11. Big Sur Coast Biogeographic Population Group

"Assessment at the group level indicates a priority for securing inland populations in southern Coast Ranges and Transverse Ranges, and a need to maintain not just the fluvial-anadromous life-history form, but also lagoon-anadromous and freshwater-resident forms in each population."

NOAA Fisheries Technical Recovery Team
Viability Criteria for South-Central and Southern California Steelhead, 2007

11.1 LOCATION AND PHYSICAL CHARACTERISTICS

The Big Sur Coast BPG includes seven watersheds that drain the steep coastal slopes of the northern Santa Lucia Range. This region extends approximately 60 miles along a sparsely populated section of coastal Monterey County from the Monterey Peninsula southward almost to the San Luis Obispo County line. From north to south, these watersheds are: San Jose Creek, Garrapata Creek, Bixby Creek, Little Sur River, Big Sur River, Willow Creek, and Salmon Creek (see Figure 11-1).

The Big Sur Coast BPG topography resembles the Conception Coast BPG in Santa Barbara County and the Santa Monica Mountains BPG in Ventura and Los Angeles counties in that its component watersheds are, with one or two exceptions, small, steep, and have limited stream lengths. Although average annual precipitation shows little spatial variation across the component watersheds, total seasonal rainfall in this region is highly variable from year to year, depending on the intensity and duration of Pacific storms.

Big Sur Coast

In general, the higher elevations receive greater amounts of precipitation, and persistent spring and summer fog is characteristic of this region. All of the watercourses in this BPG are perennial (though some reaches may be intermittent in drought years (Hunt & Associates 2008a, Kier Associates and National Marine Fisheries Service 2008a, 2008b, Berge *et al.* 2004, Stephenson and Calcarone 1999).

11.2 LAND USE

The Big Sur Coast BPG exhibits the lowest level of development, and the smallest total human population of all the BPGs within the SCCCS Recovery Planning Area. The BPG is also buffered from urban areas by extensive undeveloped open space and rural lands, particularly within the Los Padres National Forest. Human population density averages about 4 persons per square mile. Table 11-1 summarizes land use and population density in the Big Sur Coast BPG.

Several small commercial areas are centered in the unincorporated communities of Carmel Highlands, Big Sur, Gorda, and Ragged Point. The closest resident population centers are the towns of Carmel immediately north of the BPG and San Simeon south of the BPG.

Big Sur River

There are no major cities within this BPG. There is a strong gradient of increasing public ownership of watershed lands, from less than 1 percent in the San Jose Creek watershed in the north to over 98% in the Salmon Creek watershed in the south. Most of the federal lands are in the Los Padres National Forest. Small parcels of National Recreation Area lands occur along the immediate coast. The Los Padres National Forest encompasses several federally designated wilderness areas, including Ventana Silver Peak and Santa Lucia Wilderness Areas.

Additionally, the Big Sur River, including the North and South Forks, is a federally designated Wild River. There are several State Parks and designated wilderness areas within the Big Sur Coast BPG. Several of the larger State Parks, such as Andrew Molera and Pfeiffer-Big Sur in the Big Sur River watershed, extend inland from the coast.

Little Sur River

Urban and agricultural conversion of land in these watersheds lands is correspondingly low, with the overwhelming majority of watershed lands being open space (see Table 11-1). Significantly - and almost uniquely along the coast south of San Francisco – there is relatively little development adjacent to the estuaries associated with the watersheds in the Big Sur Coast BPG, with the notable exception of Highway 1. There are no major dams in this region, though there are seasonal recreational dams and diversions in some drainages that may affect anadromous *O. mykiss*, particularly the instream movement of juveniles (Hunt & Associates 2008a, Kier Associates and National Marine Fisheries Service 2008a, 2008b, U.S. Forest Service 2004, 2005a, 2005b, Stephenson and Calcarone 1999, California Department of Water Resources 1978). See Figure 11-2 for the pattern of federal and non-federal land ownership within the Big Sur and Little Sur River watersheds.

Table 11-1. Physical and Land Use Characteristics of Watersheds in the Big Sur Coast BPG.

