmon from the Shasta River. Previous studies have shown that naturally produced yearling coho salmon can have extended estuarine residence times, up to several weeks (Miller and Sadro 2003). Although the estuary is short and small compared to the large size of the watershed, it does provide numerous habitat types and vital rearing habitat for juvenile and smolting coho salmon (Wallace 1995). The degraded conditions that exist throughout the Klamath Basin today may mean that the estuary plays an even more important role for all Klamath populations by providing the opportunity 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 (Hiner 2006). Levees along the Lower Klamath and development on the floodplain have led to the loss and degradation of habitat in the estuary.

Mainstem conditions in the Shasta and Klamath Rivers are stressful because of poor water quality, sedimentation, and degraded habitat. Because of the distance that this population must travel to and from the ocean, and the time spent in the mainstem Klamath River, this stress is especially significant for the Shasta River population. Juveniles, fry, and smolts transitioning through estuarine and mainstem habitat are stressed by the degraded conditions in these migratory habitats and suffer from the lost opportunity for increased growth and consequently a lower survival rate. The loss and degradation of estuarine and mainstem habitat is considered a high stress for the population, with the most affected life stages being juveniles and smolts due to the degradation of rearing and migratory habitat.

### **Increased Disease/Predation/Competition**

Disease, predation, and competition present a very high stress for juveniles and smolts, a medium stress for adults and fry, and a low stress for eggs. Disease does become a significant stress to Shasta River coho salmon when they enter the Klamath River, where pathogens become pervasive during the late spring and summer. Pathogens that have caused diseases in juvenile

fish include *Ceratonova shasta* (resulting in ceratomyxosis), *Flavobacterium columnare* (columnaris), aeromonid bacteria *Nanophyetus salmonicola*, and the kidney myxosporean *Parvicapsula minibicornis* (Federal Energy Regulatory Commission 2007). Actinospore concentrations of both *C. shasta* and *P. minibicornis* in the mainstem Klamath River are often above the threshold necessary to induce infection and disease (Stocking et al. 2006, Nichols and True 2007). By late spring and summer, both diseased hatchery and natural-stock juveniles are seen dead or moribund in Klamath River screw traps. In addition to disease, competition can occur when numerous, larger-sized hatchery fish displace wild juveniles in refugia along the Klamath River, take available prey, or eat undersized wild juvenile fish. Non-native piscivorous fish and amphibians also prey on juvenile coho salmon originating from the Shasta River population (Knechtle 2011).

### **Lack of Floodplain and Channel Structure**

Lack of floodplain and channel structure presents a high stress for all life stages. Agricultural practices occurring adjacent to the mainstem Shasta River and several important tributaries has led to degradation and loss of rearing habitat, refugia, wetlands, and other off-channel habitats. Loss of riparian vegetation cover throughout the Shasta Valley has caused the loss of large perennial riparian vegetation recruitment, channel margin degradation, and excessive sediment, decreasing available rearing summer and winter rearing habitat, pool depth, and instream cover. These impacts collectively limit the development of complex stream habitat necessary to sustain spawning and rearing throughout much of the high IP areas of the Shasta Valley.

### **Adverse Hatchery-Related Effects**

While there are no hatcheries nor does artificial propagation currently occur in the Shasta River basin, there is a fish hatchery on the Klamath River at the base of Iron Gate Dam, approximately 13 miles (21 km) upstream of the mouth of the Shasta River. Approximately 75,000 coho salmon yearlings, along with 6,000,000 fall Chinook salmon and 200,000 steelhead yearlings are released from Iron Gate Hatchery each year. These hatchery steelhead yearlings compete with out-migrating coho salmon for mainstem Klamath River habitat, and may also prey upon them. As adults, some of these hatchery coho salmon stray into the Shasta River basin when migrating back upstream, and can breed with natural origin Shasta River coho salmon. Hatchery coho salmon can simplify natural coho salmon population's genetics and decrease the productivity of natural coho salmon populations over time. On average, 16 percent of adult carcasses recovered in the Shasta River basin in 2001, 2003, and 2004 were of hatchery origin (Ackerman and Cramer 2006; note: fish carcass recruitment into interior basins is considered a natural and beneficial nutrient addition to riparian chemistry and productivity). Hatchery origin coho salmon returns to the Shasta River fish counting facility from 2007 to 2012 (Chesney and Knechtle 2013), averaged 43 percent. The impacts from such straying of hatchery coho salmon increase as naturally produced Shasta River populations decline. Therefore, adverse hatchery-related effects pose a very high stress to all life stages because hatchery origin adults generally make up greater than 30 percent of the total number of adults (Appendix B).

In January 2013, NMFS received an application from the California Department of Fish and Wildlife and PacifiCorp for a permit to enhance the propagation and survival of SONCC coho salmon. This application included a Hatchery and Genetic Management Plan (HGMP) for coho

salmon produced at the hatchery. The HGMP specifies methods for the operation of the Iron Gate Hatchery coho salmon program that are intended to reduce adverse hatchery-related genetic impacts on the natural coho salmon populations, including the Shasta River population. The HGMP shifts the coho salmon program from a mitigation program to an integrated program with natural populations and incorporates artificial propagation, monitoring, and evaluation activities, both within the hatchery and major tributary streams in the Upper Klamath River Population Unit. NMFS anticipates making a final decision on whether to issue the permit and approve the HGMP in 2014.

### **Degraded Riparian Forest Conditions**

Degraded riparian forest conditions pose a medium stress to adults, and a high stress to fry, juvenile, and smolt life stages. Stream corridor vegetation and cover is considered very good (fully functional) in the southern portion of the Shasta Valley including upper Parks Creek, Eddy Creek, and the upper tributaries of the Shasta River (Dale, Boles, Broughton and Carrick creeks) while the upper Little Shasta River has fair, partially functional stream corridor cover. However, the loss of riparian cover in other areas of the basin has left portions of the mainstem Shasta River and tributary riparian areas downstream of Dwinnell Dam exposed, degraded, and unable to sustain productive biotic communities. Riparian assessments of the Shasta River on the Nelson Ranch (Mount et al. 2008) and the Shasta Big Springs Ranch (Mount et al. 2009) indicate that highly productive riparian habitat can be sustained and restored along portions of the Shasta River watershed, but natural recruitment of woody perennials is inconsistent, due to soil chemistry, current agricultural practices, and other anthropogenic changes in land use.

### **Altered Sediment Supply**

Altered sediment supply presents a medium stress for the juvenile life stage, and a low stress for all other life stages. The Shasta Valley is geologically young and relatively stable (CH2M HILL 1985), and sediment that is delivered to the Shasta River derives from unstable sloughing stream banks, unpaved upland roads, and residential development. Alterations in sediment can simplify and fill in pool habitat, preclude the establishment and maintenance of riparian vegetation cover, cause embeddedness of gravels in spawning areas, and alter channel morphology. Since juvenile coho salmon rear for an extended period in freshwater environments, changes such as these can be detrimental to their fitness and ability to survive.

