CHAPTER 7: POPULATION, HABITAT & THREATS RESULTS

"There is presently no other way for humans to educate themselves for survival and fulfillment than through the instruction available from the natural world."

Freeman House

INTRODUCTION

Appropriate actions to recover CCC coho salmon will not be possible until there is (1) a clear understanding of coho salmon environmental requirements, (2) which requirements may be lacking or degraded, and (3) what threatens to further degrade habitats and limit the recovery. Results from the assessments of population viability, habitat conditions, and ongoing and future threats are therefore an essential foundation to the recovery plan. This chapter provides an overview of those results. Descriptions of the methods used to arrive at these conclusions are provided in Chapter 6.

Results include patterns and trends of watershed conditions currently impairing CCC coho salmon habitats and are presented by life stage and watershed to help prioritize recovery actions based on attributes most limiting to existing populations. This summary is based on assessments of current conditions and future threats conducted using the CAP protocol and workbook. Twenty eight focus watersheds were assessed across the ESU using data collected and generously provided by local and State agencies, public entities, landowners and others.

POPULATIONS SELECTED FOR RECOVERY

A total of 75 watersheds, between Mendocino County and Santa Cruz County (including San Francisco Bay tributaries) were identified by Bjorkstedt *et al*. (2005) as historically supporting CCC coho salmon populations. All 12 independent populations and 16 dependent populations (DPs) were chosen across four diversity strata for the CCC coho salmon ESU recovery scenario; no populations were chosen for the San Francisco Bay Diversity Stratum. Recovery targets for spawner abundance for each FIP or PIP within the ESU coincide with the low extinction risk targets identified in Spence *et al.* 2008, except for the Russian River. Occupancy targets for DPs were derived from abundance estimates from Waddell Creek data from the 1930's (Shapavolov and Taft 1954). The combined abundance targets for the CCC coho salmon ESU recovery scenario we believe represent broad sense recovery goals which are designed to provide for commercial, recreational, or tribal harvest as well as providing for additional ecological benefits (such as maintenance of ecosystem productivity). These targets have the added benefit of improving the redundancy, resiliency and representation of coho salmon in the ESU.

The current recovery scenario expects 37 percent of historical populations (28 individual watersheds) to achieve and maintain viability across all potential habitats for CCC coho salmon to meet ESU-level criteria. These 28 watersheds occupy **43 percent** of the total land area in the ESU, and represent **33 percent** of all the stream kilometers with the potential to have provided habitat historically (*i.e*. IP km). Though these 28 populations are the focus of this analysis and subsequent strategy development, recovery and threat abatement actions should not be limited exclusively to these watersheds. In particular, efforts to prevent coho salmon extirpation and facilitate their recovery should be initiated where this species is present. In addition, all coho salmon populations and individuals and their designated critical habitat remain fully protected under the ESA wherever they occur and are therefore still subject to all the protections therein; including prohibitions on take and habitat modifications (unless legally exempted by permit).

IP habitat for coho salmon were output for each population and are displayed on maps that include a range of IP values across three scales: 0.0 to 0.35; 0.35 to 0.7 and > 0.7. These scales represent: (1) relative likelihood for historic channel and flow conditions to provide higher quality rearing habitats for coho salmon; and (2) likelihood of areas within a watershed to historically provide higher or lower abundance per length of stream reach to meet overall abundance target for the population. The IP values across these scales represent the historical potential of channel width, mean annual discharge and gradient to provide suitable habitats and support higher abundances of coho salmon with > 0.7 having a high likelihood, 0.35 to 0.7 having a moderate likelihood and 0.0 to 0.35 having a lower likelihood.

For recovery planning purposes, NMFS is evaluating those areas identified as > 0.7 as having a higher potential for responding to instream restoration actions (e.g., input of large wood and pool formation). With the current goal to prevent extinction, these areas will be evaluated for their potential to respond quickly to restoration activities and provide immediate or very near term benefits to improve CCC coho salmon survival. These areas are also those most likely to respond negatively as upstream conditions degrade. Nevertheless, the overall persistence of this species relies on restoration and maintenance of watershed processes across IP and non-IP areas.

Revisiting IP in the Coastal Diversity Stratum

The Coastal Diversity Stratum contains three historically independent populations of CCC coho salmon. The TRT concluded the Russian River, the largest watershed in the ESU, historically supported two coho salmon populations: a major functionally independent population that spawned in tributary watersheds in the lower basin where coastal climates moderated summer temperatures and a dependent, possibly "ephemeral" population that occupied tributaries in the northwest corner of the basin (Bjorkstedt *et al*. 2005). Lagunitas Creek is believed to have also supported a functionally independent population, while Walker Creek historically supported a potentially independent population (Spence *et al*. 2008).

The estimate of historical IP-km in the Russian River basin was estimated at 779 IP-km. A density of 20 spawners/IP-km results in a population target of 15,600 adult fish in the Russian River. However, approximately 22 IP-km lie upstream of Warm Springs and Coyote Valley dams, and approximately 251 IP-km has limited potential for coho production in the basin due to a combination of urban development and extensive channelization for flood control. The degraded, channelized condition of heavily urbanized portions of the Russian River watershed makes attainment of the TRT's population viability

target, (is based on historical habitat availability), highly unlikely. Thus, numeric spawner targets for recovery criteria were calculated from a revised estimate of IP km, to account for habitat loss associated with urban development and cold water habitat gains in the Russian River basin as discussed below.

The Russian River is both the largest watershed and a major center of human population within the CCC coho salmon ESU, where large portions of this watershed are urbanized and a large proportion of historical coho salmon habitat has been lost. The Santa Rosa Creek watershed and the Laguna de Santa Rosa watershed (upstream from the confluence with Santa Rosa Creek) collectively have 98 km of trapezoidal flood control channels[14]. These straightened channels run through urban and other highly developed areas that may preclude channel restoration capable of supporting rearing habitats for coho salmon. The hydrology of urban flood control channels are highly altered and may not be conducive to providing quality coho salmon habitat. Much of the remaining habitat in the Laguna de Santa Rosa (upstream of Santa Rosa Creek) is low gradient sloughs without significant spawning habitat. However, the Laguna de Santa Rosa does continue to provide abundant potential winter refugia for coho salmon. Appreciable amounts of the Laguna channel remains well connected to its flood plain, so that during winter the Laguna forms a network of large shallow ponds. Unfortunately, potential production of juveniles in these sloughs is likely prevented by the paucity of spawning habitat due to the network of numerous flood control channels and extensive low gradient, silt bottomed sloughs that make up most of the habitat in these two subwatersheds.

