COASTAL RAINBOW TROUT

Oncorhynchus mykiss irideus

Low Concern. Status Score = 4.7 out of 5.0. Coastal rainbow trout are the least concern among native trout species due to their life history plasticity, environmental tolerance, large natural and expanded range (through introductions) and resilience.

Description: Coastal rainbow trout are typically silvery in color, with a white belly, black spots on the tail, adipose fin, dorsal fin, and back; spots on the tail radiate in lines (NMFS 2016). There is a pink to rosy lateral band on each side, and the gill covers are usually also pink to purple. Color is highly variable, however, so trout from small streams may be fairly dark on the back with a yellowish belly and orange tips on the fins, while lake-dwelling fish tend to be more silver in color. Coastal rainbow trout rarely exhibit the chrome coloration characteristic of fish that have reared in the ocean. The mouth is large, with the main bone of the upper jaw (maxillary) extending behind the eye; small teeth line the jaws, tongue, and roof of mouth. The tail is only slightly forked, with rounded tips. Other fins are pointed, with a white leading edge and translucent rays. Fin ray counts are as follows: dorsal, 10-12; anal, 8-12; pelvics, 9-10; pectorals, 11-17. Scales are small and highly variable in number: lateral line 110-160, rows above 18-35, and rows below 14-29. Generally, rainbow trout that undertake ocean migration attain larger sizes than inland coastal rainbow trout as a result of feeding opportunities in rich marine waters in the California Current (NMFS 2016). In California's anadromous waters, any rainbow trout greater than 41 cm (16 in.) in length are usually considered to be "steelhead" for management purposes and catch limits, although in productive reaches of river, resident coastal rainbows this size and larger are common. See Moyle (2002) for a more detailed description.

Taxonomic Relationships: The taxon "coastal rainbow trout" in this account refers to all wild rainbow trout that spend their entire life cycle in fresh water and are not part of some other taxon; they are often referred to as resident rainbow trout. Non-migratory rainbow trout in anadromous waters, which are capable of undertaking ocean migrations or of producing offspring that do, are technically included in the relevant steelhead Distinct Population Segment (DPS) accounts elsewhere in this report. However, the large resident rainbow trout populations in tailwaters of dams in the Sacramento and San Joaquin rivers are not included as part of the Central Valley steelhead DPS, even though at least some of them are capable of anadromy (Zimmerman and Reeves 2000).

The National Marine Fisheries Service (NMFS) summarizes these DPSs in California in Williams et al. (2016):

> "The Klamath Mountains Province Steelhead DPS begins at the Elk River in Oregon and extends to the Klamath/Trinity basin in California, inclusive. The Northern California Steelhead DPS extends from Redwood Creek in the north to the Gualala River in the south, inclusive. The Central California Coast Steelhead DPS begins at the Russian River, contains populations in streams tributary to the San Francisco/San Pablo Bay system, and stretches south to Aptos Creek, inclusive. The South-Central California Coast Steelhead DPS starts at the Pajaro River in the Monterey Bay Region and continues to Arroyo Grande in San Luis Obispo Bay. The Southern California Steelhead DPS begins at the Santa Maria River, inclusive, and stretches to the border with Mexico. The

> California Central Valley Steelhead DPS includes all populations in the Sacramento/San Joaquin River system and its delta. *All of these DPSs include only potentially anadromous fish below definitive natural or manmade barriers to anadromy* (pg. 4)."

Rainbow trout upstream of migration barriers are excluded from California's six steelhead DPSs (Pearse and Garza 2015), although many should probably not be because, if isolation was recent, they may still be contributing to downstream populations. Therefore coastal rainbow trout can be defined as self-sustaining rainbow trout populations that are (a) isolated above natural barriers as the result of geologic activity (landslides etc.), (b) isolated above anthropogenic barriers, such as dams, and (c) the result of introductions by people into isolated areas, such as the historically fishless region of the Sierra Nevada. Many of these populations are derived from stocking hatchery fish of diverse strains. Presumably all rainbow trout had steelhead as ancestors, but developed as resident fish as the result of strong natural selection against anadromy.

