21. Little River Population

- Central Coastal Stratum
- Non-Core, Potentially Independent Population
- Moderate Extinction Risk
- 140 Spawners Required for ESU Viability
- 45.9 mi^2
- 34 IP-km (21 mi) (46% High)
- Dominant Land Uses are 'Agriculture' and 'Timber Harvest'
- Principal Stresses are 'Altered Sediment Supply' and 'Lack of Floodplain and Channel Structure'
- Principal Threats are 'Timber Harvest' and 'Agriculture'

21.1 History of Habitat and Land Use

The most prominent land use in the Little River basin, and the most damaging, has been timber harvest. The first sawmill opened on the Little River in 1909, and the logging town of Crannell was built soon after on the coastal plain near the mouth of the Little River. The basin was intensely harvested throughout the early 1900s. The river was modified for sawmill use and logging operations. Historic photographs from the Humboldt State University Library's Boyle Collection show a millpond at the mouth of Bullwinkle Creek and the main channel of Little River flowed through the mill (Figure 21-2). Historic pictures also show a fish ladder, but how well it functioned is unknown. Crannell was a booming town and even had its own railroad with 18 miles of railway, which was used for hauling timber to and from the mill. Historic logging practices severely degraded habitat throughout the basin (Figure 21-3).

Large-scale clear cuts, road construction, skid trails, and landings occurred on the highly erodible Franciscan soils that are dominant throughout the basin. These practices led to many slope failures, delivering sediment into the stream and severely aggrading the system. During the years of intense harvest, the river likely flowed with high amounts of turbidity, severely affecting development and behavior of all fish species. Additionally, trees were cut in the sensitive riparian zone, removing potential for instream wood recruitment and exposing the stream to increased solar radiation. Over a short period of time the combination of increased sediment and removal of large wood led to a highly disturbed basin with highly degraded fish habitat conditions.

