BUREAU OF RECLAMATION

Long-Term Operation – Biological Assessment

Chapter 13 – Conclusion

October 2024

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Contents

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Chapter 13 Conclusion

Population and critical habitat analyses are included in this Biological Assessment to assist U.S. Fish and Wildlife and National Marine Fisheries Service in making the determination of whether the Proposed Action would reasonably be expected to jeopardize the continued existence of a listed species--i.e., "directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species[,]" or result in the destruction or adverse modification of the critical habitat of such species. 50 C.F.R. § 402.02; 16 U.S.C. § 1536(a)(2). Three possible determinations exist regarding a Proposed Action's effects on listed species:

- No effect - "No effect" is the appropriate conclusion when it is determined that the Proposed Action will not affect a listed species or designated critical habitat.
- "May affect, but is not likely to adversely affect" is the appropriate conclusion when effects on listed species or critical habitat are expected to be discountable (extremely unlikely to occur), insignificant (never resulting in take), or completely beneficial (positive effects without adverse effects).
- May affect, likely to adversely affect is the appropriate conclusion if any adverse effect may occur to listed species or critical habitat as a direct result of the Proposed Action, and the effect is not discountable, insignificant, or beneficial. If incidental take is anticipated to occur as a result of the Proposed Action, an "is likely to adversely affect" determination is made.

This chapter presents a summary of the effects for listed species and their designated critical habitat.

13.1 Sacramento River Winter-run Chinook salmon

The Proposed Action may affect, and is likely to adversely affect, Sacramento River winter-run Chinook salmon. The Proposed Action is also likely to have some beneficial effects on Sacramento River winter-run Chinook salmon.

By deconstructing the seasonal operations of the Proposed Action, Reclamation and California Department of Water Resources (DWR) systematically evaluated each stressor identified by the SAIL conceptual models. Stressors not linked to the Proposed Action were identified as "are not anticipated to change." Stressors influenced by the Proposed Action in an insignificant or discountable manner were documented. Stressors exacerbated by the Proposed Action that are anticipated to result in incidental take of winter-run Chinook salmon are summarized below and the Proposed Action includes conservation measures.

13.1.1 Shasta and Sacramento Division

The Proposed Action may affect the stressors described below on winter-run Chinook salmon in the Shasta and Sacramento Division resulting in potential adverse effects.

13.1.1.1 Holding and Spawning Adults

The Proposed Action is expected to have a beneficial effect on winter-run Chinook salmon adult holding and spawning through a reduction of water temperatures achieved by releasing water from Trinity and Shasta reservoirs and increasing flows below Keswick Dam, in compliance with water right terms and conditions. Additionally, the Proposed Action is expected to decrease the pathogens and disease stressor as cooler waters diminish the occurrence of pathogen virulence.

The Proposed Action is expected to incidentally take spawning adult winter-run Chinook salmon by:

1. Resulting in occasionally and temporarily unsuitable water temperatures for holding and spawning adults in the Sacramento River by operating the Shasta Temperature Control Device (TCD). Although the Proposed Action generally may result in beneficial effects on winter-run Chinook salmon adults by aiming to provide suitable water temperatures, Reclamation may operate the TCD to release warmer water temperatures to preserve water for egg incubation later in the year, and those water temperatures may not be colder than would occur without the Proposed Action.

   An exception to the Proposed Action providing benefits related to water temperature is a warmwater bypass action taken as part of the drought toolkit. This action is assumed to occur only when the coldwater pool volume is limited, preventing water temperature management for egg incubation. Warmer temperatures may result in pre-spawning mortality of female winter-run Chinook salmon.

Because of the ongoing nature of the Proposed Action, the effects of operations for water temperature management under the Proposed Action cannot be separated from the environmental baseline. Therefore, Reclamation and DWR are requesting incidental take coverage for water temperature management as a whole, without attempting to parse out the specific effects of the Proposed Action. HEC-5Q modeling can identify when water temperatures in the upper Sacramento River may cause pre-spawning mortality.