We follow Behnke (1992, 2002) in using *O. mykiss irideus* to refer to non-redband trout under this designation. In general, "coastal rainbow trout" as used here is a catch-all term to refer to resident rainbow trout that cannot access the ocean and thus are not included in a steelhead DPS. As indicated above, the boundary between steelhead and resident coastal rainbow trout is fuzzy because it is not biologically based, but a distinction of convenience for management. Many different populations of resident rainbow trout presumably had independent origins from steelhead, as well as populations established through introductions. These populations include (a) those in upstream areas above natural barriers in coastal watersheds, (b) those in Central Valley streams upstream of dams and other manmade barriers, and (c) those established through introductions above natural barriers (e.g., in lakes and streams in the Sierra Nevada, Cascades, and Trinity Alps) in native watersheds, and (d) those established in non-native watersheds as a result of introductions.

The distinction between coastal rainbow trout and steelhead is particularly hard to sustain in the Central Valley, especially the Sacramento River. Large populations of rainbow trout exist in reaches such as the Sacramento River between Keswick Dam and Red Bluff, where anadromy is only weakly supported by conditions that favor the resident life history in wild fish, and most steelhead presumably originate in hatcheries (see Central Valley steelhead account).

Another difficult distinction exists in populations of rainbow trout in reservoirs above dams that engage in steelhead-like behavior in tributary streams. Before dams were constructed across Central Valley watersheds, most rainbow trout there were genetically part of a DPS that also included steelhead. Not surprisingly, rainbow trout upstream of these dams have been found to be more similar genetically to one another than they are to fish downstream of the dams in the same watersheds, while also showing watershed-specific traits. This suggests that they are remnants of the original steelhead populations that adapted their life history to reservoir conditions, where reservoirs replace the ocean as the place where fish can grow rapidly to a large size (see next section). It is also possible that at least some of these populations are the result of decades of stocking various strains of rainbow trout, although locally adapted trout/steelhead are remarkably resilient. Pearse and Garza (2015) surprisingly found little evidence that out-of-basin coastal rainbow trout contributed to the genomes of above-reservoir trout, despite a century of introductions of hatchery strains of domesticated fish of mixed geographic sources from rim of the Central Valley (California Hatchery Scientific Review Group 2012). Traits of wild native fish have presumably been selected for under natural conditions and contributed to this result.

In contrast, rainbow trout of all persuasions below Central Valley dams are genetically fairly uniform, showing a strong influence of steelhead introduced from the Eel River in the 1950s (Pearse and Garza 2015). Although individuals from above dam populations may occasionally be washed downstream, these populations are presumably on their own evolutionary trajectories, providing reason not to include them in the relevant steelhead DPS downstream. In addition, the remaining upstream populations may better represent the pre-dam steelhead genome than the introgressed populations present below the dams today, especially in the American River (Pearse and Garza 2015). For further discussion, see Moyle (2002).

Life History: Coastal rainbow trout have a high diversity of life history strategies, which is the principal reason for their success. Strategies vary widely. For example, the classic pattern for resident fish is to spend most of their lives in a short section of stream, perhaps making a short migration (a few meters to a few kilometers) for spawning. Rainbow trout that display a non-anadromous life history but maintain a connection to downstream areas are often capable of producing anadromous offspring; this fact is suspected to be the a major reason for persistence of very small populations of returning adult steelhead to small, coastal streams in South-Central and Southern California (Courter et al. 2013).

In contrast, reservoirs often develop steelhead-like runs of fish that grow in lakes and spawn in tributary streams, using the large reservoir to rapidly increase growth and fecundity (adfluvial life history). Such runs may or may not have been derived from steelhead that became trapped behind dams after their construction over the last century. Additional research is needed on the genomes and life histories of migratory fish in and above reservoirs, including their relationships with resident forms.