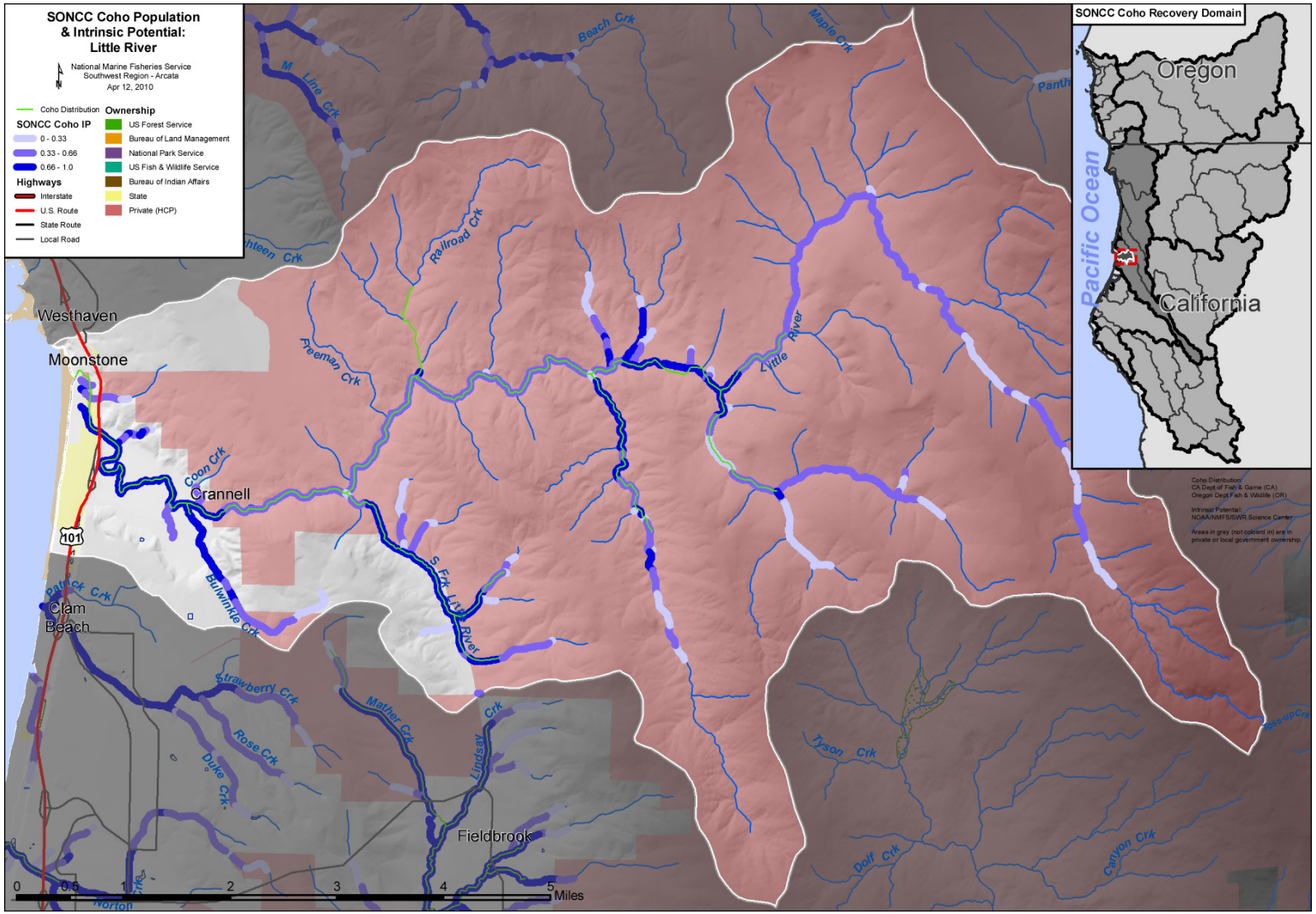

Figure 21-1. The geographic boundaries of the Little River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

Figure 21-2. Historic Little River Redwood Company saw mill. Courtesy of Humboldt State University Library.

Figure 21-3. Logs on landing. Courtesy of Humboldt State University Library

Today, the historic town of Crannell has all but faded away. The flat coastal plain near the mouth of the Little River is now occupied by a few farm houses and large agricultural fields with virtually no remnants of the mill or town that once dominated the valley. Agriculture is now the primary land use in the valley. The land is used for grazing livestock and cranberry farming.

While the effects of grazing are less disturbing to salmonids and their habitat than the previous logging practices, adverse effects are still present. Livestock that are not properly fenced out of riparian zones are degrading the sensitive vegetation in these areas and contributing to bank instability and erosion. This further exacerbates the issue of excess sediment in the lower basin. Other agricultural practices, such as construction of cranberry bogs, have destroyed riparian and seasonal wetlands next to Little River. High IP reaches occur where agricultural lands dominate, which decreases rearing habitat quality and limits coho salmon production potential.

The majority of the basin in the uplands is still managed for timber production, which is mostly under the guidelines of current state timber harvest regulations and an aquatic habitat conservation plan (HCP). Management under the HCP helps protect the river from many of the destructive practices that originally took place. An extensive road system, with road density >3 mi./sq. mi., winds through the basin, contributing to runoff of surface material and increasing sediment delivery to streams. Gibbons and Salo (1973) concluded that sediment input per unit area from roads is usually greater than input from all other timber harvesting activities. Highly erosive geology in combination with extensive timber harvest and road building over the years has led to mass wasting events, deep-seated landslides, and chronic sediment delivery into Little River.

21.2 Historic Fish Distribution and Abundance

Historic coho salmon abundance data in the Little River prior to development in the basin is unavailable to infer trends, however recent data suggest the system can support, and likely has supported in the past, substantial numbers of coho salmon for its size. The IP model suggests that the areas with the highest potential for coho salmon production occur in the lower reaches of the Little River and its tributaries. Also, the Lower South Fork and mainstem Little River near its confluences with the Lower South Fork and Upper South Fork provide high production potential.

Currently, coho salmon appear to be distributed throughout the mainstem and in lower portions of the major tributaries. Coho salmon consistently spawn and rear in these areas, and occur in generally moderate abundance. This conclusion is supported by limited spawner survey and juvenile monitoring data. Since 1998, Green Diamond Resource Company (Green Diamond, GDRC) has monitored juvenile out-migration in four tributaries (Lower South Fork, Upper South Fork, Carson Creek, and Railroad Creek). Combining results from all tributaries between 1999 and 2009, out-migrant population estimates for Little River are highly variable and fluctuate between 200 and 5,800 smolts (Figure 21-4). The average annual out-migrant production over this time was 3,156, with the highest production in Carson Creek (1,596) and the lowest in Railroad Creek (71).

A combination of presence/absence data from CDFG, NMFS, and Green Diamond is available for additional tributaries that are not regularly monitored. Coon Creek, Water Gulch, C-Line Creek, and Pattie's Creek have no records of coho salmon presence. Bullwinkle Creek, Freeman Creek, Railroad Creek, Danielle Creek, and Heightman Creek show coho salmon presence from Green Diamond records only (GDRC 2006 and 2009, Perry 2009). Production varies by tributary and by year, but the basin is able to consistently produce coho salmon smolts.

