4. Current DPS-Level Threats Assessment

"A widespread trend observed in this Steelhead Recovery Planning Area is severe to very severe degradation of habitat conditions along the mainstems of impaired watersheds, while the upper mainstem and tributaries retain relatively high habitat values for steelhead."

California Coast Steelhead Recovery Planning Area: Threats Assessment
Hunt & Associates 2008

4.0 INTRODUCTION

Anadromous *O. mykiss* in California face significant threats from water and land management practices that have degraded or curtailed freshwater and estuarine habitats, reducing the capability of the species to persist within most watersheds (Moyle *et al.* 2011, 2008). Extensive agricultural development in the Pajaro and Salinas River basins, as well as in segments of the Pismo, San Luis Obispo, and Arroyo Grande Creek basins, have significantly modified and degraded major steelhead-bearing watersheds, particularly their mainstems and estuarine habitats. In addition, given the current threatened status of the species and the degraded condition of many freshwater and estuarine ecosystems, the persistence and recovery of the species may be further threatened by shifts in climatic and oceanographic conditions. See Chapter 5, South-Central California Coast Steelhead and Climate Change.

Table 4-1 summarizes the top-ranked[1] sources of threats across the SCCCS Recovery Planning Area. These were identified in the threats assessment conducted for watersheds within each BPG. The threat sources with a "very high" or "high" severity ranking were dams and surface water diversions, wildfires, and groundwater extraction. The adverse effects of dam and surface water diversions are particularly significant because they impact steelhead by, blocking migration routes to spawning and rearing habitats, and altering natural flow regimes essential for maintaining these habitats.

While wildfires are a natural occurrence, and an important part of the life cycle of the chaparral plant community that dominates a significant portion of the SCCCS Recovery Planning Area, they ranked as a very high threat throughout the SCCCS DPS. Consequently, their management, and role in determining the distribution of watersheds to be restored is fundamental to the over-all recovery strategy of the Recovery Plan (see further discussion in Chapter 6, Criteria D-2- Redundancy and Geographic Separation).

Urban development, levees and channelization, and other passage barriers also adversely affect a large percentage of steelhead watersheds in the SCCCS Recovery Planning Area and were therefore ranked high in the threats assessment for significant portions of the SCCCS DPS.

[1] Threat sources were ranked in terms of the level of contribution and degree of irreversibility of the stressors emanating from the threat source. See Appendix D for further information.

Finally, while not captured explicitly in The Nature Conservancy's threats assessment process, the impacts of environmental variability, including projected changes in precipitation patterns and the consequences of fluctuations in ocean conditions will likely play a significant role in the persistence and recovery of the SCCCS DPS. The basic recovery strategy, to restore and protect a wide variety of steelhead habitats (including refugia habitats) throughout the SCCCS Recovery Planning Area is intended to address the this largely unpredictable threat to the recovery and persistence of the SCCCS DPS; this issue is addressed in Section 4.1 and 4.2.7 below, and Chapter 5, South-Central California Coast Steelhead and Climate Change.

This chapter provides an introduction to the threats assessment process and summarizes the results of NMFS' threats assessment at the DPS level. Summaries of the threats posed to individual BPGs are presented in the chapters devoted to each BPG (Chapters 9-12).

4.1 THREATS ASSESSMENT PROCESS

NMFS assessed current and expected future threats to steelhead persistence and recovery in key watersheds identified by the TRT and NMFS staff. This assessment used The Nature Conservancy's Conservation Action Planning (CAP) framework (The Nature Conservancy 2007, 2000). This method and NMFS' application to the threats assessment for South-Central California Coast steelhead is further detailed in Appendix D, South-Central California Coast Steelhead Recovery Planning Area Threats Assessment (CAP Workbooks) method. Use of this method allowed NMFS to organize the best available information (and professional judgment when no other information was available) on the threats impacting SCCC steelhead. Information was entered into electronic workbooks programmed to summarize and track the information for use in identifying, developing and implementing recovery actions designed to address the identified threats. The threats assessment process is iterative and new information can be incorporated as it becomes available or as periodic status reviews of the species occur (Kier Associates and National Marine Fisheries Service 2008a, 2008b, Hunt & Associates 2008a).

