SOUTH-CENTRAL/SOUTHERN CALIFORNIA COAST STEELHEAD RECOVERY PLANNING DOMAIN

5-Year Review: Summary and Evaluation of

Southern California Coast Steelhead Distinct Population Segment

Steelhead, Mission Creek (Mark H. Capelli)

National Marine Fisheries Service
West Coast Region
California Coastal Office, Long Beach, California

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5-YEAR REVIEW
South-Central/Southern California Coast Steelhead Recovery Planning Domain: Southern California Coast Steelhead DPS

Species Reviewed	Evolutionarily Significant Unit or Distinct Population Segment
Steelhead *(Oncorhynchus mykiss)*	**Southern California Coast Steelhead DPS**

1.0 GENERAL INFORMATION

1.1 Preparers and Reviewers

1.1.1. West Coast Region

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1.2 Introduction

The Southern California Coast Steelhead Distinct Population Segment (DPS) is listed as endangered and is comprised of a suite of steelhead populations (*Oncorhynchus mykiss*) that inhabit coastal stream networks from the Santa Maria River system south to the U.S. border with Mexico. Freshwater-resident (non-anadromous) *O. mykiss*, commonly known as rainbow trout, also occur in the same geographic region, frequently co-occurring in the same river systems as the anadromous form. Clemento *et al.* (2009) found that *O. mykiss* above and below impassable dams within the Southern California DPS tended to be each other's closest relatives, suggesting that each steelhead DPS is simply the anadromous component of a corresponding Evolutionarily Significant Unit (ESU; Waples 1991) comprising both anadromous and resident *O. mykiss*.

Anadromous and/or freshwater forms of the species also occur in some basins south of the U.S. border, on the Baja California Peninsula (Ruiz-Capos and Pister 1995).

West Coast salmon and steelhead (*Oncorhynchus* spp.) stocks have declined substantially from their historic numbers and many are now listed as threatened or endangered. Multiple factors have contributed to the decline of individual populations. These include the loss of freshwater and estuarine habitat, periodic poor ocean conditions, and a variety of land-use, flood control, and water management practices which have impacted many watershed-wide processes; these include hydrologic and sedimentation processes which create and maintain essential steelhead habitats. These factors collectively led the National Marine Fisheries Service (NMFS) to list southern California steelhead (the anadromous form of *O. mykiss*) as endangered under the ESA in 1997 (Figure 1).

Section 4(c)(2) of the ESA directs the Secretary of Commerce to review the listing classification of threatened and endangered species at least once every five years. After completing this review, the Secretary must determine if any species should be: (1) removed from the list; (2) have its status changed from threatened to endangered; or (3) have its status changed from endangered to threatened. The most recent listing determinations for salmon and steelhead occurred in 2005 and 2006. This document reflects the agency's 5-year status review of the ESA-listed Southern California Coast Steelhead Distinct Population Segment (DPS) since the last status review in 2010 (Williams *et al.* 2011).

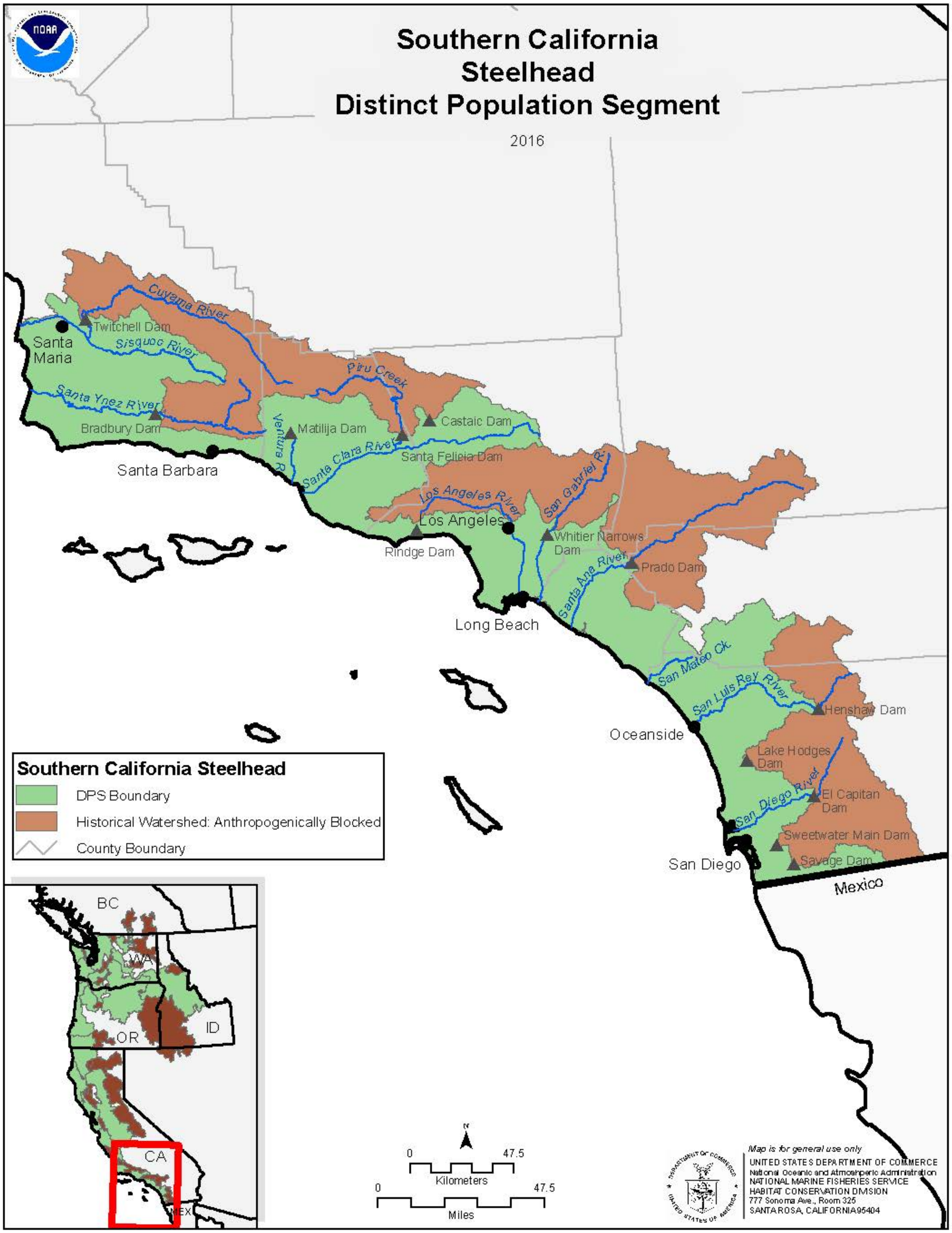

Figure 1. Southern California Coast Steelhead DPS.

1.3 Methodology used to complete the review

Section 4(c) (2) of the ESA requires 5-year status reviews for all listed species to determine if a change in status is necessary. A public notice initiating this review and requesting information was published on *February 6, 2015*, with a 90-day response period (80 FR 6695).

This 5-year status review was conducted by NOAA's Southwest and Northwest Fisheries Science Centers and West Coast Regional personnel. The review relied principally on a 2016 viability assessment update prepared by NOAA's Fisheries Science Centers, Technical Memoranda prepared by NOAA's Southwest Fisheries Science Center, Santa Cruz Laboratory, DPS wide threats assessments prepared for the Southern California Steelhead Recovery Plan, and run-size data from a small number of watersheds where such data is regularly collected.

NOAA's Southwest and Northwest Science Centers reviewed all new and substantial scientific information since the most recent review in 2010 and produced an updated viability assessment for the listed salmon and steelhead in California (Williams *et al*. 2016). The purpose of their review is to determine whether or not the biological status of the Southern California Coast Steelhead DPS had changed since the 2010 status review. NOAA staff from the California Coastal Office, Long Beach reviewed the status report and assessed whether the five ESA listing factors (threats) had changed substantially since the most recent 2006 listing determination (71 FR 5248).

1.4 Background – summary of previous reviews, statutory and regulatory actions, and recovery planning

1.4.1 FR Notice citation announcing initiation of this review

80 FR 6695 February 6, 2015

1.4.2 Listing history

Table 1. Summary of the listing history under the Endangered Species Act for the Southern California Coast Steelhead DPS.

Salmonid Species	ESU/DPS Name	Original Listing	Revised Listing(s)
Steelhead Anadromous *O. mykiss*	**Southern California Coast Steelhead DPS**	**FR Notice: 62 FR 43937 Date Listed: 08/18/1997 Classification: Endangered**	**FR Notice: 67 FR 21586 Date: 05/01/2002 Classification: Southern Range Extension FR Notice: 71 FR 5248 Date: 01/05/2006 Reconfirmed Classification: Endangered**

1.4.3 Associated rulemakings

Table 2. Summary of rulemaking for 4(d) protective regulations and critical habitat for the Southern California Coast Steelhead DPS.

Salmonid Species	ESU/DPS Name	4(d) Protective Regulations	Critical Habitat Designations
Steelhead Anadromous *O. mykiss*	**Southern California Coast Steelhead DPS**	**FR Notice: N/A** **Date: N/A**	**FR Notice: 70 FR 52488** **Date: 09/02/2005**

1.4.4 Review History

The first comprehensive status review of steelhead was conducted by Busby *et al.* (1996), who characterized Evolutionarily Significant Units (ESUs) using the conceptual framework of Waples (1991), and then assessed extinction risk of each ESU. The Southern California Coast Steelhead ESU was subsequently listed as endangered by NMFS under the U.S. Endangered Species Act in l997. The original listing characterized the southern range limit as the eastern end of the Santa Monica Mountains just up coast of Los Angeles, but it was later determined (2002) to occur further south, at least as far as the Tijuana River system at the U.S. border with Mexico, and possibly further south in Baja California. The listing was also modified (2006) to include only the anadromous component of the ESU, which is composed of both anadromous and freshwater-resident forms of *O. mykiss*. Good *et al.* (2005) updated the status of Pacific coast steelhead populations, and another update was conducted in 2010 (Williams *et al.* 2011). None of these updates led to changes in the status of the listed DPS, which has remained endangered.

Consistent with the requirements of the ESA, the listing triggered the preparation of a recovery plan for the Southern California Coast Steelhead DPS. The first phase of recovery planning focused on the synthesis of scientific information and developing technical guidance for recovering the DPS, and was conducted by NOAA's Southwest Fisheries Science Center, Santa Cruz Laboratory and its scientific partners. This phase of planning was based on available scientific information and a conceptual framework for viable salmonid populations (McElhany *et al.* 2000). Findings are described in a series of NMFS Technical Memoranda describing ESU structure (Boughton *et al.* 2006, Boughton and Goslin 2006), viability criteria (Boughton *et al.* 2007), research needs (Boughton 2010c), a conceptual framework for recovery (Boughton 2010a), and a conceptual plan for ongoing monitoring the risk status of California costal salmonid populations (Adams *et al.* 2011).

The second phase focused on preparation of a recovery plan that identified threats, recovery actions, research, monitoring and adaptive management issues, and described strategies and goals for recovering, and ultimately de-listing, the DPS. Since the last status review update (2010), NMFS has completed and formally adopted a recovery plan for the Southern California Coast Steelhead DPS (National Marine Fisheries Service 2012). The recovery plan is based on the biological needs of the fish and provides a foundation for restoring the DPS and its constituent populations to levels at which they would no longer be considered at risk of extinction.

These “levels” of risk are formally known as viability criteria, and the summary statistics used to assess the DPS are known as viability metrics (Figure 2). With the publication of the Southern California Steelhead Recovery Plan and a conceptual monitoring plan, the goal of status-review updates now becomes an assessment of whether viability metrics for the DPS are moving toward or away from the viability criteria. Unfortunately, this simple process of reviewing the status of the DPS is currently hampered by two problems: 1) scientific uncertainty about the viability criteria themselves, and 2) incomplete data on viability metrics. To address #1, below we review new information relevant to the viability criteria. To address #2, we review the implementation thus far of the monitoring plan, known formally as the California Coastal Monitoring Plan (CMP). See Sections 2.1.4 and 2.3 below.

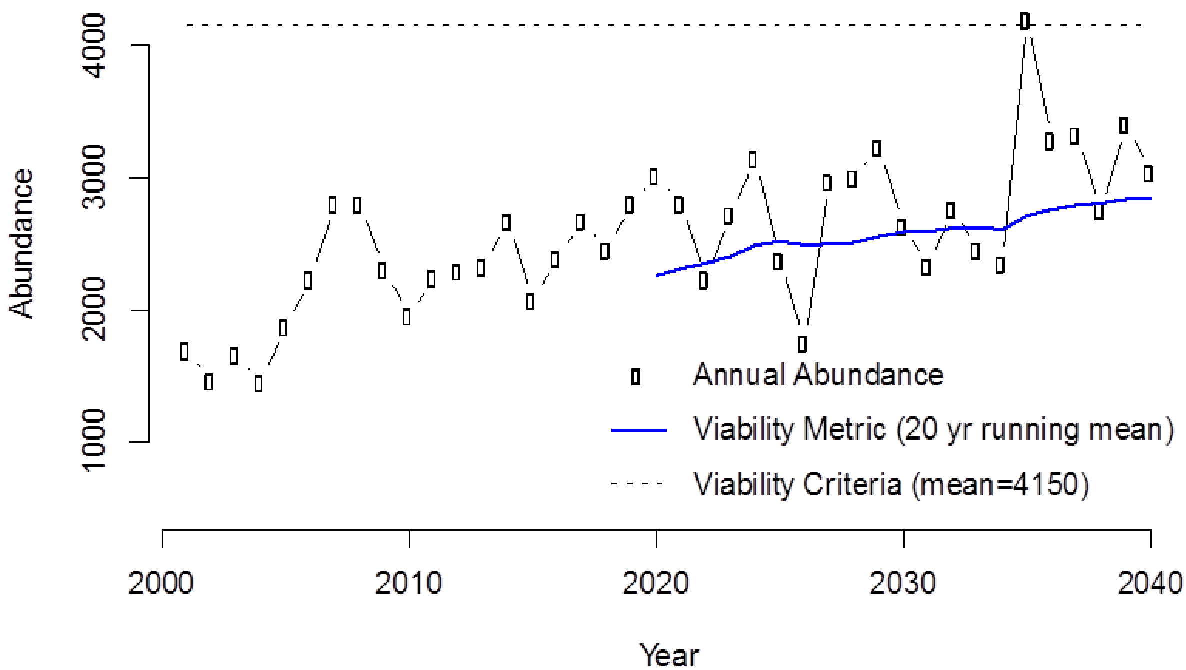

Figure 2. Concept of viability metric and a viability criterion applied to a hypothetical population.

Table 3. Summary of previous scientific assessments for the Southern California Coast Steelhead DPS.

Salmonid Species	ESU/DPS Name	Document Citation
Steelhead Anadromous *O. mykiss*	**Southern California Coast Steelhead DPS**	**Williams, T. H. *et al.* 2011. Status Review Update for Pacific Salmon and Steelhead Listed Under the Endangered Species Act. NOAA Southwest Fisheries Science Center.** **Boughton, D. A. 2010c. Some Research Questions on Recovery of Steelhead on the South-Central and Southern California Coast. NOAA-TM-NMFS-SWFSC-467.**

		Clemento, A. J. *et al.* 2009. Population Genetic Structure and Ancestry of *Oncorhynchus mykiss* Populations Above and Below Dams in South-Central California. *Conservation Genetics* 10:1321-1336. **Pearse, D. and J. C. Garza. 2008. Historical Baseline for Genetic Monitoring of Coastal California Steelhead, *Oncorhynchus mykiss.* Final Report for California Department of Fish and Wildlife Fisheries Restoration Grant Program P0510530.** **Garza, J. C. and A. Clemento. 2007. Population Genetic Structure of *Oncorhynchus mykiss* in the Santa Ynez River, California. Final Report for Project Partially Funded by the Cachuma Conservation Release Board.** **Boughton, D. A. *et al.* 2007. Viability Criteria for Steelhead of the South-Central and Southern California Coast. NOAA-TM-NMFS-SWFSC-407.** **Jackson, T.A. 2007. California Steelhead Fishing Report-Restoration Card: A Report to the Legislature. California Department of Fish and Wildlife, Sacramento, California.** **Girman, D. and J. C. Garza. 2006. Population Structure and Ancestry of *O. mykiss* populations in South-Central California Based on Genetic Analysis of Microsatellite Data. Final Report for California Department of Fish and Wildlife Project No. P0350021 and Pacific State Marine Fisheries Contract No. AWIP-S-1.** **Boughton, D. A. *et al.* 2006. Steelhead of the South-Central/Southern California Coast: Population Characterization for Recovery Planning NOAA-TM-NMFS-SWFSC-394.** **Boughton, D. A. and M. Goslin. 2006. Potential Steelhead Over-Summering Habitat in the South-Central/Southern California Coast Recovery Domain: Maps Based on the Envelope Method NOAA-TM-NMFS-SWFSC-391.** **Boughton *et al.* 2005. Contraction of the Southern Range Limit for Anadromous *Oncorhynchus mykiss*. NOAA-TM-NMFS-SWFSC-380.** **Helmbrecht, S and D. A. Boughton. 2005. Recent Efforts to Monitor Anadromous *Oncorhynchus* Species in the California Coastal Region: A Complication of Metadata NOAA-TM-NMFS-SWFSC-381.**

		Good, T. P. *et al*. (eds.) 2005. Updated Status of Federally Listed EUS of West Coast Salmon and Steelhead. NOAA-TM-NWFSC-66. **Busby, P. *et al.* 1996. Status Review of West Coast Steelhead from Washington, Idaho, Oregon, and California. NOAA-TM-NWFSC-27.**

1.4.5 Species' Recovery Priority Number at start of 5-year review

NOAA Fisheries issued guidelines in 1990 (55 FR 24296) for assigning listing and recovery priorities. Three criteria are assessed to determine a species' priority for recovery plan development, implementation, and resource allocation: 1) magnitude of threat; 2) recovery potential; and 3) existing conflict with activities such as construction and development. The recovery priority number for this DPS, as reported in the *2008-20010 Biennial Report to Congress on the Recovery Program for Threatened and Endangered Species,* is listed in Table 4 below.

1.4.6 Recovery Plan or Outline

Table 4. Recovery Priority Number and Endangered Species Act Recovery Plans for Southern California Coast steelhead DPS.

Salmonid Species	ESU/DPS Name	Recovery Priority Number	Recovery Plans/Outline
Steelhead Anadromous *O. mykiss*	**Southern California Coast Steelhead DPS**	**3**	**Final Recovery Outline - 2007** **Draft Recovery Plan - 2010** **Final Recovery Plan - 2012**

The recovery priority number "3" for the Southern California Coast Steelhead DPS is based on a high magnitude of threat to a small number of extant populations vulnerable to extirpation due to loss of accessibility to freshwater spawning and rearing habitat, low abundance, degraded estuarine habitats, and altered watershed processes essential to maintain freshwater habitats. The recovery potential is low to moderate due to the lack of additional populations, lack of available/suitable freshwater habitat, fish passage barriers, and inadequate instream flow. There is a moderate magnitude of threat to smaller watersheds, and higher risk in larger watersheds with major water supply and flood control facilities. Conflict was determined to be present due to existing and anticipated future development, habitat degradation, and conflict with land development and associated flood control activities and water supplies.

2.0 REVIEW ANALYSIS

2.1 Delineation of Species under the Endangered Species Act

2.1.1 Is the species under review a vertebrate?

ESU/DPS Name	YES	NO
Southern California Coast Steelhead DPS	**X**	

2.1.2 Is the species under review listed as a DPS?

ESU/DPS Name	YES	NO
Southern California Coast Steelhead DPS	**X**	

2.1.3 Was the DPS listed prior to 1996?

ESU/DPS Name	YES	NO	Date Listed if Prior to 1996
Southern California Coast Steelhead DPS		**X**	***n/a***

2.1.3.1 Prior to this 5-year review, was the DPS classification reviewed to ensure it meets the 1996 policy standards?

In 1991 NMFS issued a policy to provide guidance for defining ESUs of salmon and steelhead that would be considered for listing under the ESA (56 FR 58612; November 20, 1991). Under this policy a group of Pacific salmon populations is considered an ESU if it is substantially reproductively isolated from other con-specific populations and it represents an important component in the evolutionary legacy of the biological species. This DPS was originally defined and listed under NMFS's ESU policy in 1997. The 1996 joint NMFS-U.S. Fish and Wildlife Service (FWS) DPS policy affirmed that a stock of Pacific salmon (or steelhead) was considered a DPS if it represented an ESU of a biological species and concluded that NMFS' ESU policy was a detailed extension of the joint DPS policy. Accordingly, NMFS considered the originally defined and listed ESU to be a distinct population segment under the ESA. After reassessing the status of steelhead ESUs in 2005, NMFS decided to use the joint NMFS-FWS DPS policy to define steelhead only DPSs and in 2006 announced final listing determinations for steelhead based on the DPS policy (71 FR 834). That analysis concluded that Southern California Coast Steelhead constituted a DPS under the joint DPS policy and that it continued to be an endangered species. In summary, therefore, the Southern California Coast steelhead DPS has been found to meet the 1996 DPS policy standards.

2.1.4 Summary of relevant new information regarding the delineation of the ESUs/DPSs under review

Since publication of the last status review (Williams *et al.* 2011), significant new genetic data are available for populations across much of coastal California.

The prevalence of extensive non-native *O. mykiss* ancestry in the Mojave Rim and Santa Catalina Gulf Coast BPGs indicates that risk status of the Southern California Coast Steelhead DPS is greater than previously thought. Native lineages have been nearly extirpated from this far southern region of the native range of *O. mykiss*, with only a few relict populations persisting in the headwaters of the San Gabriel, Santa Ana, and San Luis Rey rivers. See Figures 5, 6, and 7. Introduced lineages, primarily from the Central Valley DPS, are extant, introgressing with and in some cases replacing native lineages. Presumably these introduced lineages have begun to evolutionarily adapt to the local habitats, but do not have the long history of adaptation that the native lineages have had. Their potential role in the recovery of the species is unclear.