PHYSICAL CHARACTERISTICS						LAND USE			
WATERSHEDS (north to south)	**Area** (acres)[1]	**Area** (sq.miles)[1]	**Stream Length**[2] (miles)	**Ave. Ann. Rainfall**[3] (inches)	**Total Human Population**	**Public Ownership***	**Urban Area**[5]	**Agriculture/ Barren**[5]	**Open Space**[5]
San Jose Creek	8,826	14	23	20.3	213	0.1%	0.2%	0%	> 99%
Garrapata Creek	6,925	11	16	20.5	63	11%	0.0%	0%	> 99%
Bixby Creek	7,218	11	15	20.8	44	27%	0.0%	0%	> 99%
Little Sur River	26,541	41	64	20.8	70	63%	< 0.3%	0%	> 99%
Big Sur River	37,374	58	92	20.8	142	85%	< 0.7%	0%	> 99%
Willow Creek	10,410	16	26	18.5	35	96%	0.0%	0%	> 99%
Salmon Creek	5,406	8	12	19.5	6	98%	0.0%	0%	> 99%
TOTAL or AVERAGE	**193,561**	**302**	**442**	**20.1**	**2,426**	**60.4%**	**<1%**	**0%**	**>99%**

[1] From: CDFFP CalWater 2.2 Watershed delineation, 1999 (www.ca.nrcs.usda.gov/features/calwater/)
[2] From: CDFG 1:1,000,000 Routed stream network, 2003 (www.calfish.org/)
[3] From: USGS Hydrologic landscape regions of the U.S., 2003 (1 km grid cells
[4] From: CDFFP Census 2010 block data (migrated), CalFire FRAP (http://frap.cdf.ca.gov/data/frapgisdata/select.asp)
[5] From: CDFFP Multi-source land cover data (v02_2), 2002 (100 m grid cells) (http://frap.cdf.ca.gov/data/frapgisdata/select.asp)
** National Forest Lands only; Military Reservations or State and County Parks not included.*

