habitat for juvenile Chinook salmon and steelhead migration within the estuarine region of the Delta.

5.4.1.3.3 BDCP Effects on Essential Fish Habitat for Pacific Salmon

The Bay-Delta system has been identified as Essential Fish Habitat (EFH) under the Magnuson-Stevens Act for several groups of fish species including Pacific salmon, Coastal Pelagic Species, and West Coast Groundfish. EFH includes those waters and substrate necessary for fish production needed to support a long-term sustainable fishery and contributions to a healthy ecosystem. The BDCP effects analysis included an assessment of EFH for Pacific salmon which includes winter-run, spring-run, fall-run, and late fall-run Chinook salmon from all Central Valley river systems.

The BDCP conservation measures and operations will result in localized temporary effects on EFH. These effects would be reduced through implementation of BMPs during construction and other actions. The BDCP actions would result in small changes in local habitat conditions in some areas of the upstream rivers and Delta, but would also result in improvements in aquatic habitat conditions through changes in local hydrodynamics such as reductions in Old and Middle River reverse flows and significant expansion of aquatic habitat within a variety of regions distributed throughout the Delta and within Suisun Marsh. Operations will not result in substantial or detectable changes in habitat conditions for EFH species inhabiting regions of the Bay-Delta downstream of Suisun Bay. Based on these factors, it was concluded that implementation of BDCP will not result in adverse effects to EFH that would impact Chinook salmon at a population level. Instead, many of the proposed conservation actions will contribute to enhanced EFH conditions within the Delta.

5.4.1.3.4 BDCP Effects on Salmonid Population Viability

The long-term recovery of Central Valley Chinook salmon and steelhead is measured by four fundamental viable salmonid population (VSP) criteria as described in the NMFS (2009) draft Central Valley salmonid recovery plan and Lindley et al. (2007):

- Population abundance (population size) as reflected in the numbers of adult Chinook salmon and steelhead returning to Central Valley rivers to spawn;
- Population growth rates (productivity) as reflected in survival rates for each life stage and increasing population abundance trends (positive cohort replacement);
- Population spatial structure (habitat and population distribution) as reflected in the geographic distribution of suitable habitat, habitat heterogeneity and complexity, abundance of juvenile smolts produced in different watersheds, and dispersal of distinct population segments among watersheds; and
- Diversity (variation in behavioral and genetic traits) as reflected in diversity and complexity of habitat types, reduced percentage of hatchery produced Chinook salmon

and steelhead, variation in life history and run timing, and access to suitable upstream spawning and rearing habitat and migration pathways.

Additional considerations include reducing and avoiding threats and stressors on the populations associated with actions such as changes in instream flows, water diversion effects, increased vulnerability to predation, and other factors.

Results of the BDCP effects analysis indicate that changes predicted to occur as a direct result of implementation of the conservation strategy are consistent with the principles of recovery planning for Central Valley salmonids. The BDCP conservation actions will contribute to recovery for salmonids because they will result in the following:

Restoration of habitat will increase abundance, growth rate, spatial structure, and diversity. The BDCP will contribute to increased abundance of Central Valley Chinook salmon and steelhead through protection and enhancement of suitable habitat conditions such as instream flows and water temperatures within the upstream spawning and juvenile rearing habitats, as well as contribute to increased geographically distributed and complex juvenile rearing habitat within the Delta. Increased access to expanded seasonal floodplain, tidal wetlands, and improved channel margin habitat will contribute to increased juvenile growth and survival, thereby improving survival and contributing to increased adult abundance. Long term implementation of BDCP conservation measures will reduce the adverse effects of a number of current stressors and improve juvenile and adult Chinook salmon and steelhead survival that will result in improved population growth rates (a greater probability of maintaining positive cohort replacement) over a wide range of hydrologic and environmental conditions that occur within the Central Valley.

Salmonid independent populations. Conservation measures included as part of BDCP would not result in the expansion of winter-run or spring-run Chinook salmon or Central Valley steelhead populations into additional upstream habitats or result in the formation of additional independent spawning populations. Habitat conditions and water operations within the Sacramento River and Delta, however, would be complementary to the formation of additional winter-run or spring-run Chinook salmon or steelhead populations within the Central Valley if that should occur in the future.

Reduction in SWP/CVP losses will increase survival. While entrainment in the south Delta SWP and CVP project facilities has never been determined to have a population level effect, reduced entrainment would provide some increases in survival thereby benefiting the species. Reduction in south Delta SWP and CVP exports through dual facility operations would contribute to: (1) increased juvenile winter-run and fall-run Chinook salmon and steelhead survival through a reduction in losses resulting from reductions in south Delta SWP and CVP export operations; (2) increased juvenile rearing habitat and survival, particularly for juvenile Chinook salmon and steelhead produced in the San Joaquin, Mokelumne, and Consumes river watersheds as a result of reductions in Old and Middle river reverse flows and associated increases in net downstream flows through the Delta; and (3) reduced risk of indirect mortality

for juvenile salmonids migrating through the Delta and improvements in net downstream flows through the Delta channels. Actions such as expanded closure times of the Delta Cross Channel gates and installation and operation of non-physical barriers at key locations (Georgiana Slough, head of Old River) will further contribute to increased juvenile survival, improved attraction, and reduced straying for adult Chinook salmon and steelhead returning to the San Joaquin River system and east side tributaries.

5.4.1.3.5 Overall Conclusions for Chinook Salmon and Steelhead

The following overall conclusions were made based on the results of the effects analysis for Chinook salmon and steelhead.