Attempts to restore natural stream meanders with backwater or scour pool habitats in these reaches, or to reconnect the channels with floodplains for the development of offchannel pools, is precluded by the adjacent extensive urban development. Similarly, placement (and retention) of large woody debris in heavily maintained flood control channels, may impair conveyance or provide marginal habitat improvements (when considering the accelerated runoff from impervious surfaces in the adjacent highly residential floodplain).

This evaluation is supported by DFG which has regarded the Laguna de Santa Rosa as a subwatershed with inconsequential potential coho salmon rearing and spawning habitat as the result of both habitat loss and extreme habitat degradation (R. Coey, former DFG Supervisory Fishery Biologist, personnel communication). Nevertheless, given the value of the Laguna as potential winter habitat for coho salmon, we have retained the lowermost portion of the Laguna (downstream of the mouth of Santa Rosa Creek) as current IP km which could potentially serve as winter habitat for coho salmon spawned in Mark West Creek.

Another revision to the TRT estimate of IP km in the Russian River watershed includes the subtraction of IP km for a small number of streams in the Northwest corner of the Russian River watershed (*e.g.*, Forsythe Creek and others). These few small streams were considered a small Dependent Population that relied on immigration from the much larger independent population in the southern end of the watershed. However, based on flow, temperature conditions, and natural barriers to migration in this northern area, it was unlikely that coho salmon consistently occupied these streams. Considering the distance from the Core Areas in the lower basin, and the conditions for migration to the upper basin

[14] Tables 28 and 29 in NMFS (2008) from Russian River Biological Opinion

tributaries through the mainstem, much of what is effectively channelized, the IP km for this ephemeral population was removed from analysis of current conditions. It is unlikely that these few streams in the upper northwest corner of the Russian River watershed could be restored to a state where they would contribute significantly to the recovery of the independent coho population (R. Coey, former DFG Supervisory Fishery Biologist, personnel communication).

Finally, while subtracting Santa Rosa Creek, the Laguna de Santa Rosa (upstream from the mouth of Santa Rosa Creek), and the few streams in the northwest corner of the watershed from the estimate of current IP km, we added 14 miles of Dry Creek as current IP km. Dry Creek had been excluded from the TRT estimate of IP km due to high summer air temperatures predicted by the model - it is possible that, prior to the construction and operations of Warm Springs Dam, the high air temperatures elevated water temperatures in lower Dry Creek above the tolerance levels for rearing coho salmon. However, with current high summer flow releases of cold water from Warm Springs Dam, water temperatures in Dry Creek are now highly favorable for rearing juvenile coho salmon and coho presences has been documented routinely in recent history in Dry Creek and it's various tributaries.

Walker Creek is heavily impacted by livestock ranching practices and wild CCC coho salmon have not been observed in several decades (the stream was planted with Russian River captive broodstock in 2004). The Walker Creek coho salmon population was categorized by the TRT as "extinct." Similar to the Russian River, Walker Creek does not currently maintain conditions to support the number of spawners needed to achieve the TRT (low extinction) viability target of 2,800. However, Walker Creek is impacted by land uses practices that are potentially easier to reverse than land-use practices in the Russian River.

Unlike the Russian River and Walker Creek, Lagunitas Creek maintains a consistent run of CCC coho salmon. Data from this watershed is the most reliable set for any Independent Population in the CCC coho salmon ESU. Thought the TRT categorized this population at "moderate risk" of extinction, Lagunitas Creek currently does not have suitable habitat conditions, to achieve the viability target of 2,600. Trends do indicate, though, that this may be the only watershed that could potentially satisfy low risk extinction criteria in the near future, if significant restoration were to occur.

To identify recovery targets for these three populations which would reflect a realistic recovery scenario for a viable Russian, Walker and Lagunitas Creek salmon populations, while still achieving Diversity Strata targets and ESU level viability criteria, we revised the current IP-km for the Russian River watershed, excluding areas that because of substantial and irreversible degradation are unlikely to contribute to a viable Russian River population. We then calculated a recovery target abundance based on currently accessible habitat using density criteria proposed by the TRT – also calculating low-risk targets based on currently accessible habitat (*i.e.*, excluding area upstream of impassible dams) for Lagunitas and Walker creeks.

To ensure that ESU-level criteria were met, the total projected cumulative abundance for the three independent populations in the Coastal diversity strata (Russian, Lagunitas, Walker) was determined *a priori* to be not less than 50% of the total historical aggregate abundance of these populations.

Results indicate the recovery target for the Coastal Diversity Stratum is adequate to achieve the conditions necessary for viability (Table 13), and that those conditions can be met from the Russian River and Lagunitas Creek populations alone, or with contribution from Walker Creek (which could also be restored to a viable population of at least 2,800 individuals). Given the uncertainty regarding the large recovery target for the Russian River, and the significant extent of urbanization of this watershed, pursing restoration actions in Walker Creek to approach a level of several thousand spawners (which could contribute to reaching the stratum total of 11, 850) would seem a reasonable and prudent target to pursue.

Table 17: Proposed Abundance Targets for the Russian River and Coastal Diversity Stratum

Population	Historic IP Km	Historical viability	Current IP km	Stratum target
Russian River	779	15,600	506	10,100
Walker Creek	103	3,600	76	2,800
Lagunitas Creek	137	4,500	70	2,600
Aggregate Target		50% of 23,700 = 11,850	__	15,500

CAP WORKBOOK: ESU POPULATION RESULTS

Coho salmon viability, as characterized by the four population viability indicators (adult density, juvenile density, juvenile distribution, and smolt productivity) rated in the CAP workbooks, is generally poor throughout the ESU (Table 15). This condition is especially apparent south of the Lost Coast Diversity Stratum, where few ratings for viability rise above poor condition. With the exception of Lagunitas Creek, every population from the Navarro River (inclusive) south appear at a critically high risk of extinction. While the Lost Coast Diversity Stratum is less so, the abundance of poor and fair ratings still suggest endangered populations.

The number of watersheds in the ESU with "Poor" ratings for population viability indicators illustrates the extent of depressed populations:

- 24 of 28 watersheds had poor juvenile densities (defined as having a watershed average of <0.2 fish per square meter);
- 24 of 28 watersheds had poor adult spawning densities (defined as having a watershed average of <1 spawning per IP km); and
- 14 of 28 watersheds had poor juvenile distributions (defined as having a watershed average of <20 percent of its historic distribution).

These results are consistent with the legal designation of Endangered for this species, the latest status reviews, and other sources (Good et al. 2005, Spence *et al*., 2008). The collapse of the 2006/2007 adult cohort in response to poor ocean conditions (Hayes and McFarlane 2008) is a testament to the vulnerability of a species on the brink of extinction.