Current conditions of essential habitat elements for steelhead were assessed with information from a variety of sources including published and unpublished reports. The severity of threats to steelhead or their habitat was estimated and ranked. Based on the initial threats assessment, the threats and associated sources of those threats across the SCCCS Recovery Planning Area, within each BPG, and within specific watersheds, were identified. A listing of the individual watersheds evaluated in the CAP framework is located in Appendix D.

In addition to the CAP threats assessment, NMFS evaluated the best available information regarding impacts of predicted shifts in climate and the marine environment and the impacts of these shifts on the ability of steelhead to recover. These two threats were not easily addressed in the CAP workbooks and so are not explicitly reflected in the tables depicting the threats assessments results below. However, NMFS considered the threats posed by shifting climate and a varying marine environment when identifying an overall recovery strategy for the species and particular recovery actions. Steelhead will be able to persist through changing environmental conditions with recovery of well-distributed viable populations across the SCCCS Recovery Planning Area. Well distributed and viable population will support a variety different life stages and life history strategies which will add resiliency to the SCCCS DPS. Recovery actions addressing climate and marine conditions are embedded within recovery actions designed to achieve these objectives; some of the most significant for the SCCCS DPS are the restoration and protection of flows, ensuring access to spawning and rearing habitat, and restoration of riparian and estuarine habitats providing refugia during extreme droughts or other weather events that can degrade steelhead habitat.

4.2 CURRENT DPS-WIDE THREATS ASSESSMENT SUMMARY

The following discussion presents information on current and future threats impacting steelhead in the SCCCS DPS. The discussion is organized around a set of threat sources identified for each BPG in Chapters 9-12 and associated appendices. The information presented in this chapter is a summary of threats across the SCCCS Recovery Planning Area.

The current conditions of 27 major watersheds within the SCCCS Recovery Planning Area ranged from "Fair" to "Poor" at the northern and southern ends of the SCCCS Recovery Planning Area, whereas habitat conditions were generally rated as "Good" or "Very Good" in the central portion of the Recovery Planning Area within the Big Sur Coast and northern San Luis Obispo Terrace BPGS (see CAP Workbook summaries for more detailed information).

Table 4-1. Percentage of watershed within the BPGs with High or Very High threat sources.

THREAT SOURCE*	Biogeographic Population Group (BPG)			
	Interior Coast Range	Carmel River Basin**	Big Sur Coast	San Luis Obispo
Dams and Surface Water Diversions	100%	100%	14%	50%
Groundwater Extraction	71%	100%	14%	58%
Levees and Channelization	43%	100%	0%	50%
Recreational Facilities	29%	100%	14%	25%
Urban Development	29%	100%	0%	25%
Roads and Culverts (Other Passage Barriers)	14%	100%	29%	8%
Agricultural Development	71%	0%	0%	67%
Non-Point Pollution	50%	0%	29%	33%
Mining	50%	0%	0%	0%

** Percentages were identified as "High" or "Very High" as part of the CAP Workbook analyses. See individual BPG Threat Summaries in Chapters 9-12 for threats ranking in individual watersheds.*
*** The Carmel River is the only watershed within the Carmel River Basin Biogeographic Population Group.*

Many of the watersheds contain high-quality spawning and rearing habitat, but are compromised by one or more anthropogenic factors; for example, Salinas River (San Antonio, and Nacimiento, and upper Salinas Dams), Carmel River (San Clemente and Los Padres Dams, other passage barriers), and Pajaro River and tributaries (groundwater extraction, Uvas, Chesbro, and Pacheco Dams, flood control, and diversions in the lower reaches) in the Interior Coast Range BPG. A widespread trend in the SCCCS Recovery Planning Area is severe to very severe degradation of habitat conditions along the mainstem of many watersheds, while the upper mainstem and tributaries (above and below dams) retain relatively high habitat values for steelhead. This is particularly evident in the Pajaro River, Salinas River, and Arroyo Grande Creek watersheds. Another DPS-level threat is impacts associated with wildland fires, including fire-fighting measures to control or extinguish them, and the post-fire measures to repair damages incurred in fighting wildland fires. (see for example, Verkaik *et al.* 2013, Keeley *et al.* 2012, Cooper 2009, Capelli 2009, National Marine Fisheries Service 2008b, Finger 1997).