Recent work shows that the tendency to out-migrate (versus maturing in freshwater) is associated with particular juvenile body sizes, gender, the presence of a particular "supergene" on chromosome Omy5, and interactions of these effects. Both variants of the supergene occur in most populations, but one variant tends to predominate in sites with connectivity to the ocean, and the other in populations without connectivity. Overall, these results show that the resident and anadromous forms are tightly integrated at the population level, suggesting a revision of the viability criterion for 100% anadromous fraction. However, such revision would require additional quantitative analysis of population viability. See further discussion in Section 2.3 below.

2.2 Recovery Criteria

2.2.1 Do the species have final, approved recovery plans containing objective, measurable criteria?

ESU/DPS Name	YES	NO
Southern California Coast Steelhead DPS	**X**	

A recovery plan has been prepared for the Southern California Coast Steelhead DPS (National Marine Fisheries Service 2012). The recovery plan contains objective measurable recovery criteria for both individual populations and the DPS as a whole based upon the viability criteria developed by NOAA's Southwest Fisheries Science Center, Santa Cruz Laboratory (Boughton *et al.* 2007) and the recovery strategy developed by NOAA Fisheries', California Coastal Office, Long Beach. These criteria specify a minimum number of populations distributed through five distinctive biogeographic population groups within the DPS which must exhibit a suite of biological characteristics, including minimum annual run-size, life-history diversity, persistence through long-term oceanic conditions, population and spawning density, and an anadromous fraction.

2.2.2 Adequacy of recovery criteria

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

ESU/DPS Name	YES	NO
Southern California Coast Steelhead DPS	**X**	

The provisional recovery criteria reflect the best available and most up to date information on the biology of the species based upon the viability criteria developed by NOAA's Southwest Fisheries Science Center, Santa Cruz Laboratory. The Southern California Steelhead Recovery Plan has undergone independent scientific peer and co-manager review.

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria?

ESU/DPS Name	YES	NO
Southern California Coast Steelhead DPS	**X**	

2.2.3 List the recovery criteria as they appear in any final or interim recovery plan, and discuss how each criterion has or has not been met, citing information

The Southern California Steelhead Recovery Plan contains objective measurable recovery criteria based upon the viability criteria developed by NOAA's Southwest Fisheries Science Center, Santa Cruz Laboratory and the recovery strategy developed by NOAA Fisheries' West Coast Region California Coastal Office, Long Beach. The following summarizes the provisional recovery criteria:

Population-Level Criteria

Mean Annual Run Size - Each population identified as a core population within each of the 5 Biogeographic Population Groups (BPG) must meet the mean annual run size. In some cases the population may be comprised of two or more closely interacting watersheds. This numeric criterion is subject to modification pending further research, and may differ for individual populations. See Figure 3, and Tables 5 and 6.

Ocean Conditions - Each population identified as a core population within each of the 5 BPGs must meet the mean annual run size during variable oceanic conditions over the course of at least 6 decades. In some cases the population may be comprised of two or more populations from closely interacting watersheds. This criterion will require multi-decadal monitoring; currently the monitoring of individual populations is inadequate to assess how they meet this criterion (See Section 4.0 Recommendations for Future Actions below).

Population Density - Each population identified as a core population within each of the 5 BPGs must meet the density criteria (currently unspecified pending further research). In some cases the population may be comprised of two or more closely interacting watersheds. Further research is needed on this criterion; currently the monitoring of individual populations is inadequate to assess how they meet this criterion. See section 4.0 Recommendations for Future Actions below.

Anadromous Fraction - The portion of each of the populations identified as a core population within each of the 5 BPGs that is counted towards the meeting the population size criteria must be comprised of 100% anadromous individuals. In some cases the population may be comprised of two or more closely interacting watersheds. This numeric criterion is subject to modification pending further research. See Section 4.0 Recommendations for Future Actions below.

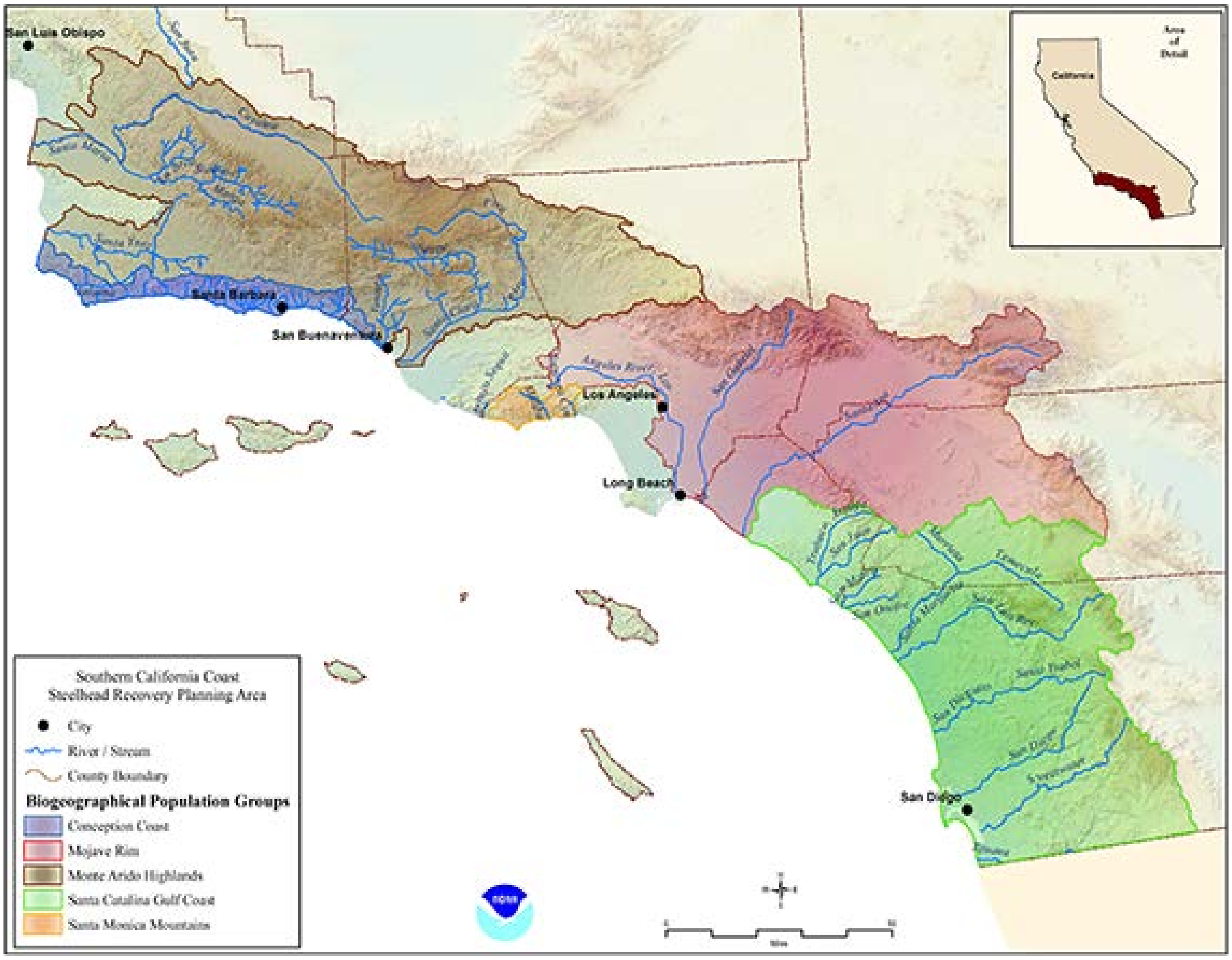

Figure 3. Five Biogeographic Population Groups (BPGs) making up the Southern California Coast Steelhead DPS.

DPS-Level Criteria

Biogeographic Diversity - A minimum number of viable populations must be distributed through each of the 5 BPGs. These viable populations must inhabit watersheds with drought refugia and be separated a minimum of 68 km to the maximum extent possible. The recovery plan identifies a minimum suite of core populations within each BPG, including those portions of the watersheds that contain drought refugia. See Tables 5 and 6. Further research is needed on this criterion, in particular the identification of drought refugia in the core watersheds. See Section 4.0 Recommendations for Future Actions below.

Life-History Diversity - The viable populations within each BPG must exhibit the three principal steelhead life-history types (fluvial-anadromous, lagoon-anadromous, and freshwater resident). The recovery plan identifies a suite of core populations in each biogeographic population group with habitats having the intrinsic potential to support the three principal life-history types. New findings demonstrate that resident and anadromous life-histories in *O. mykiss* in the Southern California Coast Steelhead Recovery Planning Area are tightly integrated. This in turn suggests that the viability criterion for a 100% anadromous fraction in core populations (Table 6) should be revised. However, the studies summarized below do not include any population-viability analyses, which would be necessary for proposing a specific revision of the criterion.

2.3 Updated Information and Current Species Status

2.3.1 Analysis of Viable Salmonid Population (VSP) Criteria

There is little new evidence to suggest that the status of the Southern California Coast Steelhead DPS has changed appreciably in either direction since publication of the last status review (Williams *et al.* 2011). New and additional information available on anadromous runs since Williams *et al.* (2011) remains limited but does not appear to suggest a change in extinction risk, with the notable exception discussed below regarding the southernmost populations within the Southern California Coast Steelhead DPS, and the overall effects of the current drought, and projected climate change. However, there is new information on genetics and the methodology relevant to viability criteria. Below we present a discussion of these topics, followed by an updated summary of current monitoring efforts and results (Boughton *in* Williams *et al*. 2016).

Risk status is based on the concept of viability at two levels of organization: the overall DPS, and individual populations composing the ESU of which the DPS is part.

2.3.1.1 DPS Viability

The Southern California Steelhead Recovery Plan (National Marine Fisheries Service 2012) included viability criteria for a set of core populations (Table 5, Figure 4) and incorporated the scientific recommendations by specifying a set of core populations on which to focus the recovery effort, *i.e.*, “Core 1” and “Core 2” populations (Table 5 and Table 6, DPS-Level Criteria). Formally, if each of these core populations were restored to viability (Table 6, Population-Level Criteria), and they also meet DPS-level criteria (Table 6, DPS-Level Criteria), the DPS as a whole would be considered viable from a scientific perspective (Boughton *et al*. 2007). However, there *appear* to be two discrepancies between the scientific recommendations for DPS viability (Table 6) and the list of core populations (Table 5).

Table 5. Monitoring status in Core 1 and 2 populations designated by Southern California Steelhead Recovery Plan for recovering to viability.

Population	Adult Abundance?	Spatial Structure?	Smolt Counts?
Southern California Coast DPS			
Monte Arido Highlands populations			
Santa Maria River	N	N	N
Santa Ynez River	B	Y	B
Ventura River	B	Y(I)	B
Santa Clara River	B	N	B
Santa Barbara Coast populations			
Canada de la Gaviota	N	N	N
Goleta Slough complex	N	N	N
Mission Creek	N	N	N

Carpinteria Creek	Y	N	N
Rincon Creek	N	N	N
Santa Monica Mountains populations			
Arroyo Sequit	B*	Y	Y
Malibu Creek	B*	Y	Y
Topanga Canyon	B*	Y	Y
Mojave Rim populations			
San Gabriel River	N	N	N
Santa Ana River	N	N	N
Santa Catalina Gulf Coast populations			
San Juan Creek	N	N	N
San Mateo Creek	N	N	N
San Onofre Creek	N	N	N
Santa Margarita River	N	N	N
San Luis Rey River	N	N	N
San Dieguito River	N	N	N

Y = yes, N = No, B = estimates are likely biased (B* = redd counts, which can be bias-corrected with data from life-cycle monitoring stations.) Note: San Diego, Sweetwater, Otay, and Tijuana rivers are currently classified as Core 3 populations in the Southern California Steelhead Recovery Plan.

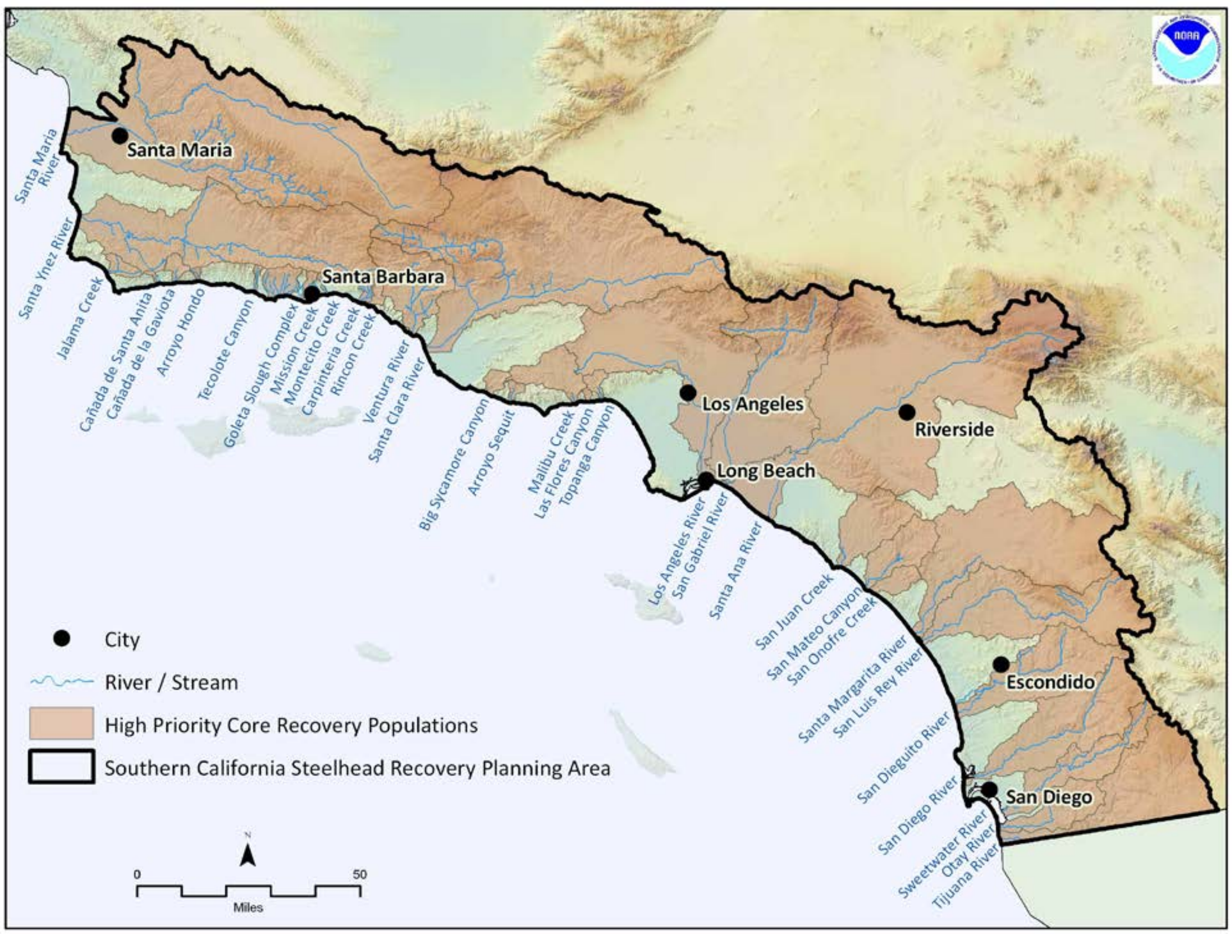

Figure 4. High priority core recovery populations in the Southern California Coast Steelhead DPS.

Table 6. Biological recovery criteria for the Southern California Steelhead DPS.

POPULATION-LEVEL CRITERIA: Applies to Populations Selected to Meet DPS-Level Criteria		
Criterion Type[1]	**Recovery Threshold**	**Notes**
P.1 Mean Annual Run Size	Run size is sufficient to result in an extinction risk of < 5% within 100 years	Monitoring run size will provide information on year-to year fluctuations in the population necessary to determining the appropriate recovery threshold for individual populations. Research on the role of non-anadromous spawning fraction in stabilizing anadromous faction will also enable refinement of the minimum recovery threshold (see Boughton *et al.* [2007] for discussion of steps in determination of threshold value for each viable population)
P.2 Ocean Conditions	Run Size criterion met during poor ocean conditions	"Poor ocean conditions" determined empirically, or size criterion met for at least 6 decades
P.3 Spawner Density	*Unknown at present*	Research needed
P.4 Anadromous[2] Fraction	N = 100% of Mean Annual Run Size	Requires further research
DPS-LEVEL CRITERIA		
Criterion Type	**Recovery Threshold**	
D.1 Biogeographic Diversity	1. Biogeographic Population Group contains minimum number of viable populations: Monte Arido Highlands: 4 populations Conception Coast: 3 populations Mojave Rim: 3 populations Santa Monica Mountains: 3 populations Santa Catalina Gulf Coast: 8 populations[3] 2. Viable populations inhabit watersheds with drought refugia 3. Viable populations separated from one another by at least 42 miles or as widely dispersed as possible[4]	
D.2 Life-History Diversity	All three life-history types (fluvial-anadromous, lagoon-anadromous, freshwater resident) are exhibited and distributed across each Biogeographic Population Group	

[1] It is assumed that all spawner criteria represent escapement (*i.e.*, un-harvested spawning adults) rather than migrating adults that may be captured before having an opportunity spawn.

[2] The anadromous fraction is the percentage of the run-size that must exhibit an anadromous life-history to be counted toward meeting the mean annual run size criteria. However, the recovery strategy recognizes the potential role of the non-anadromous form of *O. mykiss* and includes recovery actions which would restore habitat occupied by the non-anadromous form, as well as reconnect such habitat with anadromous waters, and thus allow the anadromous and non-anadromous forms to interbreed, and the non- anadromous forms to potentially express an anadromous life-history.

[3] See Boughton *et al*. 2007 for detailed discussion.

[4] This geographic separation is based on the maximum width of recorded historic wildfires.

First, NOAA's Technical Review Team (TRT) for the Southern California Coast Steelhead Recovery Planning Area designated three populations in the Mojave Rim BPG to be restored to viability, but the Recovery Plan designated only two (San Gabriel River, Santa Ana River) as either Core 1 or Core 2 populations. The third population (Los Angeles River) was designated as a Core 3 population. In addition, the TRT recommended that eight populations in the Santa Catalina Gulf Coast BPG be restored to viability, but the Recovery Plan designated only six (San Juan Creek, San Mateo Creek, San Onofre Creek, Santa Margarita River, San Luis Rey River and San Dieguito River) as either Core 1 or Core 2 populations. Four other populations (San Diego Sweetwater, Otay, and Tijuana) were designated as Core 3 populations. Core 3 populations are not assigned as high a recovery implementation priority as Core 1 and 2 populations, though Core 3 populations are recognized as important in promoting connectivity between populations, and genetic diversity across the DPS, and are, therefore, an integral part of the overall biological recovery strategy of the Recovery Plan. This approach is, therefore, broadly consistent with the recommendations in the viability criteria developed by the TRT, which noted that it is not clear if historically, the anadromous life-history was consistently expressed in the populations at the extreme southern range limit of steelhead (Boughton 2007).

Significant new genetic information bears on the question of native steelhead populations in the far south. Jacobson *et al.* (2014) analyzed genetic composition of *O. mykiss* sampled from a variety of sites in the Monte Arido, Mojave Rim and Santa Catalina Gulf Coast BPGs (see also Abadia-Cardoso *et al.* 2016). The majority of sites within the two southernmost BPGs (Mojave Rim and Catalina Gulf Coast) were found to harbor *O. mykiss* lineages derived from hatchery stocks of rainbow trout rather than native coastal steelhead lineages. Native lineages were generally found throughout the Monte Arido sites, but most of the Mojave Rim and Santa Catalina Gulf Coast sites consisted of non-native hatchery lineages, "representing almost complete introgression or replacement of native fish by introduced hatchery rainbow trout" (Jacobson *et al*. 2014, p. 22). However, three groups of sites contained significant evidence of native steelhead ancestry: 1) the San Luis Rey River, 2) Coldwater Canyon, tributary to the Santa Ana River, and 3) the San Gabriel River, except for sites on the Iron Fork and Devil's Canyon Creek that showed hatchery lineage. These three groups of sites are part of three core populations listed in Tables 5 and 6. A few other sites, especially Bear Creek, tributary to Santa Ana River, and Devil's Canyon Creek, tributary to San Gabriel River, showed detectable signals of native ancestry co-existing with a strong signal of hatchery lineages. The authors of the report concluded that "overall, relatively few populations [sites] in this study appear to be pure native Southern California *O. mykiss*" (Jacobson *et al.* 2014, p. 22), but they also noted that some of the non-native genetic introgression may increase the potential for evolutionary adaptation to changing conditions and might, therefore, contribute to viability.

Figures 5 through 7 depict the locations at which *O. mykiss* genetic samples were taken and the genetic make-up of the sampled population determined by trout tissue genetic analysis (Dr. J. C. Garza's Molecular Ecology and Genetics Analysis Team, NOAA Southwest Fisheries Science Center, Santa Cruz Laboratory).