13.1.1.2 Eggs and Larvae

The Proposed Action is expected to have a beneficial effect on winter-run Chinook salmon eggs and larvae through increasing redd quality. The Proposed Action will increase surface flows that may improve dissolved oxygen levels and reduce sedimentation. The Proposed Action is also expected to have a beneficial effect on winter-run Chinook salmon eggs and larvae through generally decreasing water temperatures. Conversely, the Proposed Action is also expected to sporadically increase water temperature as described below.

The Proposed Action is expected to incidentally take winter-run Chinook salmon eggs by:

1. Resulting in redd dewatering from storing water and a reduction of flows in the Sacramento River. Redd Dewatering curves identify relevant changes in flow.

2. Resulting occasionally and temporarily in unsuitable water temperatures for eggs and larvae in the Sacramento River by operating the Shasta TCD. Although the Proposed Action generally may result in beneficial effects on winter-run Chinook salmon eggs by aiming to provide suitable water temperatures, managing water temperatures as part of the Proposed Action consist of tradeoffs that may result in temperature dependent mortality of incubating eggs by blending water from Shasta Dam with water from Trinity Reservoir.

Because of the ongoing nature of the Proposed Action, the effects of operations under the Proposed Action cannot be separated from the environmental baseline. Therefore, Reclamation and DWR are requesting incidental take coverage for water temperature management as a whole, without attempting to parse out the specific effects of the Proposed Action. The Anderson and Martin models identify temperature dependent mortality.

13.1.1.3 Rearing and Outmigrating Juveniles

The Proposed Action is expected to incidentally take winter-run Chinook salmon rearing and outmigrating juveniles by:

1. Increasing stranding by storing water, and thus, decreasing flows on the Sacramento River. Winter-run Chinook salmon rearing and outmigrating juveniles can then become stranded in habitat disconnected from the main channel.

2. Masking the outmigration cues during the rearing and outmigration period by storing water and reducing flows on the Sacramento River. Masking the outmigration cues, in turn, reduces winter-run Chinook salmon travel rates. Incidental take of winter-run Chinook salmon impacted by changes to outmigration cues are quantified using the XT and flow-survival threshold models.

3. Decreasing refuge habitat from storing water and a reduction in flows that, in turn, reduce suitable margin and off-channel habitat available in the Sacramento River.

4. Decreasing quality and quantity of food for rearing and outmigrating winter-run Chinook salmon by storing water and a reduction in the Sacramento River flows. The decrease in quality and quantity of food may impact growth rates and have sub-lethal physiological effects on individuals.

13.1.2 Delta Division

The Proposed Action may affect the following stressors on juvenile rearing and outmigrating winter-run Chinook salmon in the Delta Division resulting in potential adverse effects.

13.1.2.1 Rearing and Outmigrating Juveniles

The Proposed Action is expected to incidentally take winter-run Chinook salmon rearing and outmigrating juveniles by:

1. Entraining rearing and outmigrating juveniles in the Sacramento–San Joaquin Delta (Delta) fish collection facilities by diversion of flow in the Delta through exports, and also by influencing fish to migrate away from the Sacramento River mainstem and be routed into the central and south Delta. Incidental take of winter-run Chinook salmon entrained into the central and south Delta can be quantified by zone of influence (ZOI) and ecological particle tracking model (ECO-PTM) analyses. Incidental take of winter-run Chinook salmon entrained in the Delta fish collection facilities can be quantified using salvage density model, negative binomial salvage model, and the machine learning salvage model.

13.1.3 Life Cycle Analyses

The Proposed Action is expected to result in incidental take of winter-run Chinook salmon. Winter-run Chinook salmon face a number of stressors in their current environment, including habitat loss, climate change and extreme vulnerability to catastrophic events. Once the effects of the Proposed Action are isolated from baseline conditions that include ongoing effects from construction of the Central Valley Project (CVP) and State Water Project (SWP) facilities and other non-discretionary activities, most effects on winter-run Chinook salmon associated with the Proposed Action in the Sacramento River upstream of the Delta are beneficial.