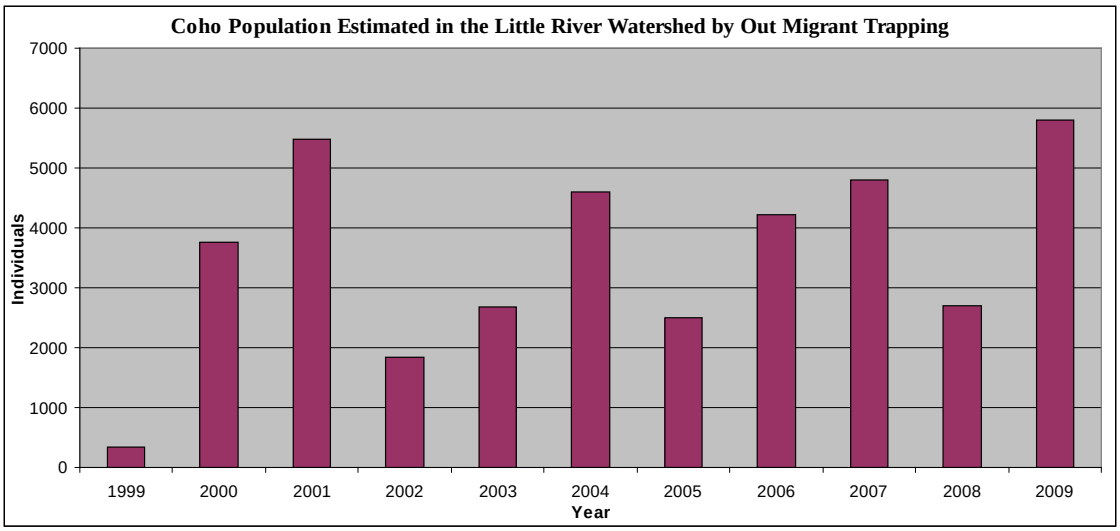

Figure 21-4. Out-migrant population estimates. Estimates are from Little River tributaries 1999 to 2009 (Carson Creek trap was added as a trapping location in 2000).

Young-of-the-year snorkel surveys in three major tributaries (Lower South Fork, Railroad Creek, and Upper South Fork) were conducted to estimate the summer juvenile coho salmon population over this same time period (1999 to 2009). Outmigrant trapping data was then used in combination with fry population estimates from the previous year to estimate overwintering survival in each of the tributaries. The calculated overwinter survival rates varied greatly, but provide good estimates of rearing potential in the system. Outmigrant trapping only documents fish that are moving through the system in the spring. It is assumed that many fish may move out of the tributaries earlier to rear in the mainstem or estuary. Because early outmigrants are not captured, the overwinter survival rate is probably underestimated. Additionally, in some years, Railroad Creek had an outmigrant population estimate that was greater than the fry population estimate. This may simply be observer error, but could also be an indication of a life history strategy where fry from other tributaries are moving into Railroad Creek to seek refugia. Based on available data, Railroad Creek and Upper South Fork show the highest overwintering survival rates between 1999 and 2009 (average 27.6 and 26.2 percent, respectively); while Lower South Fork had substantially lower survival rates (average of 17.0 percent). Studies in other basins have shown survival rates between 1.2 and 1.7 percent between the fry and smolt life stage (Godfrey 1965) so this basin appears to have very good rearing conditions in these creeks (GDRC 2006).

Spawning surveys were conducted in 6 streams within the Little River HPA from 1998 through 2000. Unfortunately, because of high flows and turbid waters, few adult coho salmon were observed. A total of 18 adult coho salmon were seen in Railroad Creek during that time. Because of the lack of adult spawning data, juvenile surveys provide the best indication of distribution in the Little River.

Table 21-1. Tributaries with instances of high IP reaches (IP value > 0.66). (Williams et al 2006).

Stream Name	Stream Name	Stream Name
Bullwinkle Creek	Railroad Creek	Lower South Fork Little River
Carson Creek	South Fork Little River	Upper South Fork Little River

21.3 Status of Little River Coho Salmon

Spatial Structure and Diversity

Although coho salmon maintain some spatial diversity by using select tributaries, many tributaries appear to be underutilized. Only a few known unnatural barriers exist within the basin, which allows coho salmon to access different watersheds and improves the overall connectivity and diversity of the population. The major tributaries of the Lower South Fork, Upper South Fork, Carson Creek, and Railroad Creek are all proven coho salmon producing tributaries within the Little River basin. Underutilized areas include Coon Creek, Water Gulch, C-Line Creek, and Pattie's Creek, which have no records of coho salmon presence. These creeks have moderate and high IP values, suggesting coho salmon likely occupied habitat in these areas. The low numbers of coho salmon and minimally known unique life history traits suggest an overall low diversity within the population.

Quality of instream habitat may be the main limiting factor to coho salmon distribution. Some creeks, such as Bullwinkle Creek, have been modeled as having high intrinsic potential; however no coho salmon have been observed. Perhaps because of the history of the millpond and the alterations made to streams like this in the past, coho salmon have not been able to recolonize the habitat. Other creeks located in the lower basin probably have similar levels of degraded habitat due to the history of intense modification during the early 1900s.

Carson Creek contains high IP habitat and surveys have shown this tributary to be the greatest producer of juvenile coho salmon. Lower South Fork Little River and Carson Creek have much higher production than any other tributaries in the Little River. Lower South Fork also had the highest average overwintering survival rate for coho salmon. High production and overwintering data suggest that these creeks contain high quality habitat.

The more restricted and fragmented the distribution of individuals within a population, and the more spatial distribution and habitat access diverge from historic conditions, the greater the extinction risk. Williams et al. (2008) determined that at least 41 coho salmon per-IP km of habitat are needed (1,400 spawners total) to approximate the historical distribution of Little Creek coho salmon and habitat. Currently, coho salmon appear to have access to most historically occupied habitats in the basin but are limited by habitat quality in some areas.