Photo Courtesy: Noyo River, Mendocino County, CA. Rick Macedo, DFG

CAP WORKBOOK: CURRENT HABITAT CONDITION RESULTS

Using results generated from the TNC CAP workbooks, NMFS calculated the current "percent poor" values across habitat and population attributes for all ESU populations (Figure 13). Percent poor values represent habitat conditions that are currently outside the range of natural variability and therefore limit populations. Percentages in the proceeding figures should be viewed as provisional, as they were based on assessments that were in some instances uncertain, however they provide a picture of the relative status of different habitat and population attributes for CCC coho salmon.

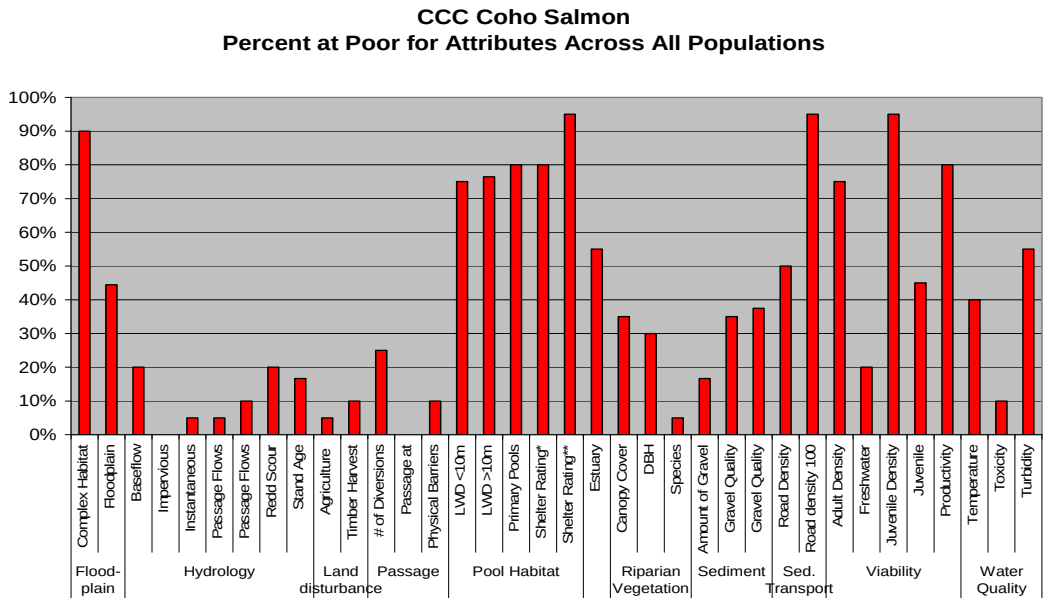

Figure 14: Current "Percent Poor" values for habitat and population attributes across all populations

*** Pool habitat shelter rating for summer rearing life stage **Pool habitat shelter rating for multiple life stage**

NMFS made the following generalizations from the information provided:

- *Attributes are considerably variable across populations.* Habitat and population attributes tend to occur at discrete spatial and temporal scales. In particular, the distribution of both spawning and rearing habitat, under natural conditions is largely determined by physical processes controlled by watershed characteristics (e.g., topography, hydrology, vegetation, etc) that are effectively constant over millennial timescales (Frissell *et al*. 1986; Montgomery and Buffington, 1998);
- *Pool habitats represent the highest "percent poor" ratings across all populations.* For example, poor shelter ratings for summer and multiple life stages occur in 80-95% of the population, respectively. A larger number of ESU populations are lacking in primary pools and adequate LWD. NMFS assumes that the increased landuse practices, which increase rates of sedimentation and reduce wood recruitment to streams is the likely cause of such high percentage values; and
- *As a whole, hydrology attributes represent the lowest "percent poor" values across all ESU populations, ranging from 0-25%.* Among these attributes redd scour represents 20% the highest "percent poor" values for this category.

Using reports generated by the TNC CAP workbooks, NMFS also calculated the current "percent poor" value across all populations and attributes for each life stage of the CCC coho. These values represent the percentage of populations with poor conditions for eggs, multiple life stage, smolts, spawning adults, summer rearing, and winter rearing per total IP-km. NMFS made the following generalization from the information:

- *Eggs and spawning adults have the lowest "percent poor" values across all populations per watershed.* Approximately 20% of the streams rated poor for spawning adults. As shown above in Figure 13, approximately 25-35% of the populations were rated as poor for sediment attributes that affect spawning adults (amount of gravel, gravel quality bulk and embeddedness). In general, streams in the ESU for spawning adults are not gravel limited;
- *Summer rearing and multiple life stages were estimated to have percent poor values of 57 and 46% respectively*; and
- *Winter rearing and smolt CCC coho have the highest "percent poor" values across all populations and attribute indicators, 95 and 73% respectively.* These estimates are consistent with estimates of high percent poor ratings for pool habitats attributes: shelter, primary pools, and LWD (Figure 14) and high percent poor values for complex habitat and shelter rating known to affect summer and winter rearing coho (Figure 14).