Coastal rainbow trout mature in their second or third year of life, spawn 1-3 times, and rarely live more than five or six years. Spawning takes place in spring (February to June, depending on flows and temperatures). However, under artificial flow conditions, such as those found in the tailwaters below dams (e.g. Putah Creek, Solano/Yolo counties), coastal rainbow trout can spawn in winter months (late November-January, K. Davis, pers. comm. 2016). In spring-fed systems, such as the Fall River (Shasta Co.), which lack strong seasonal cues of flow and temperature, spawning can occur from September through June (R. Lusardi, unpubl. obs.). Each female digs a series of redds and buries the fertilized embryos. Embryos hatch in 3-4 weeks (at 10-15°C) and the fry emerge 2-3 weeks later. Fry aggregate in shallow water along shore, and gradually move into deeper water as they grow larger. If they live in riffles or shallow runs, fish may be territorial or partially so, but fish in pools tend to congregate in groups, albeit with some sorting by size.

Diets of stream-dwelling trout are primarily aquatic and terrestrial insects that drift in the water column, although frogs and fish may be consumed on occasion. Benthic feeding also occurs and may be a dominant mode in some rivers, such as the McCloud (Tippets and Moyle 1978). In lakes and reservoirs, they frequently feed heavily on planktivorous fish, such as threadfin shad. Moyle (2002) provides more information on the diversity of life history strategies.

Habitat Requirements: Resident rainbow trout are found primarily in cool, clear, fast-flowing waters. They typically thrive in tailwaters of large dams, but also can easily adapt to inhabiting lakes and reservoirs with ample food. Rainbow trout are among the most physiologically tolerant of salmonids, which is why they are often the only salmonid found in streams that are thermally marginal. For most studies of thermal tolerances of domesticated coastal rainbow trout, a maximum critical thermal threshold of 26°C is assumed (Robinson et al. 2008). However, coastal rainbow trout in California can live in waters that temporarily reach 22.3-33.1°C (Sloat and Osterback 2013) in summer for short periods of time, provided there is sufficient acclimation time and food available to offset higher energetic costs and stress associated with warm water (see Box 1 on bioenergetics in SONCC coho salmon account). Thermal refuges (e.g. upwelling ground water, cool tributary stream mouths, springs) and cooling temperatures at night are also important in marginal thermal habitats. For the most part, rainbow trout in summer prefer temperatures between 15 and 18° C (Moyle 2002) At low temperatures, rainbows can survive under relatively low dissolved oxygen concentrations, although saturation is needed for embryo development and most activities. They also can survive and grow in a wide range of water chemistry, including water with a pH between 6 and 9.

Different life stages have different habitat requirements as defined by depth, water velocity, and substrate (Moyle 2002). Smaller fish generally require shallower water, lower velocities, and less coarse substrates than larger fish. Given a choice, trout in streams live in areas where they can hold in place with minimal effort, while food is delivered to them in nearby fast water. They also require nearby cover, such as downed trees or overhanging vegetation, to protect them from predators.

Distribution: Coastal rainbow trout were originally present in virtually all permanent coastal streams from San Diego north to the Smith River, although almost all resident fish are/were closely related to the local steelhead DPS than to resident fish in other regions. Likewise, coastal rainbow trout were found in most rivers in the Central Valley from the Kern River north to the Pit River system. Resident forms were typically found above barriers difficult to pass by steelhead. Today, due to numerous official and unofficial introductions across California, resident trout with coastal rainbow origins are found in virtually all streams where suitable habitat exists. Their expanded range includes most of the lakes and streams in the once-fishless Sierra Nevada north of the Upper Kern basin as well as lakes and streams in the Cascades and Trinity Alps. For more details, see Moyle (2002).