Population Size and Productivity

The population of coho salmon in Little River is depressed from historic levels modeled by Williams et al. (2006); however, the last decade of monitoring suggests the juvenile coho salmon

population may be somewhat stable with no recognizable downward trends (GDRC 2009). Current data suggest that the population produces approximately 2,000 to 6,000 smolts per year from various tributaries throughout the basin. Although spawning estimates are unknown, considering that the basin produces over 16,000 fry a year then there are likely at least 66 spawning pairs on average in any given year. Currently, the population likely contains less than 200 adults. This is based on an average of 2,000 eggs per female and an egg mortality rate of 88 percent (Neave 1949; Crone and Bond 1976). Based on the biological data collected in the last decade, it appears the Lower South Fork Little River and Carson Creek have much higher production than any other tributaries in the Little River. The Lower South Fork also had the highest average overwintering survival rate for coho salmon.

At least 34 coho salmon must spawn in the Little River each year to avoid effects of extremely low population sizes, and 140 spawners are needed to be at the moderate risk threshold and be 90% confident that the population will not fall below the depensation threshold (Chapter 4). Currently, the number of spawning adults in the population is greater than moderate risk threshold of 140, but less than the low risk spawner threshold for the population (1,400; Williams et al. 2008.

Because the basin is still in a state of recovery from historic logging practices and stress and threats from timber harvest and agriculture remain, the population hasn't had a chance to fully recover. Even though population numbers seem to be stable, the overall abundance is much lower than historic condition and below the low-risk threshold.

Extinction Risk

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

Role in SONCC Coho Salmon ESU Viability

The Little River population is a potentially independent population (Williams et al. 2008), with a high likelihood of persisting in isolation over 100-year time scales, but is strongly influenced by immigration from other populations and does not exhibit dynamics independent of other nearby populations. Several nearby populations may interact with the Little River population. The Maple Creek population to the north is a potentially independent population (Williams et al. 2008), and may produce coho salmon strays that spawn in the Little River. Maple Creek has a lagoon that breaches its sandbar annually, allowing adult fish to reach their spawning grounds. Occasionally, the lagoon may not breach during the winter, and adult coho salmon are forced to find other basins to spawn. Little River is the first major stream south of Maple Creek. In years when Maple Creek is inaccessible, coho salmon from the Maple Creek population likely enter the Little River.

Because these nearby populations also have low abundance, the adjacent populations are not likely contributing large numbers of spawners to the Little River. The Little River population, in fact, may be contributing strays to adjacent populations, and may influence their dynamics. Ultimately, recovery of the Little River population depends on concurrent improvements to the status of all coastal populations.

21.4 Plans and Assessments

California Department of Fish and Game

Recovery Strategy for California Coho Salmon

Coho salmon north of San Francisco are listed as threatened under the California Endangered Species Act, and this document describes a recovery strategy for the species in California. The Little River HSA is included in the Trinidad HU, and the strategy contains specific recommendations for the restoration of Little River and its major tributaries. Most recommendations address the impacts of logging and agriculture in the lower river basin. Restoration actions focus on the rehabilitation of the riparian zone and estuary.

Green Diamond Resource Company

Green Diamond HCP

The Green Diamond HCP (GDRC 2006) outlines a plan for the conservation of aquatic species in select watersheds in the Little River. The majority of the roughly 99.4 percent of private land in the Little River is owned by Green Diamond and therefore managed according to the provisions of the HCP. The plan was developed in accordance with the ESA section 10 regulations which require Green Diamond to develop a conservation strategy to minimize and mitigate the potential adverse effects of any authorized taking of aquatic species that may occur incidental to Green Diamond's activities; to ensure that any authorized take and its probable impacts will not appreciably reduce the likelihood of survival and recovery in the wild of aquatic species; and contribute to efforts to reduce the need to list currently unlisted species under the ESA in the future by providing early conservation benefits to those species. The plan has a number of provisions designed to protect coho salmon and salmon habitat throughout the Little River.

Under the provisions of the Green Diamond HCP, the company conducted initial assessment of salmon populations and habitat and conduct ongoing monitoring of certain physical and biological metrics. Initial channel and habitat typing assessments as well as LWD surveys, and juvenile presence/absence and spawning surveys were conducted on tributaries on Green Diamond land between 1994 and 1998 (GDRC 2006). Green Diamond also conducts long-term monitoring of instream habitat, water quality, mass wasting and slope stability, LWD, summer juvenile salmon population estimates, and out-migrant salmon abundance. Juvenile fish surveys and outmigrant trapping is conducted on the Little River. A report summarizing the results of these monitoring efforts is submitted to NMFS every other year.

Pacific Coast Fish Wildlife and Wetlands Restoration Association

21.5 Stresses

Table 21-2. Severity of stresses affecting each life stage of coho salmon in the Little River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

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

[1] Key limiting factor(s) and limited life stage(s).
[2] Increased Disease/Predation/Competition is not considered a stress for this population.