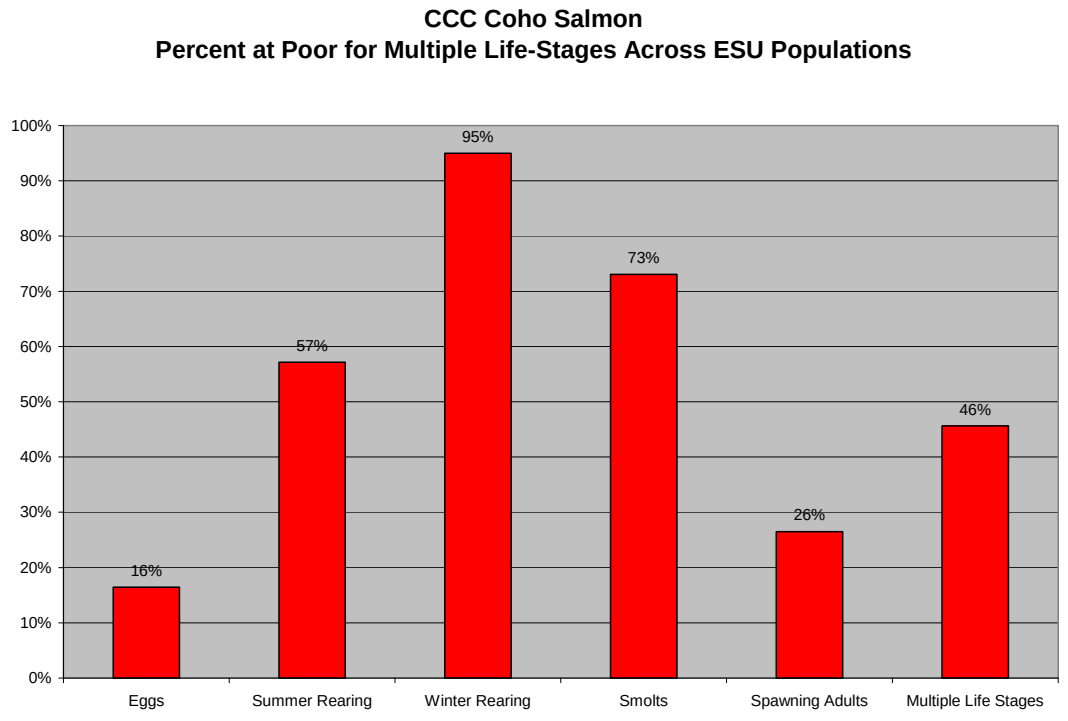

Figure 15: Current "Percent Poor" values across all populations and attributes for each life stage

(Note: Winter Rearing has 1 indicator)

Using the results from the TNC CAP workbooks, NMFS rated the current key habitat attributes for summer and winter rearing CCC coho for each focus population. NMFS made the following generalizations from the information provided:

- *Across all CCC coho populations for summer rearing, baseflow was indicated as the attribute with the lowest percent poor value*. This indicates that 20% of the populations do not meet flow requirements for summer rearing coho;
- *Pool habitat indicators, primary pools and shelter rating, show similar high "percent poor" values for summer rearing habitat.* Results show that 70% of the watersheds lack primary pools and adequate stream shelter within the ESU. In addition, complex habitat for winter rearing is also lacking across the ESU with a high percent poor value of 95%;
- *Water quality attributes for temperature show that 40% of the populations do not meet temperature requirements for summer rearing*; and
- *NMFS, population viability attributes show that 95% of the populations have extremely low juvenile densities during the summer. Less than half, 45% of the population, have adequate juvenile distributed throughout the potential rearing habitat.*

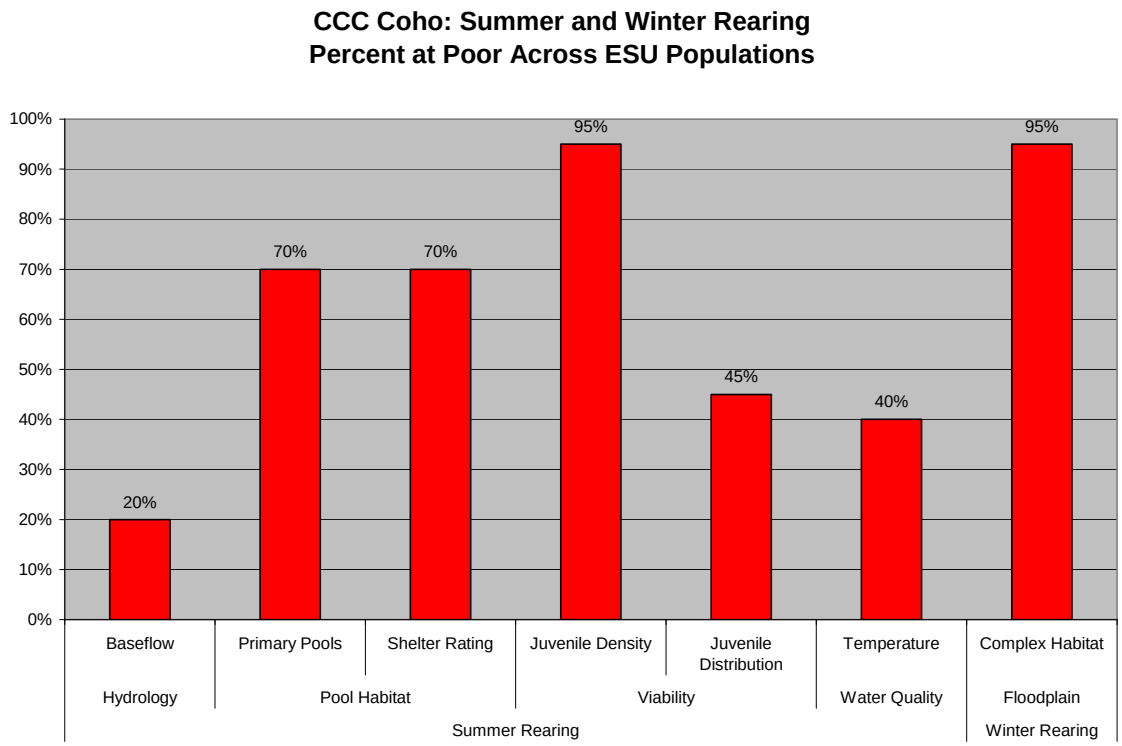

Figure 16: Current "Percent Poor" habitat and population attributes for CCC coho salmon summer and winter rearing across all populations

Habitat Results by Freshwater Attribute

The overall pattern of results for habitat indicators suggests watershed processes throughout the ESU are substantially degraded. This condition is illustrated most prominently in the degradation of summer rearing habitat. Interestingly, the pattern for summer rearing condition is largely mirrored by the pattern

of poor population indicators, and suggests summer rearing life stage is limiting population viability. Winter rearing also appears to be a limiting life stage, but the lack of multiple indicators makes this discernment less obvious than the summer rearing indicator. What follows is a broad discussion of some of the critical habitat limitations affecting the ESU. Note that data was limited for certain habitat attributes within several watersheds, and not all attribute summaries encompass each focus watershed.

Road density (i.e., indicator Road density 100, or miles of road within 100 meters of the stream channel) was rated as poor in 27 of 28 watersheds. This suggests high road density is the most widespread indicator of poor habitat condition within the ESU. Riparian roads are often associated with problems such as sedimentation, migration barriers, lack of large wood recruitment, and channel encroachment. The San Lorenzo River had the most habitat attributes rated in poor condition (21 of 35 attributes), followed by the Russian River (19 of 36), and Walker Creek, (19 of 35). Cottaneva, Pudding, Caspar, Pine Gulch, and Gazos creeks all had ten or fewer poor indicators (Usal, Wages, San Gregorio, and Soquel creeks also had ten or fewer poor indicators but there were several indicators). While these results are important in determining priorities for restoration, recovery actions are also contingent upon the interaction of current conditions with future threats and population based viability criteria.