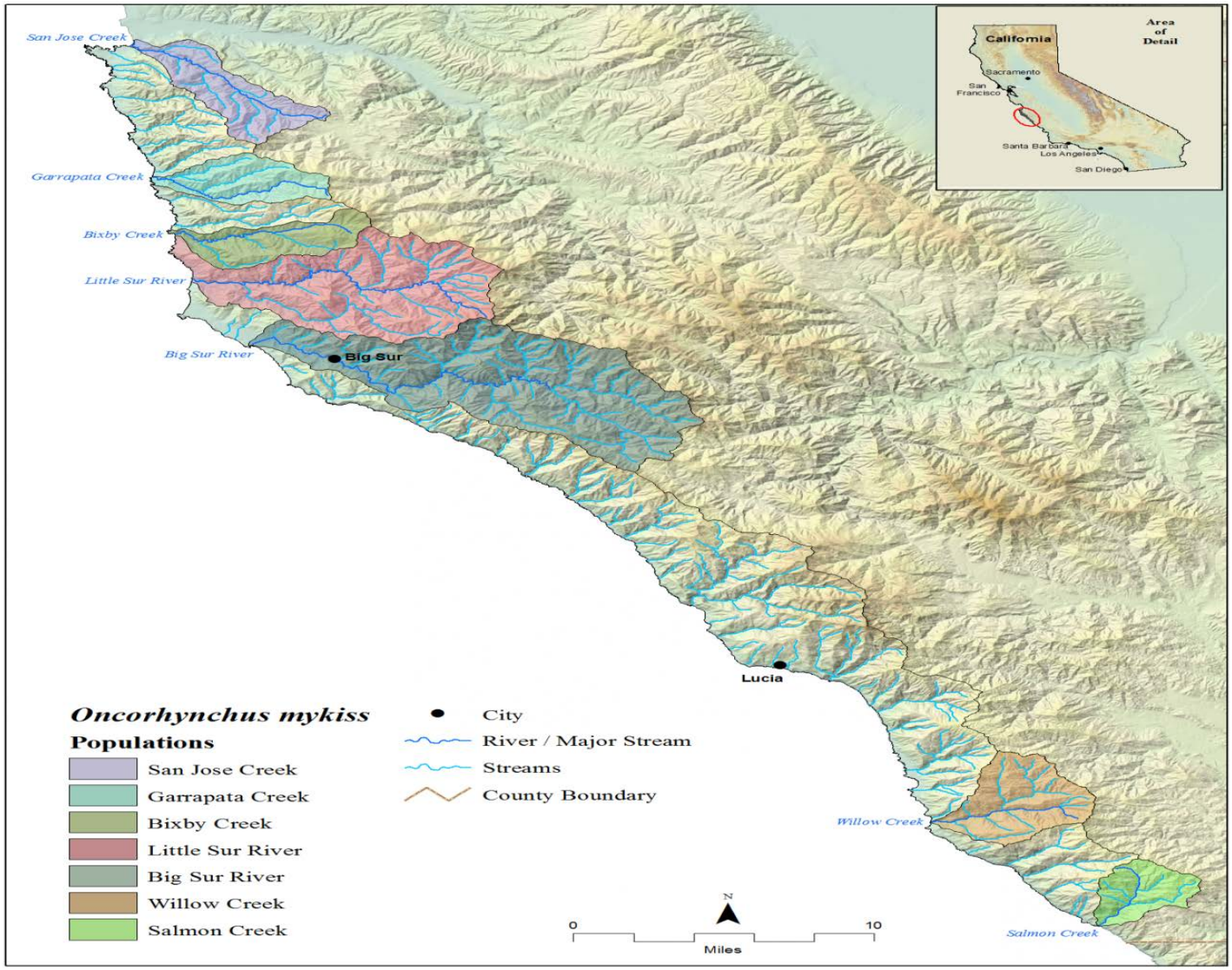

Figure 11-1. The Big Sur Coast BPG. Seven populations/watersheds were analyzed in this region.