4.2.1 Dams, Surface Water Diversions and Groundwater Extraction

Dams, surface water diversions, and groundwater extraction are common across the SCCCS Recovery Planning Area, especially on the larger rivers, such as the Pajaro, Salinas (and major tributaries, San Antonio and Nacimiento), and Carmel Rivers, but also Old, Pismo, and Arroyo Grande Creeks (California Department of Fish and Wildlife 2012a, California Conservation Corps 2005, California Coastal Conservancy 2004, California Department of Water Resources 1988). Loss of surface flows through the operation of dams or surface water diversions along the mainstem of the river adversely affect the productivity of important downstream mainstem habitats, and upstream tributaries otherwise providing spawning and rearing habitats for anadromous steelhead. Re-establishing surface flows and/or maintaining hydrologic connections and physical access between the ocean and upper watersheds would expand access to historically important spawning and rearing habitats. Restoring hydrologic connection and physical access is essential to recovery of the SCCCS DPS. Such a strategy improves the overall habitat conditions (amount and complexity) for steelhead, as well as the existing populations of native residualized *O. mykiss* that currently are isolated above dams and reservoirs.

San Clemente Dam – Carmel River

Dams also negatively affect the hydrology, sediment transport processes, and geomorphology of the affected drainages. In addition, dams and reservoirs frequently include recreational development for fishing and camping, which can lead to the introduction non-native predators and/or competitors (*e.g.*, largemouth and smallmouth bass, carp, crayfish, western mosquitofish) as well as promote trampling of the active channel, which potentially can lead to direct loss of redds (Petts and Gurnell 2013, Muhlfeld *et al.* 20011a, 2011b, Brown and Bauer 2009, Johnson *et al.* 2008, Keefer *et al*. 2008, Caudill *et al*. 2007, Dickens *et al.* 2007, Malcolm *et. al.* 2003, Williams and Bisson 2002, Brandt 2000, Pacific States Marine Fisheries Commission 1999, Ligon *et al.* 1995, National Marine Fisheries Service 1996a, Roberts and White 1992).

4.2.2 Agricultural and Urban Development, Roads, and Other Passage Impediments

Human population density is high in some parts of the SCCCS Recovery Planning Area and development pressures in general are concentrated in the coastal terraces and middle and lower portions of watersheds. Population density is a relative measure of intensity of land use and impacts to individual watersheds. Some of the watersheds in the Interior Coast Range BPG were extensively developed for agriculture, which typically occurs on floodplains. In addition, the upland slopes in several of the watersheds in the San Luis Obispo Terrace BPG are extensively planted in orchard crops (California Department of Water Resources 1978).

Agricultural Activity –Pismo Creek

The typical pattern of urban and agricultural development focuses on the flatter portions of a watershed, typically within the floodplain and usually along the mainstem of the drainage and one or more tributaries, thereby magnifying potential impacts to steelhead even if most of the watershed remains undeveloped. Agricultural development on lower floodplains has resulted in channelization, removal of riparian vegetation, and simplification of channel structures, as well as the elevation of fine sediments and other types of pollution such as pesticides and fertilizers which can elevate nutrient levels and increase bio-oxygen demands. Public ownership of lands in the SCCCS Recovery Planning Area varies widely between watersheds but generally decreases southward. Although public ownership of these watersheds (U.S. National Forest and BLM lands, military bases, *etc.*) can be extensive, these public lands are typically concentrated in the upper watersheds leaving the middle and lower watersheds subject to private development (Cooper *et al.* 2013, Kier Associates and National Marine Fisheries Service 2008a, 2008b, Hunt & Associates 2008a, United States Army 2007, United States Forest Service 2005a, 2005b, 2004, National Marine Fisheries Service 1996a).

4.2.3 Flood Control, Levees and Channelization

Urban and agricultural conversion of floodplain lands adjacent to the mainstem of rivers and streams frequently requires levees or other structures to protect these lands from flooding. The urban and agricultural reaches of a majority of the watersheds in the SCCCS Recovery Planning Area have been subjected to some degree of channelization and/or levee construction with a resulting loss or degradation of the riparian corridor and streambed. Flood control practices and associated channelization of streams and placement of levees impair the function and quality of stream habitats (Jeffres *et al*. 2008, Brown *et al.* 2005, National Marine Fisheries Service 1996a, Faber *et al.* 1989). Extensive channelization has occurred along the Pajaro River, and a number of its tributaries, as well as along the lower Salinas River which has been realigned, and long portions of the Carmel River, Pismo, San Luis Obispo, and Arroyo Grande Creeks (Kier Associates and National Marine Fisheries Service 2008a, 2008b, Hunt & Associates 2008a).