Table 14 demonstrates the pervasiveness of poor conditions across the ESU and highlights watersheds with the poorest conditions. The San Lorenzo River, Russian River, and Walker Creek are, by this measure, in the worst condition. While this may imply that they become top priorities for recovery actions, there are additional considerations, such as the potential role of each population in the ESU, which must be considered. Other pertinent details generated through the CAP process include:

1. Pool habitat shelter rating was rated as being in Poor condition in 26 of 28 focus watersheds for smolts and 22 of 24 watersheds for summer rearing juveniles. Habitat complexity is lacking in all watersheds across the ESU;
2. Primary pool abundance was rated as Poor in 21 of 24 focus watersheds. Primary pools are formed by habitat complexity elements, which are lacking across the ESU;
3. LWD volume for both large (width > 10 meters) and small (width < 10 meters) streams was rated as poor in 18 of 28 and 20 of 28 focus watersheds, respectively. LWD is an important constituent of habitat complexity and is lacking across much of the ESU;
4. The complexity of flood plain habitat was rated as Poor in 26 of 28 focus watersheds. Many streams across the ESU are incised or modified and disconnected from historic floodplain habitat;
5. Road density was rated as Poor in 19 of 28 focus watersheds, suggesting roads represent a significant disturbance across the ESU;
6. Temperature (*i.e.*, water temperature during summer rearing) was rated as Poor in 11 of 28 focus watersheds;
7. Gravel quality, as represented by both fine sediment percentage (*i.e.*, Gravel Quality (bulk)) and substrate embeddedness, was rated as Poor in 10 of 27 and 7 of 15 focus watersheds, respectively. These results reflect the unnaturally high sediment loads common to many watersheds within the ESU;
8. Riparian DBH was rated as Poor in 9 of 28 focus watersheds. A high proportion of small diameter trees within a riparian corridor suggests future LWD quality will be lacking, since

smaller trees are limited in their ability to influence channel morphology. Also, larger diameter trees typically last longer within the stream environment (*i.e.*, are slower to rot and flush downstream);

9. Estuary conditions were rated as Poor in 8 of 28 focus watersheds. This was most severe in the Santa Cruz Mountains diversity strata, where six of the nine estuaries have been highly modified by encroaching transportation corridors or other developments;
10. Floodplain connectivity was rated as poor in 7 of 24 focus watersheds. Many streams across the ESU are incised or modified and disconnected from historic floodplain habitat;
11. Freshwater harvest was rated as Poor in only 4 of 28 focus watersheds. Typically, freshwater harvest occurs where coho presence overlaps with a steelhead sport fishery, or where poaching is known to be a problem.
12. Redd scour was not a limiting factor within many of the CCC coho salmon watersheds, having been rated as Poor in only 4 of 28 focus watersheds. Redd scour occurs in simplified instream habitats with friable parent geology;
13. Passage flows for smolts were rated as Poor in the Russian and San Lorenzo Rivers, where agricultural diversions (Russian River) and a major municipal diversion by the City of Santa Cruz (San Lorenzo) are likely impairing smolt migration through critical reaches.
14. Land disturbance due to timber harvest was rated as Poor in the Ten Mile and Albion Rivers and Big Salmon Creek. All three watersheds have had extensive logging operations in the recent past;
15. Passage flows for spawning adults was rated as Poor in the San Lorenzo River. Major diversions operated by the City of Santa Cruz and San Lorenzo Valley Water District and other private and public diversions in the San Lorenzo watershed likely impair migration through critical reaches in the lower watershed under some flow regimes.
16. Physical barriers were rated as poor in Lagunitas Creek. Much of the historical coho salmon habitat within the Lagunitas Creek watershed lies upstream of impassable dams forming Kent and Nicasio Lakes.
17. Amount of gravel was rated as Poor in Pescadero Creek. The native bedrock geology in that watershed is highly friable sandstone and does not currently provide high quality spawning substrate.
18. Instantaneous flow conditions were rated as Poor in the Russian River where water withdrawals for frost protection can lower the water surface and desiccate redds or strand juvenile fish during late Winter/early Spring.
19. Passage conditions into and through estuaries for spawning adults was rated as Fair, Good, or Very Good across all focus watersheds, indicating the factor is not likely limiting the populations. However, during drought conditions it could potentially result in severe adverse effects to the population (*e.g.*, the 2007/2008 cohort in Scott Creek).

Habitat Results by Freshwater Life Stage

Spawning Adults: Instream habitat and watershed conditions appear to be generally supporting the adult life stage, as few habitat indicators were determined as Poor. Incidental capture from freshwater harvest, however, may be a limiting factor for adults in five watersheds (Russian River, Garcia River, Gualala River, Pescadero Creek, and San Lorenzo River).

Photo Courtesy: Adult CCC coho salmon, Albion River, Mendocino Co.,CA Tom Daugherty, NMFS

Eggs within redds: Gravel quality for egg incubation and fry emergence was commonly rated Poor to Fair across the ESU, with some exceptions. Poor conditions south of San Francisco Bay reflect an increased susceptibility to fine sediment intrusion and lower egg survival due, in part, to an abundance of unconsolidated geologic land forms in this area. Though other life stages may be in more immediate need of attention, reducing fine sediment concentrations should be considered a high priority for restoration throughout the ESU because of the pervasive nature by which sediment affects multiple life-stages and habitat types (e.g., infilling of summer pool habitat, degrading winter water quality via elevated turbidity, etc.).

Summer Rearing: Summer rearing habitat is consistently in poor condition across the ESU, with a few notable exceptions. All six summer rearing habitat indicators were poor in the Russian and San Lorenzo Rivers and Walker Creek, suggesting this life stage is limiting salmon productivity for those populations. Several watersheds have Poor ratings for at least four of the six indicators. High summer water temperatures limit juvenile survival in 11 of 28 populations; only four watersheds are rated as good. Pool habitat (frequency and complexity) was deficient in most watersheds. Given the preponderance of indicators in poor condition, restoration actions aimed at supporting the summer rearing life stage should be considered a top priority during recovery planning and implementation.

Photo Courtesy: Juvenile CCC coho salmon, Scott Creek, Santa Cruz Co., Morgan Bond, SWFSC

Winter Rearing: Habitat conditions influencing winter rearing success (*i.e.*, complex habitat types, such as off-channel and floodplain refugia for smolts from high flows) were consistently rated as Poor across much of the ESU, with the notable exception of Caspar Creek and Pine Gulch[15]. Given the preponderance of Poor ratings, habitats supporting

[15] Our confidence in the off-channel habitat assessment was low due to problems with assessment methods and lack of quantifiable data.

this life stage should be considered a top priority for recovery actions.