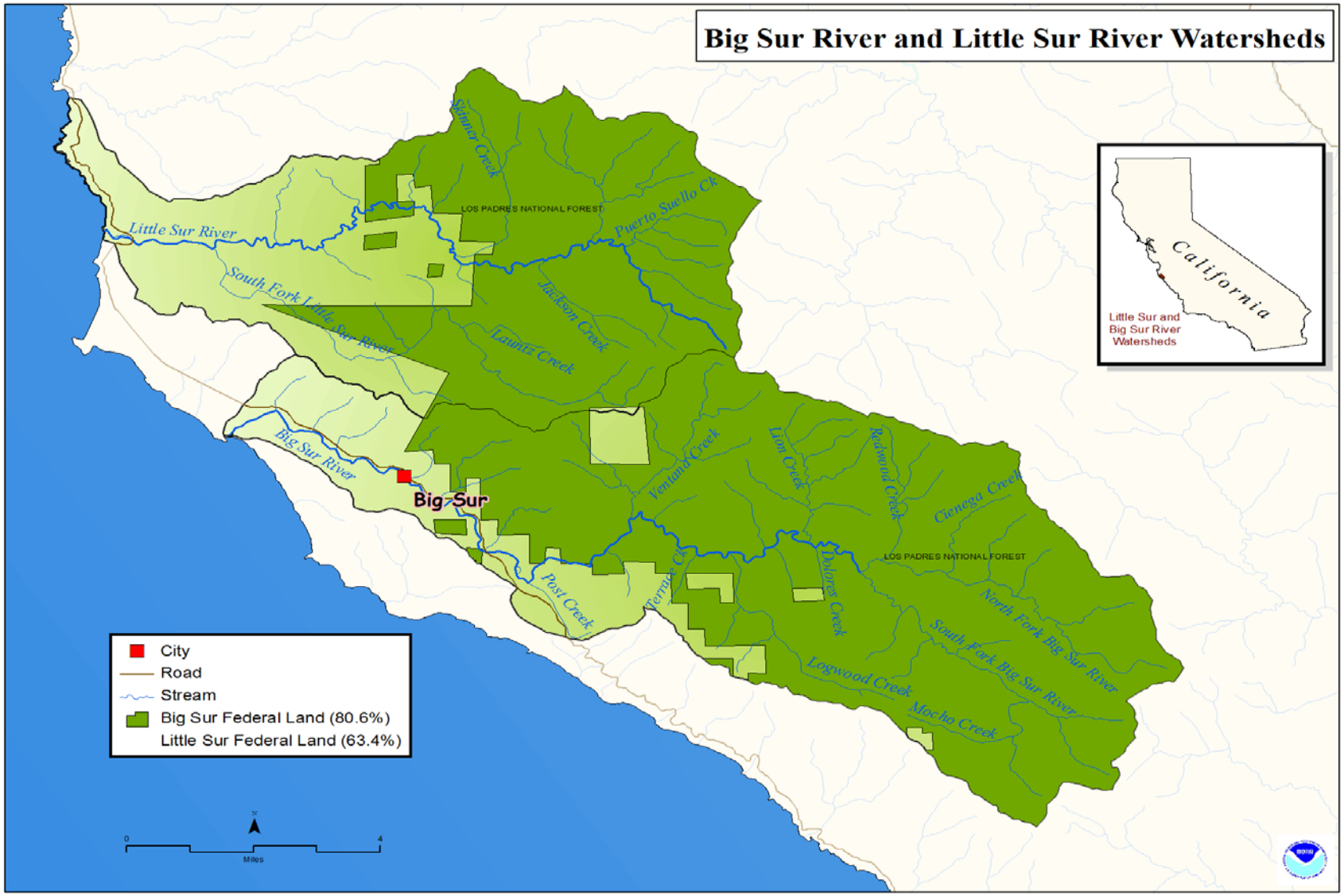

Figure 11-2. Federal and Non-Federal Land Ownership within the Big and Little Sur Watersheds

11.3 CURRENT WATERSHED CONDITIONS

Watershed conditions were assessed for seven major drainages in the Big Sur Coast BPG chosen from those identified by the TRT, with the focus on conditions most directly relevant to steelhead. Instream, riparian, and upland habitat conditions in the watersheds in this region are collectively rated the highest of any of the BPGs within the SCCCS Recovery Planning Area by the CAP Workbook analyses. The CAP Workbooks rated overall habitat conditions for steelhead as "Fair" in the San Jose Creek watershed, "Good" in the Garrapata Creek, Big Sur River, and Salmon Creek watersheds, and "Very Good" in the Bixby Creek, Little Sur River, and Willow Creek watersheds, though there is a significant development along the middle sections of the Little Sur River, and some livestock grazing in both the Little Sur River and Bixby Creek watersheds. Garrapata Creek is impacted by logjams which impede fish passage, and elevated levels of fine sediments resulting from roads. The Little Sur River Estuary is the most intact estuary within the SCCCS Recovery Planning Area – the result of the Highway 1 alignment upstream of the estuary; however, groundwater extraction operations are common through the Big Coast BPG (Smith *et al.* 2009, 2006, 2005, Garrapata Creek Watershed Community Council 2006, Nelson *et al.* 2006a, 2006b, Casagrande and Smith 2006, 2005, Nedeff 2005, 2004, Nelson 2005, U.S. Forest Service 2004, 2005a, 2005b, Berg *et al.* 2004, Ford 2004, Denise Duffy & Associates 2003, Hagans and Kraemer 2003, Pacific Watershed Associates 2003, Smith *et al*. 2003, Hagar Environmental Science 2002, Kittleson Environmental Consultants 2003, Kittleson Environmental Consultants *et al*. 2002, Stephenson and Calcarone 1999, Collin 1998, Rathbun *et al.* 1991).

Little Sur River Estuary

Land-use activities that negatively affect these ratings are most pronounced in watersheds that are mostly under private ownership. For example, San Jose, Garrapata, and Bixby watersheds are characterized by groundwater and surface water diversions, old logging roads (some of which have been decommissioned or weather proofed to reduce erosion), and fish-passage barriers created by log or debris jams associated with past logging activities. The alignment and configuration of the Highway 1 bridge over San Jose Creek has filled in a significant portion of this estuary and constrained the natural migration of the creek channel (Nelson *et al.* 2006a, 2006b, Nedeff 2005, 2004, Nelson 2005, Ford 2004, Entrix Environmental Consultants and Denise Duffy and Associates 2003, Hagan and Kraemer 2003, Hagar Environmental Science 2002.