Modeling the Proposed Action's effect on the population growth rate of winter-run Chinook salmon demonstrates that the population can experience positive and negative population growth rates when evaluated based on water year type. Over the twenty-year simulation period, winter-run Chinook salmon population growth rate increased in wet and dry water years, and decreased in critically dry and above normal years. This suggests hydrologic influences, which broadly drive water year type, affect winter-run Chinook salmon population growth rates and operations may be able to provide some stability during some water year types.

13.1.4 Summary

The Proposed Action provides cold water for pre-spawning, spawning, and incubation conditions for winter-run Chinook salmon. The Proposed Action would improve flows and water temperatures for spawning, rearing, and migration of winter-run Chinook salmon. The Proposed Action would have higher flows during summer, when flow is generally low and potentially limiting winter-run Chinook salmon holding and spawning success. Cooler water temperatures may diminish stress on adults taxed from upstream migration and spawning. Moreover, occurrence of pathogen virulence is diminished in cooler waters. Additionally, the Proposed Action would allow for higher fall flows, leading to less dewatering, more food and more rearing habitat and cover. Water temperatures under the Proposed Action provide benefits to rearing juvenile winter-run Chinook salmon in the upper Sacramento River. During the juvenile rearing and outmigration period, the Proposed Action will release water from Shasta Reservoir resulting in cooler water temperatures with higher dissolved oxygen saturation potential in the Sacramento River below Keswick Dam. Cooler water temperatures may reduce overall harm to juveniles spending time in the Sacramento River preparing for outmigration, particularly early in the

outmigration season. During most of the juvenile rearing and outmigration period, the Proposed Action will result in Sacramento River water temperatures within or cooler than optimum growth range below Red Bluff Diversion Dam and in Clear Creek above the confluence with the Sacramento River. Spring pulse flows under the Proposed Action would trigger outmigrating juveniles and adults migrating upstream in late spring and provide benefits to multiple life stages.

Despite the beneficial effects associated with the Proposed Action, the Proposed Action is expected to result in incidental take of winter-run Chinook salmon, as described above and in Chapter 5, ,*Winter-Run Chinook Salmon*. The Proposed Action provides for key operational measures to minimize salvage and other effects related to exports including Old and Middle River (OMR) management. In addition, the Proposed Action includes water temperature management that serves as a conservation measure to ameliorate stressors in the environmental baseline.

13.2 Critical Habitat for Sacramento River Winter-run Chinook Salmon

The Proposed Action may affect and is likely to adversely affect critical habitat for winter-run Chinook salmon by changing river flow, spawning substrate, water temperature, food availability and quality, and riparian habitat. The Proposed Action will not alter or destroy constituent elements of the critical habitat to the extent that the survival and recovery of winter-run Chinook salmon would be appreciably reduced.

The PCEs for the winter-run Chinook salmon critical habitat include: access from the Pacific Ocean to appropriate spawning areas; clean gravel for spawning substrate; river flows for spawning, incubation, fry development and emergence, and downstream transport of juveniles; water temperatures between 42.5 and 57.5°F for spawning, incubation, and fry development; habitat and adequate prey that are not contaminated; riparian habitat for juvenile development and survival; and access downstream for juvenile migration to San Francisco Bay and the Pacific Ocean. For an explanation of the specific components of each PCE see Chapter 5.

The Proposed Action is not anticipated to affect adult winter-run Chinook salmon migration from the Pacific Ocean to appropriate spawning areas.

The Proposed Action may affect clean gravel for spawning substrate. Under the Central Valley Project Improvement Act (CVPIA), separate from this consultation, Reclamation has undertaken gravel augmentation projects to improve spawning habitat at key locations below Keswick Dam.

The Proposed Action may affect river flows for spawning, incubation, fry development and emergence, and downstream transport of juveniles, as well as access downstream for juvenile migration. Implementation of the Coldwater Pool Management action, the Fall and Winter Refill and Redd Maintenance action, and ramping rates minimize the risk of adverse effects of flow on the spawning through fry emergence life stages. The risk of entrainment through the Delta is reduced and minimized through the implementation of Old and Middle River export restrictions

and reductions during specific time frames, in response to specific abiotic factors and associated with the salvage of winter-run Chinook salmon.