Limiting Stresses, Life Stages, and Habitat

Land use in the Little River basin has led to an increase in sediment and a lack of instream wood, which are the greatest stressors for this population. Filling of pools by excess sediment combined with lack of wood to sort and meter out sediment or provide complex habitat has degraded rearing habitat. Over wintering and summering juvenile coho salmon is the most limited life stage due to the degraded quality of rearing habitat that should provide deep pools and complex channels for juveniles to escape high velocity flows during the winter season and provide cover during the summer season.

Increased channel complexity in the Little River basin would provide vital habitat for juvenile rearing opportunities. Historically, greater habitat complexity existed within the basin, but has been degraded by the long history of intense timber harvest. Currently, the lack of LWD due to past logging practices and the increase in sediment supply reduce complexity by filling in pools and reducing habitat structure. Additionally, a historic network of tidal and backwater channels once existed in the estuary. Highway 101 acts as a dike, channelizing and filling the historic channels that once provided high quality rearing habitat for coho salmon. Carson Creek contains high IP habitat and surveys have shown the tributary to be the greatest producer of juvenile coho salmon. Winter survival rates have been calculated highest in the Lower South Fork Little River. These tributaries should be noted as vital habitat for the population.

Altered Sediment Supply

Altered sediment supply is the highest stress affecting all life history phases of coho salmon, imposing a very high stress on all sub-adult life stages and a high stress on adults. Increased sediment delivery is a result of high road density, timber harvest, and agriculture in the lower Little River. An increase in fine sediment contributes to multiple problems including the simplification of stream habitat, increased turbidity, and increased embeddedness, which reduces survival rates of eggs. Additionally, fine sediment can interfere with gill function, feeding, and other normal behaviors of juvenile coho. The high stress ranking was based on measurements of D50 (particle size) and V* (a measure of pool filling), which were derived from surveys conducted in upper portions of the basin. The D50 of particle sizes was rated as fair, (38 to 50 and 110 to 128) indicating the mean size of substrate is smaller than desired. The V* was rated as poor (>0.35), indicating pools were filled with excess fines.

Lack of Floodplain and Channel Structure

Lack of floodplain and channel structure is a high stress across all life stages of coho salmon. Simplified channel and floodplain structure are primarily the result of a lack of large wood in the Little River system, an overabundance of fine sediment, and levees in the lower Little River. Green Diamond completed large wood surveys for the Little River Basin in 2009. Table 21-3 shows the results of the survey. The results of the survey show that South Fork Little River and Railroad Creek have the highest volume of large wood, while the mainstem Little River has the lowest volume (GDRC 2009). It can be assumed that with the history of logging in the area, the basin likely experiences low wood recruitment. Large wood is required to sort sediment, scour pools, and facilitate channel complexity. The V* surveys in the upper basin indicate pool habitat is filling with sediment. The oversimplified stream channel and floodplain provide fewer refugia and less rearing habitat for juveniles, and attributes such as deep pools and side channels are reduced in number.

Table 21-3. Large woody debris survey for Little River and its tributaries. Surveys were done in 1994 and 1995. Volume calculation comes from separate spreadsheet (GDRC 2006).

Stream	Surveyed Length (feet)	Metric (per 100' stream)	Size Classes of In-channel Large Wood; Max Diameter (ft)					
			1-1.9	2-2.9	3-3.9	≥4	Total Pieces	Total Volume (ft^3)
Carson Creek (SF Little River)	12356	Pieces	6	1	0	0	8	1603
Carson Tributary	3021	Pieces	4	2	1	0	8	1767
Little River	14497	Pieces	2	0	0	0	3	1000
Lower South Fork Little River	9847	Pieces	4	2	0	0	8	2203
Railroad Creek	6877	Pieces	4	2	1	1	8	22669
Upper South Fork Little River	9673	Pieces	3	1	0	0	5	1858

Riparian Forest Conditions

The degraded riparian forest conditions across the Little River basin are rated as a medium to high stress for coho salmon with the greatest impacts to fry and juvenile life stages. As described above, a healthy riparian forest is essential to the continued input of wood into streams, to riparian shading and hydrologic function, and to the creation of complex fish habitat and stream morphology. Currently, riparian areas lack old growth conifer trees and are now dominated by second growth hardwood species, primarily red alder (GDRC 2006). A diverse age class of conifers is needed to supply a source for future wood recruitment. This stress is especially significant in the lower floodplain, which is dominated by agricultural land and experiences chronic destruction of the riparian vegetation through grazing. The riparian zone in these lowlands is dominated by dense shrubs such as willow and blackberry and provides reduced potential for future large wood recruitment

Impaired Estuary/Mainstem Function

This stress refers to just the estuary conditions in the Little River, since this is a single population basin. Mainstem conditions are addressed through other stressors such as floodplain and channel structure, riparian condition, hydrologic function, etc. Estuary function is important to the population because of its unique role in the life history and survival of coho salmon.