Smolts: For the smolt life stage, estuary condition is likely limiting coho salmon production within many watersheds south of Lagunitas Creek, due primarily to habitat degradation and impeded migration within the estuary environment. Pool habitat complexity, as represented by shelter rating, was also consistently poor for smolts, the lone exception being Pine Gulch Creek. Issues of channel complexity have already been identified as a priority for winter rearing. The frequency of water diversion structures was rated as poor in 5 of the 28 watersheds, suggesting smolt entrainment is not currently a major limiting factor in the ESU.

Multiple Life Stages: Analyses of instream habitat conditions can provide insight regarding how a particular stream reach may function at a specific site for a specific life stage. While these site-based and life stage specific analyses are informative, conducting a higher level review oriented to major watershed processes (*e.g.* dynamic interactions of wood, water and sediment through the stream system) that support all life stages provides a more comprehensive overview of watershed scale processes.

Results indicate current watershed process conditions (*e.g.*, multiple life stage categories) are variable, but tended toward a Poor condition rating. Impervious surfaces had no poor ratings, suggesting it is not a factor impairing the recovery of the ESU as represented by the 28 focus watersheds. The Russian River was the only watershed where agriculture rated as poor. Attributes for large woody debris and road density were more consistently rated as poor. These findings were consistent with the life stage specific findings of low pool complexity and degraded spawning gravel condition. Because LWD and sediment condition tend to affect multiple coho salmon life stages, projects addressing these factors should be considered a high priority for restoration actions.

CAP WORKBOOK: THREATS AND DIVERSITY STRATA RESULTS

ESU Threat Results

Results from the CAP threats analysis for the 28 populations are provided in Table 15. Generally, the greatest threats for CCC coho salmon across the ESU come from the three threat categories of (1) Roads and Railroads, (2) Droughts, and (3) Residential and Commercial Development. Threats are presented below based on their rank and prevalence across the ESU:

1. Roads and Railroads were ranked as a High or Very High threat in 24 of 28 focus watersheds. The amount of Very High or High ranks suggests that the threat of roads has a significant effect to coho salmon, and a high priority should be placed on actions to reduce this threat. Roads are clearly a significant factor contributing to habitat degradation across all ESU watersheds and populations;
2. Droughts were also ranked as a High or Very High threat in 19 of 28 focus watersheds. This threat was ranked Very High in five watersheds suggesting that a high priority should be placed on actions to reduce this threat. While NMFS cannot address naturally occurring droughts directly, we can facilitate planning, water storage, and other actions that will reduce the adverse effects of drought on coho salmon populations. This threat was most severe in watersheds from the Russian River south;

3. Logging and Wood Harvesting ranked as a High or Very High threat in 16 of 28 focus watersheds. Eleven of these watersheds are located in Mendocino County. Because approximately 75-80 percent of watersheds where coho salmon are currently persisting are in privately held timber lands, abating this threat is a high priority that will require extensive partnering with private landowners, CalFire and the State Board of Forestry;
4. Channel Modification ranked as a High or Very High threat in 8 of 28 focus watersheds. Channel modification occurs in all watersheds where coho salmon are currently extirpated and is a significant threat for the Russian River and watersheds south of the Russian River. Achieving properly functioning riparian conditions is difficult in modified channels, due to the permanent nature of bank stabilization, maintenance, and channelization activities;
5. Climate Change was ranked as a High or Very High threat in nine watersheds, from Salmon Creek south. Climate change is likely to have effects across the ESU; however, expected variation in watershed conditions will affect species response to climate change and thus their resiliency to such change. Watersheds at the southernmost extent of the range are likely to suffer the most severe effects;
6. Water Diversion and Impoundment ranked as a High threat in the Russian River and for six watersheds south of the Russian River. This threat occurs across nearly all CCC coho salmon watersheds and, due to potentially complex political and societal ramifications, is expected to be one of the most difficult threats to abate in the CCC ESU;
7. Agricultural Practices ranked as a Very High threat in the Russian River, and as High threats in four other focus watersheds. The conversion of forestlands to agriculture (particularly grape vineyards) is of particular concern;
8. Storms and Flooding ranked as a High threat in 11 watersheds. Reduced instream habitat complexity, a common issue across the ESU, reduces the resiliency of coho salmon to large storm events;
9. Residential and Commercial Development ranked as a very high threat in San Gregorio, San Vicente, and Aptos Creeks, and in the San Lorenzo River. It was ranked as a High threat in the Russian River, Lagunitas and Pescadero Creeks;
10. Disease, Predation and Competition ranked as a High threat in four watersheds south of the San Francisco Bay;
11. Fishing and Collecting ranked a Low or Medium threat to coho populations across the ESU, indicating that this activity is not likely to impede recovery;
12. Livestock Farming and Ranching ranked as a High threat in Salmon Creek, and as a Very High threat in Walker Creek;
13. Fire and Fuels Management ranked as a High threat in eight focus watersheds; all watersheds from Redwood Creek south excluding Gazos and Waddell Creeks;
14. Recreational Areas and Activities ranked as a High threat in the San Lorenzo River and in Aptos Creek;
15. Mining ranked as a Very High threat in San Vicente Creek. All other focus watersheds were ranked as Medium or Low for this threat, indicating that this activity is not likely to impede recovery; and
16. Hatcheries and Aquaculture ranked as a Medium or Low-ranked threat, indicating that these activities are not likely to impede recovery.

Diversity Strata Threat Results

Across Diversity Strata, threats increase in each category, with the exception of logging and wood harvesting, from north to south with the Santa Cruz Mountain Diversity Strata having the greatest number of threats ranked as High or Very High. The most significant threats are listed below.

Lost Coast

Roads and logging were ranked as high or very high in every watershed in the Lost Coast stratum, with the exclusion of logging in Usal Creek, which is a medium. Three watersheds each received a High rank in Channel Modification, Disease, and Residential and Commercial Development; Storms and Flooding received two High ranks; and Droughts received four. All other threats in the individual watershed comprising the stratum were ranked as Medium or Low. This stratum supports some of the most robust coho salmon populations in the ESU, and will be a critical component for preventing extinction and promoting recovery.

Navarro Point-Gualala Point

Roads, Logging and Wood Harvesting, Storms and Flooding, and Droughts are the greatest threats to coho salmon within the Navarro Point-Gualala Point stratum. Agricultural Practices ranked as a High threat in the Gualala River.

Coastal-Gualala Point

Channel Modification, Droughts, and Water Diversion and Impoundment are the greatest threats across the stratum. Climate Change ranked as a high threat in Salmon, Lagunitas and Redwood Creeks. Roads were ranked as High in the Russian River, and Salmon and Redwood Creeks. Residential and Commercial Development ranked a High threat in the Russian River and Lagunitas Creek. And Livestock Farming and Ranching was ranked as Very High in Walker Creek and High in Salmon Creek.