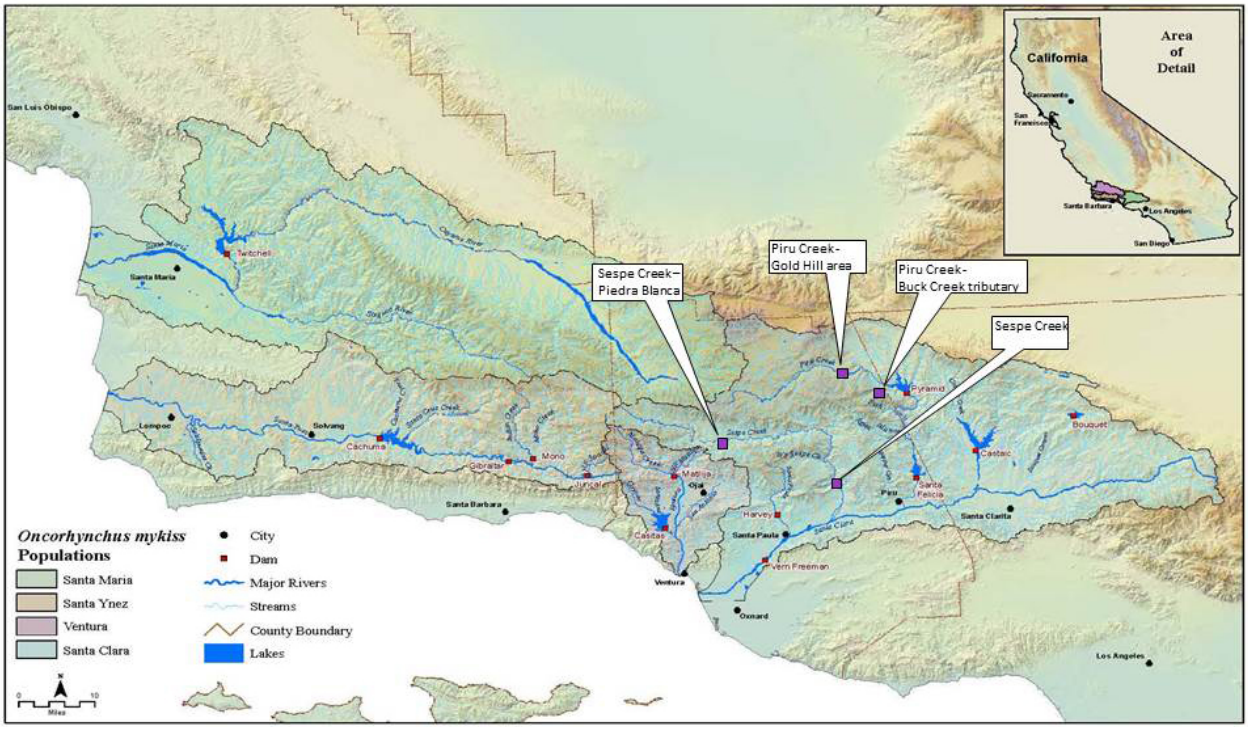

Figure 5. Northern end of southern California rainbow trout genetics study area (Monte Arido Highlands BPG): Piru Creek, Sespe Creek, tributaries of the Santa Clara River. Purple squares = native trout of coastal steelhead decent. Figure courtesy Sandra Jacobson, South Coast Steelhead Coalition.

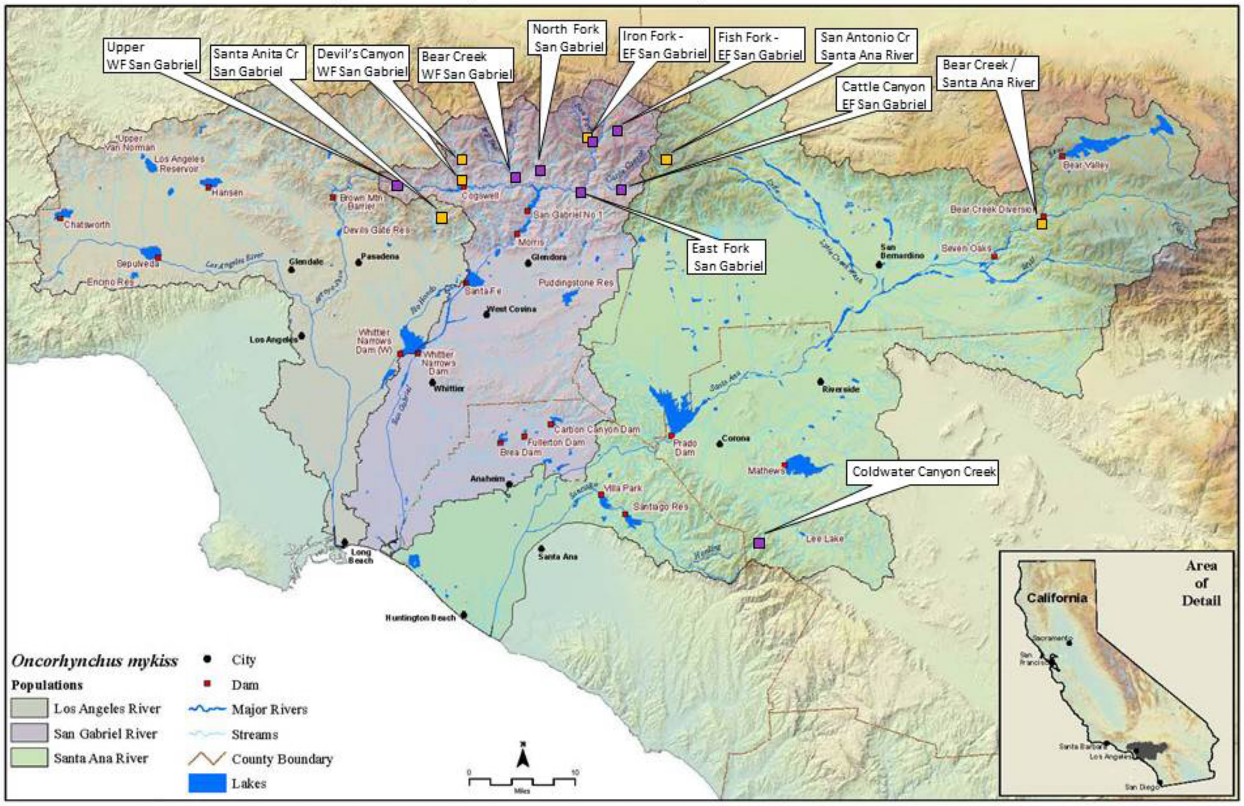

Figure 6. Central region of Southern California Rainbow Trout genetics study area (Mojave Rim BPG): Los Angeles River, San Gabriel River, Santa Ana River. Purple squares = native trout of coastal steelhead descent. Yellow squares = rainbow trout of hatchery lineage. Figure courtesy Sandra Jacobson, South Coast Steelhead Coalition.

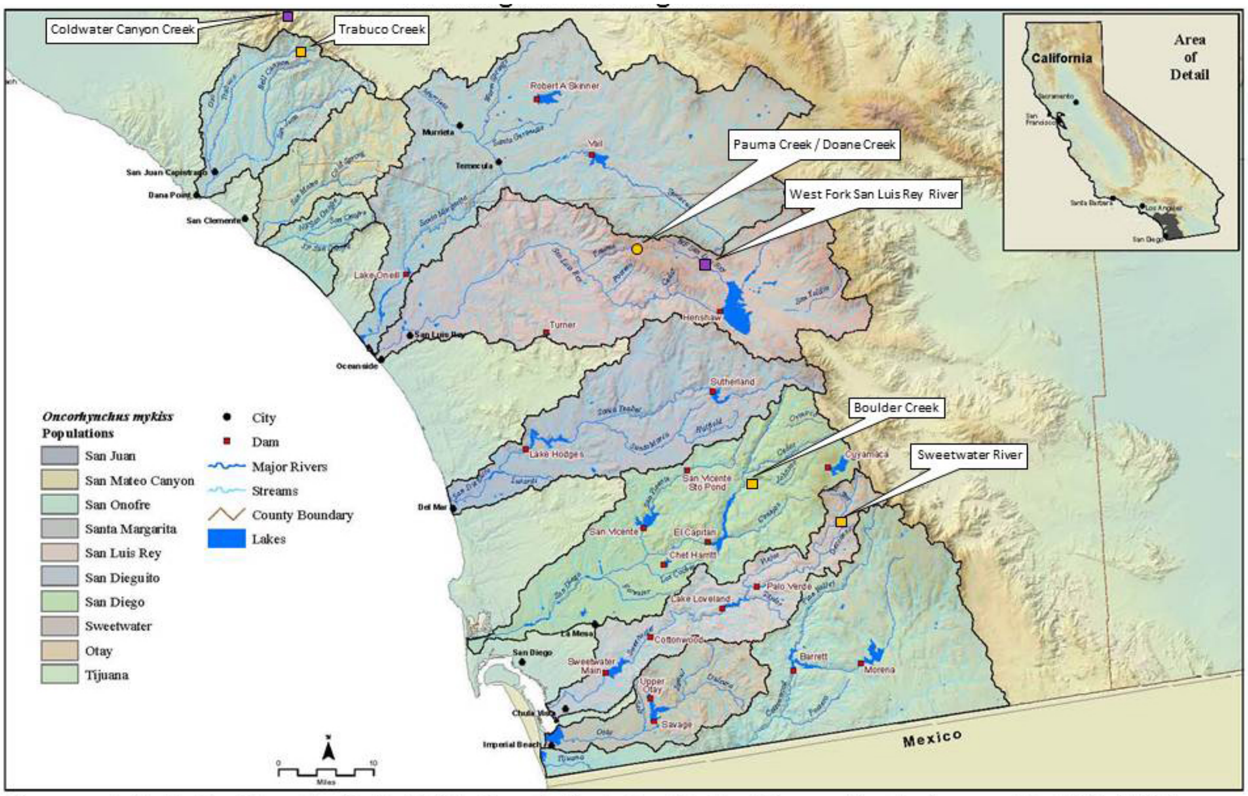

Figure 7. Southern end of Southern California Rainbow Trout genetics study area (Santa Catalina Gulf Coast BGP): San Juan/Arroyo Trabuco Creek, San Luis Rey River (Pauma Creek, West Fork San Luis Rey River), Sand Diego River (Boulder Creek), Sweetwater River. Purple squares = native trout of coastal steelhead descent. Yellow squares = rainbow trout of hatchery lineage. Yellow circle = absence of dam/reservoir below site. Figure courtesy Sandra Jacobson, South Coast Steelhead Coalition.

Second, the TRT recommendations emphasized that core populations be situated in watersheds with drought refugia (Table 6, DPS-Level Criteria). There does not appear to be any systematic information on the distribution of drought refugia, even though the current drought provides a valuable opportunity to identify such refugia; however, anecdotal evidence indicates that sections of the middle reaches of Sespe Creek and it's lower tributary, West Fork (both tributary to the Santa Clara River, a core population) continue to support populations of *O. mykiss* through the current drought (Mark Capelli, National Marine Fisheries Service, personal observation 2015). Thus it is unclear if the selected set of core populations, as a whole, meets this criterion.

The viability report developed for the Southern California Coast Steelhead Recovery Planning Area noted that " . . . tree-ring data described by Cook *et al.* (2004) go back to the year 800 A.D., and record at least 4 multi-decade droughts prior to 1300 A.D. These events had far greater magnitudes than anything observed during the historical period. The aboriginal steelhead populations must have either survived in drought-resilient refugia, or have been regionally extirpated prior to 1300 A.D. and recolonized in the subsequent centuries. If the refugium hypothesis is correct, ESU viability is probably contingent on forecasting the location of refugia under future climate regimes. If the recolonization hypothesis is correct, ESU/DPS boundaries are currently mis-specified. Evaluation of the refugium hypothesis, particularly as it relates to future climate, is an obvious research priority." (Boughton *et al.* 2007, p. 21).

2.3.1.2 Population Viability

Viability criteria at the population level are summarized in Table 6. There was broad agreement among the TRT that the viability metrics of Table 6 were sufficient for assessing risk, but also agreement that the specific viability criteria were highly sensitive to scientific uncertainty about key aspects of steelhead ecology (Boughton *et al.* 2007). These key knowledge gaps included 1) uncertainty about the magnitude of normal fluctuations in adult abundance, and 2) uncertainty about the underlying biological mechanisms for expression of life-history diversity, especially factors triggering anadromous versus resident life-histories within populations. Thus the criteria that mean annual spawner abundance 1) be greater than 4,150, and 2) be composed of 100% anadromous individuals, were recommended as a risk-averse approach. It was expected that further scientific work would either support these criteria or allow one or both to be relaxed, depending on results.

NMFS convened a research and monitoring colloquium in 2014 at the National Center for Ecological Synthesis and Analysis (NCEAS). The participants identified several key areas of research, including: 1) the functional basis for partial migration of *O. mykiss*; 2) habitat structure and its relationship to life-history strategies; 3) the assessment of nursery habitats, including mainstem, intermittent stream reaches, and estuaries; 4) interactions with non-native species, including predation and disease; and 5) the general ecology of the marine phase of *O. mykiss* life-histories. The group elected to work on the first four of these topics, by producing white papers further refining the research needs and approaches to carrying out this research. The last five years have seen little progress in developing better scientific information on population fluctuations, but significant progress on maintenance of life-history diversity. However, there has been no work on how the ecological and biological factors that maintain life-history diversity at the population level bear on the viability criterion for the anadromous fraction of the *O. mykiss* complex.

Data on population fluctuations will emerge over time with the implementation of the California Coastal Monitoring Plan (CMP), discussed further in the next section. The California CMP emphasizes annual estimates of abundance of anadromous adults in each Core 1 and Core 2 population, which is intended to provide data on abundance and productivity metrics, including abundance fluctuations. Missing from the California CMP, but just as important with respect to any future revision of viability criteria, are ongoing monitoring of abundance and fluctuations of the resident life-history type in each population over time, and the lagoon-anadromous form (Boughton *et al.* 2007). Finally, the U.S. Forest Service developed a steelhead monitoring, tracking and reporting program for the Los Padres National Forest which incorporates elements of the California CMP and the Southern California Steelhead Recovery Plan, but has not devoted significant resources to its implementation (HDR Engineering, Inc. 2013).

2.3.1.3 Maintenance of Life-History Diversity

Previous research led by NMFS and UC Santa Cruz suggested that diversity of life-histories (anadromous versus resident life-histories, diversity in age of smolting and age of maturation) was largely controlled by diversity in growth rates during the early life-history of the fish (Satterthwaite *et al.* 2012, 2009, Beakes *et al.* 2010, Bond *et al.* 2008), and thus was largely under ecological control. On the other hand, numerous studies have demonstrated the heritability and genetic influence on expression of anadromy (Kendall *et al.* 2015). In particular, a recent analysis identified an important genetic component on chromosome Omy5 (Pearse *et al.* In review, Pearse *et al*. 2014, Martinez *et al.* 2011). Evidently, a portion of *O. mykiss* chromosome 5 has undergone an inversion, in which a segment of the chromosome has been reversed end to end in some fish but not others. This presumed inversion is passed on to progeny, but for fish in which one chromosome is inverted and the other not (*i.e.*, a parent of each type), no crossing-over can occur during meiosis (double cell division producing four cells – sperm in males, eggs in females - containing half the original amount of genetic material), and so the set of genes on the inverted section of chromosome are tightly linked (*i.e.*, prevented from mixing between the two chromosome types). Such tightly linked sets of genes are sometimes called "supergenes."

Pearse *et al.* (2014) surveyed the occurrence of these two chromosome types in existing genetic samples from throughout the California coastal mountains, and found several interesting patterns:

1) Both chromosome types were present at most sites;
2) There was strong evidence of selection on the set of linked genes within the inversion; and
3) One chromosome type dominated sites in anadromous waters, whereas the other chromosome type dominated sites in formerly anadromous waters that are now upstream of impassable dams (a notable exception is the adfluvial population in the upper Santa Ynez River above Juncal Dam where the population contains a high frequency of the chromosome type associated with anadromy).

Pearse *et al.* (2014) concluded that natural selection favors one chromosome type in anadromous waters, and this chromosome type, therefore, likely plays a role in maintaining the anadromous life-history, and natural selection favors the other chromosome type in non-anadromous waters, and it, therefore, likely plays a role in maintaining the resident life-history. However, both chromosome types occur in both types of waters, and both life-histories are observed in anadromous waters, so the relationship is probably not a simple association between resident and anadromous genomic elements.

Pearse *et al.* (In review) combined genetic analysis of the Omy5 inversion with a mark-recapture study of juvenile *O. mykiss* in a small population in the Big Sur BPG (in the neighboring South-Central California Coast Steelhead DPS). For age 0 fish, the probability of emigrating from freshwater to the ocean was associated with chromosome type, sex, and juvenile body size, and also interaction effects for these three traits. However, the associations were probabilistic rather than "complete": emigrants included juveniles of both sexes, a broad range of sizes (100 – 250 mm), and both chromosome types. Pearse *et al.* (in review) conclude that the Omy5 inversion region represents a "supergene with a major effect on a complex behavioral trait [*i.e.*, migration], " but that the individual component genes have not yet been resolved, and also that chromosome Omy12 "also contains regions important for smoltification-related traits . . . In addition, other genomic regions, heritable epigenetic effects, and subtle population structure or assortative mating may also affect this complex life-history trait." Rundio *et al.* (2012) also described evidence that females were more likely than males to emigrate in this study population, and

Ohms *et al.* (2014) documented similar female-biased emigration in 9 populations distributed broadly across the Pacific Northwest, southern Alaska, and northern California.

These new findings demonstrate that resident and anadromous life-histories in *O. mykiss* in the South-Central/Southern California Steelhead Recovery Planning Domain and elsewhere are tightly integrated. This in turn suggests that the viability criterion for a 100% anadromous fraction in core populations (Table 6, Population-Level Criteria) should be revised. However, the studies summarized above do not include any population-viability analyses, which would be necessary for proposing a specific revision of the criterion.

2.3.1.4 New Information on Methodology for Viability Metrics

California's (CMP) draws on the Viable Salmonid Population (VSP) framework of McElhany *et al.* (2000) to assess viability in terms of four population metrics: abundance, productivity, spatial structure and diversity. The California CMP also outlines the creation of a system of Life-Cycle Monitoring (LCM) stations to collect additional data necessary for the interpretation of those four metrics (Adams *et al.* 2011). The California CMP is intended to provide data sufficient to conduct status reviews under the ESA, but at present is only partially implemented. Here we review methodological issues that appear to be impeding implementation (Boughton *in* Williams *et al*. 2016); in Section 2.3.1.4.2 we review the level of implementation thus far within the Southern California Coast Steelhead DPS.

According to Adams *et al.* (2011), the California CMP divides the coastal zone of California into *northern* (Santa Cruz to California-Oregon border) and *southern* (Monterey to U.S.-Mexico border) areas based on differences in species composition, levels of abundance, distribution patterns, and habitat differences that require distinct monitoring approaches. The South-Central and Southern California Coast Steelhead DPSs are in the California CMP's *southern* area. Implementation of the California CMP in the southern area involves monitoring the following metrics in the core populations listed in Table 5 (Adams *et al.* 2011):

1) Unbiased estimates of annual anadromous run size, for tracking abundance and productivity;
2) Unbiased estimates of the spatial distribution of juveniles, possibly also in lower priority populations, for tracking spatial structure;
3) Unbiased estimates of annual smolt production in a subset of Table 5 populations that are well-distributed biogeographically (using LCMs), for distinguishing between changes in ocean conditions and freshwater conditions; and
4) Unbiased estimates of diversity metrics, still to be determined, for tracking diversity.

Here, "unbiased" is used in the statistical sense of estimators whose long-run sampling distribution is equal to the parameter being estimated—for example, methods that do not systematically undercount or over count fish over repeated surveys. Below we summarize methodological progress on estimating these four metrics.

2.3.1.4 (a) Abundance and Productivity

In both northern and southern California CMP monitoring areas, the assessment of abundance and productivity is based upon unbiased estimates of the annual number of anadromous adults across each ESU/DPS, with productivity calculated as the trend in anadromous adults over time. In the northern California CMP monitoring area, adult abundance is estimated via redd surveys conducted in a spatially balanced, stratified-random sample of stream reaches, and bias-corrected by redds-per-female estimates obtained from life-cycle monitoring stations. At the time of California CMP development, redd surveys were believed to be infeasible in the southern area due to the extremely episodic flow regime and high bed loads (movement of sand and gravel) during the spawning season, as well as the inaccessibility of many upland tributaries during the rainy season. Instead the California CMP specified that abundance be estimated by counting upstream migrants at fixed counting stations in the lower mainstems of rivers, but was somewhat agnostic about how it would be done.

To fully support a status review update such as this one, such counting would need to occur in the full complement of populations listed in Table 5. However, counting would not necessarily need to occur in every population in every year; a rotating-panel sampling plan could probably be used, similar to the sampling of reaches used for redd surveys in the northern area, but with sampling units being whole populations rather than individual stream reaches. That is, some of the populations in Table 5 would be counted every year, others would be counted every 3 or 4 or 12 years on a staggered schedule. This is not something envisioned in the original California CMP, but would be consistent with its goals and more efficient to implement.

Since the development of the California CMP strategy outlined in Adams *et al.* (2011), there appear to have been two efforts to conduct redd surveys in the southern area, with mixed results. The Monterey Peninsula Water Management District has conducted redd surveys in the lower Carmel River (in the neighboring South-Central California Coast Steelhead DPS) as District resources have permitted, but could not fully implement the protocols used in the northern area (*e.g.*, Gallagher and Gallagher 2005). These protocols specify that sampled reaches be surveyed every two weeks for the duration of the spawning season, and this was not possible in the lower Carmel due to high flows associated with the episodic flow regime, probably leading to an undercount of redds (Kevan Urquhart, Monterey Peninsula Water Management District, personal communication 2015). On the other hand, the NMFS's California Coastal Office in Long Beach has had success conducting redd surveys in the Ventura River that adhere closely to the northern area protocol, though these data have not been continued for sufficiently long to support a status assessment (Richard Bush, National Marine Fisheries Service, personal communication 2015, Bush and Spina 2011).

These efforts suggest that redd surveys might be able to produce unbiased estimates of adult abundance in certain situations but not others. In situations where they appear feasible, such as the Ventura River system, redd surveys would need to be bias-corrected using estimates of redds-per-female estimated at LCM stations (Adams *et al.* 2011). If redd surveys were to become a strategy for implementing the California CMP in the southern area, they would probably not be a universal solution as in the north. The problem with sampling during high flows is also encountered in the northern area (Dana McCanne, California Department of Fish and Wildlife, personal communication 2015). The problem with sampling in inaccessible mountain tributaries during the rainy season has not yet been addressed.

At the time of California CMP development, one of the most promising methods for counting anadromous adults was the new DIDSON acoustic camera (Pipal *et al.* 2012, Pipal *et al.* 2010a, Pipal *et al*. 2010b). These have started to be deployed in the South-Central/Southern California Coast Steelhead Recovery Planning Domain; currently in the Carmel River, Ventura River, Carpinteria Creek and Salsipuedes Creek (lower tributary of Santa Ynez River). There appear to be three problematic methodological issues. The most important is that in some situations, upstream migrating steelhead frequently drift or swim back and forth across the front of the camera. As a result, a single upstream migrant can be counted as multiple individual fish moving in the up and downstream direction. As an example of the estimation problems this behavior poses, if significant numbers of adult steelhead survive spawning, and migrate downstream to the ocean as kelts, then accurate counts of kelts and upstream adults would be confounded, leading to biased estimates. Two other methodological issues are species identification and the sheer number of person-hours required to review DIDSON output in order to reliably produce accurate counts. The latter issue should be amenable to improvement by using machine-learning techniques to aid in image interpretation. This is a promising avenue for research that might lead to cheaper, more efficient DIDSON monitoring.