Trends in Abundance: Wild, naturally spawning resident coastal rainbow trout are undoubtedly more abundant today than they were historically in California. They have been introduced into most suitable waters, including reservoirs, where they are often the dominant species. They are abundant in tailwaters below large dams in valley flow reaches. Starting roughly in the 1950s, increasing emphasis was placed on supporting fisheries with domesticated trout from hatcheries for put-and-take fisheries. In recent times, maintaining such fisheries has been an important activity of the California Department of Fish and Wildlife (CDFW). However, the growing popularity of catch-and-release fisheries for wild trout has resulted in improved management of many streams, by reducing grazing and road impacts, protecting riparian corridors, improving flow regimes below dams, and other actions. Hybridization of locally adapted strains of coastal rainbow trout with hatchery origin fish is often regarded as a problem, but most hatchery strains today survive poorly in the wild, especially in streams, and have limited opportunities to reproduce. “Although the genetic identities of distinct local populations may have been lost in many instances as the result of planting hatchery fish, wild strains adapted to local conditions may persist” (Moyle 2002, p. 280). Therefore, many of the remaining fish above man-made barriers have limited introgression with hatchery or domesticated strains from out-of-basin (see Central Valley steelhead account).

While local populations in urban and heavily agricultural areas may be diminished or even eliminated, total abundance statewide is generally high. However, coastal rainbow trout abundance across California was likely depressed during the ongoing (2012-16) drought. While it is impossible to detail every single population's abundance trends statewide, a smattering of drought rescue information from CDFW and other management partners suggest that less coldwater habitat was available for all species across most of the state for the last five years of drought (2012-2016).

Factors Affecting Status: At one time or another, every factor discussed for other salmonids in this report has reduced local resident rainbow trout populations, including: over-exploitation, water diversions, dams, pollution, poor watershed management (through logging, agriculture, over-grazing, road building), mining, channelization of streams, introductions of alien species, etc. Despite many possible causes of decline, rainbow trout overall continue to thrive throughout California.

Part of the success story of resident rainbow trout is their wide introduction outside their native range across California, North America, and the world. Most of these populations are at least partially, if not wholly, derived from California coastal rainbow stocks. Where introduced, rainbow trout are alien species responsible for the depletion and even extinction of native fishes, especially other trout species (e.g., Lahontan cutthroat trout [*Oncorhynchus clarkii henshawi*] in the eastern Sierra Nevada). They are considered one of the hundred worst invaders in the world by the International Union for the Conservation of Nature (Lowe et al. 2000).

Dams. Dams are a major cause of resident coastal rainbow trout replacing steelhead in many waters, including in cold tailwaters below dams. Above dams, tributary streams at higher elevations fed by snowmelt support resident coastal rainbow trout, while reservoirs themselves often support populations of adfluvial trout. Overall, it can be argued that resident or adfluvial coastal rainbow trout have benefited from dams, despite isolation and fragmentations of populations.

Agriculture. Water diversions, especially for agriculture and municipal use, often reduce the quantity and quality of water available to coastal rainbow trout. Countless pumps, levees, dikes, and other water infrastructure to support drawing water from reservoirs and streams remove cold water inputs to watersheds and often contribute to conditions that are better suited to alien fishes than coastal rainbow trout. Return flows to watersheds are often warmer and include pollutants and sediment that degrade water quality for salmonids, limiting their growth and abundance.

Hatcheries. Most populations of coastal rainbow trout in California were introduced to through stocking hatchery-reared fish, so from the perspective of coastal rainbow trout as a taxon, hatcheries have been beneficial. However, these widespread introductions have displaced and negatively affected native fishes and other aquatic species, such as amphibians, throughout California.

Logging. Both private and public forest lands across California have been heavily logged in the past century, often reducing the quality of rainbow trout habitat but rarely eliminating populations completely. In some parts of the state, current logging practices are well managed, but legacy effects from past unregulated timber harvest may continue to limit coastal rainbow trout populations in some areas. Contemporary logging, along with associated roads and widespread legacy effects from extensive historical timber harvest, has increased erosion rates, increasing sediment loads in streams (Lewis et al. 2004). Increased sediment loads cause pools to fill, embed spawning gravels in fine materials, and create shallower runs and riffles, decreasing the amount of usable spawning and rearing habitat and increasing vulnerability of fish to poachers and predators. Sedimentation is also known to significantly reduce eyed egg survival in coastal rainbow trout at concentrations of fines >30% (Jensen et al. 2009), while removal of trees can reduce canopy cover and shading and indirectly increase water temperature.