Channelization – Pajaro River

Habitat impairments for *O. mykiss* may include increased water temperature, incision of the streambed and loss of structural complexity and instream refugia (meanders, pools, undercut banks, *etc.*), complete loss of bed and bank habitat, increased sedimentation, turbidity, and substrate embeddedness, and excessive nutrient loading (Richardson, *et al.* 2010, Jeffres *et al.* 2008, Naiman *et al.* 2005, Newcombe 2003, National Research Council 2002, Naiman and Bilby 1998, Newcombe and Jensen 1996, Capelli and Stanley 1984, Warner and Hendrix 1984, Newcombe and McDonald 1991).

4.2.4 Non-Native Species

Non-native game species, such as large and smallmouth bass, and bullhead catfish, are often stocked into both non-anadromous and anadromous waters (including artificial reservoirs) by public and private entities. Additionally, other non-native species such as striped bass have spread into some of the watersheds of the SCCCS Recovery Planning Area (*e.g.*, Pajaro, Salinas, and Carmel Rivers) from other areas. While these stocking efforts have provided seasonal fishing opportunities, the impacts of these no-native fishes on native, naturally-reproducing *O. mykiss* stocks are not well understood, though there is a potential adverse impact as a result of predation, disease, disruption of behavior or habitat displacement (Cucherousset and Olden 2011, Davis 2009, Fraser 2008, Fritts and Pearsons 2006, Hayes *et al.* 2004, Noga 2000, Wood 1979, Dill and Cordone 1997, National Marine Fisheries Service 1996a, Rucker and Ordall 1953).

There are no production steelhead hatcheries operating in or supplying hatchery reared steelhead to the SCCCS DPS. However, there is an extensive stocking program of hatchery cultured and reared, non-anadromous *O. mykiss* (*i.e.*, rainbow trout) that supports a put-and-take fishery. Competition and disease transmission resulting from hatchery introductions have the potential to reduce the production and survival of native, naturally-reproducing steelhead, though genetic investigations of SCCCS steelhead have not detected any substantial interbreeding of native with hatchery reared *O. mykiss* (Clemento *et al.* 2009, Girman and Garza 2006). These stockings are now generally conducted in non-anadromous waters.

However, California's steelhead stocking practices in the past have distributed non-native steelhead stocks in many coastal rivers and streams in California (California Department of Fish and Wildlife and U.S. Fish and Wildlife Service 2010). Because of problems associated with the practice of transplanting non-native steelhead stocks, CDFW developed its Salmon and Steelhead Stock Management Policy. This policy recognizes stock mixing can be detrimental and seeks to maintain the genetic integrity of all identifiable stocks of salmon and steelhead in California, as well as minimize interactions between hatchery and natural populations. To protect the genetic integrity of individual salmon and steelhead stocks, this policy directs CDFW to evaluate the stocks of each salmon and steelhead stream and classify it according to its probable genetic source and degree of integrity (McEwan and Jackson 1996). Additionally, CDFW has eliminated the stocking of hatchery cultured and reared fish in most coastal streams where steelhead have direct access from the ocean (California Department of Fish and Wildlife and U.S. Fish and Wildlife Service 2010).

Striped Bass - Pajaro River (Courtesy Joel Casagrande)

In addition to the intentional introduction of non-native game species of fish, many other non-native species of wildlife and plant species have been introduced into the watersheds of South-Central California Coast which have the potential to displace native species, or adversely affect aquatic habitat conditions. Invasive plants such as the Giant reed *(Arundo donax)* and Tamarisk (*Tamarix* spp.) currently displace extensive areas of native riparian vegetation in major drainages such as the Salinas River and, in some cases, can reduce surface flows through the uptake of large amounts of groundwater. Non-native plant species such as water primrose (*Ludwigia uruguayensis*) can displace aquatic living space and, in extreme conditions, inhibit or block the instream movement of fish. Non-native plants can also reduce the natural diversity of insects that are important food sources for juvenile *O. mykiss* (Bell *et al.* 2009, Bossard *et al.* 2000, McKnight 1993).

