The primary stressor categories presented in the NMFS recovery plan (2014) were not necessarily considered to be an exhaustive list of stressors. However, the list contains the major threats and stressors to listed fish. Definitions with *"italics"* are taken directly from the Threats Assessment. Others were defined from text within the threats assessment, or as indicated from CWF effects analysis.

1. *"Passage Impediments/Barriers"* were considered to be threats affecting both the adult immigration and staging, and the spawning life stages, because the impediments/barriers may physically block access to historic staging and spawning habitats. As a consequence, they also eliminate the spatial segregation of spawning habitat that historically existed for spring-run and fall-run Chinook salmon.

2. *"Harvest/Angling Impacts"* include recreational and commercial harvest in the ocean, Bay-Delta, and river systems, as well as incidental impacts of anglers physically disturbing incubating embryos while wading through the river.

3. Water Temperature – see CWF description

4. Water Quality – see CWF description

5. *"Flow Conditions"* includes flow dependent habitat availability in-river systems and the anthropogenically altered hydrology in the Delta. For example, the CVP and SWP have resulted in changing the Delta from a tidally driven saline-estuarine-freshwater system to one that is primarily fresh water. Additionally, the C.W. Jones (formerly Tracy) and the Harvey O. Banks pumping plants affect Delta flow conditions in several ways including: (1) by creating reverse flow conditions in Old and Middle Rivers; (2) by effectively pulling Sacramento River water down into the central Delta.

6. Loss of Riparian Habitat and Instream Cover – refers to channelized rearing/migratory corridor for flood control measures. Channelization involves rip-rapping the river bank and removing vegetation along the bank and upper levees which removes most instream and overhead cover in nearshore areas. Woody debris and overhanging vegetation within SRA habitat provide escape cover for juvenile salmonids from predators. Aquatic and terrestrial insects are an important component of juvenile salmon diet. These insects are dependent on a healthy riparian habitat.

7. *"Loss of Natural River Morphology and Function"* is the result of river channelization and confinement, which leads to a decrease in riverine habitat complexity, and thus, a decrease in the quantity and quality of juvenile rearing habitat. Additionally, this primary stressor category includes the effect that dams have on the aquatic invertebrate species composition and distribution, which may have an effect on the quality and quantity of food resources available to juvenile salmonids. For example, in a natural river system without one or more large dams, there is an upstream source of lotic aquatic invertebrate species available to juvenile salmonids, whereas on a river with a large terminal dam, the upstream drift of food resources to juvenile salmonids is drastically altered.

8. Loss of Floodplain Habitat – within the Central Valley, the process of channelizing the rivers and Delta has resulted in a loss of connectivity with the floodplains which serves as an important source of woody debris and gravels that aid in establishing a diverse riverine habitat, as well as providing juvenile salmonid rearing habitat.

9. Loss of Tidal Marsh Habitat (this stressor needed for ROConLTO?)
Reclamation of land at the edge of the Bay-Delta filled in or altered 85 to 95 percent of the wetlands in the Bay-Delta (SFEP 1999). In San Francisco Bay, remaining tidal marshes are located in isolated pockets or in linear strips along sloughs or bay-front dikes. The largest marshes in the Bay-Delta are in Suisun Bay, along the Petaluma, Sonoma, and Napa rivers, and along the northern shore of San Pablo Bay (NMFS 1997).
The importance of marsh habitat to juvenile Chinook salmon in the Bay-Delta is unclear. Some Chinook salmon have been collected in tidal marsh areas near Liberty Island and Little Holland Tract (NMFS 1997), but data supporting that juvenile Chinook salmon extensively rely on tidal marsh habitat in the Bay-Delta for rearing do not exist or at least have not been published. However, research in the Pacific Northwest has demonstrated that tidal marsh habitat is important to the growth and survival of juvenile Chinook salmon (Bottom *et al.* 2005; Levy and Northcote 1981). The benefits of tidal marshes to juvenile Chinook salmon include the availability of rich feeding habitat, refugia from predators, and increasing the overall productivity of tidal habitats. The lack of tidal marsh habitat in the Bay-Delta, relative to estuaries in the Pacific Northwest, may partially explain why juvenile Chinook salmon produced in the Central Valley spend little time rearing in the Bays and Delta, and exhibit slow growth and decreased condition while there (MacFarlane and Norton 2002).
The need to restore tidal marsh habitats in the Bay-Delta has been recognized. The first attempt to prescribe restoration needs for the entire Bay-Delta was in 1993, when the Governor and the U.S. Environmental Protection Agency (EPA) approved the Comprehensive Conservation and Management Plan for the Bay-Delta (San Francisco Estuary Project Website). Three North American Wetland Conservation Act grants totaling nearly $3 million have been allocated for wetland conservation actions in Suisun Marsh and in the Yolo and Delta basins. For a comprehensive list of wetland restoration projects that have been implemented around the San Francisco Bay, see the database and maps available at the Wetlands and Water Resources web site, www.swampthing.org (SFEP and CALFED 2006).

10. The *"Spawning Habitat Availability"* category was considered to include the quantity and quality of spawning habitat currently accessible to the fish, whereas, as previously mentioned, the loss of access to historic spawning habitat was considered in the "Passage Impediments/Barriers" category.

11. Physical Habitat Alteration (e.g., lack of instream gravel supply, watershed disturbance)
The construction of dams and resultant controlled flows and extensive gravel mining affect spawning habitat. Chinook salmon require clean loose gravel from 0.75 to 4.0 inches in diameter for successful spawning (NMFS 1997). The construction of dams in the upper Sacramento River has eliminated the major source of suitable gravel recruitment to reaches of the river below Keswick Dam. Gravel sources from the banks of the river and floodplain have also been substantially reduced by levee and bank protection measures.

12. The “Invasive Species/Food Web Changes” category included the potential effects of native (i.e., microsystis) and non-native (e.g., Asian clam, *A. aspera*) species on the quantity and quality of food available to juvenile salmonids in the Bay-Delta system.

13. Entrainment
Unscreened water diversions entrain outmigrating juvenile fish and fry. (RP has descriptions of Delta/CVP/SWP)

14. Predation
Predation is a threat to listed salmonids, especially in the Delta where there are high densities of non-native fish (e.g., small and large mouth bass, striped bass, catfish, and sculpin) that prey on outmigrating salmonids. The presence of man-made structures in the environment that alter natural conditions likely also contributes to increased predation by altering the predator-prey dynamics often favoring predatory species. In the ocean, and even the Delta environment, salmonids are common prey for harbor seals and sea lions.

15. Hatchery Effects
The *“Hatchery Effects”* primary stressor category was considered a threat to the spawning and the juvenile rearing and outmigration life stages. The spawning life stage is affected due to the potential for hatchery-origin salmon to compete with naturally-origin for spawning habitat, and due to the potential for reduced genetic integrity when hatchery-origin salmon spawn with natural-origin salmon. The juvenile rearing and outmigration life stage is affected due to competition between hatchery- and natural-origin for habitat and food, and due to predation by yearling-sized or larger steelhead released from hatcheries on young-of-year Chinook salmon.