Various other methods have been or are starting to be used to count anadromous adults, such as monthly snorkel surveys in Topanga Creek (Dagit *et al.* 2016, 2015, Dagit and Krug 2011, Stillwater-Sciences *et al.* 2010, Dagit *et al.* 2009), trapping stations in tributaries of the Santa Ynez River (Robinson *et al*. 2009), a visual imaging system at a fish passage facility on the Salinas River (Cuthbert *et al.* 2014a, 2014b), and a counter on a fish ladder on the Carmel River (Monterey Peninsula Water Management District 2013). In addition, a method has been proposed to use two-stage sampling and PIT (Passive Integrated Transponder)-tagging of juveniles combined with monitoring of migrants (Boughton 2010b). We summarize data from these sources and methodological issues later in this section, and in the update on the status of the Southern California Coast Steelhead DPS below in Section 2.3.1.4.2. The most important methodological issues appear to be 1) the need to consistently provide unbiased estimates of adult abundance, for example by estimating observation or capture probabilities and by use of randomly sampled stream reaches rather than subjectively chosen index reaches; and 2) the need for methods suitable for the normal range of environmental conditions expected for the domain, which typically involve extreme flow events, high bed loads, and remote rivers and tributaries that are difficult to access during the wet season.

2.3.1.4 (b) Spatial Structure

The California CMP recommends that spatial structure be monitored using summer and fall snorkel surveys that count juveniles in a stratified-random, spatially balanced sample of reaches (Adams *et al.* 2011). The sampling is achieved using Generalized Random Tessellation Stratified (GRTS) sampling to achieve spatial balance, and a rotating panel design to achieve a balance between the need to estimate structure at a particular time, and the need to estimate trends in structure over time. This is the same sampling framework used in the northern California CMP area for both red surveys and juvenile surveys.

To our knowledge, no such data have been collected in the Southern California Coast Steelhead DPS in the last 5 years. The Santa Ynez River, Gobernador Creek and Topanga Creek populations, have received comprehensive snorkel surveys, the last for over a decade (Dagit *et* *al*. 2016, 2015, Dagit and Krug 2011, Stillwater-Sciences *et al.* 2010, Dagit *et al.* 2009), but no broad-scale data using reach-sampling have been produced. The California Department of Fish and Wildlife (CDFW) is in the process of developing a ground-truthed sampling frame for the Santa Barbara Coast (Dana McCanne, California Department of Fish and Wildlife, personal communication 2015) and for Monterey County (Jennifer Nelson, California Department of Fish and Wildlife, personal communication 2015).

2.3.1.4 (c) Diversity

At the time of California CMP development, diversity traits were not sufficiently understood for their monitoring to be specified. Adams *et al.* (2011) stated that "local diversity traits will need to be surveyed, eventually leading to local diversity monitoring plans. Specific projects targeting both broad and focused levels and patterns of genetic diversity will be developed. Tissue collections for these projects will be coordinated with other California CMP activities." We are now in a better position to propose some diversity traits that need to be monitored to assess viability. The viability criteria (Table 6, see also Boughton *et al.* (2007)) emphasize the critical importance of *resident* adults. The findings of Adadia-Cardoso *et al.* 2016, Pearse *et al*. (2014) and Jacobson *et al.* (2014) show the importance of genetic information for assessing viability, both in terms of genetic heritage *(e.g.*, native *vs*. hatchery introductions) and in terms of occurrence of the supergene variants.

Diversity metrics in the form of unbiased estimates of resident adults and the distribution and diversity of genetic polymorphisms, could all be integrated in a straightforward manner with the broad-scale juvenile sampling that the California CMP specifies for spatial structure. An important methodological change would be required: Collection of genetic samples requires handling the fish, which means that mark-recapture or depletion electrofishing would need to occur at a subsample of the reaches selected for juvenile snorkel counts. Such subsampling would also allow the snorkel counts to be bias-corrected (Boughton *et al.* 2009). If methods were developed to distinguish juveniles from resident adults in both snorkel counts and electrofishing samples, an unbiased estimate could then be made of the number of resident adults in the sampling domain. Additionally, tissues could be taken from electrofishing sites for genetic analysis that would provide unbiased estimates of various gene frequencies. It is important that the California CMP be updated to include such diversity monitoring.

Environmental DNA (eDNA) is an emerging surveillance tool to monitor the genetic presence of an aquatic species; it might provide another avenue for monitoring genetic diversity, but its statistical properties for inferring unbiased gene frequencies in the steelhead population is unclear.

2.3.1.4.1 Life-Cycle Monitoring Stations

According to Adams *et al.* (2011), LCM stations are a fundamental component of the California CMP that perform two functions: providing unbiased estimates of ocean survival so that changes in salmonid numbers can be parsed into changes due to freshwater versus marine conditions; and as "magnets for other kinds of recovery-oriented research, particularly studies of fish habitat-productivity relationships and evaluations of habitat restoration effectiveness." For the first function (estimating marine survival), an LCM station needs three attributes: 1) annual, unbiased estimates of anadromous adults, 2) annual, unbiased estimates of smolt production, and 3) sufficiently large number of anadromous adults to provide accurate estimates of marine survival (at least 20 per year, preferably more than 100 anadromous adults each year).

Methodological issues for estimating anadromous adults were described above in the section on abundance and productivity.

Methodological issues for estimating smolt production have seen little progress since the last status review (2010) and remain problematic. Originally the DIDSON acoustic camera seemed promising as a tool for estimating smolt production, but the size of smolts is close enough to the resolution of DIDSON imagery that detection probability is likely substantially less than 1 (Kerrie Pipal, NOAA Southwest Fisheries Science Center, Santa Cruz Laboratory, personal communication 2015). Fyke nets, traps, and visual imagery at fish passage facilities, developed for counting anadromous adults, are also being used to count smolts, but with qualified success. The main problem is counts that are likely biased low due to failure of counting stations during high flow events. Two other problems involve distinguishing smolts from juvenile downstream migrants (typically age-0 or age-1 fish moving down to the estuary near the end of smolting season and in early summer), and the difficulty of accurately estimating smolt body sizes. Although estimates of smolt body sizes were not emphasized in the California CMP, we should expect marine survival to involve strong interaction effects between ocean conditions and smolt sizes at ocean entry (Ward 2000, Bond 2006). If this were not accounted for then some unknown component of change in marine survival may instead be due to changes in freshwater conditions via its effect on smolt body size.

Boughton (2010b) described a framework for using PIT tags to estimate both smolt production and adult abundance. PIT tags would be implanted in juveniles sampled from reaches selected from a stream network, and thus would be straightforward to integrate with the reach-sampling methods used for spatial structure (described above). Smolt production is estimated from the proportion of tagged fish that are detected at a downstream tag-reading station near the mouth of the river. An application of this approach in the South-Central/Southern California Coast Steelhead Recovery Planning Domain has not yet been described, but some advantages and disadvantages are already clear. Advantages are that the method could be integrated with spatial-structure sampling; could provide information on smolt size (via pre-smolt size at the time of sampling); and since the originating reaches of tagged smolts would be known, it could provide a powerful tool for evaluating habitat-productivity relationships, including testing of various habitat-restoration actions, regulatory actions, or flow-management actions relative to “control” reaches. Disadvantages are that progress is still needed for designing reader stations (particularly antennae) that are robust in high-flow events, and that over time this approach is likely to lead to an accumulation of tags in the river bed (from dead juveniles) (David Rundio, NOAA Southwest Fisheries Science Center, Santa Cruz Laboratory, personal communication 2015). These “ghost tags” get moved by high-flow events and cannot be readily distinguished from live smolts, thus generating overestimates of smolt production. The bias would tend to increase over time as tags accumulate, such that the ghost tags would generate a “ghost recovery” of smolt production.

See also the discussion of monitoring issues in Chapter 14 “Southern California Steelhead Research, Monitoring and Adaptive Management” in the Southern California Steelhead Recovery Plan (National Marine Fisheries Service 2012).

2.3.1.4.2 Summary of viability metrics currently collected in the Southern California Coast Steelhead Recovery Planning Area.

The following provides a summary of the viability metrics that are currently being collected within the Southern California Coast Steelhead Recovery Planning Area from those few watersheds where monitoring has occurred (Williams *et al.* 2016). In general the metrics are not formally assessed because the period of record is too short for such an assessment to be meaningful. See Figure 8 for general monitoring/surveying locations.

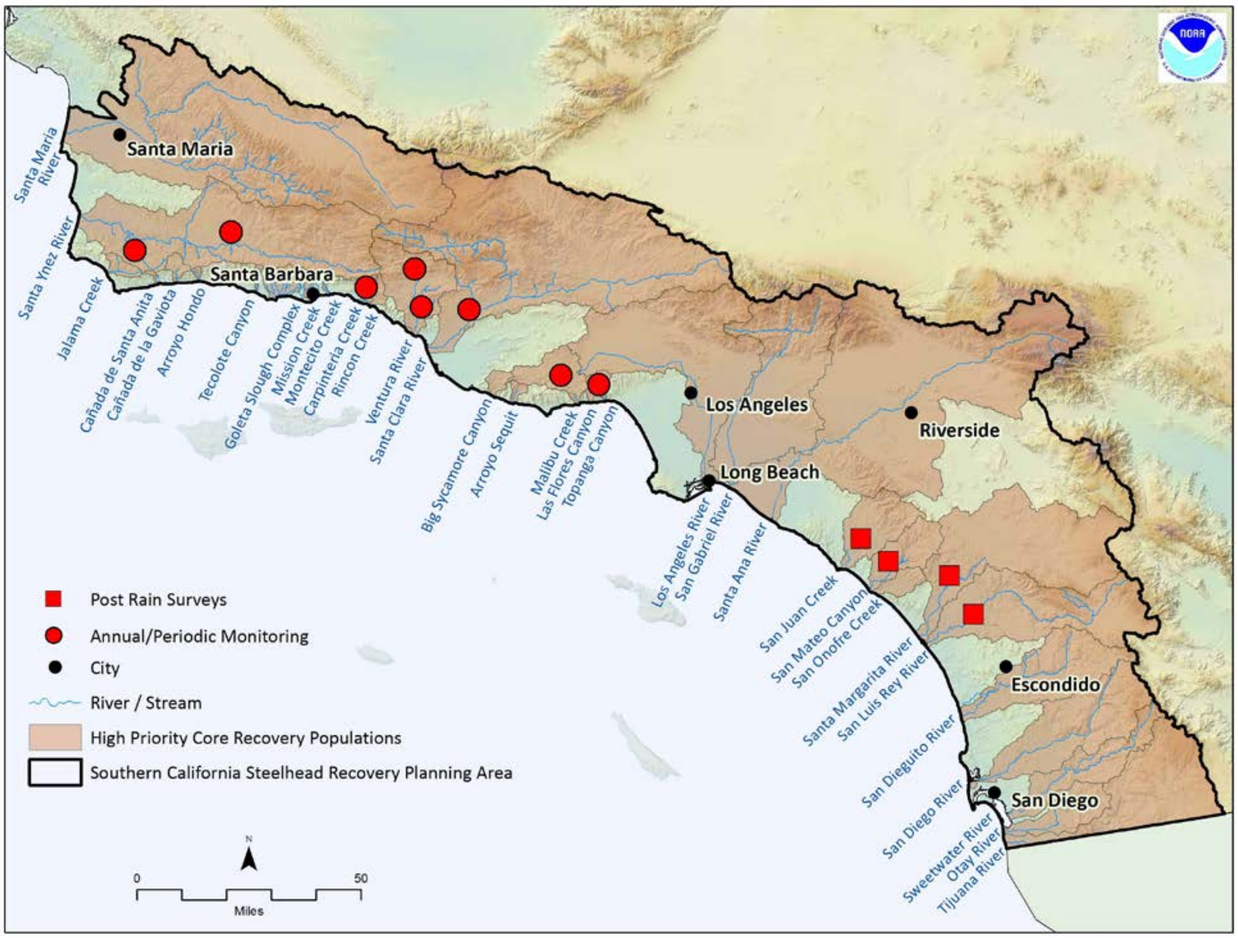

Figure 8. Annual or periodic monitoring or surveying within the Southern California Coast DPS.

Monte Arido Highlands BPG

Santa Maria River

The Santa Maria River population does not appear to be monitored for any of the viability metrics.

Santa Ynez River

Adult and smolt counts have been collected by the Cachuma Operations and Maintenance Board (COMB) since 2000 via migrant trapping (Tim Robinson, Cachuma Operation and Maintenance Board, personal communication 2015, Cachuma Operation and Maintenance Board 2013), primarily through migrant trapping on two tributaries, Salsipuedes Creek and Hilton Creek, and a section of the mainstem downstream of Bradbury Dam (which is a complete passage barrier for steelhead) in the mid-basin. See Figure 9.

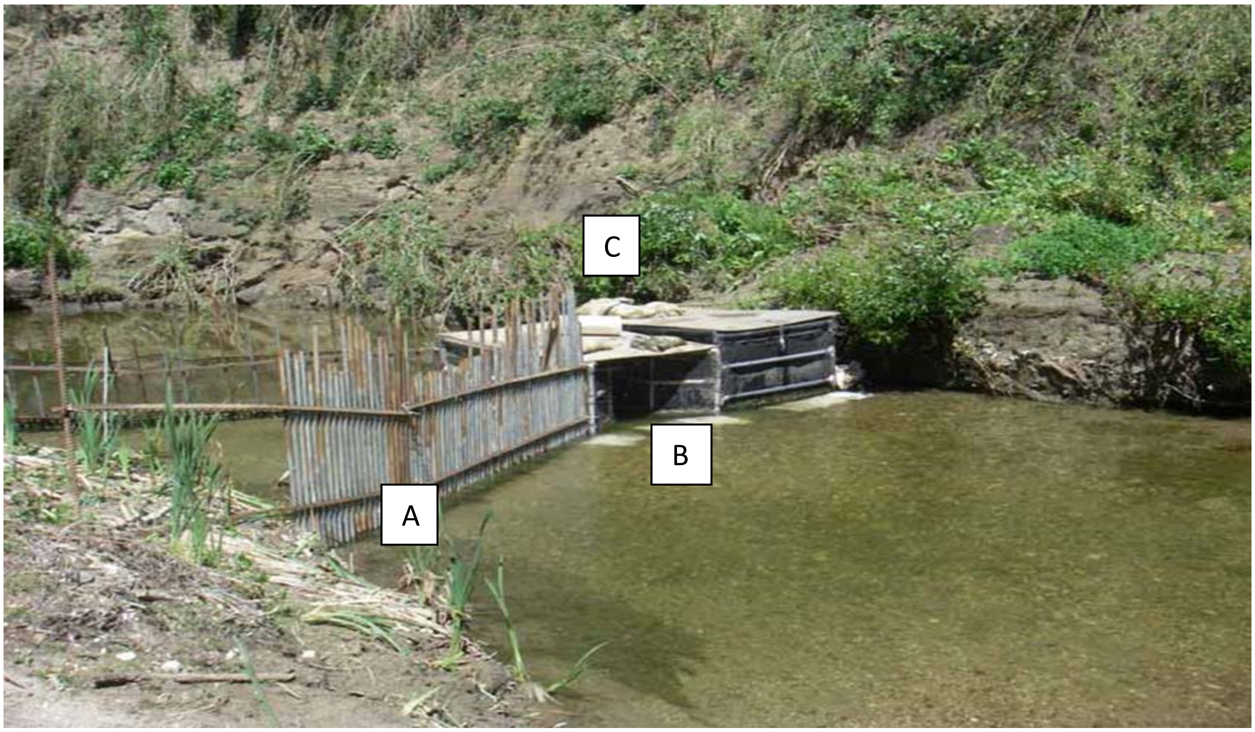

Figure 9. Adult and juvenile steelhead monitoring station, Sal Salsipuedes Creek, lower Santa Ynez River. Photo courtesy Cachuma Operation and Maintenance Board. A - Guidance panel. B - Upstream Fyke net entrance. C - Downstream Fyke net (against bank).

From 2001 to 2011 (the latest date for which counts are published), the mean number of anadromous adults trapped per year was 3.4 (sd=5.2) and the mean number of smolts trapped per year was 146 (sd=116), though the counts are likely biased low due to inability to trap during high flows and the focus of trapping effort on two key tributaries rather than the whole river system (Robinson *et al.* 2009). No adults have been reported since 2010 (Tim Robinson, Cachuma Operations and Maintenance Board, personal communication 2016). CDFW initiated DIDSON counts in the lower tributary (Salsipuedes Creek) in 2013 but has not yet released a report. Comprehensive snorkel surveys have been conducted since 2001 by COMB, and may be suitable for estimating spatial structure if broken down by reach.

The number of anadromous adults observed each year varied between zero and four, except for the year 2008, when 16 anadromous adults were observed (Figure 10). Resident fish were commonly caught in traps as well, indicating the co-occurrence of the anadromous and resident forms in the same tributaries.

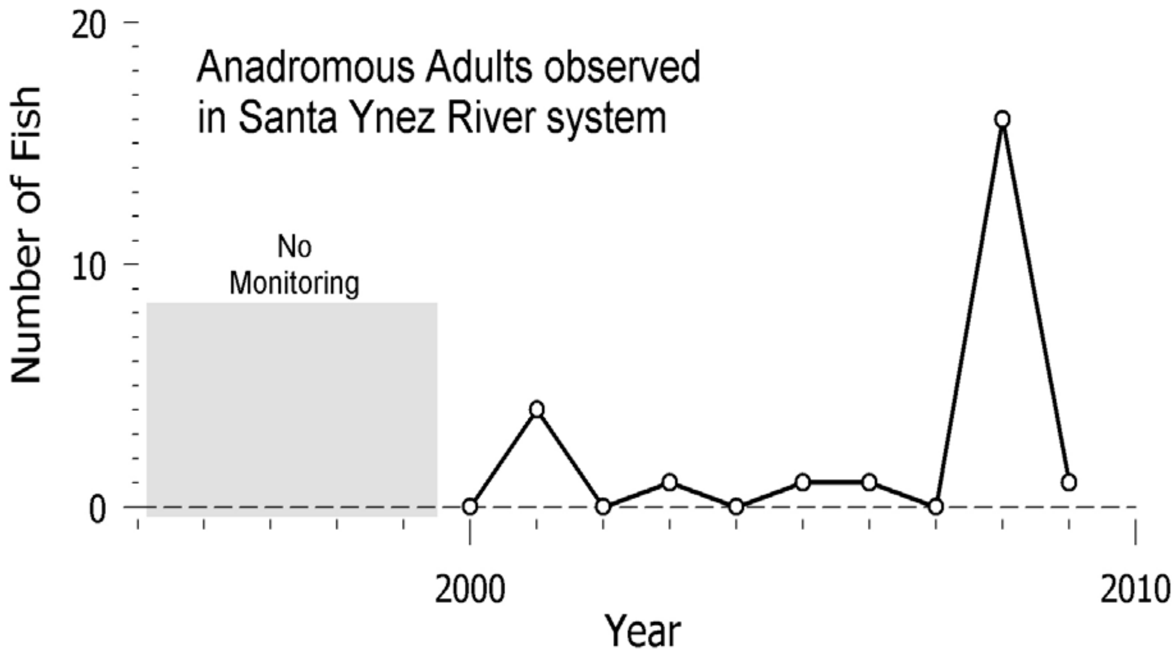

Figure 10. Adult steelhead observed in the Santa Ynez River System. Numbers are incomplete counts, unadjusted for observation probabilities/errors (Williams *et al.* 2011).

Ventura River

A fish passage facility on the Robles Diversion Dam located on the Ventura River was completed in 2006 and since that time upstream migrants passing through the ladder have been monitored using a VAKI River Watcher staffed by the Casitas Municipal Water District (CMWD). See Figure 11.

Figure 11. Robles Diversion Fish Passage Facilities, Ventura River. A - Fish ladder entrance. B - Fish ladder exit. C - Diversion fish screens. D - Diversion intake. E - High-flow bypass.

The annual number of upstream migrants observed at the Robles Diversion Dam from 2006 through 2009 was 4, 0, 6, and 0 fish, for a mean annual run of 2.5 fish (not including fish spawning downstream of the dam and in San Antonio Creek). Most of these fish were judged anadromous based on their size, but the 4 fish observed in 2006 were relatively small and possibly freshwater residents (Figure 13).

CMWD staff believes observation probabilities are effectively equal to 1.0 (Scott Lewis, Casitas Municipal Water District, personal communication 2015). However, effects of turbidity on the performance of the VAKI are unknown; for example, 5 larger *O. mykiss* were detected in 2011 that were recorded as resident, but at some time after recalibration of the VAKI may be reclassified as adult steelhead. (Scott Lewis, Casitas Municipal Water District, personal communication 2016). Also unknown is whether adult individuals are unable to enter the ladder and pass the dam because they cannot detect the ladder entrance. Therefore, while the counts probably represent a useful index of the true abundance, the reliability of the adult counts for accurately characterizing the true abundance is unknown. Additionally, the diversion dam occurs about 14 miles upstream from the ocean and the counts made there omit adults spawning in the lower portion of the mainstem Ventura River, as well as an important tributary, San Antonio

Creek. Redd surveys were conducted in 2009 and 2010 to estimate the entire spawning run, but these estimates are not yet available (Casitas Municipal Water District, 2014, 2013, 2012, 2011, 2010, Bush and Spina 2011).

The CMWD issues annual reports on movement of *O. mykiss* through the Robles Fish Passage Facility. The most recent report was 2014 (Casitas Municipal Water District 2014). Currently, counts do not distinguish adult steelhead or smolts from other life-stages of the species. Allen (2014) surveyed spatial structure from 2006 to 2012 using a combination of snorkel surveys and electrofishing of juveniles. Rather than using GRTS sampling, Allen (2014) used a three-stage hierarchical sampling scheme: the first stage was sub-basin, the second stage used index reaches, and the third stage used random selection of sites within index reaches. The drought during the most recent five year period has resulted in prolonged river mouth closures and limited the upstream migration of fish to the Robles Diversion Dam.