4.2.5 Estuarine Loss

The mouths of most South-Central California Coast watersheds are characterized by one of several distinct types of estuaries formed by a combination of coastal topography, geology, and the hydrologic characteristics of the watershed (Jacobs *et al.* 2011, Ferren *et al.* 1995). Estuaries are used by steelhead as rearing areas for juveniles and smolts as well as staging areas for smolts acclimating to saline conditions in preparation for entering the ocean and adults acclimating to freshwater in preparation for spawning (Kier Associates and National Marine Fisheries Service 2008a, 2008b).

Estuarine Fill- Pajaro River

Because estuaries are located at the downstream end of coastal watersheds, and on relatively level coastal plains which are the most heavily urbanized portions of South-Central California, they have been subjected to a majority of the DPS-wide threats identified through the threats assessment. Estuarine functions are adversely affected in a wide variety of ways (*e.g.*, degradation of water quality, modification of hydrologic patterns, changes in species composition). One indicator of the magnitude of the loss of estuarine functions is loss of wetland acreage, through a range of activities, including filling, diking, and draining. Approximately 75 percent of estuarine habitats across the SCCCS Recovery Planning Area have been lost and the remaining 25 percent is constrained by agricultural and urban development, levees, and transportation corridors such as highways and railroads (primarily in the more extensively developed northern and southern portions of the SCCCS Recovery Planning Area). Gleason *et al*. (2011), Grossinger *et al.* (2011, 2008), Kier Associates and National Marine Fisheries Service (2008a, 2008b), Dahl (1990), Ferren *et al.* (1995). In addition to the loss of overall acreage, the habitat complexity and ecological functions of South-Central California Coast estuaries have been substantially reduced as a result of: (a) loss of shallow-water habitats such as tidal channels, (b) degradation of water quality through both point and non-point waste discharges, and (c) artificial breaching of the seasonal sandbar at the estuaries mouth which can reduce and degrade steelhead rearing habitat by reducing water depths and the surface area of estuarine habitat.

Estuarine habitat loss varies widely across BPGs, with the Pajaro and Salinas estuaries experiencing the largest physical modification and the estuaries along the Big Sur Coast (*e.g.*, Little Sur and Big Sur River) and the northern portion of the San Luis Obispo County coast (*e.g.,* San Carpoforo, Arroyo de la Cruz, and Little Pico Creeks) the most physically intact, though they are impaired by reduced freshwater inflows as well as and point and non-point waste discharges. Table 4-2 provides an estimate of the relative loss of South-Central California Coast wetland estuarine acreage for some of the key estuaries associated with steelhead populations in South-Central California Coast for which information was available (see Chapter 2, Steelhead Biology and Ecology, for a discussion of the role of estuaries in the life history of steelhead).

Table 4-2. Estuarine habitat loss in component watersheds of the South-Central California Coast Steelhead Recovery Planning Area, grouped by BGP.[1]

BPG	Watershed	Remaining Estuarine Habitat (% of historical habitat)
Interior Coast Range	Pajaro River	15
	Salinas River	10
Carmel River Basin	Carmel River	67
Big Sur Coast	San Jose Creek	10
	Garrapata Creek	100
	Bixby Creek	100
	Little Sur River	100
	Big Sur River	100
	Willow Creek	70
	Salmon Creek	100
San Luis Obispo Terrace	San Carpoforo Creek	90
	Arroyo de la Cruz	90
	Little Pico Creek	100
	Pico Creek	60
	San Simeon Creek	50
	Santa Rosa Creek	62
	Morro Creek	< 1
	Chorro and Los Osos Creeks	83
	San Luis Obispo Creek	60
	Pismo Creek	30
	Arroyo Grande Creek	20

[1] Note: these percentages are of based on a comparison of a variety of sources, which used different methods for defining wetland habitats, and differing methods of calculating their areal extent. Nonetheless, these data provide an approximate measure of *relative* estuarine habitat loss. Adapted from Kier Associates and National Marine Fisheries Service (2008a, 2008b).