Net Beneficial Effects on San Joaquin River Salmonids. Steelhead, fall-run Chinook, and future re-introduced spring-run Chinook salmon runs in the San Joaquin River Basin would benefit from BDCP implementation by a reduction in south Delta exports and the associated reduced risk of entrainment at the export facilities, reduction in the magnitude of Old and Middle rivers reverse flows and improvement in the net downstream flow of water from the San Joaquin River through the Delta. Reduction in potential indirect effects on the survival of juvenile salmonids. Expansion of aquatic habitat in the south Delta in the LLT and habitat expansion in the west Delta and Suisun Marsh in the ELT and LLT will provide opportunities for juvenile salmonids emigrating from the San Joaquin River system to rear and contribute to increased juvenile growth rates and survival. BDCP would have no effect on instream flows, water temperatures, or other habitat conditions within the mainstem San Joaquin River or its tributaries relative to existing biological conditions. Increased flow from the San Joaquin River passing through the Delta will improve adult salmonid attraction and olfactory cues and contribute to improved survival of emigrating juveniles. Application of a non-physical barrier at the head of Old River and the effects of reductions in other stressors would contribute to the cumulative benefits of BDCP conservation measures on the growth, survival, and abundance of San Joaquin River salmonids.

Net Beneficial Effects on Mokelumne and Cosumnes River Salmonids. Steelhead and fall-run Chinook runs in the Mokelumne and Cosumnes rivers would benefit under BDCP by a reduction in south Delta exports and the associated risk of entrainment at the export facilities, reduction in the magnitude of Old and Middle River reverse flows and improvement in the net downstream flow of water from the Mokelumne and Cosumnes rivers through the Delta. Expansion of aquatic habitat in the lower reaches of the Mokelumne and Cosumnes rivers and habitat expansion in the west Delta and Suisun Marsh would provide opportunities for juvenile salmonids emigrating from the Mokelumne and Cosumnes rivers to rear and contribute to increased juvenile growth rates and survival. BDCP would have no effect on instream flows, water temperatures, or other habitat conditions within either the Mokelumne or Cosumnes rivers relative to existing biological conditions. Closure of the Delta Cross Channel gates during the fall would potentially improve attraction to the Mokelumne and Cosumnes rivers and reduce straying to other Central Valley rivers. The effects of reductions in other stressors would

contribute to the cumulative benefits of BDCP conservation measures on the growth, survival, and abundance of steelhead and fall-run Chinook salmon produced in the two rivers.

Net Beneficial Effects on Sacramento River Salmonids. Steelhead, winter-run, spring-run, fall-run and late fall-run Chinook runs in the Sacramento River Basin would benefit from BDCP implementation by a reduction in south Delta exports and the associated risk of entrainment at the export facilities. Diversions from the north Delta would make use of state-of-the-art positive barrier fish screens designed and operated to avoid entrainment and impingement of juvenile salmonids. An increased risk of predation associated with the north Delta intake structures was identified in the effects analysis, but can be substantially reduced by intake re-design in combination with predator management. Reduction in the magnitude of Old and Middle rivers reverse flows and improvement in Delta habitat available for juvenile salmonid rearing will provide an improvement in hydrologic conditions affecting habitat and survival of juvenile salmonids in the central and south Delta. Reduction in reverse flows and reductions in south Delta exports results in a reduction in potential indirect effects on the survival of juvenile salmonids. Expansion of aquatic habitat in the north Delta through substantial increases in the frequency and duration of access to expanded seasonal floodplain rearing habitat within the Yolo Bypass, that is interconnected to substantially increased tidal habitat within the Cache Slough complex, will increase juvenile growth and survival, contribute to increased habitat diversity and complexity, and provide opportunities for expanded diversity of life history characteristics. In combination, these changes would result in greater juvenile survival and increased adult salmonid abundance. Habitat expansion in the west Delta and Suisun Marsh would provide opportunities for juvenile salmonids emigrating from the Sacramento River and its tributaries to rear and contribute to increased juvenile growth rates and survival. BDCP would have no effect on instream flows, water temperatures, or other habitat conditions in many of the Sacramento River tributaries. Relatively small beneficial and adverse changes in upstream habitat within the mainstem Sacramento River and Feather River were identified. Refinements in Shasta Reservoir operations may help reduce a projected increase in spring-run Chinook salmon egg mortality in wetter years in the mainstem Sacramento River. Reduced flows in the lower reach of the Sacramento River downstream of the north Delta intakes in wetter years may affect adult salmonid attraction and juvenile survival, however, the potential for adverse effects within the tidal reach of the river are uncertain. Installation of a non-physical barrier at Georgiana Slough and the effects of reductions in other stressors would contribute to the cumulative benefits of BDCP conservation measures on the growth, survival, and abundance of Sacramento River salmonids.

Contribution to Recovery. [**Note to Reviewers:** The Steering Committee has not completed discussion on the sufficiency of the BDCP to contribute to recovery of covered species] BDCP conservation measures are consistent with and complementary to salmonid recovery within the Central Valley as identified in the NMFS draft recovery plan (NMFS 2009). BDCP conservation measures would not result in the establishment of new independent salmonid populations within the Central Valley. Habitat conditions and water operations within the Sacramento River and Delta would, however, be complementary to the formation of additional winter-run or spring-run Chinook salmon or steelhead populations within the Central Valley if that should occur in the