San Francisco Bay

This diversity stratum was not assessed since Independent Populations were not identified within the stratum and are believed extirpated from all watersheds in this stratum.

Santa Cruz Mountains

The high numbers and rankings of so many threats in the Santa Cruz Mountain stratum suggest focused and immediate threat abatement actions are necessary to prevent extinction of coho in this area. Roads and Droughts are the greatest threats across this stratum, ranking as High or Very High threats in every watershed. Climate Change was also a serious threat, ranking as High in every watershed except Pescadero, Gazos, and Waddell Creeks. Fire and Fuel Management ranked as High in every watershed except Gazos and Waddell Creeks. The Storms and Flooding threat ranked as High or Very High in every watershed except Gazos, Waddell, and San Vicente Creeks. Logging and Wood Harvesting ranked as a high threat in five of the nine watersheds. Residential and Commercial Development were Very

High in San Gregorio, Soquel, and Aptos creeks and the San Lorenzo River. Water Diversions and Impoundments ranked as high in Pescadero and San Vicente Creeks, and in the San Lorenzo River.

Table 18: CAP data analysis results for current conditions across life stages and populations. VG=Very Good; G=Good; F=Fair; P=Poor; Blank=N/A or data forthcoming

Target	Habitat Attribute	Indicator	Usal	Cottaneva	Wages	Ten Mile	Pudding	Noyo	Caspar	Big	Albion	Big Salmon	Navarro	Garcia	Gualala	Russian	Salmon	Pine Gulch	Walker	Lagunitas	Redwood	San Gregorio	Pescadero	Gazos	Waddell	Scott	San Vicente	San Lorenzo	Soquel	Aptos
Spawning Adults	Hydrology	Passage Flows		VG		G	G	G	VG	G	G	VG	F	G	F	F		G	G	VG	G		F	G	VG	G	G	P		VG
Spawning Adults	Passage	Passage at Mouth	G	G	G	F	G	VG	G	VG	VG	VG	G	G	G	G	G	VG	VG	VG	G	G	G	G	F	F	G	G	G	G
Spawning Adults	Passage	Physical Barriers	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	F	P	VG	G	G	VG	VG	VG	VG	G	G	P
Spawning Adults	Sediment	Amount of Gravel*		VG		G	G	VG	VG	VG	VG	F	VG	F	F	F	F	G	F	P	G		P	F	VG	VG	P	VG		G
Spawning Adults	Viability	Adult Density	P	P	P	P	P	P	P	P	P	P	P	P	P	F	G	P	VG	P	P	G	P	G	P	F	F	F	P	VG
Spawning Adults	Viability	Freshwater Harvest	G	F	G	F	G	G	G	G	G	G	F	P	P	F	G	G	G	G	G	G	P	G	G	F	G	P	G	G
Eggs	Hydrology	Instantaneous Condition		VG		G	G	G	VG	G	F	VG	F	G	F	P		G	F	G	G		G	VG	VG	VG	G	F		G
Eggs	Hydrology	Redd Scour		VG		G	G	F	VG	F	F	G	P	F	F	P		VG	F	G	G		F	F	F	P	F	P		F
Eggs	Sediment	Gravel Quality (Bulk)		F	F	P	P	G	P	F	P	P	F	F	F	G	F	G	P	G	VG	F	P	F	G	P	F	P	F	P
Eggs	Sediment	Gravel Quality (Embeddedness)	G	G		P	P	P	P	F	P	G	G	G	P	G									F		P			
Summer Rearing	Hydrology	Baseflow		G		G	F	F	G	F	F	G	P	F	F	P		F	P	G	F		F	G	G	F	F	P		G
Summer Rearing	Pool Habitat	Primary Pools		P		P	F	P	P	P	P	P	P	P	P	P	P	P	P	G	P		P	F	P	P	P	P		P
Summer Rearing	Pool Habitat	Shelter Rating		P		P	P	P	P	P	P	P	P	P	P	P	P	F	P	P	P		P	F	P	P	P	P		P
Summer Rearing	Viability	Juvenile Density	P	F	P	P	F	P	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	F	P	P	P	P
Summer Rearing	Viability	Juvenile Distribution	P	F	P	F	G	F	VG	F	G	G	F	P	P	P	P	P	P	G	F	P	P	F	P	G	G	P	P	P
Summer Rearing	Water Quality	Temperature		F	F	P	F	P	G	P	F	F	P	P	P	P	F	G	P	P	G	F	P	F	F	F	G	P	F	F
Winter Rearing	Floodplain	Complex Habitat**	P	P	P	P	P	P	F	P	P	P	P	P	P	P	P	F	P	P	P	P	P	P	P	P	P	P	P	P
Smolts	Estuary	Estuary	F	G	F	G	VG	F	G	F	F	G	F	F	G	F	F	P	F	F	P	G	P	P	F	P	P	P	F	P
Smolts	Hydrology	Passage Flows		VG		G	G	G	VG	G	G	VG	F	G	F	P	F	G	G	VG	G		F	F	G	G	G	P		G
Smolts	Passage	# of Diversions**	VG	VG	F	G	G	G	VG	G	F	G	F	F	G	F	F	F	G	F	P	P	P	P	F	F	VG	P	F	G
Multiple Life Stages	Floodplain	Floodplain Connectivity	G		G		F	F	G	F	F	F	F			P	F	F	F	P	P	P	P	P	F	G	G	F	P	G
Multiple Life Stages	Hydrology	Impervious Surfaces ***	VG	VG	VG			G	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG		VG	VG	VG	VG	VG	VG	VG	G	VG	VG
Multiple Life Stages	Hydrology	Stand Age	G		F			G	G		F		G		P	P	F	G	P	G	G	G	G	G	G	G	G	G	G	G
Multiple Life Stages	Land disturbance	Agriculture ***	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	G	VG	G	G	G	F	P	F	G	G	G	G	G	G	G	G	G	G
Multiple Life Stages	Land disturbance	Timber Harvest ***	G	F	F	P	F	G	VG	G	P	P	G	G	G	VG	VG	VG	G	G	G	VG	G	VG	VG	VG	G	VG		VG
Multiple Life Stages	Pool Habitat	LWD <10m	P	P	P	F	P	P	VG	P	P	F	P	F	P	P	P	F	P	P	VG	P	P	G	P	P	P	P	VG	P
Multiple Life Stages	Pool Habitat	LWD >10m	P		P	P	F	P		P	F		P	P	P	F	P	P	P	F	F	P	P	P	P	P		P	P	
Multiple Life Stages	Pool Habitat	Shelter Rating		P		P	P	P	P	P	P	P	P	P	P	P	P	F	P	P	P		P	P	P	P	P	P		P
Multiple Life Stages	Riparian Veg.	Canopy Cover	F	G	F	F	G		G	F	G	P	F	P	F	P	F	P	P	F	P	F	P	G	G	G	F	G	G	G
Multiple Life Stages	Riparian Veg.	DBH	G	G	F	P	P	F	G	P	F	P	P	F	P	P	F	P	P	F	F	G	G	G	G	G	G	G	G	F
Multiple Life Stages	Riparian Veg.	Species Composition	P	G	G	G	G	G	F	F	G	G	F	F	F	F	F	G	P	G	F	G	F	G	VG	G	G	G	G	G
Multiple Life Stages	Sediment Transport	Road Density ***	P	P	P	P	P	P	P	P	P	P	P	P	P	P	F	VG	VG	G	P	F	F	G	G	F	P	P	P	P
Multiple Life Stages	Sediment Transport	Road density 100 ***	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	F	P	P	P	P	P	P	P	P	P	P	P	P
Multiple Life Stages	Water Quality	Toxicity	G	G	G	G	G	F	G	F	G	G	F	G	F	F	G	F	P	G	F	F	G	F	F	F	F	P	F	G