### **Barriers**

Barriers present a high stress for juvenile and smolt life stages and a medium stress for fry and adult life stages. There are two permanent dams that act as barriers in the Shasta River. Dwinnell Dam blocks about 22 percent of Shasta River anadromous fish habitat (NRC 2004). Greenhorn Dam was built in the 1950s in Greenhorn Creek, a tributary to Yreka Creek, for municipal and industrial water storage. Greenhorn Dam blocks access to upstream areas in Greenhorn Creek, blocks the movement of gravel down Yreka Creek, and alters the hydrology in Yreka Creek. Multiple diversion dams, small impoundments, one small micro-hydro installation at the entrance to the Shasta River canyon (Klamath River Basin Fisheries Task Force 1991) and road/stream crossings also cause partial or complete barriers to high IP habitat in several Shasta River basin locations. Diversion dams reduce instream flows and allow impounded water to

reach lethal temperatures during the summer, while the larger Dwinnell Dam changes channel morphology, impedes coarse sediment input, alters the hydrologic function of the mainstem Shasta River (Knechtle 2010). Diversion dams also create a pond-like environment, rich in nutrients, where algae bloom in abundance. Of the six flashboard summer irrigation dams on the mainstem Shasta River, five have been removed, locally improving the function and condition of the mainstem river. Several flashboard dams also continue to operate on the Little Shasta River.

**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.

**37.6 Threats**

Table 37-5. Severity of threats affecting each life stage of coho salmon in the Shasta River. Threat rank categories, assessment methods, and data used to assess threats are described in Appendix B.

Threats <sup>2</sup>		Egg	Fry	Juvenile <sup>1</sup>	Smolt	Adult	Overall Threat Rank
1	Agricultural Practices <sup>1</sup>	Very High	Very High	Very High <sup>1</sup>	Very High	Very High	Very High
2	Dams/Diversions <sup>1</sup>	Very High	Very High	Very High <sup>1</sup>	Very High	Very High	Very High
3	Channelization/Diking	High	High	High	High	High	High
4	Roads	High	High	High	High	High	High
5	Hatcheries	Very High	Very High	Very High	Very High	Very High	Very High
6	Climate Change	Low	Low	Medium	Medium	Medium	Medium
7	Timber Harvest	Low	Low	Low	Low	Low	Low
8	High Severity Fire	Medium	Medium	Medium	Medium	Medium	Medium
9	Mining/Gravel Extraction	Low	Low	Low	Low	Low	Low
10	Urban/Residential/Industrial Dev.	Medium	Medium	Medium	Medium	Medium	Medium
11	Road-Stream Crossing Barriers	-	Low	Low	Low	Low	Low
12	Fishing and Collecting	-	-	Low	Low	Medium	Low
<sup>1</sup> Key limiting threats and limited life stage <sup>2</sup> 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 agricultural practices and dams/diversions.

### Agricultural Practices

Current agricultural practices are a very high threat to all life stages of coho salmon. Many sub-basins of the Shasta Valley have pasture/hay and cultivated crops, which together account for more than 10 percent of the land area. Agricultural areas adjacent to coho salmon habitat occur along the mainstem Shasta River downstream from Dwinnell Dam to the Shasta River canyon entrance, the Little Shasta River, Parks Creek, Yreka Creek, and Big Springs Creek. Excessive fine sediment, low flows, and warm-water inputs damage spawning and rearing habitat and hinder migration. Erosion from agricultural practices can contribute fine sediment to the river. Livestock along the Shasta River can compound these problems by damaging stream banks and riparian vegetation, and by adding nutrients to the stream, thereby reducing dissolved oxygen levels. Beyond these basin-wide impacts, there is considerable risk of trampling of redds in the upper portions of the Shasta Valley (Parks Creek and the upper Shasta River), where areas suitable for salmon spawning are also frequently preferred by livestock for crossings and in-channel grazing. Livestock exclusion fencing now precludes these impacts in most of the Shasta Valley, with remaining unfenced reaches located along both the upper Shasta River near Dwinnell Dam and upper Parks Creek.

Water diversions and warm irrigation tailwater returns in scarce cool-water areas severely limits habitat values in critical refuge spawning and rearing areas. Even in areas where water temperatures are generally good, intermittent pulses of warm tailwater can overwhelm available cold water, forcing fish to relocate or killing them outright. The Shasta Valley RCD's Agricultural Water and Tailwater Management Program is improving on-farm management, beginning in high priority areas in the Big Springs Complex, including river miles 32 to 38 of the Shasta River and river mile 4 to 6 of Parks Creek, to reduce tailwater creation and to implement projects that contain, store, cool, and reuse agricultural tailwater.

The onset of the irrigation season in the Shasta River watershed has a dramatic impact on instream flows when large numbers of irrigators begin taking water simultaneously. This results in a rapid decrease in flows below the diversions, stranding coho salmon as channel margin and side channel habitat disappears (CDFG 1997a). Low stream flows can limit access to rearing areas and decrease rearing habitat for juvenile coho salmon. Diversion of surface water has limited the quantity of cold water from the spring complexes within the basin, causing water temperatures to rise above the lethal level of the 25.6 °C for salmon (Carter 2005). Low dissolved oxygen levels also occur along the Shasta River, adversely affecting salmonids. Though much diminished since 1991, livestock access to the Shasta River contributes to these problems, by damaging stream banks and riparian vegetation that provide shade and cover, and by also adding excessive nutrients to the stream, contributing further to reduced dissolved oxygen levels. Warm, nutrient-rich tailwater entering cool-water reaches of the Shasta River severely degrade habitat quality in adjacent spawning and rearing areas that are already scarce.

## Dams/Diversions

Dams, diversions, and associated reductions in water availability downstream, as well as the timing of that availability, are a very high threat to all life stages of coho salmon. In 1926, the Shasta River was dammed at river mile 37 to form Dwinnell Reservoir (Lake Shastina). Dwinnell Dam blocks about 22 percent of salmon habitat in the Shasta River basin (NRC 2004), though the condition of this habitat in 1926 was not documented. In 1955, the capacity of the dam was increased, bringing the total storage capacity to 50,000 acre-feet. For decades, there were no or minimal instream flow releases (i.e., for priority water right holders downstream of Dwinnell Dam) from Dwinnell Dam, which further diminished Shasta River flows during the summer irrigation season. In December 2013, the MWCD agreed to settle a lawsuit that would result in 2,250 to 11,000 acre-feet of water released from Dwinnell Dam for fisheries benefits each year. During the winter, Lake Shastina's capture of peak winter flows significantly reduces the ability of the Shasta River to flush fine sediment from spawning gravels and recruit spawning gravel, and changes the hydrology downstream. However, Dwinnell Dam's presence does appear to influence neighboring groundwater and related springs that provide cold over-summering habitat for juvenile coho salmon and other salmonids. The Dwinnell Dam infrastructure is also used by MWCD in collaboration with fishery managers to provide pulse flows that assist juvenile salmon to either relocate to better rearing habitat or to out migrate towards the Pacific Ocean.