Grazing. Heavy livestock grazing throughout the coastal rainbow trout range, particularly cattle in riparian zones in the Sierra Nevada, has degraded stream habitat with broad effects including loss of riparian vegetation, channel incision, and siltation. Loss of riparian vegetation has resulted in higher water temperatures and reduced cover, leaving fish more vulnerable to reduced water quality, disease, and predators. Much coastal rainbow trout habitat exists on Bureau of Land Management and National Forest lands, where grazing has historically or is still permitted. Public lands are far less heavily grazed today, but in areas where grazing still occurs, canyon areas should be prioritized for cattle exclusion to protect areas of hyporheic flow that provide refuge for salmonids during warm summer and fall months with low flows (Boxall et al. 2008). In general, while grazing has probably reduced trout populations in many areas, it has rarely eliminated them, so recovery can be rapid once grazing management is improved. For a more complete account of grazing on trout populations at high elevations, see the California Golden Trout account.

Rural/residential development. Much of the coastal rainbow trout range in California is impacted by rural and/or residential development, especially at lower elevations, reducing carrying capacity of streams for rainbow trout. Residential and municipal users have placed high demands on limited water supplies through diversions and groundwater pumping, which have led to habitat reductions, degradation, fragmentation, and non-point pollution exposure. Water diversions for human uses in rural areas throughout California generally reduce the supply of cold, subsurface flows, which support coastal rainbow trout oversummering habitat. In addition, numerous tributaries are currently listed as impaired water bodies under the Clean Water Act due to high levels of sedimentation, elevated water temperatures, presence of pathogens or contaminants, pharmaceutical products, and poor water quality. Urban development throughout the coastal rainbow trout range has greatly reduced riparian habitat, contributing to reductions in water quantity and quality.

Fire. Most of the coastal rainbow trout range lies within forested areas from moderate to high elevations. Populations can therefore be affected by wildfires. Fires can increase water temperatures in holding and rearing headwater streams, cause landslides, increase sediment loading, and remove shading canopy cover. Large rainfall events can quickly mobilize debris from steep slopes and bury spawning and rearing habitats in headwater reaches. In addition, fire can fragment populations by creating barriers (physical, thermal, etc.).

Transportation. Roads cross most streams containing coastal rainbow trout. Unsurfaced and unimproved roads (mining, logging, and rural/residential access) are abundant in the Sierra Nevada foothills, and Forest Service access roads bisect National Forests throughout California. Many of these roads are sources of fine sediment and pollutant runoff (oil, gasoline) and can significantly degrade water and habitat quality. Culverts associated with road crossings over streams block access to and fragment habitat in many streams, reducing population connectivity and resilience.

Alien species. Alien species, especially non-native salmonid species, such as brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*) can out-compete and prey directly upon juvenile coastal rainbow trout, although the species also frequently coexist because of different reproductive strategies (Kiernan and Moyle 2012). Across the native range of rainbow trout in California, stocking practices have likely reduced populations, in some cases considerably. Predation on coastal rainbow trout, especially by basses (*Micropterus spp.*) and other predators can also cause direct mortality, as can predation by native predators including fish, birds, and sea lions. However, rainbow trout are remarkably adaptable and predation is likely to be a cause of decline only if also associated with habitat alteration.

Harvest. Harvest demands drove California's management of coastal rainbow trout for decades (CHSRG 2012), whereby domesticated strains of rainbow trout from hatcheries were stocked into waters to provide fishing opportunities for the public. More recently, angler preferences have shifted towards catch-and-release fishing for wild trout on most streams, although put-and-take fisheries are favored in urban areas and in reservoirs. For streams, changes in regulations over time have seen reductions in daily bag limits (e.g. 2 fish instead of 5 per angler, per day), or zero retention altogether, to protect the quality of the angling experience and satisfaction. Put-and-take fisheries will likely continue to have a prominent place in fisheries management for rainbow trout in California; this results in some incidental take of wild fish but likely has small impact on wild coastal rainbow trout populations. However, legal catch-and-release fishing for wild fish also results in some low levels of mortality, but the population level impacts of managing a fishery in this way are poorly understood and require further study.