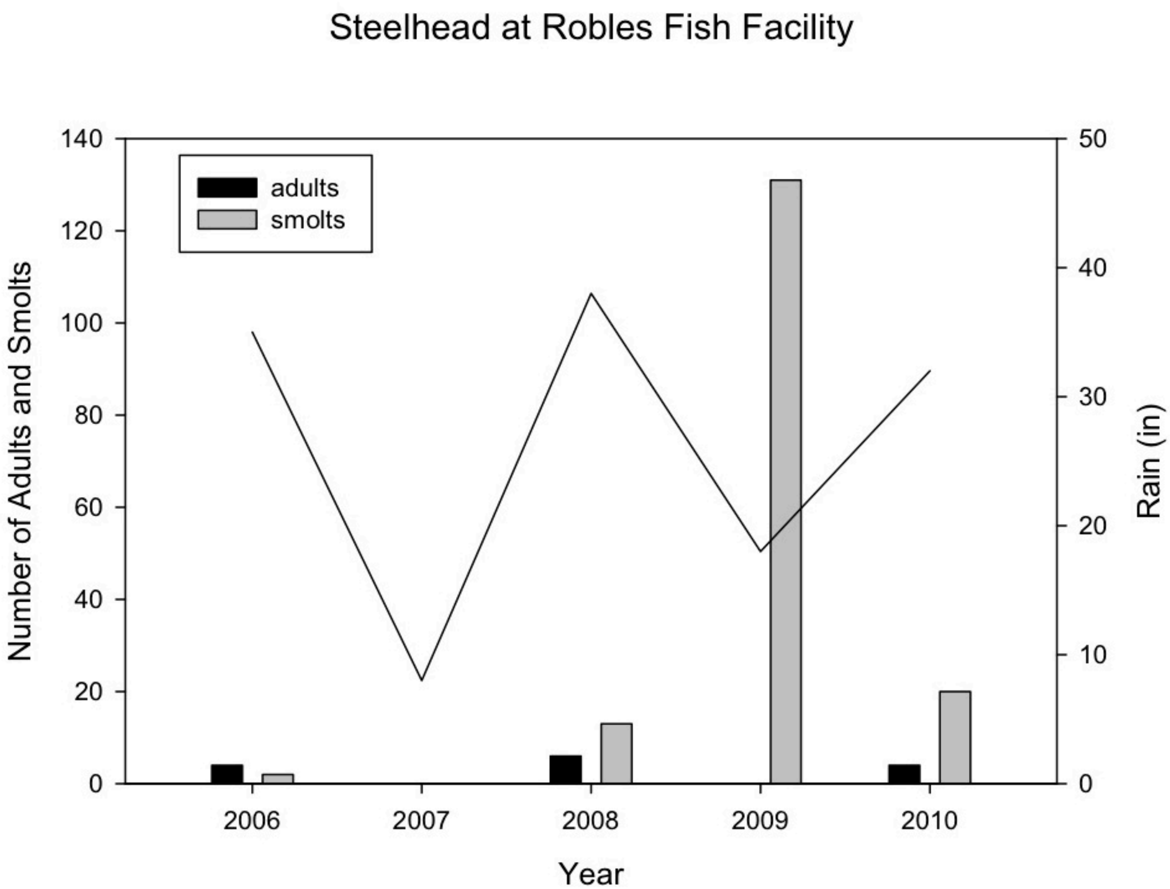

Figure 12. Adult steelhead observed in the Ventura River System. Numbers are incomplete counts, unadjusted for observation probabilities/errors (Williams *et al.* 2011)

CDFW has also recently begun to use a DIDSON camera on the lower mainstem of the Ventura River to detect adults that may spawn below the Robles Diversion Dam; no steelhead have been detected to date. See Figure 13.

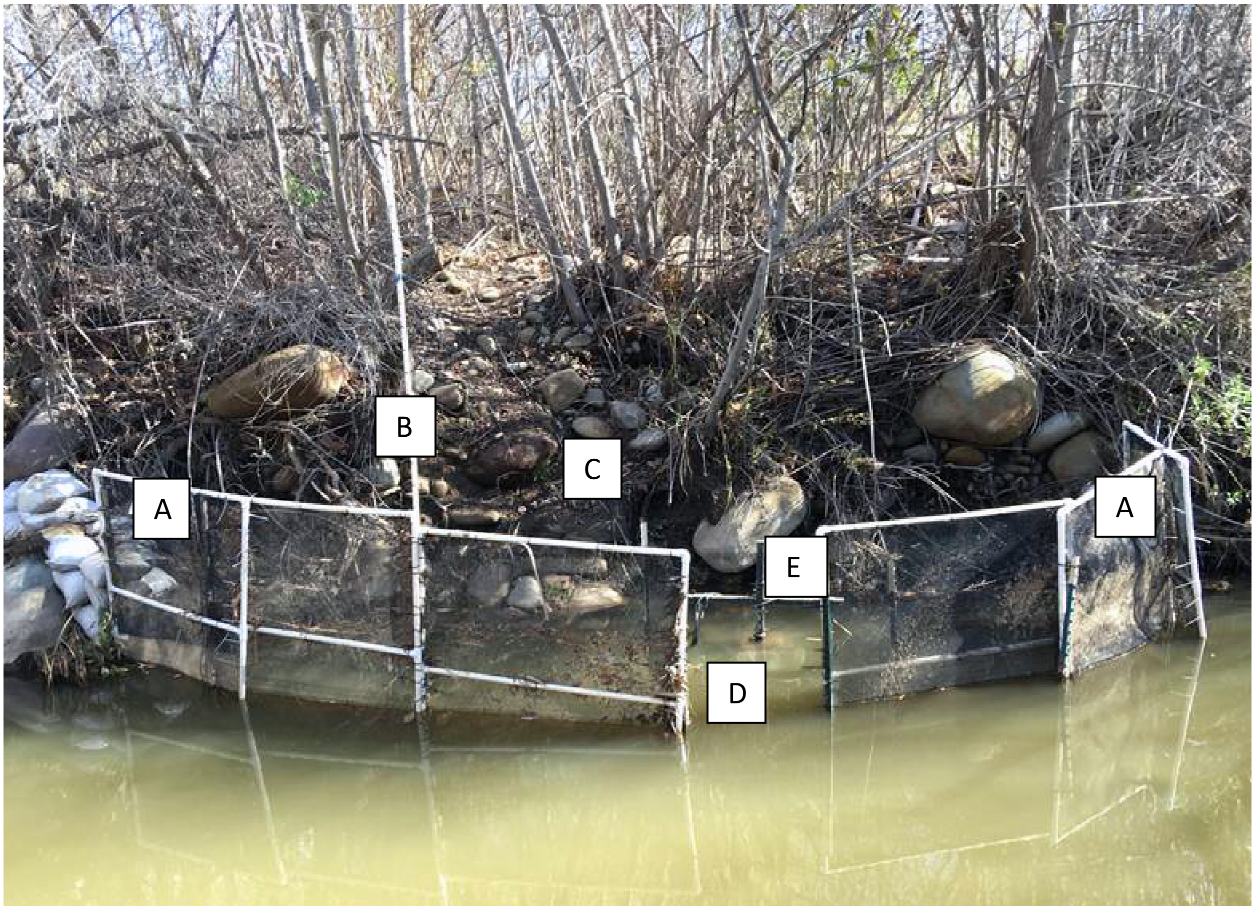

Figure 13. DIDSON camera, Ventura River. A - Detection panels. B - Depth gage. C - Security tether. D - DIDSON housed in metal debris box, and plastic silt exclusion box. E - A-frame mounting system. Photo courtesy Sam Bankston, Pacific Marine Fisheries Commission.

Santa Clara River

Anadromous *O. mykiss* migrating upstream have been monitored, with uncertain observation probabilities, since 1995 at the Freeman Diversion Dam on the mainstem of the Santa Clara River. This dam is situated about 10 miles from the ocean; all adult steelhead must pass this dam if they are to access the extensive spawning and rearing habitat upstream in the upstream tributaries (Figure 14).

Figure 14. Vern Freeman Diversion Denil fish ladder, looking downstream, Santa Clara River. A - Fish ladder entrance. B - Denil fish ladder segments.

The United Water Conservation District (UWCD) issues annual reports describing counts of adult steelhead and smolts passing through the Freeman Diversion Dam Fish Passage Facility in the lower river United Water Conservation District 2014, 2013, 2012, 2011, 2010). The active upstream migrant trap was decommissioned in 1997 and counting methods and staff expertise were variable through 2002. A passive upstream migrant counter was installed in 2003 or 2004, but was thought to be inefficient, and a more complete counting system was put on line for the 2010 season. Thus, the anadromous run through the facility is likely somewhat larger than implied by the counts. Numerous resident *O. mykiss* passed through the facility during the period of observation, in numbers ranging from 0 to 68 per year. (Steve Howard, United Water Conservation District, personal communication 2015). The total resident population, mostly resident to the lower mainstem, Santa Paula, Sespe, Hopper, and Piru creeks, and their tributaries, has not been estimated but is presumably much larger. The reliability of counts obtained at UWCS's facility for accurately characterizing true abundance of adult steelhead in this river system is unknown, owning to problems associated with the detectability of the fish ladder entrance.

Figure 15 shows that counts ranged from 0 to 2 anadromous adults per year between 1995 and 2009; however, the counts suffer from various technical difficulties in operating the passage facility and/or observing fish in it. The most recent report was 2014 (United Water Conservation District 2014), when 0 anadromous *O. mykiss* and 0 resident *O. mykiss* were observed. In general these counts represent lower bounds on abundance, as they do not enumerate fish that pass over the low diversion dam itself. The drought during the most recent five year period has resulted in prolonged river mouth closures and limited the upstream migration of fish to the Freeman Diversion Dam.

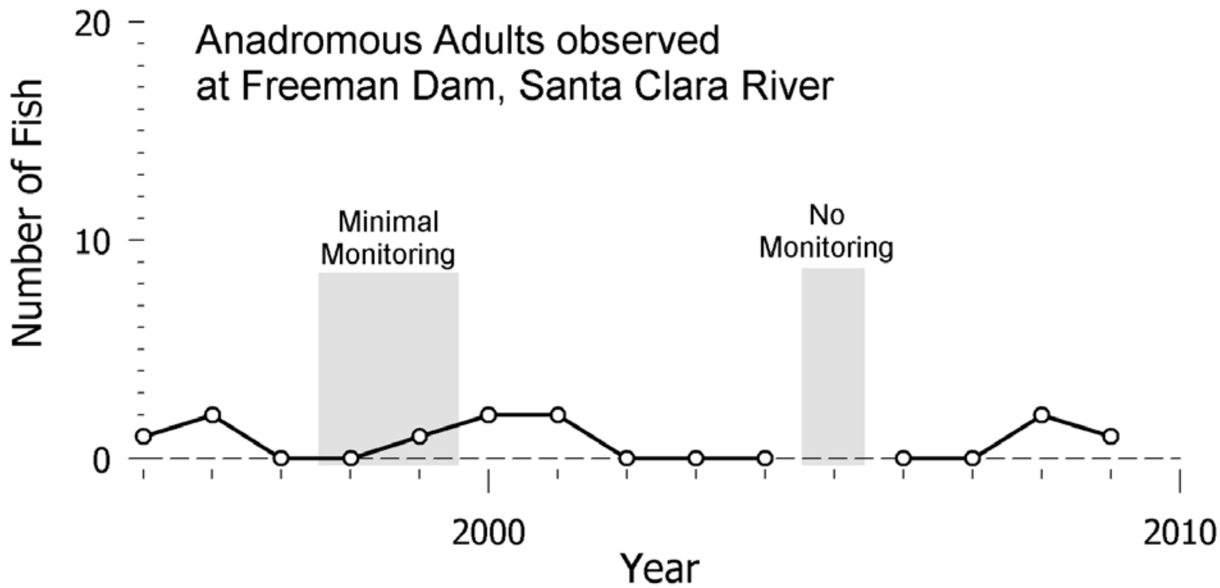

Figure 15. Adult steelhead observed in the Santa Clara River System. Numbers are incomplete counts, unadjusted for observation probabilities/errors (Williams *et al.* 2011).

Conception Coast BPG

Carpinteria Creek

DIDSON counts have been initiated by CDFW in Carpinteria Creek in 2014; data are not yet available (Dana McCanne, California Department of Fish and Wildlife, personal communication 2015).

CDFW is developing a sampling frame and plans to initiate spatial-structure sampling in other populations of the BPG. They have conducted pilot surveys in Gaviota Creek, Refugia Creek, and Arroyo Hondo.

Santa Monica Mountain BPG

Arroyo Sequit

Population data are being collected by the Resources Conservation District of the Santa Monica Mountains (RCDSMM) in Arroyo Sequit, Malibu, and Topanga Creeks (Dagit 2016). Snorkel surveys have been conducted monthly in reaches of the creek “where the majority of *O. mykiss* were confined due to . . . low water levels . . .” (Dagit *et al. 2015*). A random sample of reaches had multi-pass dives to calibrate detection probabilities. Life-stages were visually classified using a rating protocol. Presumptive “Smolt” counts were generated from the snorkel data using the visual classification.

Malibu Creek

Population data are being collected by the RCDSMM (Dagit 2016, 2015). Snorkel surveys have been conducted monthly in reaches of the creek “where the majority of *O. mykiss* were confined due to either low water level . . . or . . . below Rindge Dam” (Dagit *et al.* 2015). A random sample of reaches had multi-pass dives to calibrate detection probabilities. Life-stages were visually classified using a rating protocol.

Snorkel surveys have been conducted in Malibu Creek downstream of Rindge Dam, and one anadromous adult has been reported in each of the summers of 2007 through 2015 (Rosi Dagit, Santa Monica Mountains Resource Conservation District, personal communication). These surveys occur year round although can compromise observations during high winter flow months (Dagit 2016, Dagit and Krug 2011). Presumptive “smolt” counts were generated from the snorkel data using a visual classification protocol. Between 2012 and 2015 a total of 11 adults (≥ 55 mm) were observed during snorkel survey (Dagit 2016).

Topanga Creek

Snorkel-counts have been conducted monthly since June 2001. Tagging and recapture efforts using PIT tags were conducted in fall of 2008 through 2015, and March 2011 - 2013, and migrant trapping was conducted opportunistically for a total of 27 days from February 2003 through March 2015. Redd counts were also made during the snorkel surveys *(i.e.,* once per month), and twice per month since 2011 in Topanga Creek during the January – May spawning season (Dagit 2016, Dagit *et al.* 2015, Dagit and Williams 2009).

Trapping efforts by the RCDSMM have documented downstream migrants of age 1+ and 2+, and a total of three upstream migrants, though the size and age of these migrants are not reported (Dagit and Krug 2011). Snorkel counts indicate the persistent occurrence of juvenile and freshwater-resident *O. mykiss*. The authors consider fish with fork length greater than 50 cm (20”) to be anadromous adults; fish with fork length between 25 cm and 50 cm are believed to be resident adults (Rosi Dagit, Resource Conservation District of the Santa Monica Mountains, personal communication 2015). These assumptions allow a rough estimate for the lower bound of abundance of the two life-history types.

The number of anadromous adults is likely undercounted relative to resident adults, because conditions for observation are less favorable during the winter and spring migration season than in the summer and fall, when many of the largest counts of resident adults were made. Observed numbers of anadromous fish ranged between zero and 4 annually. Even with observation probabilities as low as 10%, the largest run would have been about 40 fish at the most.

Figure 16 shows that counts ranged from 0 to 3 anadromous adults per year between 2001 and 2010.

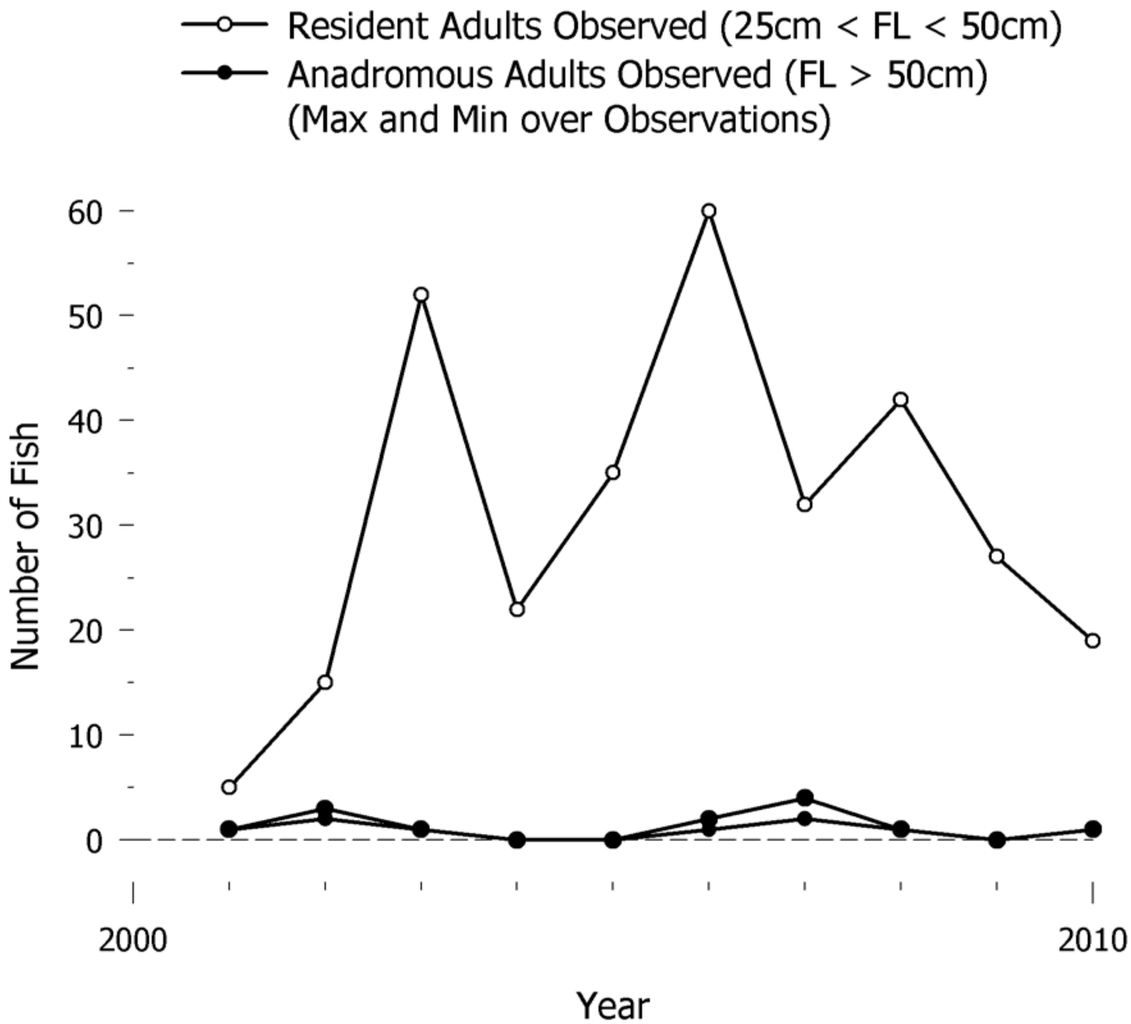

Figure 16. Adult steelhead observed in the Topanga Creek. Numbers are incomplete counts, unadjusted for observation probabilities/errors (Williams *et al.* 2011).

Mojave Rim BPG

No apparent monitoring of viability metrics.

Santa Catalina Gulf Coast BPG

No apparent monitoring of viability metrics.

However, post-rain reconnaissance surveys of steelhead in the San Juan/Arroyo Trabuco Creek, San Mateo Creek, Santa Margarita River, and San Luis Rey River have been inaugurated by the South Coast Steelhead Coalition (Sandra Jacobson, South Coast Steelhead Coalition, personal communication 2016).

Discussion

The data summarized in this status review indicate small (<10 fish) but surprisingly persistent annual runs of anadromous *O. mykiss* are currently being monitored across a limited but diverse set of basins within the range of this DPS, periodically interrupted in years when the mouth of the coastal estuaries fail to open to the ocean due to low flows (Williams *et al.* 2016, Dagit 2015, Williams *et al.* 2011).

The question raised by these observations is: How can such small runs of anadromous *O. mykiss* (single digits) persist, even over the short term (a single decade)? As noted in the previous status review (Williams *et al.* 2011), these small runs could be maintained either by natural dispersal from some source population located elsewhere and/or from the consistent production of smolts by the local population of freshwater non-anadromous *O. mykiss*, including *O. mykiss* populations currently residing upstream of introduced, long-standing barriers to upstream migration (National Marine Fisheries Service 2012).

Genetic assignment tests can be used to assess the likelihood that anadromous fish are strays from other basins. Of the 16 anadromous fish captured in the Santa Ynez River system in 2008, data from tissue samples assigned 6 (38%) to origins outside the basin, and 10 to origins within the basin (Tim Robinson, Cachuma Operations and Maintenance Board, personal communication 2010, Garza and Clemento 2007). The broader-scale study of Clemento *et al.* (2009) tended to indicate that populations in different basins are linked by frequent straying, although "frequent" should be understood here in a genetic sense rather than a demographic sense: *i.e.*, frequent enough so that family structure dominated the genetic distinctions among basins.

There is a variety of anecdotal evidence that freshwater resident populations of *O. mykiss* can produce smolts (reviewed in previous status reviews and TRT reports; Beakes *et al.* 2010). Size and growth rates may provide valuable information as to whether the anadromous or freshwater-resident strategy would provide greater reproductive potential. If this model is generally applicable, then fish with this plastic life-history strategy should generally outcompete either a purely resident or purely anadromous strategy over the long term. However, conditions particular to a given basin and time period may select for a pure strategy in the short term. One would expect that if such a situation persisted long enough, the ability to express the plastic life-history strategy would become vestigial, like the eyes of cave-dwelling fish. This has yet to be empirically demonstrated in *O. mykiss.*

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range

Southern California steelhead have declined in large part as a result of agriculture, mining, and urbanization activities that has resulted in the loss, degradation, simplification, and fragmentation of habitat (Hunt & Associates 2008).