San Jose Creek Estuary

The Big Sur River and Salmon Creek have natural barriers that block anadromous *O. mykiss* passage to the middle and upper portions of these watersheds, which constitute the majority of the potential steelhead spawning and rearing habitats in these watersheds. While this limits the amount of accessible spawning and rearing habitat, particularly in Salmon Creek, the most significant developments within the Big Sur River are water supply development (including groundwater and surface water diversions) in the lower reaches and barriers created by culverts, fords, and seasonal rock dams built for recreational purposes. Additionally, both public and private recreational development within the vicinity of U.S. Highway 1 have encroached on riparian habitat and resulted in a variety of associated recreational activities (*e.g.*, collection of natural woody debris for campfires, construction of seasonal rock dams) which impacts steelhead habitats, particularly summer rearing habitat (Allen and Riley 2012, California Department of Fish and Wildlife 2012a, 2011a, 2011a Kittleson Environmental Associates 2002, Denis Huffy & Associates 1998, Titus 1994, Rischbieter 1990a, 19990b, .

Salmon Creek (above Highway 1)

Salmon Creek (below Highway 1)

Increased fire frequency in these watersheds was rated as a severe threat because of potential sedimentation and various other fire-related impacts to instream and riparian habitats. In general, however, the six watersheds south of San Jose Creek provide excellent spawning and rearing habitat (Watson *et al*. 2008, Denise Duffy and Associates 2003, Kittleson Environmental Consultants, Denise Duffy and Associates and Fall Creek Engineering 2002, Collin 1998, Rischbieter 1990a).

Willow Creek (above Highway 1)

11.4 THREATS AND THREAT SOURCES

The number of threats identified in the CAP Workbook analysis in the Big Sur Coast BPG region is very low compared to other BPGs, ranging from three in the Bixby Creek watershed to eleven in the San Jose Creek watershed; however, additional information developed since the preparation of the CAP has also been incorporated into the threats assessment. These relatively low numbers of threats reflect the low human population density and fewer associated land-use impacts in this portion of the SCCCS Recovery Planning Area. The most pervasive threats stem from roads (as a source of sedimentation), wildfires, fish passage barriers, and groundwater extractions which pose significant threats to rearing juvenile steelhead, particularly in dry years (Hunt & Associates 2008a, Kier Associates and National Marine Fisheries Service 2008a, 2008b; see also references cited above).

Big Sur Coast – Post-Fire Debris Control Structure

See Figure 11-3 for the location of major fish passage impediments within the Big Sur Coast; but note that the status of fish passage impediments is in constant flux, with old structures being removed or modified, while new impediments may be installed, or discovered through updated inventories; a current inventory of fish passage impediments can be found on the California Department of Fish and Wildlife website:
http://www.cafishpassageforum.org/

Little Sur River – Road Cut

On-going restoration and re-vegetation of eroded slopes and decommissioned logging roads in the Garrapata Creek watershed should eventually reduce or eliminate this threat source and improve habitat conditions for steelhead. Land-use activities in the mostly privately-owned San Jose Creek watershed pose a number of problems. Groundwater extractions in the mainstem of San Jose Creek severely impair instream habitat quality and quantity for anadromous *O. mykiss*. Such diversions create passage barriers (*i.e.,* dry stream reaches), and can exacerbate poor water quality under extremely low-flow conditions. Higher road density in this watershed serves to further degrade water quality through input of sediment and other sources of pollution arising from road surfaces (Watson *et al*. 2008, Garrapata Creek Watershed Council 2006, Nelson *et al*. 2006a, 2006b,, Nedeff 2004, 2005, Ford 2004, Hagans and Kraemer 2003, Hagar Environmental Science 2002, McNight 2002).