In addition to Dwinnell Dam, another permanent dam was placed in Greenhorn Creek, a tributary to Yreka Creek, in the 1950s for municipal and industrial water storage. Greenhorn Dam blocks access to upstream areas in Greenhorn Creek, blocks the movement of gravel down Yreka Creek, and alters the Yreka Creek hydrograph. The City of Yreka does not routinely release water from this reservoir during the summer, and such releases could help maintain sufficient flow in Yreka Creek for coho salmon holding and rearing there.

Irrigation diversions block stream channels, reduce flows and often create riverine impoundments. These impoundments warm water to lethal temperatures during the summer, become rich in nutrients, and foster algae blooms. Additionally, if not screened, irrigation diversions can trap fish and create passage problems for juveniles looking for refugia. Diverted irrigation water becomes warmed and nutrient rich before it drains back into the river as tailwater. Pervasive diversion of irrigation water results in diminished peak flows that historically inundated the valley and expanded juvenile rearing habitat. One flashboard diversion dam remains on the Shasta River, and continues to create passage problems for juvenile and smolt coho salmon. There is also several smaller diversion dams listed in the California Fish Passage Assessment Database (CalFish 2009), most of which are seasonal barriers located in high IP areas. Dams and diversions which pose significant barriers to fish passage, including upstream juvenile migration, are listed in Table 37-6.

Other barriers associated with small water diversion have been observed in lower Parks Creek, an area with several small, cold water springs that are critically important for the survival of juvenile coho salmon. Adult radio tagging information since 2004 confirms that many coho salmon tracked in the upper Shasta River ultimately spawned in lower Parks Creek (CDFG 2008b), the southwest portion of the Big Springs Complex.

Table 37-6. List of dams/diversion barriers in the Shasta River basin (Elfgen 2013).

IP priority	Stream Name	Dam/Diversion Name	Miles of habitat blocked habitat (partial* or full)
1	Shasta River	Dwinnell Dam (Shasta River Dam & diversion)	26
1	Yreka Creek	Greenhorn Dam	4
1	Shasta River	Novy/Rice Dam	28*
1	Parks Creek	Cardoza Diversion Dam	9*
2	Shasta River	USGS gage near Montague, CA	31*
2	Little Shasta River	Hart Diversion Dam	4*
2	Little Shasta River	Blair Smith / Musgrave Dam (diversion)	3*

### Channelization/Diking

Channelization and diking pose a high threat to all life stages of coho salmon, and occur primarily along many reaches of Parks Creek, Willow Creek, the Little Shasta River, and the urban reach of Yreka Creek. Channelization and diking of rivers and streams has been shown to decrease the quantity and quality of winter rearing habitat by eliminating the availability of low flow energy, off channel habitats: habitat which is already lacking in the Shasta River basin. This channel alteration has resulted in the conversion of beaver-occupied wetlands to drained agricultural lands. In contrast, natural channel form and floodplain connectivity remain good (fully functional) in portions of the upper Shasta River and its tributaries.

### Roads

Roads are a high threat to all life stages of coho salmon in the Shasta River population. Road density is very high (>3 miles of roads/sq. mile) in the following tributary sub-basins, where high IP reaches predominate: upper Shasta River, upper Little Shasta River, Yreka Creek; and upstream of Dwinnell Dam/Reservoir in Boles Creek. Road density is high (2.5 to 3.0 miles of roads/sq. mile) in Eddy Creek, upper Parks Creek, Willow Creek, upper Juniper Creek; and upstream of Dwinnell Dam/Reservoir in Carrick Creek. Mobilization of sediments from roads and road related erosion sources upstream of Dwinnell Dam are currently captured in the reservoir. Road density improves downstream and is considered a medium to low threat throughout most of the Shasta Valley. Erosion potential from unmaintained roads is greatest in the upper portions of sub-basins where heavy rain, and rain on snow occur in areas containing roads from past timber harvest activities. The associated increases in fine sediment from these conditions have been shown to suffocate redds, degrade pool quality, and decrease pool depth (Newcombe and Jensen 1996, Suttle et al 2004). Residential development in the Shasta Valley, and the increasing number of un-engineered private roads mobilize sediment to stream channels, thereby further increasing impacts to juvenile coho salmon rearing in adjacent streams.

### Hatcheries

Hatcheries pose a very high threat to all life stages. The rationale for these ratings is described under the “Adverse Hatchery-Related Effects” stress.

## **Climate Change**

Climate change poses an overall medium 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 temperature shows a large increase over the next 50 to 100 years (see Appendix B for modeling methods). Average temperature could increase by up to 3° C in the summer and by 1.3° C in the winter. Annual precipitation in the Shasta Valley is already less than 20 inches, and is likely to trend downward over the same time period. Snowpack in upper elevations of the basin will decrease with changes in temperature and precipitation (Howat et al. 2007, California Natural Resources Agency 2009). Changes will impact water yield of natural springs, which is one of the most important components of the hydrologic regime of the Shasta River, and this will impact summer rearing habitat. The vulnerability of the Klamath estuary to sea level rise is low to moderate and therefore does not pose a significant threat to estuarine rearing habitat downstream. Juvenile and smolt rearing and migratory habitat in the Shasta River and Klamath mainstem is most at risk to climate change. Increasing temperatures and changes in the amount and timing of precipitation and snowmelt will impact water quality and hydrologic function in the summer and winter. Overall, the range and degree of variability in temperature and precipitation are likely to increase. 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). Sustained monitoring of ocean conditions will be needed to detect possible correlation(s) with future trends in Klamath Basin salmonid population survival and productivity (see Chapter 3).

## **Timber Harvest**

The volume of timber harvested on national forest land diminished in the early 1990s, and has remained low since the implementation of the Klamath National Forest and Shasta Trinity National Forest Land and Resource Management Plan in 1994 (USFS 1994b). General Forest Management Areas available for timber harvest in the Shasta River basin are small and are confined to the western slopes of the Cascade Range, and portions of upper Parks and Eddy Creeks west of Weed, California. Small scale projects involving understory fuels reduction, hazard tree removal, and small commercial thinning projects are expected to continue at current rates into the future. The Shasta Trinity National Forest has identified the Parks and Eddy Creek watersheds as priorities for restoration (see: [Shasta-Trinity National Forest 2013](#)).

## **High Severity Fire**

High severity fire, and the riparian habitat destruction and surface erosion it causes, is a medium threat to all life stages of coho salmon. Because of past timber harvest practices and fire-suppression efforts over the past century, understory forest fuel loads have become excessive and have severely altered the fire regime in the region. High severity fires result from these excessive forest fuel loads and could occur in the uplands of the Shasta River watershed, creating erosion/sedimentation problems, large areas of bare, unstable soil, and degrading riparian vegetation along stream banks. In addition, fire suppression activities could lead to impacts to coho salmon from misapplication of fire retardant, increased water withdrawals in summer

months, and mobilization of sediment through the creation of fire lines and other fire prevention methods.