Water withdrawal, storage, and conveyance, and diversions for agriculture, flood control, domestic, and hydropower purposes have greatly reduced or eliminated historically accessible steelhead habitat. Modification of natural flow regimes by dams and other water-control structures have resulted in increased water temperatures, changes in fish community structures, depleted flow necessary for migration, spawning, rearing, flushing of sediments from spawning gravels, and reduced gravel recruitment. The substantial increase of impermeable surfaces as a result of urbanization (including roads) has also altered the natural flow regimes of rivers and streams, particularly in their lower reaches.

In addition to these indirect effects development activities have increased direct mortality of adult and juvenile steelhead. Land-use activities associated with urban development, mining, agriculture, ranching, and recreation have significantly altered steelhead habitat quantity and quality. Associated impacts of these activities include: alteration of stream bank and channel morphology; alteration of ambient stream water temperatures; degradation of water quality; elimination of spawning and rearing habitats; fragmentation of available habitats; elimination of downstream recruitment of spawning gravels and large woody debris; removal of riparian vegetation resulting in increased stream bank erosion; and increased fine sedimentation input into spawning and rearing areas. The net effect is the loss of channel complexity, pool habitat, suitable gravel substrate, and large woody debris.

A significant percentage of estuarine habitats have been lost across the range of the DPS with an average of 22 percent of estuarine habitat remaining. The condition of these remaining wetland habitats is in many cases highly degraded, with many wetland areas at continued risk of loss or further degradation (National Marine Fisheries Service 2012).

Although numerous historically harmful practices have been halted, much of the historical damage remains to be addressed, and the necessary restoration activities will likely require decades. Many of these threats are associated with most of the larger river systems such as the Santa Maria, Santa Ynez, Ventura, Santa Clara, Los Angeles, San Gabriel, Santa Ana, San Luis Rey, Santa Margarita, San Dieguito, and San Diego rivers, and many also apply to the smaller coastal systems such as Maria Ygnacio, Rincon, Malibu, San Juan/Arroyo Trabuco, and San Mateo Creeks.

These systemic threats have remained essentially unchanged since the last status review (Williams *et al.* 2011) though individual, site specific threats may have been reduced or eliminated as a result of conservation actions such as the removal of small fish passage barriers. See Section 2.4.1 below.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes

Steelhead populations traditionally supported an important recreational fishery throughout their range. Recreational angling for both winter adult steelhead and summer rearing juveniles was a popular sport in many coastal rivers and streams, but began to decline in the late-1950s, particularly winter steelhead angling. Recreational angling in coastal rivers and streams for native steelhead increased the mortality of adults (which represent the current generation of brood stock) and juveniles (which represent the future generations of brood stock) and may have contributed to the decline of some naturally small populations but is not considered the principal cause for the decline of the species as a whole. During periods of decreased habitat availability (*e.g.*, drought conditions or summer low flow when fish are concentrated in freshwater habitats), the impacts of recreational fishing or harassment on native anadromous stocks are likely heightened (National Marine Fisheries Service 2012).

Until the listing of this DPS in 1997, recreational angling for *O. mykiss* was permitted in all coastal drainages (and continues in areas above barriers, such as major dams, which are currently impassible to fish migrating upstream). Angling for both adults and juveniles in those portions of coastal rivers and streams accessible to anadromous runs from the ocean has been eliminated through modification of the CDFG's angling regulations, with the notable exception of the upper portions of the North Fork of Matilija Creek (including Bear Creek), and Sespe Creek above Alder Creek, tributaries to the Santa Clara River. However, poaching or harassment remain potential forms of unauthorized take of southern California steelhead (California Department of Fish and Wildlife 2015a).

Ocean harvest of steelhead is extremely rare, and is in particular an insignificant source of mortality for Southern California steelhead. High seas driftnet fisheries in the past may have contributed slightly to a decline of this species in local areas, although steelhead are not targeted in commercial fisheries and reports of incidental catches are rare. Commercial fisheries are not believed to be principally responsible for the large declines in abundance observed along most of the Pacific coast over the past several decades. Sport and commercial harvest of steelhead in the ocean is prohibited by CDFG (California Department of Fish and Wildlife 2015b).

While insufficient data exists to estimate Southern California steelhead freshwater exploitation rates, these rates are likely relatively low given California's statewide prohibition of capture and retention of natural-origin steelhead since 1998, and the prohibition of angling in the anadromous waters within the DPS. Fishing effort estimates based on angler self-report cards are available for 1993–2014 which suggest extremely low levels of effort in this DPS over this period (Figure 17). Although fishing effort estimates for more recent years are not available, there has been no change in the fishing opportunity during the period covered by this status review.

In summary, while there is limited information available on the current level of Southern California steelhead fishery impacts, it is reasonable to conclude that the level of impact has not appreciably changed since the 2010 steelhead status review update in 2010 (Williams *et al*. 2016, Williams *et al*. 2011).

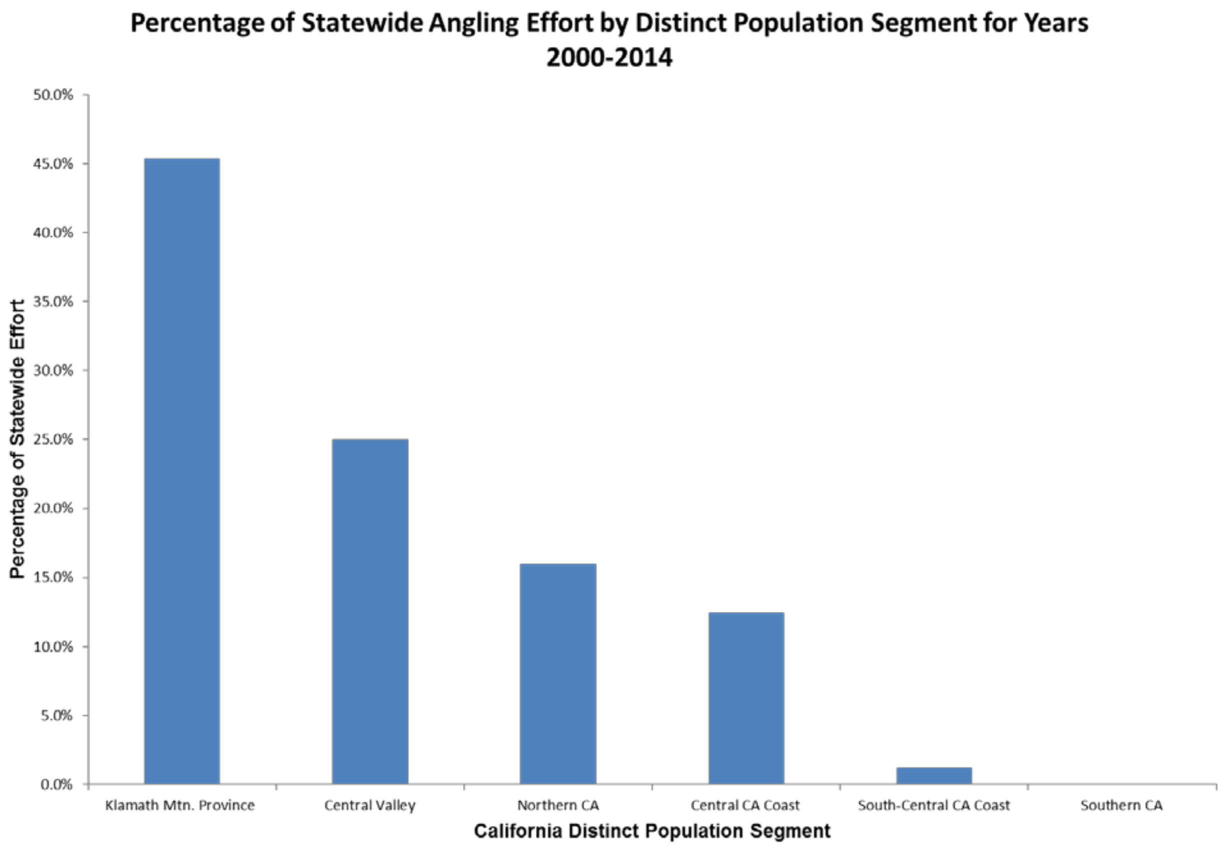

Figure 17. Distribution of California statewide steelhead fishing effort by DPS for years 2000-2014. California Department of Fish and Wildlife (provisional data); see also Jackson 2007.

2.3.2.3 Disease or predation

Infectious disease is one of many factors that can influence adult and juvenile steelhead survival. Specific diseases such as bacterial kidney disease, *Ceratomyxosis*, *Columnaris*, *Furunculosis*, infectious hematopoietic necrosis, redmouth and black spot disease, Erythrocytic Inclusion Body Syndrome, and whirling disease, among others, are present and are known to affect steelhead. Very little current or historical information exists to quantify changes in infection levels and mortality rates attributable to these diseases for steelhead. Warm water in some cases can contribute to the spread of infectious diseases. However, studies have shown that native fish tend to be less susceptible to pathogens than hatchery cultured and reared fish (*e.g.*, Miller *et al.* 2014, Gilbert and Granath 2003, Buchanan *et al.*1983).

Introductions of non-native aquatic species (including fishes and amphibians) and habitat modifications (*e.g.*, dam impoundments, altered flow regimes) have resulted in increased predator populations in numerous river systems, thereby increasing the level of predation experienced by native salmonids (Busby *et al.* 1996). Non-native species, particularly fishes and amphibians such as largemouth and smallmouth bass (*Micropterus* spp.) and bullfrogs have been introduced and spread widely. These species can prey upon rearing juvenile steelhead (and their conspecific resident forms), compete for living space, cover, and food, and act as vectors for non-native diseases (Cucherousset and Olden 2011).

Artificially induced summer low-flow conditions may also benefit non-native species, exacerbate spread of diseases, and permit increased avian predation; a recent investigation of predation of Western gulls (*Larus occidentalis*) on juvenile steelhead indicates that modern predation risk is ~2.4 times higher than historically as a result of the increase in gull population due to the increase in artificial feeding opportunities (Osterback *et al.* 2015). NMFS concluded that the information available on these impacts to steelhead did not suggest that the DPS was in danger of extinction, or likely to become so in the foreseeable future, because of disease or predation. It is recognized, however, that small populations such as southern California steelhead can be more vulnerable to extinction through the synergistic effects of other threats, and the role of disease or predation may be heightened under conditions of periodic low flows or high temperatures characteristic of southern California steelhead habitats.

These threats have remained essentially the same over the previous 5 years, though individual, site specific threats may have been reduced or eliminated as a result of conservation actions (*e.g.*, through the restoration of flows or riparian habitats which affect water temperature).

2.3.2.4 Inadequacy of existing regulatory mechanisms

At the time of the original listing of the Southern California Coast Steelhead DPS in 1997, several federal regulatory and planning mechanisms affected the conservation of steelhead populations within the DPS. These included: 1) land management practices within the four U.S. National Forests within the DPS (Los Padres, Angeles, San Bernardino, and Cleveland); 2) the regulation of dredging and the placement of fill within the waters of the United States by the U.S. Army Corps of Engineers (USACE) through the Clean Water Act (CWA) Section 404 Program; 3) the regulation of dredging and the placement of fill within the waters of the United States through the CWA Section 401 water quality certification regulations; 4) the Federal Emergency Management Agencies' (FEMA) administration of a Flood Insurance Program which strongly influences the development in waterways and floodplains; and 5) inadequate implementation of the CWA Sections 303(d)(1)(C) and (D) to protect beneficial uses associated with aquatic habitats, including fishery resources, particularly with respect to non-point sources of pollution (including increased sedimentation from routine maintenance and emergency flood control activities within the active channel and floodplain).

For example, the USACE program is implemented through the issuance of a variety of Individual, Nationwide and Emergency permits. Permitted activities should not "cause or contribute to significant degradation of the waters of the United States." A variety of factors, including inadequate staffing, training, and in some cases regulatory limitations on land uses (*e.g.,* agricultural activities) and policy direction, resulted in ineffective protection of aquatic habitats important to migrating, spawning, or rearing steelhead. The deficiencies of the current program are particularly acute during large-scale flooding events, such as those associated with El Niño conditions, which can put additional strain on the administration of the CWA Section 404 and 401programs.

Similarly, FEMAs' National Flood Insurance Program regulations allow for development in the margins of active waterways if they are protected against 100-year flood events, and do not raise the water elevations within the active channel (floodway) more than one foot during such flood events. This standard does not adequately reflect the dynamic, mobile nature of watercourses in southern California, and the critical role that margins of active waterways (riparian areas) play in the maintenance of aquatic habitats. In addition, FEMA programs for repairing flood related damages (Public Assistance Program, Individual and Households Program, and Hazard Mitigation Grant Program) promote the replacement of damaged facilities and structures in their original locations, which are prone to repeated damage from future flooding, and thus lead to repeated disturbance of riparian and aquatic habitats important to migrating, spawning, or rearing steelhead.

At the time of listing, several non-federal regulatory and planning mechanisms affected the conservation of steelhead populations within the Southern California Steelhead DPS. These included: 1) administration of the California State Water Resources Control Board (SWRCB) water rights permitting system which controls utilization of waters for beneficial uses throughout the state; 2) state and local government permitting programs for land uses on non-federal and non-state owned lands; 3) administration of the CDFW Section 1600 *et seq.* (Streambed Alteration Agreements) program; and 4) the lack of an updated and completed California CMP to inform regulatory actions such as angling restrictions.

For example, the SWRCB water rights permitting system contains provisions (including public trust provisions) for the protection of instream aquatic resources. However, the system does not provide an explicit regulatory mechanism in the Southern California Coast Steelhead Recovery Planning Area to implement the CDFG Code Section 5937 requirement for the owner or operator of a dam to protect fish populations below impoundments (Grantham and Moyle 2014). Additionally, SWRCB generally lacks the oversight and regulatory authority over groundwater development comparable to surface water developments for out-of-stream beneficial uses, though the passage of the California Sustainable Groundwater Management Act in 2014 partially addresses this inadequacy for some water basins.

The Section 1600 Lake or Streambed Alteration Agreements program is the principal mechanism through which CDFG provides protection of riparian and aquatic habitats. Inadequate funding, staffing levels, training and administrative support have led to inconsistent implementation of this program, resulting in inadequate protection of riparian and aquatic habitats important to migrating, spawning and rearing steelhead.

The deficiency in governmental regulatory mechanisms is compensated in part within the Southern California Coast Steelhead Recovery Planning Area by local or regional public institutions involved in steelhead recovery planning and implementation. Several special districts (Cachuma, Water District, Casitas Municipal Water District, United Water Conservation District, and the Resource Conservation District of the Santa Monica Mountains) have been engaged in habitat restoration and modifying infrastructure and operations to address impacts to steelhead in the Santa Ynez River, Santa Barbara south coast creeks, Ventura River, Santa Clara River, and the Santa Monica Mountains. The Southern California Wetlands Recovery Project is an amalgam of federal, state and local entities that promotes the restoration of coastal wetlands and watersheds throughout southern California. The Southern California Coastal Water Research Project is made up of wastewater dischargers, storm water agencies, and water quality regulators with an independent scientific staff that investigates how to monitor and protect ocean and coastal watersheds in southern California. The City of Santa Barbara supports a Creeks Restoration and Water Quality Improvement Division through a bed tax and undertakes restoration and management of the creeks within the City's jurisdiction (Mission Creek, Arroyo Burro Creek, Sycamore Creek, Lighthouse Creek, Arroyo Honda, and Laguna Creek). The California Conservation Corps Veterans Green Jobs Program provides personnel to undertake various restoration projects, including removal of non-native vegetation, and other stream and watershed restoration projects.

Notable non-governmental organizations (NGOs) which promote funding and implementation of steelhead recovery actions include: The Tri-Counties Fish Team (San Luis Obispo, Santa Barbara, and Ventura counties); Environmental Defense Center (Santa Barbara and Ventura Counties); South Coast Habitat Restoration (Santa Barbara and Ventura counties); Santa Clara River Steelhead Coalition (Ventura County) and South Coast Steelhead Coalition (Orange, Riverside, and San Diego counties) under the direction of California Trout; San Gabriel and Lower Los Angeles Rivers Mountain Conservancy; West Fork San Gabriel River Conservancy; and the Council for Watershed Health (San Gabriel and Los Angeles rivers). Trout Unlimited's San Diego and South Coast Chapters are also active in promoting steelhead recovery in the southern portion of the DPS. These NGOs are also engaged in public outreach and education initiatives focusing on steelhead and watershed related restoration and management.

Other portions of the Recovery Planning Area are the focus of attention of individuals, groups, or agencies with broader conservation interests or responsibilities: Concerned Resource and Environmental Workers (Ventura and Santa Barbara counties); Heal the Ocean (Santa Barbara and Ventura counties); Santa Barbara ChannelKeeper (Santa Barbara County); Matilija Coalition (Ventura County); Ojai Valley Land Conservancy (Ventura County); Friends of the Ventura River (Ventura County); Friends of the Santa Clara River (Ventura and Los Angeles counties); Ventura CoastKeeper (Ventura County); Friends of the Los Angeles River (Los Angeles County); Friends of the Santa Monica Mountains (Ventura and Los Angeles counties); Heal the Bay (Ventura and Los Angeles counties); Friends of the Santa Margarita River (San Diego County); San Dieguito River Valley Conservancy (San Diego County); and Endangered Habitat League (Orange and San Diego counties).

Monitoring of stocks (particularly annual run-sizes) is essential to assess current and future status of the listed species as well as to develop basic ecological information about listed salmon and steelhead. However, the California CMP has not been updated to account for new monitoring methodologies and implementation funding has not been identified or secured. See discussion in Section 2.3.1 above and recommendations in Section 4.0 below.

These regulatory mechanisms have not been fundamentally altered in the past 5 years (with the notable exceptions of the curtailment of angling in anadromous waters and the passage of the California Groundwater Management Act) and as a consequence the threats to steelhead and its habitat from the inadequacies of regulatory mechanisms has remained essentially unchanged since the last status review (Williams *et al.* 2011).

2.3.2.5 Other natural or manmade factors affecting its continued existence

This factor category encompasses two specific threats to the species identified at the time of listing. These are: 1) environmental variability, including projected long-term climate change, and 2) stocking programs. Recent information about environmental variability, including the effects of ocean conditions on the survival of salmonid populations and increases in wildfire occurrence and severity, indicate that the threat from “environmental variability” can be expected to increase. While stocking of non-native hatchery reared *O. mykiss* in anadromous waters has ceased, and triploid fish are used in current stocking programs, the legacy effects of past stocking of non-native hatchery reared *O. mykiss* persists. See discussion above in Section 2.3.1.1 and Section 2.3.2.5.3 below.

2.3.2.5.1 Environmental Variability

Variability in natural environmental conditions has both masked and exacerbated the problems associated with degraded and altered riverine, estuarine, and marine habitats. Floods and persistent drought conditions have periodically reduced naturally limited spawning, rearing, and migration habitats. Furthermore, El Niño events and periods of unfavorable ocean-climate conditions have resulted in significant swings in returning spawning run sizes, and can threaten the survival of steelhead populations already reduced to low abundance levels due to the loss and degradation of freshwater and estuarine habitats. However, periods of favorable ocean productivity and high marine survival can temporarily offset poor habitat conditions elsewhere and result in dramatic increases in population abundance and productivity by increasing the size and correlated fecundity of returning adults.

Overall, the pattern of these threats have remained essentially unchanged since the last status review (Williams *et al.* 2011), though the threats posed by environmental variability (from projected climate change and related ocean conditions) are likely to exacerbate this factor affecting the continued existence of the species. See the discussion below (prepared by Crozier and Mantua in Williams *et al*. 2016)

2.3.2.5.2 Climate Effects

Projected impacts of future climate change on West Coast salmon

Climatic conditions affect salmonid abundance, productivity, spatial structure, and diversity through direct and indirect impacts at all life-stages (*e.g.*, Moyle *et al.* 2013, Wainwright and Weitkamp 2013, Crozier *et al.* 2008, Independenet Scientfic Advisory Board 2007, Lindley *et al.* 2007; see also, Beamish *et al.* 2010). Salmonids have adapted to a wide variety of climatic conditions in the past, and thus inherently could likely survive substantial climate change at the species level in the absence of other anthropogenic stressors.

Currently, the adaptive ability of these threatened and endangered species is depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. Without these natural sources of resilience, systematic changes in local and regional climatic conditions due to anthropogenic global climate change will likely reduce long-term viability and sustainability of populations in many ESUs/DPSs. Adapting to climate change may eventually involve changes in multiple life history traits and/or local distribution, and some populations or life-history variants might die out. Importantly, the character and magnitude of these effects will vary within and among ESUs/DPSs. See Figure 18.