The lower mainstem of Salmon Creek between the ocean and the Highway 1 culvert provides spawning and rearing habitat for anadromous *O. mykiss* (the culvert is impediment to upstream fish passage under low-flow conditions). The persistence of anadromous *O. mykiss* in the Salmon Creek watershed is potentially threatened by a large waterfall that sets the natural limit of anadromy less than two miles above the mouth of the creek, though

recolonization, both from the upstream resident *O. mykiss* and steelhead dispersal from nearby watersheds, is a possibility.

The principal sources of threats to individual steelhead populations in the Big Sur Coast BPG are passage barriers created by culverts, road crossings, and periodic landslides; impediments to migration and degradation of spawning and rearing habitats as a result of groundwater extraction (particularly in San Jose Creek and the Big Sur River), and surface water diversions; and non-point pollution, including sedimentation resulting road cuts, including abandoned logging roads.

Water extractions along the lower reaches of the Big Sur River have affected flow conditions in the lower river and lagoon, and small seasonal rock dams constructed for recreational purposes, as well as at-grade road crossings have degraded habitat in this reach of the Big Sur River. (Allen and Riley 2012, California Department of Fish and Wildlife 2011a, 2011b, Hanson 2011, Titus 1994, Monterey County 1986). The natural rock barrier in the lower portion of the Big Sur River gorge upstream of the Pfeiffer Big Sur State Park restricts access to the majority of the potential steelhead spawning and rearing habitat within the Big Sur River watershed. As a result the 92 miles of stream length for the Big Sur River in Table 11-1 is largely inaccessible to anadromous *O. mykiss*.

Wildfires within are a continuing pervasive threat within the Big Sur Coast BPG. However, CAP Workbook Analysis of the Bixby Creek watershed produced only three threats (Table 11-2). The severity of these threats compared to similar threat levels in other BPGs in the SCCCS Recovery Planning Area is generally low (Hunt & Associates 2008a, Kier Associates and National Marine Fisheries Service 2008a, 2008b).

Finally, the spread of exotic and invasive species, including plant species, continues to increase with the increasing human population and related changes in land uses within the Big Sur Coast BPG; for example, Cape Ivy (*Delairea odorata*) in watersheds such as Garrapata Creek has become more extensive and potentially invasive in other watersheds within the Big Sur Coast BPG. The early detection, rapid response to, and preferably prevention of, these introductions is an important component in any comprehensive steelhead recovery effort within the Big Sur Coast BPG.