The Proposed Action may affect water temperatures. Implementation of the Coldwater Pool Management action minimizes the risk of adverse effects of Shasta Dam operations to winter-run Chinook salmon eggs and fry.

The Proposed Action is expected to have an insignificant effect on contaminants but may affect food quality and quantity in the Sacramento River. The Proposed Action will store water which may decrease habitat from a reduction in flows that, in turn, reduce suitable margin and off-channel habitat available in the Sacramento River. Implementation of restoration projects along the Sacramento River are intended to improve shallow water habitats for rearing and migrating Chinook salmon.

13.3 Central Valley Spring-run Chinook Salmon

The Proposed Action may affect, and is likely to adversely affect, Central Valley (CV) spring-run Chinook salmon. The Proposed Action is also likely to have some beneficial effects on CV spring-run Chinook salmon.

By deconstructing the seasonal operations of the Proposed Action, Reclamation and DWR systematically evaluated each stressor identified by the SAIL conceptual model (Windell et al. 2017) that describes life stages and geographic locations for winter-run Chinook salmon, and has been adapted for spring-run Chinook salmon. Stressors not linked to the Proposed Action were identified as "are not anticipated to change." Stressors influenced by the Proposed Action in an insignificant or discountable manner were documented. Stressors exacerbated by the Proposed Action that are anticipated to result in incidental take of spring-run Chinook salmon are summarized below and the Proposed Action includes conservation measures.

13.3.1 Shasta and Sacramento Division

The Proposed Action may affect the stressors described below, resulting in potential adverse effects on spring-run Chinook salmon in the Shasta and Sacramento Division

13.3.1.1 Adult Holding and Spawning

The Proposed Action is expected to have a beneficial effect on spring-run Chinook salmon adult holding and spawning through a reduction of water temperatures achieved by releasing water from Shasta Reservoir and increasing flows below Keswick Dam. In turn, the Proposed Action is expected to have a beneficial effect on spring-run Chinook salmon holding and spawning by reducing pathogen virulence, which is diminished in cooler waters.

The Proposed Action is expected to incidentally take adult holding and spawning spring-run Chinook salmon through:

1. Reducing suitable spawning habitat by releasing water from Shasta Reservoir thereby increasing flows below Keswick Dam. Habitat suitability curves show higher flows reduce areas of spawning habitat quantity and quality.

13.3.1.2 Egg Incubation and Fry Emergence

The Proposed Action is expected to have a beneficial effect on spring-run Chinook salmon egg incubation and fry emergence through an increase in redd quality achieved by releasing water from Shasta Reservoir resulting in higher flows in the Sacramento River below Keswick Dam during the Fall. Higher flows coincide with the timing that eggs are generally incubating between September and November. Increased surface flows are likely to increase hyporheic flows that improve dissolved oxygen and additionally may reduce sedimentation improving egg and alevin essential functions and development.

The Proposed Action is expected to incidentally take incubating egg and emerging fry spring-run Chinook salmon through:

1. Increasing redd dewatering by releasing water from Shasta Reservoir resulting in higher flows in the Sacramento River below Keswick Dam, and then later storing water in Shasta Reservoir resulting in lower flows in the Sacramento River below Keswick Dam. Late spawned spring-run Chinook salmon redds at higher elevations in the Sacramento River that are occupied with incubating eggs may be dewatered when flows decrease from fall to winter.

2. Exacerbating water temperatures due to blending water from Shasta Reservoir and importing water from Trinity Reservoir to manage water temperatures below Keswick Dam as spring-run Chinook salmon eggs require cool water temperature to incubate and develop.

13.3.1.3 Juvenile Rearing and Outmigration

The Proposed Action is expected to incidentally take rearing and outmigrating juvenile spring-run Chinook salmon through:

1. Masking the outmigration cues during the rearing and outmigration period by storing water and reducing flows on the Sacramento River for the purpose of water temperature management, storage rebuilding, rice decomposition smoothing, and redd dewatering avoidance actions. Masking the outmigration cues may affect spring-run Chinook salmon outmigration behavior and travel times increasing their exposure to predators and poor environmental conditions.