Mining. Nearly every watershed containing coastal rainbow trout in California underwent hardrock, hydraulic, and dredge mining for gold or other metals in the past, which has no doubt reduced carrying capacity for wild trout of many streams. While dredge mining has been banned in California since 2005 (www.wildlife.ca.gov/licensing/suction-dredge-permits) and the days of prospecting in California for gold are past, legacy impacts persist. Mine tailing piles remain throughout many of the Sierra Nevada watersheds, bearing witness to complete turnover of streambeds that occurred on huge scales across the landscape. These alterations have been shown to have fundamentally reduced productivity of watersheds in California downstream of historical mining operations, and likely have reduced spawning habitat for coastal rainbow trout. In addition, old mines continue to leach pollutants and heavy metals into waterways, reducing water quality.

Recreation. Recreational activities in streams and lakes supporting coastal rainbow trout include: angling, boating, gold panning, swimming, hiking, and other outdoor activities. These impacts, especially at the population level, are likely minimal. Intensive motorized boating (e.g., California's major reservoirs such as Lake Shasta, Shasta Co.) may disrupt movement patterns and, potentially, temporary habitat utilization, but this has not been substantiated.

Factor	Rating	Explanation
Major dams	Low	Dams alter habitat quantity and quality for coastal rainbow trout both positively and negatively and may fragment populations.
Agriculture	Low	Agricultural diversions reduce habitat and water quality.
Grazing	Low	Grazing impacts riparian habitat, but impacts are low.
Rural/ residential development	Low	Demand for limited surface water and groundwater pumping for municipal and other uses reduce available habitat.
Urbanization	Low	Much of coastal rainbow trout range is in rural areas.
Instream mining	Low	Mostly legacy impacts after dredge mining ban in 2006.
Mining	Low	Historical impacts throughout coastal rainbow trout range, legacy impacts may have small impacts in recent times.
Transportation	Low	Dirt roads across range may increase sedimentation.
Logging	Low	Legacy impacts associated with timber harvest.
Fire	Low	More frequent and intense wildfires may reduce local habitat availability.
Estuary alteration	n/a	Coastal rainbow trout, by definition, are separate from steelhead that have access to the ocean.
Recreation	Low	Minimal impacts.
Harvest	Low	Harvest and legal catch-and-release fishing may reduce survival in some areas.
Hatcheries	Low	Many populations of coastal rainbow trout started by hatchery strains (e.g. Sierra Nevada lakes); introgression of above-dam populations and hatchery fish is low.
Alien species	Low	Possibly a limiting factor in some populations in reservoirs or degraded stream habitats suitable for alien species; alien trout species (brook and brown) have most impact across range.

Table 1. Major anthropogenic factors limiting, or potentially limiting, viability of populations of coastal rainbow trout. Factors were rated on a five-level ordinal scale where a factor rated “critical” could push a species to extinction in 3 generations or 10 years, whichever is less; a factor rated “high” could push the species to extinction in 10 generations or 50 years whichever is less; a factor rated “medium” is unlikely to drive a species to extinction by itself but contributes to increased extinction risk; a factor rated “low” may reduce populations but extinction is unlikely as a result. A factor rated “n/a” has no known negative impact. Certainty of these judgments is high. See methods for explanation.

Effects of Climate Change: Similar to species of inland native trout in California, climate change is likely to negatively impact coastal rainbow trout by reducing cold-water habitat. Moyle et al (2013) rated coastal rainbow trout as “highly vulnerable” to climate change impacts. However, coastal rainbow trout are less vulnerable than other species of trout due to their inherent tolerance for high water temperatures and poor water quality, competitive behavior, abundance, and access to diverse habitats that increase their resilience as a species. In general, climate change is likely to reduce the total amount of habitat available to rainbow trout but there will be sufficient cold water to support many self-sustaining, if reduced, populations.