### **Mining/Gravel Extraction**

Mining and gravel extraction are low threats to all life stages of coho salmon. Currently, neither gold nor gravel mining commonly occur in the Shasta River basin, and are not expected to change in the near future. The legacy impacts of historic gold mining along Yreka Creek and the lower seven miles of the Shasta River continue to degrade habitat, through alterations in floodplain connectivity, changes in channel morphology, and continuing impacts from the historic removal of gravel. Gravel recruitment has been reduced in the Shasta River downstream from Dwinnell Dam and in the depositional portions of many tributaries. Tailing piles and fill occupy large historic floodplains along Yreka and Greenhorn creeks, where riparian areas remain poorly vegetated and erodible (Shasta Valley Resource Conservation District 2005). Associated legacy effects are sometimes long lasting and need to be addressed to decrease the threat to Shasta River coho salmon. A spawning gravel evaluation and enhancement plan for the Shasta River has been completed by McBain and Trush (2010), and can be used to inform and prioritize spawning gravel enhancement efforts in the basin.

### **Urban/Residential/Industrial Development**

Urban, residential, and industrial development is a medium threat to all life stages. Within the Shasta Valley, modest densities of residences and urban development are located near Yreka, Weed, Montague, Little Shasta, Big Springs, Grenada, and Gazelle. Overall, this threat is not expected to change in the foreseeable future, as population growth is currently stable in this area.

### **Road-Stream Crossing Barriers**

Road related barriers are a low threat to all juvenile and adult life stages of coho salmon. Readily available information from CalFish (2009) and Five Counties Salmonid Conservation Program (2008) indicate road/stream crossings that require further evaluation for improved fish passage.

### **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.

## **37.7 Recovery Strategy**

Coho salmon in the Shasta River are depressed in abundance with a restricted distribution. Recovery activities in the watershed should continue to promote increased spatial distribution as well as increased productivity and abundance. Activities should occur throughout the watershed, with a focus on mainstem and tributary reaches with high IP values. Recovery actions that reduce stream temperatures, increase dissolved oxygen concentrations, and achieve sufficient instream flow targets through the summer should be a priority in the watershed. Addressing the limiting factor of inadequate summer rearing habitat for juveniles should be a top priority, and

multi-faceted, long term solutions should be sought. Winter rearing and spawning habitat improvement is also a priority, and should include beaver/beaver habitat enhancement, large/complex woody debris recruitment, and spawning substrate enhancement. Additionally, collaborative efforts with interested parties and stakeholders, working to restore mainstem and estuary conditions in the Klamath River, must expand, to assure that the Shasta River coho salmon population has the necessary habitat requirements for all freshwater life stages. The effects of fishing on this population's ability to meet its viability criteria should be evaluated.

## Shasta River Population

Table 37-7. Recovery action implementation schedule for the Shasta 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
<i>Step ID</i>	<i>Step Description</i>					
SONCC-ShaR.3.1.1	Hydrology	Yes	Improve flow timing or volume	Increase instream flows	Population wide, including upstream from Dwinnell Dam	1
<i>SONCC-ShaR.3.1.1.1</i>	<i>Identify, map, and quantify all surface water diversions</i>					
<i>SONCC-ShaR.3.1.1.2</i>	<i>Assess water diversions, prioritize, and adjust management to benefit life history requirements of coho, attaining at least a 55 cfs target summer base flow, or baseflow sufficient for recovery of all affected life stages of coho salmon, at the DWR Montague water gage</i>					
<i>SONCC-ShaR.3.1.1.3</i>	<i>Secure dedicated unused water diversion rights</i>					
<i>SONCC-ShaR.3.1.1.4</i>	<i>Verify permitted water diversions</i>					
<i>SONCC-ShaR.3.1.1.5</i>	<i>Establish a water trust to sustain and re-establish flow connectivity</i>					
<i>SONCC-ShaR.3.1.1.6</i>	<i>Use real time flow, precipitation, snowpack, groundwater, and climate information to guide Water Trust work to augment surface flows at priority locations for coho, via water leases and dedications</i>					
SONCC-ShaR.10.1.18	Water Quality	Yes	Reduce water temperature, increase dissolved oxygen	Increase cold water	Big Springs Lake Dam, Parks Creek, Kettle Springs, Bridge Field Springs Complex, Little Shasta River, and the upper Shasta River	1
<i>SONCC-ShaR.10.1.18.1</i>	<i>Evaluate quantity and quality of refugia habitat</i>					
<i>SONCC-ShaR.10.1.18.2</i>	<i>Conduct water rights assessment at spring complexes</i>					
<i>SONCC-ShaR.10.1.18.3</i>	<i>Dedicate cold water</i>					
SONCC-ShaR.10.1.19	Water Quality	Yes	Reduce water temperature, increase dissolved oxygen	Increase cold water	Dwinnell Dam, mainstem Shasta River and its downstream tributaries and springs, and upstream from Dwinnell Dam	1
<i>SONCC-ShaR.10.1.19.1</i>	<i>Investigate feasibility of changing drawdown location on Dwinnell Dam to maximize cold water and dissolved oxygen</i>					
<i>SONCC-ShaR.10.1.19.2</i>	<i>Investigate alternative sources of cold water (e.g., springs) for instream flow dedication, evaluate feasibility, and then dedicate cold water to provide instream flow benefits, guided by evaluation</i>					

## Shasta River Population

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
<i>Step ID</i>	<i>Step Description</i>					
SONCC-ShaR.10.1.16	Water Quality	Yes	Reduce water temperature, increase dissolved oxygen	Increase flow	Population wide, especially Big Springs Lake, Parks Creek, Kettle Springs, Bridge Field Springs Complex, and the upper Shasta River	1
<i>SONCC-ShaR.10.1.16.1</i>	<i>Conduct flow studies at key sites in priority watersheds to determine necessary minimum instream flows that will ensure survival and recovery of all relevant coho salmon life stages</i>					
<i>SONCC-ShaR.10.1.16.2</i>	<i>Implement plan to increase minimum instream flows in priority watersheds, using flow study information to guide priority flow augmentation projects</i>					
SONCC-ShaR.1.2.48	Estuary	No	Improve estuarine habitat	Improve estuary condition	Klamath River Estuary	1
<i>SONCC-ShaR.1.2.48.1</i>	<i>Implement recovery actions for Lower Klamath River population that address the target "Estuary", including the creation/restoration of off-channel rearing habitat throughout the lower Klamath River</i>					
SONCC-ShaR.30.1.70	Disease, Predation, No Competition		Reduce disease	Disrupt the disease cycle between salmon, myxospore, polychaetes, and actinospore stages.	Population wide	1
<i>SONCC-ShaR.30.1.70.1</i>	<i>Assess all means possible to disrupt disease cycle and develop a plan to do so</i>					
<i>SONCC-ShaR.30.1.70.2</i>	<i>Disrupt the disease cycle, guided by assessment results</i>					
SONCC-ShaR.12.1.22	Agricultural Practices	Yes	Improve agricultural practices	Improve grazing practices	All areas where coho salmon would benefit immediately	2a
<i>SONCC-ShaR.12.1.22.1</i>	<i>Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement</i>					
<i>SONCC-ShaR.12.1.22.2</i>	<i>Develop grazing management plans to improve water quality and coho salmon habitat</i>					
<i>SONCC-ShaR.12.1.22.3</i>	<i>Plant vegetation to stabilize stream bank</i>					
<i>SONCC-ShaR.12.1.22.4</i>	<i>Maintain fencing or fence livestock out of riparian zones</i>					
<i>SONCC-ShaR.12.1.22.5</i>	<i>Remove livestock watering sources away from riparian areas, including springs</i>					
SONCC-ShaR.12.1.74	Agricultural Practices	Yes	Improve agricultural practices	Improve grazing practices	Population wide	2b
<i>SONCC-ShaR.12.1.74.1</i>	<i>Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement</i>					
<i>SONCC-ShaR.12.1.74.2</i>	<i>Develop grazing management plans to improve water quality and coho salmon habitat</i>					
<i>SONCC-ShaR.12.1.74.3</i>	<i>Plant vegetation to stabilize stream bank</i>					
<i>SONCC-ShaR.12.1.74.4</i>	<i>Maintain fencing or fence livestock out of riparian zones</i>					
<i>SONCC-ShaR.12.1.74.5</i>	<i>Remove livestock watering sources away from riparian areas, including springs</i>					