The Little River has a large tidally influenced area for its size. The outlet of the Little River is surrounded by Moonstone Beach County Park and Little River State Park. Approximately 0.75 river miles of mud flat, wetland, and sandbar habitat exist downstream of Highway 101. Upstream, the estuary and many associated tidal channels have been diked, filled, and channelized for agricultural purposes and the riparian vegetation has been cleared or degraded by grazing. Estuarine function is severely hampered by the lack of channel structure and the loss of tidal wetland and tidal channels. Currently only a few off-channel and backwater habitats occur within the estuary. Although the past extent of the estuary is unknown, based on similar coastal systems, the current extent of the estuary is far less than what it was historically. Estuarine habitats are important for juvenile rearing during the summer and historically provided numerous opportunities for growth and refuge for juveniles and smolts. The reductions in estuarine function is considered a high stress for juvenile and smolt life stages because of the lack of quality rearing habitat and the lack of refugia and holding habitat. Impaired estuarine function is considered a medium stress for adults in the population.

Impaired Water Quality

Water quality in the Little River has been rated as a medium stress across all life stages of coho salmon. Water temperature monitoring has occurred since 1994 at 14 different sites in 11 permanent, fish bearing channels. Temperature has been rated as good (14 to 15 °C) throughout the basin, although a few locations in the lower floodplain zone had temperatures readings up to 17 °C. Warmest temperatures (17 to 19 ºC) occurred in the lower mainstem Little River and in the Lower South Fork Little River. The coolest of the maximum recorded temperatures (11 to 12 ºC) occurred in the upper portions of the mainstem Little River, the upper portions of the Lower South Fork Little River and in Railroad Creek (Hurt 1969, GDRC 2009). Despite inadequate

riparian cover, water temperature stays relatively cool due to the basin's location within the summer fog zone. Air temperature remains mild in this region year round.

Barriers

Barriers provide a low to medium stress for coho salmon in the Little River basin. There are no documented artificial barriers in the basin although there are several natural barriers in the form of falls and plunge pools in the upper reaches. There is potential for undocumented barriers on the private land in the upper basin, particularly with the high densities of road (e.g., >3 mi. /sq. mi. of basin) that are present there. Barriers primarily affect fry and juvenile coho, limiting access to summer and winter rearing areas.

Hydrologic Function

Altered hydrologic function is described as a low to medium threat for coho salmon. There are three water diversions present in the basin. The quantity of water that is withdrawn from these diversions and their overall impact on stream flows in the basin is unknown. In addition to diversion withdrawals, the dense road network in the basin (e.g., >3 mi. /sq. mi. of basin) contributes to altered hydrologic function by disconnecting many small streams from their natural courses. Inboard ditches can divert water out of its natural drainage, spilling it overland outside of a natural channel.

Adverse Fishery-Related Effects

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

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no operating hatcheries in the Little River population area. Hatchery-origin adults may stray into the population area; however, the proportion of adults that are of hatchery origin is unknown. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin and there are no hatcheries in the basin (Appendix B).

21.6 Threats

Table 21-4. Severity of threats affecting each life stage of coho salmon in the Little River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H

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

[1]Mining/Gravel Extraction, and Invasive Non-Native/Alien Species are not considered threats to this population.

Roads

Roads represent the most significant threat across all life stages of coho salmon in the Little River population. Road density is very high (>3 mi. /sq. mi. of basin) throughout the basin and most roads are unpaved logging and private roads. The high density of roads is the most significant contributor of sediment delivery within the basin. Sediment from roads results from road-related landslides, chronic erosion of native road surface and cut and fill slopes, and road-stream crossing failures. Roads can lead to landslides and mass wasting events where the entire roadbed can become saturated and fail, creating major sediment and diversion issues. Road maintenance can also contribute gravel spoils to the stream during grading or re-surfacing. Chronic sediment from surface runoff delivers silt to the stream, increasing water turbidity.

Roads interfere with the stream network by increasing sediment delivery at crossings and often diverting water away from natural drainages via inboard ditches. Basin-wide, an average of 30 percent of the road network in the Little River basin is estimated to be hydrologically connected to the stream network (GDRC 2006). On private property in the upper basin, inventory data

described in the Green Diamond HCP stated 74 percent of the road network on Green Diamond land, or approximately 218 miles, are hydrologically connected (GDRC 2006). Overall, the degree of connectivity varies greatly across the basin, but is potentially high in many areas (NMFS 2007a). Hydrologic connectivity to roads increases the amount of sediments delivered to streams and the channelization and diversion that occurs as a result of road surface. Without proper upgrading and decommissioning of roads in the basin, impacts are likely to continue in the future and increase in magnitude as more roads become degraded and more roads are built.

Timber Harvest

Timber harvest has been a major threat in the basin since the early 1900s and continues to threaten aquatic habitat and coho salmon today. Within Green Diamond Resource Company property, harvest occurs under the direction of the company's HCP. This plan lays out goals and procedures to minimize and mitigate effects from timber harvest through measures related to road and riparian management, slope stability, and harvesting activities. At any given time, a portion of the Little River basin is being used for timber harvest and the impacts of such land use, even if carried out under the HCP guidelines, include the reduction of pool habitat, LWD and stream complexity; altered hydrology and nutrient cycling; and increased sediment loads.