2. Decreasing refuge habitat from storing water and a reduction in flows that, in turn, reduce suitable margin and off-channel habitat available in the Sacramento River.

3. Decreasing quality and quantity of food for rearing and outmigrating spring-run Chinook salmon by storing water and a reduction in the Sacramento River flows. The decrease in quality and quantity of food may impact growth rates and have sub-lethal physiological effects on individuals.

4. Increasing stranding by storing water, and thus, decreasing flows on the Sacramento River. Spring-run Chinook salmon juveniles can then become stranded in habitat disconnected from the main channel.

13.3.1.4 Yearling Outmigration

The Proposed Action is expected to incidentally take outmigrating yearling spring-run Chinook salmon through:

1. Masking the outmigration cues during the rearing and outmigration period by storing water and reducing flows on the Sacramento River. Masking the outmigration cues may affect spring-run Chinook salmon outmigration behavior and travel times increasing their exposure to predators and poor environmental conditions.

2. Increasing stranding by storing water, and thus, decreasing flows on the Sacramento River. Spring-run Chinook salmon juveniles can then become stranded in habitat disconnected from the main channel.

3. Decreasing refuge habitat from storing water and a reduction in flows that, in turn, reduce suitable margin and off-channel habitat available in the Sacramento River.

4. Decreasing quality and quantity of food for outmigrating yearling spring-run Chinook salmon by storing water and reducing Sacramento River flows. The decrease in quality and quantity of food may impact growth rates and have sub-lethal physiological effects on individuals.

13.3.2 Trinity River Division (Clear Creek)

The Proposed Action may affect the stressors described below, resulting in potential adverse effects on spring-run Chinook salmon in Clear Creek, a tributary of the upper Sacramento River authorized as part of the Trinity River Division of the CVP.

13.3.2.1 Adult Holding and Spawning

The Proposed Action is expected to have a beneficial effect on spring-run Chinook salmon adult holding and spawning through a reduction of water temperatures achieved by releasing water from Trinity Reservoir and increasing flows below Whiskeytown Dam, in compliance with water right terms and conditions. In turn, the Proposed Action is expected to have a beneficial effect on spring-run Chinook salmon holding and spawning by reducing pathogen virulence, which is diminished in cooler waters.

The Proposed Action is expected to incidentally take spawning adult spring-run Chinook salmon in Clear Creek through:

1. Reducing suitable spawning habitat by releasing water from Trinity Reservoirs and increasing flows below Whiskeytown Dam. Habitat suitability curves show higher flows reduce areas of spawning habitat quantity and quality.

13.3.2.2 Egg Incubation and Fry Emergence

The Proposed Action is expected to have a beneficial effect on spring-run Chinook salmon egg incubation and fry emergence through an increase in redd quality achieved by releasing water from Trinity Reservoir in the fall, in compliance with water right terms and conditions. Higher

flows coincide with the timing that eggs are generally incubating between September and November. Increased surface flows are likely to increase hyporheic flows that improve dissolved oxygen and additionally may reduce sedimentation improving egg and alevin essential functions and development.

The Proposed Action is expected to incidentally take incubating egg and emerging fry spring-run Chinook salmon through:

1. Increasing redd dewatering by releasing water from Trinity Reservoir, resulting in higher flows in Clear Creek in the Fall, and then later storing water in Trinity Reservoir resulting in lower flows in Clear Creek. Late spawned spring-run Chinook salmon redds at higher elevation that are occupied with incubating eggs may be dewatered when flows decrease from fall to winter.

2. Exacerbating water temperatures due to release and blending water from Whiskeytown Reservoir and importing water from Trinity Reservoir to contribute to management of water temperatures in Clear Creek, as spring-run Chinook salmon eggs in Clear Creek require cool water temperature for incubation and development.

13.3.2.3 Juvenile Rearing and Outmigration

The Proposed Action is expected to incidentally take rearing and outmigrating juvenile spring-run Chinook salmon through:

1. Masking the outmigration cues during the rearing and outmigration period by reducing flows in Clear Creek due to storage of water in Whiskeytown Reservoir, particularly in the winter. Masking the outmigration cues may affect spring-run Chinook salmon outmigration behavior and travel times increasing their exposure to predators and poor environmental conditions.