## Shasta River Population

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
<i>Step ID</i>	<i>Step Description</i>					
SONCC-ShaR.3.1.4	Hydrology	Yes	Improve flow timing or volume	Increase instream flows	GID Ditch diversion, Dwinnell Dam diversion	2a
<i>SONCC-ShaR.3.1.4.1</i>	<i>Reduce impacts to coho salmon from the GID ditch diversion</i>					
<i>SONCC-ShaR.3.1.4.2</i>	<i>Assess the effects of relocating or redesigning the diversion point to Dwinnell Dam Reservoir to decrease the impacts to coho salmon</i>					
<i>SONCC-ShaR.3.1.4.3</i>	<i>Relocate or redesign the diversion structure to Dwinnell Dam Reservoir guided by assessment results</i>					
<i>SONCC-ShaR.3.1.4.4</i>	<i>Improve infrastructure at the Parks Creek "cross canal" diversion, to both increase bypass flows for downstream fishes and to eliminate fish impingement/entrainment</i>					
SONCC-ShaR.10.1.20	Water Quality	Yes	Reduce water temperature, increase dissolved oxygen	Reduce warm water inputs	Bridge Field Springs Complex, Kettle Springs, Upper Shasta River, and Parks Creek	2a
<i>SONCC-ShaR.10.1.20.1</i>	<i>Develop a program that identifies, designs, and constructs projects that will reduce warm tailwater input to streams</i>					
<i>SONCC-ShaR.10.1.20.2</i>	<i>Implement tailwater reduction program</i>					
SONCC-ShaR.3.1.66	Hydrology	No	Improve flow timing or volume	Increase instream flows	All areas where coho salmon would benefit immediately	2a
<i>SONCC-ShaR.3.1.66.1</i>	<i>Identify and cease unauthorized water diversions</i>					
SONCC-ShaR.3.1.68	Hydrology	No	Improve flow timing or volume	Increase instream flows	All areas where coho salmon would benefit immediately	2a
<i>SONCC-ShaR.3.1.68.1</i>	<i>Identify diversions in tributaries that have subsurface or low flow barrier conditions during the summer</i>					
<i>SONCC-ShaR.3.1.68.2</i>	<i>Reduce diversions using a combination of incentives and enforcement measures</i>					
SONCC-ShaR.3.1.80	Hydrology	No	Improve flow timing or volume	Increase instream flows	Population wide	2b
<i>SONCC-ShaR.3.1.80.1</i>	<i>Identify and cease unauthorized water diversions</i>					
SONCC-ShaR.3.1.81	Hydrology	No	Improve flow timing or volume	Increase instream flows	Population wide	2b
<i>SONCC-ShaR.3.1.81.1</i>	<i>Identify diversions in tributaries that have subsurface or low flow barrier conditions during the summer</i>					
<i>SONCC-ShaR.3.1.81.2</i>	<i>Reduce diversions using a combination of incentives and enforcement measures</i>					
SONCC-ShaR.3.1.69	Hydrology	No	Improve flow timing or volume	Provide adequate instream flow for coho salmon	Population wide	2a
<i>SONCC-ShaR.3.1.69.1</i>	<i>Conduct study to determine instream flow needs of coho salmon at all life stages.</i>					
<i>SONCC-ShaR.3.1.69.2</i>	<i>If coho salmon instream flow needs are not being met, develop plan to provide adequate flows. Plan may include water conservation incentives for landowners and re-assessment of water allocation.</i>					
<i>SONCC-ShaR.3.1.69.3</i>	<i>Implement coho salmon instream flow needs plan.</i>					

## Shasta River Population

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
<i>Step ID</i>	<i>Step Description</i>					
SONCC-ShaR.3.1.6	Hydrology	Yes	Improve flow timing or volume	Improve irrigation practices	All areas where coho salmon would benefit immediately	2b
<i>SONCC-ShaR.3.1.6.1</i>	<i>Apply a variety of techniques (e.g., Farm Irrigation Rating Index Model) to make irrigation system water use efficiency comparisons, and implement efficiency improvements</i>					
<i>SONCC-ShaR.3.1.6.2</i>	<i>Implement improved irrigation techniques and monitor associated flow and water quality enhancements</i>					
<i>SONCC-ShaR.3.1.6.3</i>	<i>Design an irrigation schedule to maximize cold water influence/extension from Clear Springs and other cold water sources</i>					
SONCC-ShaR.3.1.79	Hydrology	Yes	Improve flow timing or volume	Improve irrigation practices	Population wide	2c
<i>SONCC-ShaR.3.1.79.1</i>	<i>Apply a variety of techniques (e.g., Farm Irrigation Rating Index Model) to make irrigation system water use efficiency comparisons, and implement efficiency improvements</i>					
<i>SONCC-ShaR.3.1.79.2</i>	<i>Implement improved irrigation techniques and monitor associated flow and water quality enhancements</i>					
<i>SONCC-ShaR.3.1.79.3</i>	<i>Design an irrigation schedule to maximize cold water influence/extension from Clear Springs and other cold water sources</i>					
SONCC-ShaR.3.1.5	Hydrology	Yes	Improve flow timing or volume	Improve water management techniques	All areas where coho salmon would benefit immediately	2b
<i>SONCC-ShaR.3.1.5.1</i>	<i>Develop integrated water management plan and water budget, including groundwater surface flow dynamics, and drought year emergency contingencies</i>					
<i>SONCC-ShaR.3.1.5.2</i>	<i>Improve water use efficiency through the investigation and implementation of alternative agricultural crops and practices (e.g., grass fed beef, winter wheat, alternative pasture crops)</i>					
<i>SONCC-ShaR.3.1.5.3</i>	<i>Upgrade and expand alternative off-channel stock watering systems to increase instream flows</i>					
<i>SONCC-ShaR.3.1.5.4</i>	<i>Develop and disseminate an on-farm water use efficiency monitoring system</i>					
<i>SONCC-ShaR.3.1.5.5</i>	<i>If current water use/management is determined to be inconsistent with coho salmon recovery, modify management accordingly</i>					
SONCC-ShaR.3.1.78	Hydrology	Yes	Improve flow timing or volume	Improve water management techniques	Population wide	2c
<i>SONCC-ShaR.3.1.78.1</i>	<i>Develop integrated water management plan and water budget, including groundwater surface flow dynamics, and drought year emergency contingencies</i>					
<i>SONCC-ShaR.3.1.78.2</i>	<i>Improve water use efficiency through the investigation and implementation of alternative agricultural crops and practices (e.g., grass fed beef, winter wheat, alternative pasture crops)</i>					
<i>SONCC-ShaR.3.1.78.3</i>	<i>Upgrade and expand alternative off-channel stock watering systems to increase instream flows</i>					
<i>SONCC-ShaR.3.1.78.4</i>	<i>Develop and disseminate an on-farm water use efficiency monitoring system</i>					
<i>SONCC-ShaR.3.1.78.5</i>	<i>If current water use/management is determined to be inconsistent with coho salmon recovery, modify management accordingly</i>					
SONCC-ShaR.3.1.7	Hydrology	Yes	Improve flow timing or volume	Increase instream flows	Yreka Creek, Little Shasta River, Parks Creek, upstream from Dwinell Dam, and all streams where coho salmon would benefit immediately	2b
<i>SONCC-ShaR.3.1.7.1</i>	<i>Develop plans to detain stormwater runoff, increase infiltration, enhance floodplains, and deliver sub-surface flows</i>					
<i>SONCC-ShaR.3.1.7.2</i>	<i>Implement plans that increase groundwater recharge and connectivity</i>					