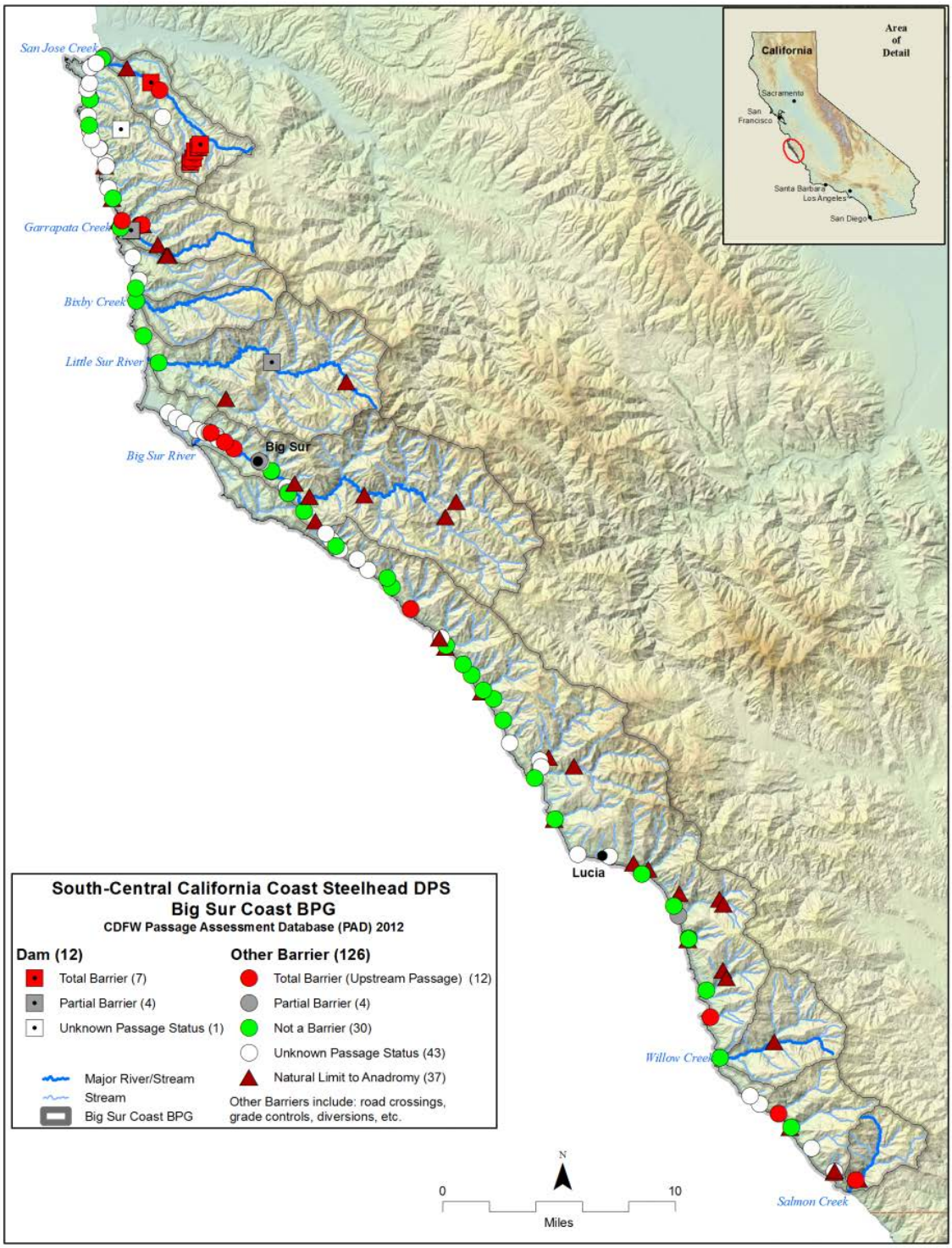

Figure 11-3. Major Fish Passage Impediments, Big Sur Coast BPG. Note: the status of fish passage impediments is in flux, with existing ones being removed or modified, while new ones may be installed, or discovered through updated inventories; a current inventory of fish passage impediments can be found on the California Department of Fish and Wildlife website: http://www.cafishpassageforum.org/

Table 11-2. Threat source rankings in the component watersheds of the Big Sur Coast BPG region (see CAP Workbook for details).

Big Sur Coast BPG Component Watershed (north to south)							
THREAT SOURCES	San Jose Creek	Garrapata Creek	Bixby Creek	Little Sur River*	Big Sur River	Willow Creek	Salmon Creek
Culverts and Road Crossings (Other Passage Barriers							
Roads							
Non-Point Pollution							
Groundwater Extraction							
Recreational Facilities							
Wildfires							
Dams and Surface Water Diversions							
Non-Native Species							

Key: Threat cell colors represent threat rating from CAP Workbook: Red = Very High threat; Yellow = High threat; Light green = Medium threat; Dark green = Low threat

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11.5 SUMMARY

The Big Sur Coast BPG contains some of the best preserved watersheds within any of the four BPGs in the SCCCS Recovery Planning Area. In particular, the Bixby Creek, Little Sur River, Big Sur River, Willow Creek, and Salmon Creek watersheds are some of the least altered, though there are significant developments along the middle portions of the Little Sur (including livestock grazing) and lower reaches of the Big Sur Rivers. With the exception of San Jose Creek and Garrapata Creek, the majority of threats in the watersheds in the Big Sur Coast BPG are rated as low. Only three medium-severity threat sources were identified for the relatively undeveloped Bixby Creek watersheds. However, these conditions could change in the future because some of these watersheds are largely under private ownership, are all traversed by Highway 1, and all support low to moderately intense livestock ranching operations. Additionally, natural wildfires remain a persistent threat throughout the Big Sur Coast BPG.