Table 19: CAP threat rank results across populations. VH=Very High; H=High; M=Moderate; L=Low; /= N/A

Threat	Usal	Cottaneva	Wages	Ten Mile	Pudding	Noyo	Caspar	Big	Albion	Big Salmon	Navarro	Garcia	Gualala	Russian	Salmon	Pine Gulch	Walker	Lagunitas	Redwood	San Gregorio	Pescadero	Gazos	Waddell	Scott	San Vicente	San Lorenzo	Soquel	Aptos
Agricultural Practices	L	M	M	M	M	L	L	L	M	M	M	M	H	H	M	M	M	M	M	H	H	M	M	H	M	M	M	M
Channel Modification	M	M	M	M	H	M	M	M	M	M	M	M	M	M	H	H	M	H	VH	M	M	M	H	H	M	H	M	M
Climate Change	M	M	M	M	M	M	M	M	M	M	M	M	M	M	H	M	M	H	H	H	M	M	M	H	H	H	H	H
Disease, Predation, and Competition	M	M	M	M	M	L	L	L	L	M	L	L	L	M	L	L	M	L	L	L	H	H	M	L	M	H	M	H
Droughts	H	M	M	H	H	M	M	M	M	H	H	M	H	H	VH	VH	M	H	VH	VH	VH	M	H	H	H	H	H	H
Fire and Fuel Management	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	H	H	H	M	M	H	H	H	H	H
Fishing and Collecting	M	L	M	L	L	L	L	L	L	L	L	M	M	M	L	L	L	L	L	M	M	L	L	L	L	M	M	M
Hatcheries and Aquaculture	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	M	L	L	L	L	L	L	L
Livestock Farming and Ranching	L	M	M	M	M	L	L	L	M	L	M	M	M	M	H	M	VH	M	M	M	M	M	L	M	M	M	M	M
Logging and Wood Harvesting	M	H	H	H	H	VH	H	H	H	H	M	H	H	M	M	M	L	M	M	M	H	M	M	H	M	H	H	H
Mining	M	M	L	M	M	L	L	L	M	M	L	M	M	M	M	M	M	L	L	L	M	L	M	M	VH	M	M	L
Recreational Areas and Activities	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	H	M	H
Residential and Commercial Development	M	M	M	M	M	M	M	M	M	M	M	M	M	H	M	M	M	H	M	VH	H	M	M	M	M	VH	VH	VH
Roads and Railroads	H	H	H	VH	H	H	H	H	H	H	H	M	H	H	M	M	M	H	H	H	H	H	H	H	H	VH	H	VH
Storms and Flooding	M	M	H	M	M	M	M	H	M	M	H	H	M	M	VH	M	M	M	M	H	H	M	M	H	M	VH	H	H
Water Diversion and Impoundment	M	M	M	M	M	M	M	M	M	M	M	M	M	H	H	H	M	H	M	VH	M	M	M	M	M	H	H	M

Table 20: CCC Coho Salmon ESU Focus Populations, Spawner Targets and Threats

Stream Name	County	Diversity Stratum	# Spawners	Threats
Albion River	Mendocino	Lost Coast	2,300	Roads; Logging
Aptos Creek	Santa Cruz	Santa Cruz Mnts	932	Roads; Urbanization
Big River	Mendocino	Lost Coast	5,500	Roads; Logging
Big Salmon Creek	Mendocino	Lost Coast	578	Roads; Logging
Caspar Creek	Mendocino	Lost Coast	435	Roads; Logging
Cottaneva Creek	Mendocino	Lost Coast	469	Roads; Logging
Garcia River	Mendocino	Navarro Point	2,800	Logging; Flooding
Gazos Creek	San Mateo	Santa Cruz Mnts	279	Roads; Droughts
Gualala River	Mendocino/Sonoma	Navarro Point	6,200	Roads; Logging
Lagunitas	Marin	Coastal	2,600	Urbanization; Droughts
Navarro River	Mendocino	Navarro Point	5,700	Roads; Droughts
Noyo River	Mendocino	Lost Coast	4,000	Logging; Roads
Pescadero Creek	San Mateo	Santa Cruz Mnts	2,300	Droughts; Agriculture
Pine Gulch Creek	Marin	Coastal	252	Droughts; Water Diversion
Pudding Creek	Mendocino	Lost Coast	983	Roads; Logging
Redwood Creek	Marin	Coastal	272	Droughts; Channel Mod.
Russian River	Sonoma	Coastal	10,100	Agriculture; Urbanization
Salmon Creek	Sonoma	Coastal	1618	Droughts, Flooding
San Gregorio	Santa Cruz	Santa Cruz Mnts	1,363	Water Diversion; Urbanization
San Lorenzo River	Santa Cruz	Santa Cruz Mnts	4,200	Urbanization; Roads
San Vicente	Santa Cruz	Santa Cruz Mnts	105	Mining; Roads
Scott Creek	Santa Cruz	Santa Cruz Mtns	510	Roads; Logging
Soquel	Santa Cruz	Santa Cruz Mtns	1,122	Urbanization,; Logging
Ten Mile River	Mendocino	Lost Coast	3,700	Roads; Logging
Usal Creek	Mendocino	Lost Coast	360	Droughts, Roads
Waddell Creek	Santa Cruz	Santa Cruz Mnts	313	Climate; Roads
Wages Creek	Mendocino	Lost Coast	340	Logging; Roads
Walker Creek	Marin	Coastal	2,800	Grazing; Droughts