## Shasta River Population

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
<i>Step ID</i>	<i>Step Description</i>					
SONCC-ShaR.3.1.82	Hydrology	Yes	Improve flow timing or volume	Increase instream flows	Population wide	2c
<i>SONCC-ShaR.3.1.82.1</i> <i>SONCC-ShaR.3.1.82.2</i>	<i>Develop plans to detain stormwater runoff, increase infiltration, enhance floodplains, and deliver sub-surface flows</i> <i>Implement plans that increase groundwater recharge and connectivity</i>					
SONCC-ShaR.10.1.12	Water Quality	Yes	Reduce water temperature, increase dissolved oxygen	Improve quality of water released from Dwinnell Reservoir	Dwinnell Dam and vicinity	2b
<i>SONCC-ShaR.10.1.12.1</i> <i>SONCC-ShaR.10.1.12.2</i>	<i>Develop plan that includes range of alternatives to improve quality of water released from Dwinnell Reservoir to upper Shasta River</i> <i>Implement water quality improvement plan</i>					
SONCC-ShaR.5.1.13	Passage	No	Improve access	Reduce sediment barriers	Kettle Springs and Bridgefield Springs Complex, and all areas where coho salmon would benefit immediately	2b
<i>SONCC-ShaR.5.1.13.1</i> <i>SONCC-ShaR.5.1.13.2</i>	<i>Inventory and prioritize barriers formed by alluvial deposits</i> <i>Remove alluvial deposits, construct low flow channels, or reduce stream gradient to provide fish passage at all life stages</i>					
SONCC-ShaR.5.1.83	Passage	No	Improve access	Reduce sediment barriers	Population wide	2d
<i>SONCC-ShaR.5.1.83.1</i> <i>SONCC-ShaR.5.1.83.2</i>	<i>Inventory and prioritize barriers formed by alluvial deposits</i> <i>Remove alluvial deposits, construct low flow channels, or reduce stream gradient to provide fish passage at all life stages</i>					
SONCC-ShaR.5.1.15	Passage	No	Improve access	Remove barriers	Greenhorn Dam, Cardoza Diversion, mainstem Shasta River, Big Springs Water Wheel, and all streams where coho salmon would benefit immediately	2b
<i>SONCC-ShaR.5.1.15.1</i> <i>SONCC-ShaR.5.1.15.2</i>	<i>Identify and prioritize all barriers and diversions, and develop a plan to provide short- and long-term passage which may include use of artificial passage designs</i> <i>Provide passage for all life stages, guided by plan</i>					
SONCC-ShaR.5.1.85	Passage	No	Improve access	Remove barriers	Population wide	2d
<i>SONCC-ShaR.5.1.85.1</i> <i>SONCC-ShaR.5.1.85.2</i>	<i>Identify and prioritize all barriers and diversions, and develop a plan to provide short- and long-term passage which may include use of artificial passage designs</i> <i>Provide passage for all life stages, guided by plan</i>					

## Shasta River Population

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
<i>Step ID</i>	<i>Step Description</i>					
SONCC-ShaR.7.1.23	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve protection and shading of spring complexes	All areas where coho salmon would benefit immediately	2b
<i>SONCC-ShaR.7.1.23.1</i>	<i>Identify and prioritize locations for planting and thinning</i>					
SONCC-ShaR.7.1.86	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve protection and shading of spring complexes	Population wide	2d
<i>SONCC-ShaR.7.1.86.1</i>	<i>Identify and prioritize locations for planting and thinning</i>					
SONCC-ShaR.7.1.24	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Population wide, unvegetated areas	2b
<i>SONCC-ShaR.7.1.24.1</i> <i>SONCC-ShaR.7.1.24.2</i>	<i>Plant riparian vegetation to increase shade/cover and habitat complexity, guided by the plan Thin, or release conifers, guided by the plan</i>					
SONCC-ShaR.26.1.25	Low Population Dynamics	No	Increase population abundance	Implement an enhancement program	Population wide	2b
<i>SONCC-ShaR.26.1.25.1</i>	<i>Assess impacts and benefits associated with different enhancement programs such as captive broodstock, rescue rearing, supplementation, and conservation hatcheries</i>					
<i>SONCC-ShaR.26.1.25.2</i>	<i>Obtain a permit and develop a facility to rear fish</i>					
<i>SONCC-ShaR.26.1.25.3</i>	<i>Operate enhancement program as a temporary strategy to increase population abundance</i>					
<i>SONCC-ShaR.26.1.25.4</i>	<i>Monitor fish populations at all life stages including juvenile snorkel counts, downstream migrant counts, spawning surveys, and Passive Integrated Transponder (PIT) tagging</i>					
SONCC-ShaR.26.1.67	Low Population Dynamics	No	Increase population abundance	Rescue and relocate stranded juveniles	Population wide	2b
<i>SONCC-ShaR.26.1.67.1</i>	<i>Survey coho-bearing tributaries and relocate juveniles stranded in drying pools</i>					
SONCC-ShaR.8.2.29	Sediment	No	Increase spawning gravel	Enhance spawning substrate	Downstream of Dwinell Dam, Parks Creek, and other tributary drainages where coho salmon would benefit immediately	2b
<i>SONCC-ShaR.8.2.29.1</i> <i>SONCC-ShaR.8.2.29.2</i>	<i>Review the McBain and Trush (2010) spawning gravel plan that identifies quantity, quality, location, and timing of gravel supplements Supplement gravel, guided by the McBain and Trush (2010) spawning gravel plan for the Shasta River</i>					