Status Score = 4.7 out of 5.0. Low Concern. Coastal rainbow trout are very widespread in California, occupy a variety of habitats, enjoy significant gene flow among populations, and are highly adaptable. As a result, they face no danger of extinction at this time. Despite the damage to trout streams in California over the past 150 years, coastal rainbow trout continue to thrive in many areas. Climate change will reduce populations but not drive the species to extinction in California.

Metric	Score	Justification
Area occupied	5	Abundant in California and widely distributed around the world.
Estimated adult abundance	5	Many fish in many populations. Adult abundance probably greater than 500,000 statewide.
Intervention dependence	5	While stream improvements and other activities greatly improve habitat for native and introduced populations, most populations can persist on their own with existing protective laws and regulations.
Environmental tolerance	4	Broad physiological tolerance.
Genetic risk	5	Lots of gene flow among populations.
Climate change	4	Low vulnerability due to widespread populations in diverse habitats.
Anthropogenic threats	5	All threats low except estuarine alteration, which is n/a.
Average	4.7	33/7.
Certainty (1-4)	4	Well-documented.

Table 2. Metrics for determining the status of coastal rainbow trout, where 1 is a major negative factor contributing to status, 5 is a factor with no or positive effects on status, and 2-4 are intermediate values. Certainty of these judgments is high. See methods for explanation.

Management Recommendations: Most ongoing conservation efforts in California for coastal rainbow trout center around increasing reliable quantities and quality of cold water habitat. An increasing focus is to support healthy populations of wild trout for catch-and-release recreational fisheries. In fact, increasing the number of stream miles and lakes devoted to thriving wild trout populations is now a major goal of the California Department of Fish and Wildlife, mandated by state law and implemented by the Wild and Heritage Trout Program. As climate change impacts continue to result in warmer water, reduced summer flows, and increased frequency of large floods throughout California, maintaining existing populations will become harder over time. In addition, there will be continuing conflicts with protecting endangered and native fishes and other aquatic species, such as listed red-legged frog (*Rana draytonii*) and mountain yellow-legged frog (*Rana muscosa*) in California. With climate change likely to reduce the consistency of precipitation patterns across the state and available snowpack in the Sierra Nevada, efforts that protect cool source waters such as springs, meadows, and hyporheic flows into streams should be prioritized and expanded where possible.

Increasing public fishing opportunities for trout around California is and will remain a priority for CDFW, California Trout, and others into the future, and domesticated strains of hatchery coastal rainbow trout will play a role in supporting this priority. However, domesticated hatchery-strain coastal rainbow trout should only be stocked in areas where their existence does not threaten listed species or native fish species. The benefits of increasing access to trout for the public should be carefully balanced and conservatively managed against providing angling for California's other native trout species wherever possible. Common sense approaches to stocking, such as utilizing native species wherever possible in their native range, should be expanded.

Management of rainbow trout in California is complex, and is made even more difficult by the changes humans have wrought on the landscape (such as dams) to support agriculture and urbanization. While steelhead DPSs were created to conserve fish with anadromous life histories, which were in severe decline, genetic information was insufficient at the time to identify the important link between above- and below-barrier populations for conservation (Courter et al. 2013, Pearse and Garza 2015, Williams et al. 2016). However, the latest information indicates that rainbow trout upstream of barriers have a critical role in supporting the anadromous life history of DPSs, with the notable exception of the heavily altered Central Valley populations (Pearse and Garza 2015).