Agricultural Practices

Next to timber harvest, agriculture is the predominant land use in the lower Little River basin and represents a high threat, especially for sub-adult life stages. The land is used for grazing livestock, hay operations, and also a minor amount of cranberry bogs. There is little to no livestock exclusion from the river and animals often trample streambanks and overgraze the riparian vegetation. The grazing of livestock adjacent to the stream leads to eroded banks and an excess of sediment and nutrients entering the water. In addition, diversions and ditches associated with agriculture in the area contribute to degraded habitat conditions and poor hydrologic connectivity. The reduction of estuarine function in the Little River is primarily the result of conversion of lowland estuarine habitat to agricultural land and the agricultural practices that occur in the estuarine floodplain.

Channelization/Diking

Most channelization and diking occurs in the lower Little River and is associated with flood protection and agriculture. Ditches and dikes occur in the lower two miles of the Little River, constraining flow and off-channel access for juvenile rearing. Channelization limits habitat complexity and diversity as well as altering the stream hydraulically. A channelized stream has a greater velocity and can erode banks as the stream tries to attain sinuosity. Juvenile fish depend on off channel areas and sinuous channels for rearing. The lower part of the basin where most of the channelization has occurred, in its natural state would form the most complex channels, providing the greatest value to rearing coho salmon. The loss of such complex habitat is a great detriment to the system.

Dams/Diversions

There are no dams in the basin; however, a few water diversions occur on Little River and Bullwinkle Creek that withdraw unknown amounts of water. As described above in the roads

section, diversions also occur as roadside ditches. Diversions affect hydrologic connectivity and function through the loss and alteration of flow. Diversions pose a moderate threat to coho salmon in this population. Juveniles are especially vulnerable to the impacts from unscreened diversions as they are often entrained in such features.

High Intensity Fire

Vegetation and climate conditions in the basin make it naturally prone to low intensity, infrequent fire. However, unnatural fuel loads and changing climate could make this a greater threat if not fully addressed. The management of the timberlands by Green Diamond and other private timberland owners can alter the natural fire regime. Densely wooded and even-aged stands can have increased potential for fire, whereas thinning and prescribed burning can reduce the potential for large-scale fire. Green Diamond's HCP prioritizes units for low intensity, controlled burns to reduce the buildup of excess fuels and reduce the risk of high intensity fire. The effects of high intensity fire could be severely detrimental, creating excessive amounts of erosion, loss of riparian vegetation, and degraded water quality.

Urban/Residential/Industrial Development

Historically, the logging town of Crannell presented a very high threat to all coho salmon life stages due to industrial and residential development, railroad construction, and extensive road systems. Currently, urban, residential, and industrial development is listed as a medium threat due to the low levels of development in the area. Development is limited to the few homes and ranches in the lower basin. Residential development could pose a greater threat in the future due to the close proximity of the basin to the large urban centers of McKinleyville and Arcata, California. As these communities grow, it is possible that the area could be rezoned and developed.

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. The effects of these fisheries on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. NMFS has authorized future collection of coho salmon for research purposes in the Little River, and has determined that these collections are not likely to jeopardize the continued existence of the SONCC coho salmon ESU.

Road-stream Crossing Barriers

Road-stream crossing barriers are defined as a low threat. There are currently no documented barriers created by road stream crossing within the basin. GDRC and local restoration groups continue to decommission roads and upgrade crossings in the upper basin, which in turn lessens this threat. Working with landowners in the lower basin will be important in the future to prevent any barriers from being created in this important rearing area.

Climate Change

Climate change poses a low threat to this population due to its cooler climate and low risk of average temperature increase and precipitation change over the next 50 years (see Appendix B for modeling methods). Also, with all populations in the ESU adults will be negatively impacted by ocean acidification and changes in ocean conditions and prey availability (see Independent Science Advisory Board 2007, Feely et al. 2008, Portner and Knust 2007).

Hatcheries

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

21.7 Recovery Strategy

Coho salmon abundance in the Little River basin is depressed, but appears to be fairly stable. Juvenile outmigrant trapping and juvenile snorkeling surveys have shown good rearing productivity within the Little River basin. Most encouraging is the documented generally high juvenile survival. Recovery activities should focus on habitat restoration aimed at increasing the quality of habitat over a wider range within the basin, encouraging greater spatial diversity and increased production potential. Restoration should particularly focus on the high IP tributaries such as Carson Creek, Bullwinkle Creek and the South Fork Little River, as well as restoring habitat to benefit summer rearing. Activities that reduce sediment delivery and increase large wood will help increase habitat complexity, water quality, and channel and floodplain structure. Excluding livestock from the riparian corridor and re-establishing riparian vegetation adjacent to the river are important recovery actions for all coho life stages in the lower basin.

Table 21-5 on the following page lists the recovery actions for the Little River population.