Shasta River Population

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
<i>Step ID</i>	<i>Step Description</i>					
SONCC-ShaR.8.2.89	Sediment	No	Increase spawning gravel	Enhance spawning substrate	Population wide	2d
<i>SONCC-ShaR.8.2.89.1</i> <i>SONCC-ShaR.8.2.89.2</i>	<i>Review the McBain and Trush (2010) spawning gravel plan that identifies quantity, quality, location, and timing of gravel supplements</i> <i>Supplement gravel, guided by the McBain and Trush (2010) spawning gravel plan for the Shasta River</i>					
SONCC-ShaR.2.2.27	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Construct off channel habitats, alcoves, backwater habitat, and old stream oxbows	All areas where coho salmon would benefit immediately, including upstream from Dwinnell Dam	2b
<i>SONCC-ShaR.2.2.27.1</i> <i>SONCC-ShaR.2.2.27.2</i>	<i>Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat</i> <i>Implement restoration projects that improve off channel habitats to create refugia habitat, as guided by assessment results</i>					
SONCC-ShaR.2.2.75	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Construct off channel habitats, alcoves, backwater habitat, and old stream oxbows	Population wide	2d
<i>SONCC-ShaR.2.2.75.1</i> <i>SONCC-ShaR.2.2.75.2</i>	<i>Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat</i> <i>Implement restoration projects that improve off channel habitats to create refugia habitat, as guided by assessment results</i>					
SONCC-ShaR.2.2.46	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Increase beaver abundance	All areas where coho salmon would benefit immediately, including upstream from Dwinnell Dam	2b
<i>SONCC-ShaR.2.2.46.1</i> <i>SONCC-ShaR.2.2.46.2</i> <i>SONCC-ShaR.2.2.46.3</i>	<i>Develop a beaver conservation plan that includes education and outreach, technical assistance for land owners, and methods for reintroduction and/or relocation of beaver as a last resort</i> <i>Implement education and technical assistance programs for landowners, guided by the plan</i> <i>Reintroduce or relocate beaver if appropriate, guided by the plan</i>					
SONCC-ShaR.2.2.77	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Increase beaver abundance	Population wide	2d
<i>SONCC-ShaR.2.2.77.1</i> <i>SONCC-ShaR.2.2.77.2</i> <i>SONCC-ShaR.2.2.77.3</i>	<i>Develop a beaver conservation plan that includes education and outreach, technical assistance for land owners, and methods for reintroduction and/or relocation of beaver as a last resort</i> <i>Implement education and technical assistance programs for landowners, guided by the plan</i> <i>Reintroduce or relocate beaver if appropriate, guided by the plan</i>					
SONCC-ShaR.2.2.28	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Restore natural channel form and function	All areas where coho salmon would benefit immediately	2b
<i>SONCC-ShaR.2.2.28.1</i> <i>SONCC-ShaR.2.2.28.2</i>	<i>Identify and prioritize mining reaches, developing a plan to restore the floodplain and channel by removing tailing piles and reconstructing the channel</i> <i>Remove tailing piles and reconstruct the channel, guided by the restoration plan</i>					

## Shasta River Population

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
<i>Step ID</i>	<i>Step Description</i>					
SONCC-ShaR.2.2.76	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Restore natural channel form and function	Population wide	2d
<i>SONCC-ShaR.2.2.76.1</i> <i>SONCC-ShaR.2.2.76.2</i>	<i>Identify and prioritize mining reaches, developing a plan to restore the floodplain and channel by removing tailing piles and reconstructing the channel</i> <i>Remove tailing piles and reconstruct the channel, guided by the restoration plan</i>					
SONCC-ShaR.30.1.71	Disease, Predation, No Competition		Reduce disease	Conduct monitoring and research actions as described in the Klamath River Fish Disease Research Plan	Population wide	2b
<i>SONCC-ShaR.30.1.71.1</i> <i>SONCC-ShaR.30.1.71.2</i>	<i>Develop monitoring plan and research actions as described in the Klamath River Fish Disease Research Plan</i> <i>Implement Klamath River Fish Disease Research Plan</i>					
SONCC-ShaR.3.1.8	Hydrology	Yes	Improve flow timing or volume	Educate stakeholders	Population wide	2d
<i>SONCC-ShaR.3.1.8.1</i>	<i>Develop an educational program addressing water conservation programs, instream leasing and water dedication programs, and water diversion/screen hardware maintenance extension support information</i>					
SONCC-ShaR.3.1.3	Hydrology	Yes	Improve flow timing or volume	Manage flow	Population wide	2d
<i>SONCC-ShaR.3.1.3.1</i>	<i>Continue watermaster program to ensure water is allocated according to established water rights</i>					
SONCC-ShaR.3.1.2	Hydrology	Yes	Improve flow timing or volume	Monitor flow for compliance	Population wide	2d
<i>SONCC-ShaR.3.1.2.1</i> <i>SONCC-ShaR.3.1.2.2</i> <i>SONCC-ShaR.3.1.2.3</i>	<i>Install flow measuring devices</i> <i>Maintain all flow measuring devices</i> <i>Install head gates and NMFS compliant fish exclusion screens on all water diversions in coho salmon habitat</i>					
SONCC-ShaR.26.1.26	Low Population Dynamics	No	Increase population abundance	Reduce take of coho salmon	Population wide	2d
<i>SONCC-ShaR.26.1.26.1</i> <i>SONCC-ShaR.26.1.26.2</i>	<i>Develop programs providing incidental take coverage for specified, legal agricultural activities, while simultaneously aiding SONCC coho salmon recovery</i> <i>Implement programs providing incidental take coverage for specified, legal agricultural activities, while simultaneously aiding SONCC coho salmon</i>					
SONCC-ShaR.10.2.21	Water Quality	Yes	Reduce pollutants	Set standard	Population wide	3b
<i>SONCC-ShaR.10.2.21.1</i>	<i>Continue implementation of TMDLs for water bodies listed under Clean Water Act Section 303(d)</i>					