2. Decreasing refuge habitat from storing water and a reduction in Clear Creek flows.

3. Decreasing quality and quantity of food for rearing and outmigrating spring-run Chinook salmon by a reduction in Clear Creek flows from the storage of water. The decrease in quality and quantity of food may impact growth rates and have sub-lethal physiological effects on individuals.

4. Increasing stranding from seasonal operations of the CVP first increasing, then decreasing, flows on Clear Creek. Reducing releases and storing water reduces flows. In turn, juveniles can become stranded in habitat disconnected from the main channel.

13.3.2.4 Yearling Rearing

The Proposed Action is expected to have a beneficial effect on spring-run Chinook salmon rearing yearlings in Clear Creek due to decreases in stranding by storing water and decreasing flows in the spring and releasing water and increasing flows in the summer. Reducing releases by storing water contributes to more stable flows resulting in reduced risk of yearlings becoming

stranded in habitat disconnected from the main channel. Additionally, the Proposed Action may have a beneficial effect by reducing Clear Creek water temperatures during the summer, when flows are increased. Spring-run Chinook salmon require cool water temperature for optimal growth, and cooler water temperatures may reduce overall harm to yearlings spending time in Clear Creek before outmigrating through the Sacramento River and the Delta.

The Proposed Action is expected to incidentally take rearing yearling spring-run Chinook salmon through:

1. Decreasing refuge habitat from storing water and a reduction in Clear Creek flows.

2. Decreasing quality and quantity of food for yearling spring-run Chinook salmon by a reduction in Clear Creek flows from the storage of water. The decrease in quality and quantity of food may impact growth rates and have sub-lethal physiological effects on individuals.

13.3.3 Delta Division

The Proposed Action may affect the stressors described below on spring-run Chinook salmon in the Delta Division resulting in potential adverse effects.

13.3.3.1 Juvenile Rearing and Outmigration

The Proposed Action is expected to incidentally take rearing and outmigrating juvenile spring-run Chinook salmon through:

1. Entraining rearing and outmigrating juveniles by decreasing flows in the Delta through storage of water and diversion in exports, and also by steering fish to be routed into the central and south Delta. Once in the central and south Delta, entrainment into the Jones and Banks pumping plants may occur.

13.3.3.2 Yearling Outmigration

The Proposed Action is expected to incidentally take rearing yearling spring-run Chinook salmon through:

1. Entraining yearling outmigrating juveniles by altering the hydrodynamic conditions in the Delta through storage of water and diversion in exports, and also by steering fish into the central and south Delta. Once in the central and south Delta, entrainment into the Jones and Banks pumping plants may occur.

13.3.4 Life Cycle Analyses

The Proposed Action is expected to result in incidental take of CV spring-run Chinook salmon. Spring-run Chinook salmon face a number of stressors in their current environment, including habitat loss and climate change. Once the effects of the Proposed Action are isolated from baseline conditions that include ongoing effects from construction of the CVP and SWP facilities and other non-discretionary activities, most effects on spring-run Chinook salmon associated with the Proposed Action are beneficial.

Modeling the Proposed Action's effect on the population growth rate of spring-run Chinook salmon demonstrates that the population can experience positive and negative population growth rates when evaluated based on water year type. Over the twenty-year simulation period, winter-run Chinook salmon population growth rate increased in wet, above normal, and dry water years, and decreased in dry years. This suggests hydrologic influences, which broadly drive water year type, affect spring-run Chinook salmon population growth rates and operations may be able to provide some stability during some water year types.

13.3.5 Summary

The Proposed Action would improve flows and water temperatures for spawning and incubation in the upper and middle Sacramento River along with Clear Creek. The Proposed Action also provides adequate flows for rearing and migration of juveniles in the middle Sacramento River through the Delta out to the ocean. Higher flows in some years under the Proposed Action benefit adult spring-run Chinook Salmon migrating in the middle Sacramento River and holding in the upper river by enhancing water quality and upstream passage, and reducing stranding, straying, poaching, and disease risks.