Increased development within several of these watersheds (*e.g.,* San Jose Creek and Little Sur River), including higher road densities, (and altered natural fire regimes), could significantly increase fine sediment loads in the Big Sur Coast BPG by allowing greater human access to portions of these watersheds. Increased fire frequency can increase slope erosion and sediment input to streams, resulting in long-term changes to substrate composition, embeddedness, water quality (*e.g.,* turbidity), and water temperature (through loss of riparian canopy cover).

Reducing one or more of the moderate threats that adversely affect anadromous *O. mykiss* habitat in the Bixby Creek, Little Sur River, Big Sur River, Willow Creek, and Salmon Creek watershed (*e.g.,* road crossings and erosion control) could to anadromous *O. mykiss* habitats in these watersheds. Recovery actions to address the severe to very severe sedimentation impacts from existing and abandoned roads and fish-passage impediments in the San Jose Creek and Garrapata Creek watersheds will require multiple, long-term, measures related to water management and land-use practices, including agricultural and residential development and related road development. Additionally, the restoration of the San Jose estuary, which has largely been eliminated as a result of the construction of Highway 1, will require removal of fill and replacement of the existing culvert with a free-spanning road crossing.

The threat sources discussed in this chapter should be the focus of a variety of recovery actions to address these threats. Spatial and temporal data acquired on specific indicators associated with sources of threats or stresses, such as water temperature, pH, nutrients, *etc.*, are generally inadequate to guide specific recovery actions. This type of data should be the subject of site-specific investigations in order to refine the recovery actions or to target additional recovery actions as part of any recovery strategy for the Big Sur Coast BPG.

Big Creek Steelhead – 2013 (Courtesy Mark D. Readdie)

Management of the steelhead populations of the Big Sur Coast BPG will require additional investigations of the population structure of the BPG; these studies should include, but not be limited to, the role of the various individual watersheds in the maintenance of the BPG as a whole (including dispersal rates between watersheds), how these individual populations contribute to the diversity of the BPG, and the

role and use of the estuaries by steelhead, particularly rearing juveniles.

Table 11-3 below highlights critical Recovery Actions recovery actions for the Big Sur Coast BPG. The following Tables 11-4 through 11-10 identify a full suite of recovery actions necessary to recover these populations and describe and prioritize recovery actions for each watershed in the Big Sur Coast BPG. These tables also provide provisional cost estimates for implementing such actions in five year increments, and where applicable extended out to 100 years, though many of the recovery actions can and should be achieved within a shorter period (Hunt & Associates 2008a 2008b, Kier Associates and National Marine Fisheries Service 2008a, 2008b).

Table 11-3. Critical recovery actions for Core 1 populations within the Big Sur Coast BPG.

POPULATION	CRITICAL RECOVERY ACTIONS
San Jose Creek	Develop and implement operating criteria to ensure the pattern and magnitude of groundwater extractions and water releases, including bypass flows around diversions, to provide the essential habitat functions to support the life history and habitat requirements of adult and juvenile steelhead. Remove or modify instream fish passage barriers to allow steelhead natural rates of migration to upstream spawning and rearing habitats, and passage of smolts and kelts downstream to the estuary and ocean. Identify sources of sediment and develop a comprehensive, watershed-wide sediment management plan. Identify, protect, and where necessary, restore estuarine and freshwater rearing habitats, including management of the artificial breaching of the creek's mouth.
Little Sur River	Develop and implement operating criteria to ensure the pattern and magnitude of groundwater extractions and water releases, including bypass flows around diversions, to provide the essential habitat functions to support the life history and habitat requirements of adult and juvenile steelhead. Remove or modify instream fish passage barriers to allow steelhead natural rates of migration to upstream spawning and rearing habitats, and passage of smolts and kelts downstream to the estuary and ocean. Manage roads to minimize sedimentation of spawning and rearing habitat.
Big Sur River	Develop and implement operating criteria to ensure the pattern and magnitude of groundwater extractions and surface diversions, including bypass flows around diversions, to provide the essential habitat functions to support the life history and habitat requirements of adult and juvenile steelhead. Remove or modify instream fish passage barriers to allow steelhead natural rates of migration to upstream spawning and rearing habitats, and passage of smolts and kelts downstream to the estuary and ocean.