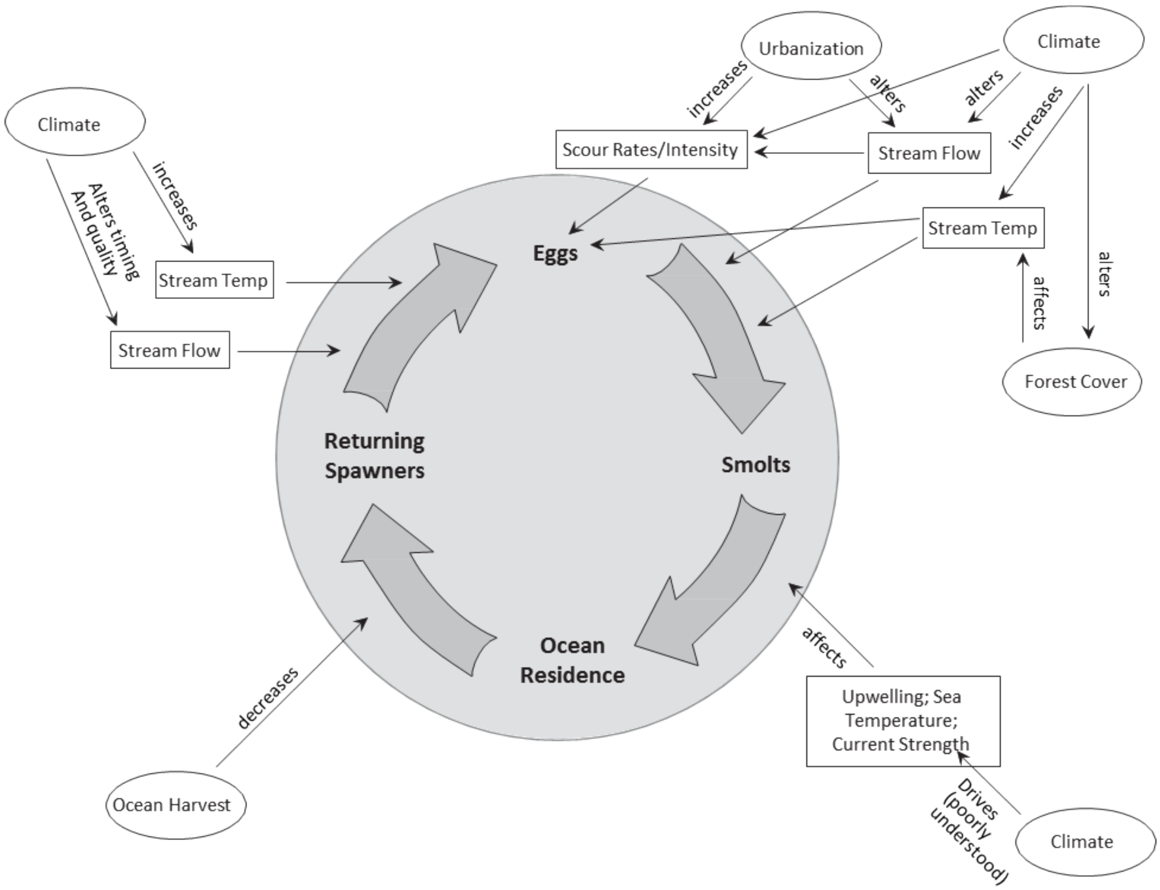

Figure 18. Conceptual model of factors affecting life-stages of Salmon and Steelhead.

The Intergovernmental Panel on Climate Change (IPCC) and U.S. Global Change Research Program recently published updated assessments of anthropogenic influence on climate, as well as projections of climate change over the next century (Melillo *et al.* 2014, Intergovernmental Panel on Climate Change 2013). Reports from both groups document ever-increasing evidence that recent warming bears the signature of rising concentrations of greenhouse gas emissions.

The U.S. Global Change Research Program report contains regional-focus chapters for the northwest (Mote *et al.* 2014, Snover *et al.* 2013) and southwest U.S. (Garfin *et al.* 2014). These regional reports synthesize information from an extensive literature review, including a broad array of analyses of regional observations and climate change projections. These synthesis reports were the primary source for this West Coast summary. References to the primary literature can be found in those reports.

Updates to this summary can be found in annual literature reviews conducted by NOAA-Fisheries at the following website: http://www.nwfsc.noaa.gov/trt/lcm/freshwater_habitat.cfm.

Historical Climate Trends

Observed historical trends in climate reflect the early influence of greenhouse-gas emissions, and often indicate the general direction of future climate change. These observations also reflect natural variability in climate at multiple time scales. Natural variability alternately intensifies and relaxes (or partially reverses) the long-term trends. Attribution of historical trends to anthropogenic factors is most certain at the global scale over time scales of centuries to millennia because at these scales we can better account for natural variability.

Historical records show pronounced warming in both sea-surface and land-based air temperatures. There is moderate certainty that the 30-year average temperature in the Northern Hemisphere is now higher than it has been over the past 1,400 years. In addition, there is high certainty that ocean acidity has increased with a drop in pH of 0.1. Furthermore, glaciers and sea-ice have receded, while sea level has risen (global mean rose 0.19 m over the last century). In recent decades, the frequency of extreme high temperature or heavy precipitation events has increased in many regions. An anthropogenic influence on this shift in frequency is “very likely” (Intergovernmental Panel on Climate Change 2014).

Regional and local trends include the following observations:

- In both the Northwest and Southwest:
  - air temperatures have increased since the late 1800s,
  - springtime snow-water equivalent has decreased (since 1950),
  - snowmelt occurs earlier in the year.
- In the Southwest, drought over the past 4 years is unprecedented in the historical record and may be the worst in over 1,000 years. This drought has been attributed to a combination of anthropogenic influence on temperature and natural variability in precipitation (Williams *et al.* 2015). Trends in precipitation vary spatially up or down, with no statistically significant trends in precipitation averages or extremes in the Northwest.
- In both the Northwest and Southwest, widespread tree mortality has been observed, wildfires have increased in both frequency and area burned, and insect outbreaks have increased (Garfin *et al.* 2014, Mote *et al.* 2014).
- Historical trends in the California Current are heavily influenced by patterns in wind-driven ocean circulation, which correlates with large-scale climate drivers such as the North Pacific Gyre Oscillation (Peterson *et al.* 2013) and Pacific Decadal Oscillation (Jacox *et al.* 2014). Spatially variable trends in upwelling intensity (Jacox *et al.* 2014) and hypoxia (Peterson *et al.* 2013), and longer trends in atmospheric forcing and sea surface temperature (Johnstone and Mantua 2014) probably reflect natural climate

variability to a much greater extent than anthropogenic forcing.

- The pH of the California Current has decreased by about 0.1 and by 0.5 in aragonite saturation state since pre-industrial times (Hauri *et al.* 2009). Furthermore, infrastructure in coastal areas is increasingly damaged by erosion and flooding (Garfin *et al.* 2014, Mote *et al.* 2014, Sweet *et al.* 2014).

Projected Climate Changes

General trends in warming and ocean acidification are highly likely to continue during the next century (Intergovernmental Panel on Climate Change 2103). Scenarios considered in the IPCC fifth assessment report range from the severely curtailed greenhouse gas emissions of representative concentration pathway (RCP) 2.6 to business as usual in RCP 8.5.

Based on means across global climate models spanning the full breadth of these emissions scenarios, IPCC projected the following ranges across the Northern Hemisphere by 2081-2100:

- Spring snow cover declines of 7-25%
- Glacier recessions of 15-85%
- Sea surface temperature increases of 1.1-3.6°C
- Global sea level increases of 11-38 inches
- Global ocean pH decreases of 38 to 109%, which correspond to a drop in pH of 0.14-0.32.

Regional projections add spatial variability and specificity to these trends. In winter across the west, the highest elevations *(e.g.* in the Rocky Mountains) will shift from consistently longer (>5 months) snow-dominated winters to shorter periods (3-4 months) of reliable snowfall (Klos *et al.* 2014); lower, more coastal or more southerly watersheds will shift from consistent snowfall over winter to alternating periods of snow and rain ("transitional"); lower elevations or warmer watersheds will lose snowfall completely, and rain-dominated watersheds will experience more intense precipitation events and possible shifts in the timing of the most intense rainfall (*e.g., et* Salathé *al.* 2014).

By the 2080s, Tohver *et al.* (2014) anticipate a complete loss of snow-dominated basins in the Cascades and U.S. portion of the Rockies, with only a few "mixed" basins of rain and snow-fed runoff remaining at the highest elevations. Flooding is projected to increase in basins that experience a mix of snow and rain in winter (Mote *et al.* 2014, Salathé *et al.* 2014, Tohver *et al.* 2014). Erosion and flooding in coastal areas are projected to increase with rising sea levels (Garfin *et al.* 2014, Mote *et al.* 2014, Sweet *et al.* 2014).

Among seasons, the greatest temperature shifts are expected in summer. Warmer summer air temperatures will increase both evaporation and direct radiative heating. When combined with reduced winter water storage, warmer summer air temperatures will lead to lower minimum flows in many watersheds. Higher summer air temperatures will depress minimum flows and raise maximum stream temperatures even if annual precipitation levels do not change (*e.g.*, Sawaske and Freyberg 2014). Summer precipitation also influences summer flows, but projections for precipitation are less certain than for temperature. Coastal weather can differ from region-wide projections due to changes in fog, on-shore winds, or precipitation (Potter 2014, Johnstone and Dawson 2010).

Widespread ecosystem shifts are likely, and may be abrupt due to disturbances from increasing wildfires, insect outbreaks, droughts, and tree diseases (Garfin *et al.* 2014, Mote *et al.* 2014). Climate projections often favor invasive fish species over native species, with declines exacerbated by the greater vulnerability of native species to existing anthropogenic stressors (Lawrence *et al.* 2014, 2012, Quiñones and Moyle 2014).

In response to projected changes in both climate and land use practices, estuary dynamics are expected to change as well, with depth and salinity altered by changing sea level, upwelling regimes, and freshwater input (Yang *et al.* 2015). Intense upwelling events can move hypoxic and acidic water into estuaries, especially when freshwater input is reduced (*e.g.*, Columbia River estuary, Roegner *et al.* 2011). Sea level projections differ at local *vs.* global scales due to local wind and temperature trends and land movement. Specifically, the National Research Council (2012) predicted a lower rise in sea level off the coasts of Washington and Oregon (62 cm) than off the coast of California (92 cm) by 2100.

Higher sea-surface temperatures and increased ocean acidity are predicted for marine environments in general (Intergovernmental Panel on Climate Change 2013). However, regional marine impacts will vary, especially in relation to productivity. The California Current is strongly influenced by seasonal upwelling of cool, deep, water that is high in nutrients and low in dissolved oxygen and pH.

Ecological effects of climate change in the California Current are very sensitive to impacts on upwelling intensity, timing, and duration. Projections of how climate change will affect upwelling are highly variable across models, with predicted trends ranging from negative to positive (Bakun *et al.* 2010, Diffenbaugh *et al.* 2008, Snyder *et al.* 2003, Mote and Mantua 2002, Bakun 1990). An analysis of 21 global climate models found that most predicted a slight decrease in upwelling in the California Current, although there is a latitudinal cline in the strength of this effect, with less impact toward the north (Rykaczewski *et al.* 2015).

Much of the near-shore California Current is expected to be corrosive (undersaturated in aragonite) in the top 60 m during all summer months within the next 30 years, and year-round within 60 years (Gruber *et al.* 2012). Thermal stratification and hypoxia are expected to increase (Doney *et al.* 2014).

Impacts on Salmon and Steelhead

Studies examining the effects of long-term climate change to salmon and steelhead populations have identified a number of common mechanisms by which climate variation is likely to influence sustainability of salmon and steelhead populations. These include direct effects of temperature such as mortality from heat stress, changes in growth and development rates, and disease resistance. Changes in the flow regime (especially flooding and low flow events) also affect survival and behavior. Expected behavioral responses include shifts in seasonal timing of important life-history events, such as adult migration, spawning, fry emergence, and juvenile migration. The movement of juvenile steelhead between upstream reaches and the estuary may be disrupted by changes in late spring, summer and early fall base flows (*e.g.,* Hayes, *et al.* 2011, Boughton *et al.* 2009).

Indirect effects on salmon and steelhead mortality, growth rates and movement behavior are also expected to follow from changes in the freshwater habitat structure and the invertebrate and vertebrate community, which governs food supply and predation risk (Crozier *et al.* 2008, Independent Scientific Advisory Board 2007, Petersen and Kitchell 2001). Both direct and indirect effects of climate change will vary among Pacific salmon ESUs/DPSs and among populations in the same ESU/DPS. Adaptive change in any salmonid population will depend on the local consequences of climate change as well as ESU/DPS-specific characteristics and existing local habitat characteristics.

Because climate has such profound effects on survival and fecundity, salmon and steelhead physiology and behavior are intricately adapted to local environmental conditions. These adaptations vary systematically among populations and are exhibited in traits such as age and timing of juvenile and adult migrations, with potential differences in physiology and migration routes (Quinn 2005). These traits often have a significant plastic (non-genetic) component, which allows them to respond quickly to environmental change. Yet these traits also differ genetically among populations (Carlson and Seamons 2008).

Directional climate change could, therefore, drive many salmonid populations into a maladaptive state. Such an outcome would likely cause reductions in abundance, productivity, population spatial structure and population diversity. In some cases, this can lead to extirpation if a population cannot adapt quickly enough. In other cases an adaptive solution may not exist because of conflicting pressures within or between life stages.

Climate impacts in one life-stage generally affect body size or timing in the next life-stage. For this reason, the cumulative life-cycle effects of climate change must be considered to fully appreciate the scope of risk to a given population. Even without interactions among life-stages, the sum of impacts in many stages will have cumulative effects on population dynamics. See Figure 18.

Climate effects tend to be negative across multiple life-stages (Wade *et al.* 2013, Wainwright and Weitkamp 2013, Healey 2011). However, there may be mitigating responses in some ESUs/DPSs or life-stages. Individualistic impacts within and among ESUs/DPSs will depend on factors such as existing physical and biological heterogeneity, proximity to the limits of physiological tolerance under present climate conditions, and the extent of local climate change.

In many cases, directional climate change exacerbates existing anthropogenic threats. Examples include streams or rivers where stream temperatures are already elevated due to land-use modifications (Battin *et al.* 2007) or where flow is reduced due to water diversions (Walters *et al.* 2013). For example, the Columbia River, dams have altered the hydrological regime by causing an earlier and smaller freshet, which is the same type of effect expected from climate change (Naik and Jay 2011a, Naik and Jay 2011b). Any of these stressors in combination with one another or with climate impacts will present pressures of much greater concern than they would individually, but they also offer potential solutions.

Changes in winter precipitation will likely affect incubation and/or rearing stages of most populations. Changes in the intensity of cool-season precipitation could influence migration cues for fall and spring adult migrants, such as coho and steelhead. Egg survival rates may suffer from more intense flooding that scours or buries redds.

Changes in hydrological regime, such as a shift from mostly snow to more rain, could drive changes in life-history, potentially threatening diversity within an ESU/DPS. It is possible that even characteristic life-history traits used to help define the ESU/DPS will be threatened. For example, the juvenile freshwater rearing period is very sensitive to temperature, with the yearling life-history strategy used only by populations in cooler watersheds (Beechie *et al.* 2006), or watershed with cooler refugia habitat. Frequency of the yearling life-history type will likely decline as movement downstream into estuaries or near-shore habitat is initiated at younger ages. Implications of this behavioral shift for juvenile survival, ocean migration behavior, and age at maturity are uncertain.

Changes in summer temperature and flow will affect both juvenile and adult stages in some populations, especially those with yearling life-histories and summer migration patterns. Juvenile rearing and migration survival is often correlated with these factors (Crozier *et al.* 2010, Crozier and Zabel 2006, Quinn 2005).

Adults that migrate or hold during peak summer temperatures can experience high mortality in unusually warm years. For example, in 2015 only 4% of adult Redfish Lake sockeye survived the migration from Bonneville to Lower Granite Dam after confronting temperatures over 22°C in the lower Columbia River. After prolonged exposure to temperatures over 20°C, salmon are especially likely to succumb to diseases that they might otherwise have survived (Miller *et al.* 2014, Materna 2001). They are also more vulnerable to any sort of stress, such as catch-and-release fisheries (Boyd *et al.* 2010).

Changing hydrology and temperature will also affect the timing of smolt migrations and spawning (Crozier and Hutchings 2014, Hayes *et al.* 2014, Otero *et al.* 2014). If smolts migrate at a smaller size because they leave freshwater habitat earlier, they might have lower survival due to size-selective predation (Thompson and Beauchamp 2014, Hayes *et al.* 2008, Bond 2006). Marine arrival timing is extremely important for smolt-to-adult survival (Scheuerell *et al.* 2009), and has been historically synchronized with the timing and predictability of favorable ocean conditions (Spence and Hall 2010). Given the uncertain effects of climate change on upwelling timing and intensity, impacts on juvenile survival from shifts in migration timing are also difficult to predict.

In some populations, behavior during the early ocean stage is consistent among years, suggesting a genetic rather than a plastic response to environmental conditions (Hassrick *et al.* In press, Burke *et al.* 2014). These populations might change their behavior over time if the fitness landscape changes, but responses will likely be relatively slow and could be dominated by decadal ocean dynamics or productivity outside the California Current (*e.g.*, the Gulf of Alaska for northern migrants).

Other populations show more variable behavior after ocean entry (Fisher *et al.* 2014, Weitkamp 2010), and some show heightened sensitivity to interannual climate variation, such as the El Niño Southern Oscillation. Such variability might increase ESU/DPS-level resilience to climate change, assuming some habitats remain highly productive.

Marine migration patterns could also be affected by climate-induced contraction of thermally suitable habitat. Abdul-Aziz *et al.* (2011) modeled changes in summer thermal ranges in the open ocean for Pacific salmon and steelhead under multiple IPCC warming scenarios. For chum, pink, coho, sockeye and steelhead, they predicted contractions in suitable marine habitat of 30-50% by the 2080s, with an even larger contraction (86-88%) for Chinook salmon under the medium and high emissions scenarios (A1B and A2).

Northward range shifts are a climate response expected in many marine species, including salmon (Cheung *et al.* 2015). However, salmon and steelhead populations are strongly differentiated in the northward extent of their ocean migration, and hence will likely respond individualistically to widespread changes in sea surface temperature.

In most Pacific salmon species, size at maturation has declined over the past several decades. This trend has been attributed in part to rising sea surface temperatures (Morita *et al.* 2005, Pyper and Peterman 1999, Bigler *et al.* 1996). Mechanisms involved in such responses are likely complex, but appear to reflect a combination of density-dependent processes, including increased competition due to higher salmon abundance in recent years and temperature (Pyper and Peterman 1999). Temperature-related size effects could involve increased metabolic costs at higher temperatures, and/or shifts in spatial distribution in response to ocean conditions. Younger spawners affect population growth rates by exhibiting lower fecundity and reducing the population stability that stems from having multiple age classes reproduce.

Numerous researchers have reported that salmon and steelhead marine survival is highly variable over time and often correlated with large-scale climate indices (Litzow *et al.* 2014, Stachura *et al*. 2014, Sydeman *et al.* 2014, Petrosky and Schaller 2010, Mueter *et al.* 2005, 2002). For example, Pacific salmon from Washington and Oregon exhibited extremely low marine survival and dramatic population declines during a warm (positive) phase of the Pacific Decadal Oscillation in the 1980s and 1990s (Zabel *et al.* 2006, Levin 2003). These declines were attributed to low ocean productivity in the warm ocean of that period.

Many fish communities, including key salmon and steelhead prey and predators, experience changes in abundance and distribution during warm ocean periods (Cheung *et al.* 2009, Wing 2006, Pearcy 2002). However, food chain dynamics in the open ocean are flexible and difficult to predict into the future, and in the case of steelhead poorly understood (Grimes *et al.* 2007; see also, Hertz and Trudel 2014).

The full implications of ocean acidification on salmon are not known at this time (National Research Council 2010). Olfaction and predator-avoidance behavior are negatively affected in some fish species, including pink salmon (Ou *et al.* 2015, Leduc *et al.* 2013). Pink salmon also showed reductions in growth and metabolic capacity under elevated CO_2 conditions (Ou *et al.* 2015). Some high-quality salmon prey (*e.g.,* krill) might be negatively affected by ocean acidification, but there are several possible pathways by which higher trophic levels might compensate for changes at a lower trophic level. From their analysis of multi-trophic responses to ocean acidification, Busch *et al.* (2013) concluded that impacts to salmon could conceivably be positive. However, they emphasized that a better understanding of both direct and indirect feedback loops is necessary before drawing definitive conclusions.

To what extent a future warmer ocean will mimic historic conditions of warm-ocean, low-survival periods is not known. Current indications are that a warmer Pacific Ocean is generally less productive at mid latitudes, and hence likely to be less favorable for salmon and steelhead.

In summary, both freshwater and marine productivity tend to be lower in warmer years for most populations considered in this status review. These trends suggest that many populations might decline as mean temperature rises. However, the historically high abundance of many southern populations is reason for optimism and warrants considerable effort to restore the natural climate resilience of these species.

Analysis of ESU/DPS-specific vulnerabilities to climate change by life-stage will be available in the near future, upon completion of the *West Coast Salmon Climate Vulnerability Assessment*. Climate effects on one Pacific salmon ESU, the Oregon coastal coho, were recently assessed by Wainwright and Weitkamp (2013). Below we present a summary of effects they reported for this ESU; many of these effects will likely be shared by other ESUs/DPSs, including the Southern California Coast Steelhead Recovery Planning Area.

2012-2015 Drought Impacts on West Coast Salmon and Steelhead Habitat

California has experienced well below average precipitation in each of the past 4 water years (2012-2015), record high surface air temperatures the past 2 water years (2014 and 2015), and record low snowpack in 2015. Some paleoclimate reconstructions suggest that the current 4-year drought is the most extreme in the past 500 or perhaps more than 1000 years. Anomalously high surface temperatures have made this a “hot drought”, in which high surface temperatures substantially amplified annual water deficits during the period of below average precipitation. The combination of low precipitation and high temperatures has promoted elevated stream temperatures. The below normal precipitation and reduced runoff has adversely affected aquatic habitat for steelhead in a variety of other ways, resulting in: 1) depleted groundwater basins which provide base flows that support critical over-summering habitat for rearing *O. mykiss*; 2) reduced hydrological connectivity between seasonally wet and dry stream sections in interrupted streams; 3) restricted instream movement of rearing *O. mykiss*; 4) delayed or reduced breaching time of sandbars at the mouth of coastal estuaries, affecting water quality, and limiting both the upstream migration of adult *O. mykiss* and the downstream emigration of juveniles and kelts. Riparian habitat has also been adversely affected by the reduction in groundwater levels and the reduction of surface flows, affecting water temperatures and food availability.

2014-15 Exceptionally Warm Ocean Conditions in the Northeast Pacific

Much of the northeast Pacific Ocean, including parts typically used by California salmon and steelhead, experienced exceptionally high upper ocean temperatures beginning early in 2014 and areas of extremely high ocean temperatures continue to cover most of the northeast Pacific Ocean. A plume of water formed offshore of the Pacific Northwest region in fall 2013 (Bond *et al.* 2015). Off the coast of Southern and Baja California, upper ocean temperatures became anomalously warm in spring 2014, and this warming spread to the Central California coast in July 2014. In fall 2014, a shift in wind and ocean current patterns caused the entire northeast Pacific domain to experience unusually warm upper ocean temperatures from the West Coast offshore for several hundred kms. In spring 2015 nearshore waters from Vancouver Island south to San Francisco mostly experienced strong and at time above average coastal upwelling that created a relatively narrow band (~50 to 100 km wide) of near normal upper ocean temperatures, while the exceptionally high temperature waters remained offshore and in coastal regions to the south and north.