Despite the beneficial effects associated with the Proposed Action, the Proposed Action is expected to result in incidental take of spring-run Chinook salmon, as described above and in Chapter 6,*Spring-RunR Chinook Salmon*. The Proposed Action provides for key operational measures to minimize salvage and other effects related to exports, including: (1) a spring pulse flows under the Proposed Action that would trigger outmigrating juveniles and adults migrating upstream in late spring and provide benefits to multiple life stages; (2) a flow program in Clear Creek; and (3) a fall water temperature management component in Shasta Reservoir.

13.4 Critical Habitat for Central Valley Spring-run Chinook Salmon

The Proposed Action may affect, and is likely to adversely affect critical habitat for CV Spring-run Chinook Salmon by changing river flow, water temperature, food availability and quality, entrainment risk, and spawning and rearing habitat. The Proposed Action will not alter or destroy physical and biological features of the critical habitat to the extent that the survival and recovery of spring-run Chinook salmon would be appreciably reduced.

The physical and biological features for spring-run Chinook salmon critical habitat are freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, estuarine areas, nearshore marine areas, and offshore marine areas. For an explanation of the specific components of each PCE see Chapter 6.

The Proposed Action is expected to have an adverse effect on freshwater spawning sites due to increased flows and water temperature modifications in the Sacramento River and Clear Creek. Decreased flows due to storage of water in Shasta Reservoir and water temperature management may increase redd stranding and dewatering during part of the egg incubation and fry emergence period; except for redd quality which is expected to be beneficial due to increased releases in the fall.

The Proposed Action will result in adverse effects on freshwater rearing sites as the storage and release of water may increase in the spring and decrease in the summer the refuge habitat and food availability and quality stressors. The decreased flows in the spring due to storage may reduce suitable margin and off-channel habitats available and may modify food web processes and cause a decrease in quality food available. During the summer increased flows are expected to be beneficial for refuge habitat and food availability and quality.

The Proposed Action will result in adverse effects on freshwater migration corridors for the juvenile and yearling life stage as the proposed diversion of water alters hydrodynamic conditions in the Sacramento River and Delta which may influence fish travel time and migration routing in the Sacramento River mainstem and the central and south Delta. Once in the central and south Delta, entrainment into the Jones and Banks pumping plants may occur. This entrainment can result in indirect mortality by routing fish into areas of poor survival (increased predation, reduced habitat quality) or direct mortality during salvage in the Delta fish collection facilities. For the adult life stage, there are no water quality, water quantity, water temperature, or water velocity related stressors that are anticipated to adversely affect adult migration.

The Proposed Action will result in adverse effects on estuarine areas as a result increased outmigration, refuge habitat, and food availability and quality stressors. Masking the outmigration cues during the juvenile rearing and outmigration and yearling outmigration due to decreased flows in the Sacramento River and Delta outflow. Masking the outmigration cues may affect spring-run Chinook salmon outmigration behavior and travel times increasing their exposure to predators and poor environmental conditions. The refuge habitat stressor is also anticipated to increase due to reduced flows which may decrease suitable margin and off-channel habitats available as refuge habitat for migrating juveniles and yearlings in both the Sacramento River and the Delta. Food availability and quality may also be affected due to reduced flows in the Sacrament River and Delta outflow. Decreases in the quality and quantity of food for foraging juvenile and yearling spring-run Chinook salmon will impact growth rates and can sometimes lead to extremes such as starvation and alter behavior resulting in predation risk.

The Proposed Action does not include components that will affect nearshore or offshore marine areas.

The Proposed Action is not anticipated to affect the structural components of physical habitat.

13.5 Central Valley Steelhead

The Proposed Action may affect, and is likely to adversely affect, steelhead. The Proposed Action is also likely to have some beneficial effects on steelhead.