Shasta River Population

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
<i>Step ID</i>	<i>Step Description</i>					
SONCC-ShaR.8.1.31	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	All areas where coho salmon would benefit immediately, including both upslope and valley floor roads	3b
<i>SONCC-ShaR.8.1.31.1</i>	<i>Assess and prioritize road-stream connection, and identify appropriate treatments</i>					
<i>SONCC-ShaR.8.1.31.2</i>	<i>Decommission roads, guided by assessment</i>					
<i>SONCC-ShaR.8.1.31.3</i>	<i>Upgrade roads, guided by assessment</i>					
<i>SONCC-ShaR.8.1.31.4</i>	<i>Maintain roads, guided by assessment</i>					
SONCC-ShaR.8.1.88	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	3d
<i>SONCC-ShaR.8.1.88.1</i>	<i>Assess and prioritize road-stream connection, and identify appropriate treatments</i>					
<i>SONCC-ShaR.8.1.88.2</i>	<i>Decommission roads, guided by assessment</i>					
<i>SONCC-ShaR.8.1.88.3</i>	<i>Upgrade roads, guided by assessment</i>					
<i>SONCC-ShaR.8.1.88.4</i>	<i>Maintain roads, guided by assessment</i>					
SONCC-ShaR.10.2.51	Water Quality	Yes	Reduce pollutants	Reduce pesticides	All areas where coho salmon would benefit immediately	3c
<i>SONCC-ShaR.10.2.51.1</i>	<i>Develop a pesticide management plan</i>					
<i>SONCC-ShaR.10.2.51.2</i>	<i>Implement pesticide management plan and technical assistance program</i>					
SONCC-ShaR.10.2.72	Water Quality	Yes	Reduce pollutants	Reduce pesticides	Population wide	3d
<i>SONCC-ShaR.10.2.72.1</i>	<i>Develop a pesticide management plan</i>					
<i>SONCC-ShaR.10.2.72.2</i>	<i>Implement pesticide management plan and technical assistance program</i>					
SONCC-ShaR.8.1.30	Sediment	No	Reduce delivery of sediment to streams	Minimize mass wasting	All areas where coho salmon would benefit immediately	3c
<i>SONCC-ShaR.8.1.30.1</i>	<i>Assess and map mass wasting hazard, prioritize treatment of sites most susceptible to mass wasting, and determine appropriate actions to deter mass wasting</i>					
<i>SONCC-ShaR.8.1.30.2</i>	<i>Implement plan to stabilize slopes and revegetate exposed areas including agricultural lands</i>					
SONCC-ShaR.8.1.87	Sediment	No	Reduce delivery of sediment to streams	Minimize mass wasting	Population wide	3d
<i>SONCC-ShaR.8.1.87.1</i>	<i>Assess and map mass wasting hazard, prioritize treatment of sites most susceptible to mass wasting, and determine appropriate actions to deter mass wasting</i>					
<i>SONCC-ShaR.8.1.87.2</i>	<i>Implement plan to stabilize slopes and revegetate exposed areas including agricultural lands</i>					

## Shasta River Population

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
<i>Step ID</i>	<i>Step Description</i>					
SONCC-ShaR.10.7.65	Water Quality	No	Restore nutrients	Add marine-derived nutrients to streams	All areas where coho salmon would benefit immediately	3c
<i>SONCC-ShaR.10.7.65.1</i> <i>SONCC-ShaR.10.7.65.2</i>	<i>Develop a plan to supply appropriate amounts of marine-derived nutrients to streams (e.g. carcass placement, pellet dispersal)</i> <i>Supply marine-derived nutrients to streams guided by the plan</i>					
SONCC-ShaR.10.7.73	Water Quality	No	Restore nutrients	Add marine-derived nutrients to streams	Population wide	3d
<i>SONCC-ShaR.10.7.73.1</i> <i>SONCC-ShaR.10.7.73.2</i>	<i>Develop a plan to supply appropriate amounts of marine-derived nutrients to streams (e.g. carcass placement, pellet dispersal)</i> <i>Supply marine-derived nutrients to streams guided by the plan</i>					
SONCC-ShaR.3.1.9	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide, including upstream from Dwinnell Dam	3d
<i>SONCC-ShaR.3.1.9.1</i> <i>SONCC-ShaR.3.1.9.2</i>	<i>Work with partners to streamline the process needed for the dedication of water to fish and wildlife resources under CA Water Code section 1707</i> <i>Implement water dedications to increase instream flows using the streamlined process</i>					
SONCC-ShaR.3.1.10	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3d
<i>SONCC-ShaR.3.1.10.1</i>	<i>Establish a categorical exemption under CEQA for water leasing to increase instream flows</i>					
SONCC-ShaR.3.1.11	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3d
<i>SONCC-ShaR.3.1.11.1</i> <i>SONCC-ShaR.3.1.11.2</i>	<i>Conduct a comprehensive inventory of current groundwater wells and well usage within Shasta River Basin, completed by a surface-groundwater integrated model, that together can evaluate the relative merit of water management alternatives</i> <i>Establish a comprehensive groundwater permit process</i>					
SONCC-ShaR.10.1.17	Water Quality	Yes	Reduce water temperature, increase dissolved oxygen	Increase flow	Emmerson Ranch Properties	3d
<i>SONCC-ShaR.10.1.17.1</i> <i>SONCC-ShaR.10.1.17.2</i>	<i>Develop emergency action ranch management plan for Emmerson Ranch</i> <i>Create an irrigation diversion and water use operations manual that conserves and assists recovery of coho salmon</i>					
SONCC-ShaR.7.1.45	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Reestablish natural fire regime	Population wide, guided by recent assessment priorities (USFS WCF 2011)	3d
<i>SONCC-ShaR.7.1.45.1</i> <i>SONCC-ShaR.7.1.45.2</i>	<i>Identify areas prone to high severity fire and develop a plan to reestablish a natural fire regime</i> <i>Carry out fuel reduction or modification projects such as thinning, prescribed burning, and piling, guided by the plan</i>					

## Shasta River Population

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
<i>Step ID</i>	<i>Step Description</i>					
SONCC-ShaR.2.1.50	Floodplain and Channel Structure	No	Increase channel complexity	Improve regulatory mechanisms	Population wide	3d
<i>SONCC-ShaR.2.1.50.1</i>	<i>Improve protective regulations for beaver and develop guidelines for relocation that are practical for restoration groups</i>					
SONCC-ShaR.16.1.33	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	3d
<i>SONCC-ShaR.16.1.33.1</i> <i>SONCC-ShaR.16.1.33.2</i>	<i>Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters</i> <i>Identify level of fishing impacts that does not limit attainment of population-specific viability criteria</i>					
SONCC-ShaR.16.1.63	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	Tribal lands	3d
<i>SONCC-ShaR.16.1.63.1</i> <i>SONCC-ShaR.16.1.63.2</i>	<i>Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters</i> <i>Identify level of fishing impacts that does not limit attainment of population-specific viability criteria</i>					
SONCC-ShaR.16.1.34	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	3d
<i>SONCC-ShaR.16.1.34.1</i> <i>SONCC-ShaR.16.1.34.2</i>	<i>Determine actual fishing impacts</i> <i>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</i>					
SONCC-ShaR.16.1.64	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Reduce fishing impacts to levels that do not limit recovery	Tribal lands	3d
<i>SONCC-ShaR.16.1.64.1</i> <i>SONCC-ShaR.16.1.64.2</i>	<i>Determine actual fishing impacts</i> <i>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</i>					

Shasta River Population

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
<i>Step ID</i>	<i>Step Description</i>					
SONCC-ShaR.16.2.35	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	3d
<i>SONCC-ShaR.16.2.35.1</i>	<i>Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters</i>					
<i>SONCC-ShaR.16.2.35.2</i>	<i>Identify level of scientific collection impact that does not limit attainment of population-specific viability criteria</i>					
SONCC-ShaR.16.2.36	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	3d
<i>SONCC-ShaR.16.2.36.1</i>	<i>Determine actual impacts of scientific collection</i>					
<i>SONCC-ShaR.16.2.36.2</i>	<i>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</i>					