Expectations for Future Climate Risks and Impacts Already in the Pipeline for West Coast Salmon and Steelhead

As with most upstream migrations of anadromous salmonids along the California coast, adult coho salmon returns this fall/winter and in the fall 2016/winter 2017 have likely been negatively impacted by poor stream and ocean conditions. Adult salmon and steelhead returns for this fall (next winter) and for the next 2 to 3 years (depending on ocean residence times, maturing in 2015-2018) have also likely been negatively impacted by poor stream and ocean conditions.

The expected effects of the 2015/16 tropical El Niño are likely to favor a more coastally-oriented warming of the Pacific Northeast this fall and winter that will persist into spring 2016. Next spring's ocean migrants will likely encounter an ocean strongly influenced by (if not dominated by) a subtropical food-web that favors poor ocean survival (Nate Mantua, NOAA Fisheries Science Center, Santa Cruz Laboratory, personal communication 2015).

Summary

Four consecutive years of drought and the past two years of exceptionally high air, stream and upper-ocean temperatures have together likely had negative impacts on the freshwater, estuary, and marine phases for many populations of salmon and steelhead. In addition to reducing over summering and migration flows, in the Southern California Coast Steelhead DPS, the drought has also resulted in a number of rivers and streams remaining closed at their mouths as a result of the lack sufficient flows to breach the at the river mouth, or reducing the times the river mouths are open to the ocean (Rich and Keller 2011, Jacobs *et al.* 2010). Delayed or prolonged river mouth closure has limited the upstream migration of adults and the downstream emigration of juveniles (smolt) or adults (kelts); low flows may have also interrupted the natural periodic movement of sub-adults between the estuary and the ocean which has been documented in some systems in the North Central California Coast Steelhead DPS.

NOAA's Climate Prediction Center (CPC) forecasts a 95% likelihood that the tropical El Niño event will persist through the winter of 2016, and they also predict a high likelihood for this event to alter North Pacific and Western US climate for the next few seasons. Seasonal climate forecasts issued by CPC in mid-September show increased odds for typical El Niño fall/winter climate conditions that include above average fall and winter temperatures in West Coast states, increased odds for below normal precipitation in the Pacific Northwest (especially large increases in the odds for a dry fall/winter in the interior Columbia Basin), and increased odds for a wet fall in Southern California, and a wet winter in all of California. Because El Niño events favor fall/winter periods with an especially strong Aleutian Low pressure anomaly centered in the Gulf of Alaska, the exceptionally warm upper ocean temperatures off the Pacific Northwest coast is expected to weaken considerably. In contrast exceptionally warm ocean temperatures between Central, Southern, and Baja California and Hawaii are expected to remain elevated for the next few seasons. El Niño-related changes in wind and related ocean current patterns are expected to cause a coast-wide warming of upper ocean temperatures from Alaska south to Mexico, but confined to a relatively narrow band within ~ 100 miles of the coast.

In summary, the strong El Niño event is predicted to substantially reduce the odds for a repeat of the extreme warmth of the past 2 winters, the extreme precipitation deficit experienced throughout California the past 4 winters, and the extreme warmth of the offshore waters of the

Northeast Pacific Ocean that have persisted for most of the past 2 years. The past 2 years have also seen persistence in the warm phase PDO pattern of North Pacific Ocean temperatures, and the warm phase of the PDO is likely to continue for another year because of it strong tendency for persistence and the expected El Niño influences on the Aleutian Low and related ocean currents in the next 6 months.

2.3.2.5.3 Stocking Program

There is no steelhead production hatchery operating in or supplying hatchery reared steelhead for stocking into streams within the range of the Southern California Coast Steelhead DPS. However, there is a CDFW stocking program of hatchery cultured and reared, non-anadromous *O. mykiss* which supports a "put-and-take" fishery that is stocked for removal by anglers. These stockings are now conducted in non-anadromous waters (using triploid fish. However, other non-native game species such as large and smallmouth bass and bullhead catfish are stocked into anadromous waters by a variety of public and private entities.

While some of these stocking programs have succeeded in providing seasonal fishing opportunities, the impacts of these programs on native, naturally-reproducing steelhead stocks are not well understood. Competition, genetic introgression, and disease transmission resulting from hatchery introductions may significantly reduce the production and survival of native, naturally-reproducing steelhead (Araki *et al.* 2009, 2008, 2007). Genetic investigations of southern California steelhead have detected interbreeding and displacement of native steelhead with hatchery reared *O. mykiss*, particularly in the southernmost portions of the DPS (Adadia-Cardoso, *et al.* 2016, Jacobson *et al.* 2014, Abadia-Cardoso *et al.* 2011, Christie *et al.* 2011). These stockings are now carried out in non-anadromous waters, though fish in some cases may escape into anadromous waters as a result of spillage over dams. Collection of native steelhead for hatchery broodstock purposes can harm small or dwindling natural populations. Artificial propagation can also, in some situations, play an important role in steelhead recovery through, among other means, preservation of individuals representing genetic resources which would otherwise be lost as a result of local anthropogenic driven extinctions, but are not a substitute for naturally-reproducing populations.

Overall, threats from stocking have remained essentially unchanged since the last status review, though the extent of legacy effects of past stocking is now better understood (Adadia-Cardoso, *et al.* 2016, Williams *et al.* 2016, Williams *et al.* 2011).

2.4 Synthesis

2.4.1 DPS Status

There is little new evidence to indicate that the status of the Southern California Coast Steelhead DPS has changed appreciably in either direction since the last status review (Williams *et al.* 2011). The extended drought and the recent genetic data documenting the high level of introgression and extirpation of native *O. mykiss* stocks in the southern portion of the DPS has elevated the threats level to the already endangered populations; the drought, and the lack of comprehensive monitoring, has also limited the ability to fully assess the status of individual populations and the DPS as whole.

The systemic anthropogenic threats identified at the time of the initial listing have remained essentially unchanged over the past 5 years, though there has been significant progress in removing fish passage barriers in a number of the smaller and mid-sized watersheds. Threats to the Southern California Steelhead DPS posed by environmental variability resulting from projected climate change are likely to exacerbate the factors affecting the continued existence of the DPS.

2.4.1 Recovery Progress

While the status of the populations of steelhead within the Southern California Coast Steelhead DPS has not changed appreciably since the last status review, a number of recovery related activities have been undertaken which may result in some reduction in threats to the species, and potentially lead to a future increase in individual populations as other habitat conditions, including resumption of winter and base flows, improve (Capelli 2015).

Fish-passage impediment inventories have been completed on major watersheds (Santa Maria/Sisquoc, Santa Ynez, Santa Ynez Mountains, Ventura, Santa Clara, and Santa Monica Mountains, San Juan/Arroyo, San Mateo, Santa Margarita, and San Luis Rey). Information obtained from these inventories has been useful for prioritizing and guiding remediation efforts, soliciting grant funds, and soliciting state and federal agency stakeholder support.

Fish-passage facilities have been constructed or fish passage barriers removed in a number of core watersheds: *e.g.,* tributaries to the lower Santa Ynez River (Sal Salsipuedes Creek, Quiota Creek, and El Jaro Creek) and the Ventura River (Lion Creek, a tributary to San Antonio Creek); several smaller watersheds along the Conception Coast (Tajiguas Creek, Maria Ygnacio Creek, Carpinteria Creek, San Ysidro Creek, and Gobernador Creek, a tributary to Carpinteria Creek); and Arroyo Sequit in the Santa Monica Mountains. The Santa Barbara County Flood Control District in Cooperation with the City of Santa Barbara have reconfigured a concrete lined portion of lower Mission Creek to provide for fish passage, and the City of Santa Barbara is in the process of replacing a series of bridge over lower Mission Creek which will accommodate higher flood flows and improve fish passage opportunities for steelhead. Removing or retrofitting obstructions to steelhead migration for the purpose of reconnecting the species spawning and rearing habitats is an essential recovery action within the DPS.

A number of fish-passage projects are in the planning stages within the Conception Coast BPG in the Santa Ynez Mountains (removal of 5 debris basins within the next five years, and additional 5 basins in the following 5 years); within the Santa Clara River watershed (Vern Freeman Diversion Dam and the 12th Street diversion on the mainstem, and Harvey Diversion Dam on Santa Paula Creek); and the Lake O'Neill Diversion on the Santa Margarita River.

In the southernmost portion of the DPS planning has proceeded on the removal of 80 fish passage barriers within the Cleveland National Forest (principally from the San Juan and San Mateo Creek watersheds), 11 of which have been removed to date. Additionally, planning for retrofitting passage barriers at the Metro-Link and I-5 crossings on Arroyo Trabuco Creek has progressed to the final design stages.

Other recovery projects include removal of non-native species and plant restoration at the estuaries of Refugio and Carpinteria Creek; biotechnical bank stabilization along Carpinteria Creek; on-going removal of non-native vegetation in the Ventura River and two tributaries, Matilija Creek and San Antonio Creek); restoration of the natural alignment of Rice Creek, tributary to the Ventura River; completion of the Santa Clara River Estuary Restoration and enhancement Feasibility Study and the Santa Clara River Invasive Non-Native Plan Removal, Ecosystem Restoration and Habitat Protection Project on the lower Santa Clara River; riparian restoration along the San Luis Rey River; and removal of non-native invasive species in the San Dieguito River watershed.

Planning for the removal of Matilija Dam in the Ventura River watershed has advanced substantially with the development of specific alternatives for the removal of the dam and the management of the stored sediment. Planning has re-commenced on the potential removal of Rindge Dam on Malibu Creek. Funding for the removal of Matilija Dam has been provided by a variety of federal, state, and local sources, including the California Coastal Conservancy, U.S. Bureau of Reclamation, U.S. Army Corps of Engineers, U.S. Department of Justice, U.S. Geological Survey, and the National Park Service, among others, as well as the dam owners (Ventura County Watershed Protection District). Planning for the removal of Rindge Dam has been by funded by the U.S. Bureau of Reclamation, U.S. Army Corps of Engineers, and the California Department of Parks and Recreation. Funding is currently inadequate to complete the projects because of reduced federal funding, but may be supplemented with State funds through the California Water Quality, Supply, and Infrastructure Improvement Act of 2014 (Proposition 1). Regarding the removal of Matilija Dam, consultants retained by the California Coastal Conservancy have recently identified several new alternatives to dam and sediment removal that would substantially reduce project costs; these are currently under evaluation.

Funding for recovery projects was provided by a wide variety of local, state, and federal sources, including: California Coastal Conservancy, California Wildlife Conservation Board, Pacific Coastal Salmon Recovery Fund (PCSRF), the CDFW Fisheries Restoration Grant Program (FRGP), National Fish and Wildlife Foundation, NOAA Restoration Center, California Department of Water Resources Integrated Regional Water Management Plan grant program (Proposition 50), California Natural Resources Agency Parkways Program (Proposition 84), Caltrans Environmental Enhancement and Mitigation Program, Santa Barbara County Coastal Resource Enhancement Fund, and San Diego Association of County Government TransNet Environmental Mitigation Program.

Local entities, including local jurisdictions (*e.g.*, City of Santa Barbara, City of Oceanside, City of San Juan Capistrano and local water districts such as Cachuma Water District/Cachuma Operations and Maintenance Board, Casitas Municipal Water District, United Water Conservation District, Resource Conservation District of the Santa Monica Mountains, Riverside-Corona Resource Conservation District, and San Diego Regional Water Quality Control Board) have contributed substantial organizational, in-kind services, and financial support for the implementation of recovery projects within their respective watersheds.

Non-Governmental Organizations (*e.g.,* California Trout [Santa Clara River Steelhead Coalition, South Coast Steelhead Coalition], Fallbrook Land Conservancy, Friends of the Santa Clara River, Friends of the Santa Margarita River, Friend of the Ventura River, Friends of the San Gabriel River, Friends of the Los Angeles River, Ojai Land Conservancy, Earth Island Institute [South Coast Habitat Restoration], Surfrider Foundation [Matilija Coalition], The Nature Conservancy [Santa Clara and Los Angeles River Project], Tri-Counties Fish Team, Trout Unlimited, and San Diego Trout), have concentrated efforts on implementing recovery actions identified in the Southern California Steelhead Recovery Plan and have contributed substantial organizational, in-kind services, and financial support for the implementation of recovery projects, including public outreach and education.

The formation of the Santa Clara River Project and the South Coast Steelhead Coalition under the auspices of California Trout, with multi-year funding through CDFW's FRGP grants has provided additional organizational support for steelhead recovery efforts within the Southern California Coast Steelhead DPS, including production of a documentary video produced by California Trout, *Southern California Steelhead: Against All Odds* (http://vimeo.com79393289).

Sportfishing regulations for native steelhead have been changed to eliminate angling in virtually all coastal rivers and streams in the Southern California Coast Steelhead DPS that are accessible to adult steelhead migrating up from the ocean. Additionally, CDFW has curtailed its stocking of hatchery-reared trout, limiting stockings to reservoirs or stream reaches above impassible barriers. CDFW has expanded its use of sterile (triploid) fish to include all the watersheds currently stocked with *O. mykiss* to prevent the interbreeding of hatchery-reared fish with native steelhead, though private entities continue to stock reservoirs in anadromous watersheds with non-native fishes.

NMFS has issued three major biological opinions addressing fish passage and/or migration flows: United Conservation District's Santa Felicia Dam on Piru Creek (tributary to the Santa Clara River); the U.S. Army Corps of Engineers Santa Paula Creek Flood Control Project (tributary to the Santa Clara River); and the Santa Barbara County Flood Control District's Flood Control Maintenance Program. NMFS continues to work on implementing the reasonable and prudent alternatives and conservation measures identified in these biological opinions. A Habitat Conservation Plan (HCP) has been initiated to cover the operations of the Vern Freeman Diversion and appurtenant facilities on the Santa Clara River. NMFS also issued a biological opinion to NOAA's Restoration Center to cover restoration projects funded by the Restoration Center, or projects that require a section 404 permit from the U.S. Army Corps Engineers that are determined by the Restoration Center to be within the scope of the program. To specifically qualify, all proposed restoration projects must satisfy one or more of the following objectives: 1) restore degraded steelhead habitat; 2) improve instream cover, pool availability, and spawning gravel; 3) remove barriers to fish passage; and 4) reduce or eliminate sources of erosion and sedimentation. Due to the evolving nature of the various techniques and guidelines for salmonid restoration, the NOAA's Restoration Center requires that projects authorized under this program must adhere to the most current practices and best available guidelines and techniques for design and implementation.

NMFS continues to participate in the Public Trust/Water Right hearings being held by the California State Water Resources Control Board on the re-licensing of the Bradbury Dam – Cachuma Reservoir Project on the Santa Ynez River, and has re-initiated consultation for this project to address new information on the effects of the project on steelhead and steelhead habitats. NMFS has also conducted both formal and informal Section 7 consultations under the ESA with federal agencies throughout the DPS that fund, carry out, or regulate projects such as flood protection, road construction, water diversion, bridge replacements, and gravel mining operations. These consultations have the functional effect of minimizing the effects of these activities on endangered steelhead.

A number of fishery investigations and habitat improvement planning projects have been initiated. These include: an instream flow study for the Santa Maria River (Proposition 84); a preliminary estuarine restoration plan for the Santa Ynez River Estuary; a fish passage barrier evaluation for Rincon Creek (Conception Coast); habitat and fish population surveys of Topanga Creek (Santa Monica Mountains); non-native invasive plant and fish passage barrier removal and population survey in Coldwater Canyon Creek, a tributary to the Santa Ana River; and fish passage barrier remediation on the Santa Margarita River. An instream flow study for the Ventura River will be initiated in 2016 as part of the California Water Action Plan.

3.0 RESULTS

3.1 Recommended Classification and DPS Boundary

Based upon a review of the best available information, we recommend that the Southern California Coast Steelhead DPS remain classified as an endangered species. Similarly, we do not recommend any changes to the geographic boundary of this DPS at this time. NOAA's Southwest Fisheries Science Center, Santa Cruz Laboratory convened a Biological Review Team to evaluate all new genetic information for this and the other coastal steelhead DPSs in California but has not completed its review. The Southwest Fisheries Science Center will provide the West Coast Region with an analysis of this and other information which will be subsequently evaluated by the Region to determine whether any change in the DPS boundary is warranted.

3.2 New Recovery Priority Number

No change is recommended in the recovery priority number 3 for this DPS.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

The follow recommendations are based on the 2015 status review and are intended to focus recovery activities within the Southern California Coast Steelhead Recovery Planning Domain in a manner that implements the provisions of the Southern California Steelhead Recovery Plan. These activities focus on five major areas: 1) monitoring, 2) research, 3) regulation, 4) recovery actions, and 5) the prevention of local extirpations of steelhead populations.

4.1 Monitoring

The status review confirms the value and need for the California CMP. Full implementation of the California CMP is necessary to more accurately understand the risk to the Southern California Coast Steelhead DPS, and assess the response of the DPS to the various recovery actions that have been undertaken to date, or will be in the future. Additionally, information gathered through the California CMP is necessary to refine the viability criteria. To address these issues we recommend the following actions:

- Update and fully implement the California CMP abundance monitoring and spatial-structure monitoring (consistent with the changes discussed above; see Sections 2.3.1.4 through 2.3.1.4.1);
- Add monitoring of resident adults and genetic diversity to the California CMP (as discussed above; see Sections 2.3.1.4 through- 2.3.1.4.1);
- Greater emphasis be placed on monitoring methods that are unbiased or can be bias-corrected (as discussed above; see Sections 2.3.1.4 through- 2.3.1.4.1);
- Site-selection and initiation of LCM stations as identified in the Southern California Steelhead Recovery Plan as discussed above in Sections 2.3.1.4 through 2.3.1.4.1. See also Table 14-1, "Potential Locations of Southern California Coast Steelhead Life-Cycle Monitoring Stations" in the Southern California Steelhead Recovery Plan;

  Among other benefits, these LCM stations could serve as study sites to clarify the role of the putative chromosome inversion in the maintenance of life-history diversity, and to clarify the potential smolt production of the medium and large alluvial rivers, such as the Santa Ynez, Ventura, Santa Clara, Santa Margarita and San Luis Rey; and
- Identification of drought refugia as provided in the Southern California Steelhead Recovery Plan; current (and projected) future droughts provide a valuable opportunity to identify and characterize drought refugia.

4.2 Research

Initiate the research into steelhead ecology identified in the Southern California Steelhead Recovery Plan and identified in the NCEAS Southern steelhead research and monitoring colloquium. Important research topics include:

- Ecological factors that promote anadromy;
- Reliability of migration corridors;
- Steelhead-promoting nursery habitats;
- Comparative evaluation of seasonal lagoon/estuaries;
- Potential nursery role of mainstem habitats;
- Potential positive spawner density as an indicator of viability;
- Role of naturally intermittent river and stream reaches;

- Partial migration and life-history crossovers; and
- Rates of dispersal between watersheds.

4.3 ESA Section 7 Consultations and Section 10 Permitting Activities.

Focus on completing and implementing key ESA Section 7 consultation and Section 10 permitting actions in core watersheds that address the most fundamental threats to the Southern California Steelhead DPS, *i.e.*, though addressing fish-passage and flow issues. These include:

- Bradbury Dam and Cachuma Reservoir Project, Santa Ynez River;
- Santa Felicia Dam Hydroelectric Relicensing Project, Santa Clara River Watershed;
- Santa Barbara County Flood Control Operations (numerous streams throughout the county);
- Santa Clara River Multispecies Habitat Conservation Plan (Vern Freeman Diversion Dam); and
- Conjunctive Use Project, Santa Margarita River.

Issue Section 10 scientific research permits which support the research and monitories activities identified above; see also Sections 2.3.1.4 through 2.3.1.4.1.

4.4 High Priority Recovery Actions

Additionally, high priority recovery actions identified in the Southern California Steelhead Recovery Plan should be implemented. These include:

- Identify and remove man-made steelhead passage barriers in all core population watersheds:
    - Re-establish access to upper watersheds in both small coastal streams (*e.g.*, Maria Ygnacio, Mission, and San Juan/Arroyo Trabuco creeks) and the larger interior river systems (*e.g.*, Santa Ynez, Santa Clara, and Santa Margarita rivers) within each BPG identified by the TRT (See Table 5).
    - Complete planning for the removal of Matilija Dam on Matilija Creek (Ventura River) and Rindge Dam on Malibu Creek.
- Provide ecological meaningful flows below dams and diversions in all core population watersheds (See Table 5):
    - Re-establish adequate flow regimes in both small coastal stream (*e.g.*, Goleta Slough Complex, San Juan Creek) and the larger interior river systems (*e.g.*,

Santa Maria, Santa Ynez, Ventura, Santa Clara, San Gabriel, Santa Ana, Santa Margarita, and San Luis Rey, San Dieguito, and Sweetwater).

- Further investigate potential recovery actions south of Malibu Creek (within the southern range extension), including watershed barrier inventories, habitat suitability assessments, and metapopulation dynamics between the larger river systems and smaller coastal streams.

4.5. Preventing Local Extinctions of *O. mykiss*

The extended drought and drying conditions associated with projected climate change has the potential to cause local extinction of *O. mykiss* populations and thus reduce the genetic diversity of fish within the Southern California Coast Steelhead Recovery Planning Area. To reduce this risk the following measures should be undertaken:

- Maintain the conservation hatchery functions of the CDFW Fillmore hatchery, and where appropriate, expand its capability to provide for temporary accommodation of fish removed from the wild to prevent their extirpation; and

- Explore other means of conserving individual populations of *O. mykiss* which may face the risk of extirpation *(e.g.,* using other existing facilities at academic institutions or museums, or natural refugia habitats).

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NATIONAL MARINE FISHERIES SERVICE
5-YEAR REVIEW
South-Central/Southern California Coast Steelhead Recovery Domain
Southern California Coast Steelhead DPS

Current Classification: Endangered

Recommendation resulting from the 5-Year Review: Retain current ESA classification as endangered and current DPS boundary.

REGIONAL OFFICE APPROVAL:

Approve: [signature] **Date:** 3/18/16

Alecia Van Atta
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