Table 21-5. Recovery action implementation schedule for the Little River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	***Step Description***					
SONCC-LitR.2.1.2	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Estuary and Bullwinkle, Lower & Upper South Forks, Railroad, and Carson Creeks	2
SONCC-LitR.2.1.2.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-LitR.2.1.2.2	*Place instream structures, guided by assessment results*					
SONCC-LitR.2.2.3	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Remove, set back, or reconfigure levees and dikes	Estuary	3
SONCC-LitR.2.2.3.1	*Assess feasibility and develop a plan to remove or set back levees and dikes that includes restoring the natural channel form and floodplain connectivity once the levees have been removed*					
SONCC-LitR.2.2.3.2	*Remove levees and restore channel form and floodplain connectivity*					
SONCC-LitR.8.1.1	Sediment	Yes	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	3
SONCC-LitR.8.1.1.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-LitR.8.1.1.2	*Decommission roads, guided by assessment*					
SONCC-LitR.8.1.1.3	*Upgrade roads, guided by assessment*					
SONCC-LitR.8.1.1.4	*Maintain roads, guided by assessment*					
SONCC-LitR.1.2.4	Estuary	No	Improve estuarine habitat	Restore estuarine habitat	Estuary	3
SONCC-LitR.1.2.4.1	*Assess tidally influenced habitat and develop a plan to restore tidal channels*					
SONCC-LitR.1.2.4.2	*Restore natural tidal channel form and function, guided by the plan*					
SONCC-LitR.1.4.5	Estuary	No	Protect estuarine habitat	Protect tidal wetland habitat	Estuary, downstream of highway 101	BR
SONCC-LitR.1.4.5.1	*Increase regulatory oversight to provide protection of existing tidal wetland habitat*					
SONCC-LitR.1.2.20	Estuary	No	Improve estuarine habitat	Assess estuary and tidal wetland habitat	Estuary	3
SONCC-LitR.1.2.20.1	*Identify parameters to assess condition of estuary and tidal wetland habitat*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	***Step Description***					
SONCC-LitR.1.2.20.2	*Determine amount of estuary and tidal wetland habitat needed for population recovery*					
SONCC-LitR.16.1.9	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-LitR.16.1.9.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-LitR.16.1.9.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-LitR.16.1.10	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-LitR.16.1.10.1	*Determine actual fishing impacts*					
SONCC-LitR.16.1.10.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-LitR.16.2.11	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-LitR.16.2.11.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-LitR.16.2.11.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-LitR.16.2.12	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-LitR.16.2.12.1	*Determine actual impacts of scientific collection*					
SONCC-LitR.16.2.12.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-LitR.27.1.13	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-LitR.27.1.13.1	*Perform annual spawning surveys*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		***Step Description***				
SONCC-LitR.27.1.14	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-LitR.27.1.14.1		*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*				
SONCC-LitR.27.1.15	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	3
SONCC-LitR.27.1.15.1		*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*				
SONCC-LitR.27.2.16	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-LitR.27.2.16.1		*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*				
SONCC-LitR.27.2.16.2		*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*				
SONCC-LitR.27.2.17	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-LitR.27.2.17.1		*Measure the indicators, pool depth, pool frequency, D50, and LWD*				
SONCC-LitR.27.2.18	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-LitR.27.2.18.1		*Measure the indicators, canopy cover, canopy type, and riparian condition*				
SONCC-LitR.27.2.19	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-LitR.27.2.19.1		*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*				
SONCC-LitR.27.2.22	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Estuarine Function'	Estuary	3
SONCC-LitR.27.2.22.1		*Identify habitat condition of the estuary*				

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		***Step Description***				
SONCC-LitR.27.1.23	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-LitR.27.1.23.1		*Develop supplemental or alternate means to set population types and targets*				
SONCC-LitR.27.1.23.2		*If appropriate, modify population types and targets using revised methodology*				
SONCC-LitR.27.2.24	Monitor	No	Track habitat condition	Determine best indicators of estuarine condition	Estuary	3
SONCC-LitR.27.2.24.1		*Determine best indicators of estuarine condition*				
SONCC-LitR.5.1.8	Passage	No	Improve access	Remove barriers	Lower mainstem, estuary, private lands	BR
SONCC-LitR.5.1.8.1		*Assess road crossing barriers*				
SONCC-LitR.5.1.8.2		*Remove road crossing barriers, guided by the assessment*				
SONCC-LitR.7.1.6	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Lower mainstem	BR
SONCC-LitR.7.1.6.1		*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*				
SONCC-LitR.7.1.6.2		*Thin, or release conifers, guided by prescription*				
SONCC-LitR.7.1.6.3		*Plant conifers, guided by prescription*				
SONCC-LitR.7.1.7	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	Lower mainstem	3
SONCC-LitR.7.1.7.1		*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*				
SONCC-LitR.7.1.7.2		*Develop grazing management plan to meet objective*				
SONCC-LitR.7.1.7.3		*Plant vegetation to stabilize stream bank*				
SONCC-LitR.7.1.7.4		*Fence livestock out of riparian zones*				
SONCC-LitR.7.1.7.5		*Remove instream livestock watering sources*				