4.2.6 Marine Environment Threats

Adult steelhead spend the majority of their life in the marine environment. Unlike the other anadromous Pacific salmon in the genus *Oncorhynchus*, steelhead do not die after entering freshwater to spawn, but may return to the marine environment and complete another year of ocean growth before returning to freshwater to repeat their reproductive cycle. Steelhead have not been observed in the marine environment in large aggregating schools with well-defined ocean migratory patterns. The incidental capture of steelhead in the marine environment as a by-catch of commercial fishing activities is relatively uncommon. As a result of the apparent dispersal of single individuals or small groups in the marine environment, information on the movements, feeding habits, and predator-prey relationships of steelhead has not been extensively studied and is not well understood (Grimes *et al*. 2007, Aydin *et al*. 2005, Burgner *et al*. 1992, 1980, Groot and Margolis 1991, Hartt and Bell 1985). Table 4-3 outlines some of the metrics relevant to assessing conditions in the marine environment for both sub-adult and adult steelhead, though the actual conditions are either highly variable, or unknown.

Table 4-3. South-Central California Coast Steelhead Marine Environment Threats Assessment.

South-Central California Coast Steelhead Marine Environment Threats Assessment								
1. Sub-Adult Steelhead								
Category	**Key Attribute**	**Indicator**	**Poor**	**Fair**	**Good**	**Very Good**	**Current Indicator Status**	**Current Rating**
Landscape Context	Habitat Availability	Vegetation density in nearshore marine areas of CA – e.g., kelp/hectare	Low kelp density		High kelp density		Baseline data unavail-able	Variable
Landscape Context	Oceano-graphic Conditions	Ocean production index	Poor ocean conditions		Good ocean conditions			Variable
Condition	Fish Health	Condition of sub-adult conspecifics collected in seines or other surveys	Data unavailable					Unknown
Condition	Fish Health	Incidence of disease/ parasitism in sub-adult conspecifics; salmon obtained from seine or other surveys	Baseline data unavailable					Unknown
Condition	Food Availability	Upwelling index	Poor ocean conditions		Good ocean conditions			Variable
Condition	Variability in Run Timing	Proportion of # of current vs. historic life history variations represented in domain	25% or less of historically known variation in run timing preserved in current runs	50% of historically known variation in run timing preserved in current runs	75% of historically known variation in run timing preserved in current runs	All historically known variation in run timing preserved in current runs		Unknown

2. Adult Steelhead								
Category	**Key Attribute**	**Indicator**	**Poor**	**Fair**	**Good**	**Very Good**	**Current Indicator Status**	**Current Rating**
Landscape Context	Oceano-graphic conditions	Ocean Production Index	Poor ocean conditions		Good ocean conditions			Variable
Condition	Fish Health	Condition factor of ocean-intercepted conspecifics	Data unavailable					Unknown
Condition	Fish Health	Incidence of disease/ parasitism in ocean-intercepted conspecifics	Baseline data unavailable					Unknown
Condition	Food Availability	Upwelling Index	Poor ocean conditions		Good ocean conditions			Variable
Condition	Variability in Run Timing	Proportion of # of current vs. historic life history variations represented in domain	25% or less of historically known variation in run timing preserved in current runs	50% of historically known variation in run timing preserved in current runs	75% of historically known variation in run timing preserved in current runs	All historically known variation in run timing preserved in current runs		Unknown

4.2.7 Natural Environmental Variability

Natural environmental variation has exacerbated the problems associated with degraded and altered riverine and estuarine habitats (see discussion in Chapter 2, Steelhead Biology and Ecology, Section 2.6). The climate of the SCCCS Recovery Planning Area is classified as Mediterranean. Mediterranean climates are characterized by two distinct annual seasons, with a high degree of inter-annual and decadal variability: a long rainless season extending from June through September (with small amounts of rain in May and October) and a brief rainy season from November through April. Rainfall is typically brief, and associated with intense, cyclonic winter storms. This region is also subject to an El Niño/La Niña weather cycle which varies in length from seven to ten years. This large-scale weather pattern can significantly affect winter precipitation, causing highly variable rainfall and significant changes in oceanic conditions between years (McMullen and Jabbour 2010, Intergovernmental Panel on Climate Change 2007a, Changnon 2000, Philander 2004, 1990). In addition to these temporal climatic patterns, there is a wide disparity between winter rainfall from north to south, as well as between coastal plains and inland mountainous areas. Annual precipitation ranges along the coast (north to south) from 32 to 24 cm, with larger variations (24 – 90 cm) due to the orographic effects of the various mountain ranges, and well as El Niño-Southern Oscillation (Castello and Shelton 2004, Felton 1965).