This fact has led to a shift in management and restoration at NMFS that focuses on reconnecting populations of rainbow trout that are currently separated by barriers promoting access to diverse habitats to restore genetic diversity and aid in recovery (e.g. South-Central and Southern California steelhead DPSs, Jacobson et al. 2014, Abadia-Cardoso et al. 2016, Williams et al. 2016). Under such an approach, if adopted by CDFW, there would be no need to differentiate between above- and below-barrier populations of rainbow trout. Rather, the term "coastal rainbow trout" would simply apply to fish that are resident upstream of natural barriers and in lakes and reservoirs with no access to the ocean. Rainbow trout in anadromous waters could be managed as a unit, albeit with significant ESA-listing implications, based on the new information on genetics and life history interactions.

New References:

Davis, K. 2016. Pers. comm. Aquatic Biologist and consultant, Sacramento, CA.

Abadia-Cardoso, A. et al. 2016. "Population Genetic Structure and Ancestry of Steelhead/Rainbow Trout (*Oncorhynchus mykiss*) at the Extreme Southern Edge of their Range in North America." *Conservation Genetics* 17(3): 675-689.

California Hatchery Scientific Review Group (CHSRG). 2012. *California Hatchery Review Report*. Prepared for the US Fish and Wildlife Service and Pacific States Marine Fisheries Commission. June 2012. 100 p.

Courter, I. et al. 2013. "Resident Rainbow Trout Produce Anadromous Offspring in a Large Interior Watershed." *Canadian Journal of Fisheries and Aquatic Sciences* 70: 701-710.

Grossman, G. 2016. "Predation on Fishes in the Sacramento–San Joaquin Delta: Current Knowledge and Future Directions." *San Francisco Estuary and Watershed Science* 14(2): 1-23.

Jacobson, S., et al. 2014. "Genetic Analysis of Trout (*Oncorhynchus mykiss*) in Southern California Coastal Rivers and Streams." Final Report for California Department of Fish and Wildlife, Fisheries Restoration Grant Program; Project No. 0950015.

Jensen, D. et al. 2009. “Impact of Fine Sediment on Egg-To-Fry Survival of Pacific Salmon: A Meta-Analysis of Published Studies.” *Reviews in Fisheries Science* 17(3): 348–359.

Kiernan, J., and P. Moyle. 2012. “Flows, droughts, and aliens: factors affecting the fish assemblage in a Sierra Nevada, California, stream.” *Ecological Applications* 22:1146-1161.

National Marine Fisheries Service (NMFS). 2016. “Steelhead Trout *(Oncorhynchus mykiss)*.” Web: http://www.fisheries.noaa.gov/pr/species/fish/steelhead-trout.html. Accessed 12/2/2016.

Pearse, D. and C. Garza. 2015. “You Can't Unscramble an Egg: Population Genetic Structure of *Oncorhynchus mykiss* in the California Central Valley Inferred from Combined Microsatellite and Single Nucleotide Polymorphism Data.” *San Francisco Estuary and Watershed Science* 13(4): 1-17.

Power, M. “The Thirsty Eel: Summer and Winter Flow Thresholds That Tilt the Eel River of Northwestern California from Salmon-Supporting to Cyanobacterially Degraded States.” *Copeia* 103.1 (2015): 200-11.

Robinson, M. et al. 2008. “Fulton’s Body Condition Factor *K* Correlates with Survival Time in a Thermal Challenge Experiment in Juvenile Lahontan Cutthroat Trout (*Oncorhynchus clarki henshawi*).” *Journal of Thermal Biology* 33: 363-368.

Sloat, M. and A.M. Osterback. 2013. “Maximum stream temperature and the occurrence, abundance, and behavior of steelhead trout (*Oncorhynchus mykiss*) in a southern California stream.” *Canadian Journal of Fisheries and Aquatic Sciences* 70: 64-73.

Williams, T. et al. 2016. “Viability Assessment for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Southwest.” U.S. Department of Commerce, *NOAA Technical Memorandum NMFS-SWFSC-564*. 170pp. Web: http://www.westcoast.fisheries.noaa.gov/publications/status_reviews/salmon_steelhead/2016/tech_memo_esa_salmon_steelhead_viaibility-swfsc.pdf. Accessed 12/15/2016.