River discharge, and therefore freshwater habitat conditions within South-Central California Coast watersheds, is strongly influenced by the intra- and inter-annual pattern of short-duration cyclonic storms (*e.g.*, frequency, timing, intensity, and duration). As a result, river discharge varies greatly between seasons, and can be highly "flashy" during the winter season, sometimes changing by several orders of magnitude over a few hours. Snow accumulation is generally small and of short duration, and does not contribute significantly to peak run-off. Base flows in some river reaches are significantly influenced by groundwater stored and transported through alluvium, faults, and fractured rock formations. Many rivers and streams naturally exhibit interrupted base flow patterns (alternating channel reaches with perennial and seasonal surface flow) controlled by geologic formations, and the strongly seasonal precipitation pattern characteristic of a Mediterranean climate (Boughton *et al.* 2009, 2006, Holland 2001, Mount 1995, Jacobs, *et al.* 1993, Faber *et al.* 1989).

Over the course of their life cycle steelhead occupy both freshwater and marine environments. Freshwater habitats are critical for their reproductive phase, providing suitable habitat for the deposition, fertilization, and incubation of eggs in nests (redds) created by adults in spawning gravels. Freshwater habitats also provide a sheltered environment, relatively free of native predator species, and with suitable food sources, for rearing juveniles. Marine habitats are important for the growth and maturation of sub-adults, providing abundant and appropriately sized food sources to support the large numbers of maturing fish emigrating from coastal watersheds to the North Pacific Ocean (Quinn 2005, Moyle 2002). Both freshwater and marine environments are affected by weather and climatic conditions varying on time scales ranging from hours to millennia. Despite the highly mobile nature of steelhead, and their ability to exploit freshwater and marine habitats in multiple ways, they remain vulnerable to natural changes in their environment (Schwing *et al.* 2010).

4.2.8 Pesticide Use

The extensive use of pesticides for commercial agricultural purposes, as well as industrial and home applications, and their effects on anadromous salmonids has become an increasing concern (Baldwin *et al.* 2010, Macneale *et al.* 2010) for salmonid conservation. Pesticide is a general term that refers to a wide range of chemicals (natural or anthropogenic in origin) or elements (such as copper sprays) used in an application with the intent to control or kill a pest species. Common classes of pesticides include insecticides, rodenticides, fungicides and herbicides. Pesticides may affect listed salmonids through direct or indirect means, via lethal or sub-lethal effects, over short time periods (acute effects) or longer time periods (chronic effects) or through the alteration of critical habitat components resulting in harm to the listed salmonids (Baldwin *et al*. 2010, Macneale *et al.* 2010). Adjuvants to pesticide active ingredients, such as surfactants or spreaders, may also cause or contribute to these adverse effects (Laetz 2009).

Pesticides may also benefit listed salmonids, when used properly, in projects that protect or restore habitat functions such as the removal of non-native species (California Department of Pesticide Regulation 2012b, Zhang and Goodhue 2010).

Several of the watersheds within the SCCC Recovery Planning Area (*e.g.*, Pajaro, Salinas, Santa Rosa, and Arroyo Grande) are developed extensively with commercial agriculture, particularly row crops which are subjected to regular applications of a variety of pesticides. The nature and extent of the short and long-term effects of these pesticides on particular populations of steelhead within the SCCC Recovery Planning Area has not been extensively studied, and consequently is not well known. NMFS is working with the EPA at the national level to address EPA's responsibilities under the ESA during the process of registering or reregistering pesticide active ingredients for use under the Federal Insecticide, Fungicide, and Rodenticide Act and for establishing water quality criteria for pesticides under the Clean Water Act. At the Regional level, NMFS works with the State of California and EPA Region IX to assess these water quality criteria as they are proposed. NMFS also works with numerous action agencies or organizations to review or help plan their pesticide application projects for protectiveness to ESA listed species and their habitats. See Appendix E for general guidance on best management practices in the application of pesticides.