By deconstructing the seasonal operations of the Proposed Action, Reclamation and DWR systematically evaluated each stressor identified by the SAIL conceptual models that describes life stages and geographic locations for winter-run Chinook salmon, and has been adapted for steelhead and its life stages. Stressors not linked to the Proposed Action were identified as “are not anticipated to change.” Stressors influenced by the Proposed Action in an insignificant or discountable manner were documented. Stressors ameliorated meaningfully by the Proposed

Action and stressors exacerbated by the Proposed Action that are anticipated to result in incidental take of steelhead are summarized below. Only life stages of steelhead that presented stressors materially affected by the Proposed Action are described. Chapter 7,*Steelhead*, takes a more comprehensive approach to describing changes to stressors in all life stages of steelhead, including kelt rearing and outmigration.

13.5.1 Shasta and Sacramento Division

The Proposed Action may affect the stressors described below resulting in potential adverse effects on steelhead in the Shasta and Sacramento Division.

13.5.1.1 Adult Migration and Holding

The Proposed Action is expected to incidentally take migrating and holding adult steelhead through:

1. Exacerbating water temperatures by storing water and reducing flows below Keswick Dam, thereby increasing water temperatures. HEC-5Q modeling can identify when water temperatures in the upper Sacramento River may cause pre-spawning mortality of steelhead.

2. Increasing pathogens and disease from decreased flows and increased water temperature, which may increase pathogen concentration and horizontal transmission, while increasing water temperature may increase pathogen virulence.

13.5.1.2 Adult Spawning

The Proposed Action is expected to have a beneficial effect on steelhead spawning through increasing the available spawning habitat in the Sacramento River. Increasing the available spawning habitat in the Sacramento River may assist in preventing redd superimposition that exposes previously deposited eggs to damage and predation.

The Proposed Action is expected to incidentally take spawning adult steelhead through:

1. Exacerbating water temperatures by storing water and reducing flows below Keswick Dam and increasing water temperatures. HEC-5Q modeling can identify when water temperatures in the upper Sacramento River may cause pre-spawning mortality of steelhead.

2. Intensifying pathogens and disease from decreased flows and increased water temperature, thereby increasing pathogen concentration and horizontal transmission, and also by increasing pathogen virulence.

13.5.1.3 Kelt Emigration

The Proposed Action, while maintenance of Shasta Reservoir storage may increase the stressor in the winter and spring, it is expected to have an insignificant impact on the water temperature stressor for kelt emigration. In the summer, releases of storage are expected to increase flows which may decrease the stressor.

The Proposed Action is expected to incidentally take steelhead kelt rearing and emigrating through:

1. Exacerbating water temperatures by storing water and reducing flows below Keswick Dam and increasing water temperatures.

2. Intensifying pathogens and disease from decreased flows and increased water temperature, thereby increasing pathogen concentration, horizontal transmission, and pathogen virulence.

13.5.1.4 Egg Incubation and Fry Emergence

The Proposed Action is expected to incidentally take steelhead in the Sacramento River during egg incubation and fry emergence through:

1. Exacerbating water temperatures by storing water and reducing flows below Keswick Dam, thereby increasing water temperatures.

2. Intensifying pathogens and disease from decreased flows and increased water temperature, thereby increasing pathogen concentration and horizontal transmission, and also by increasing pathogen virulence.

3. Increasing redd dewatering by storing water and decreasing flows below Keswick Dam.

13.5.1.5 Juvenile Rearing and Outmigration

The Proposed Action is expected to incidentally take juvenile steelhead rearing and outmigrating through:

1. Exacerbating water temperatures by storing water and reducing flows below Keswick Dam.

2. Intensifying pathogens and disease from decreased flows and increased water temperature, thereby increasing pathogen concentration, horizontal transmission, and pathogen virulence.

3. Decreasing emigration cue by storing water and decreasing flows below Keswick Dam.

4. Increasing stranding by storing water and decreasing flows below Keswick Dam.

5. Decreasing refuge habitat from storing water and a reduction in Sacramento River flows.

6. Decreasing quality and quantity of food for foraging juvenile steelhead by a reduction in flow from the storage of water. The decrease in quality and quantity of food may impact growth rates and have sub-lethal physiological effects on individuals.

13.5.2 Clear Creek

The Proposed Action may exacerbate the stressors described below resulting in potential adverse effects on steelhead in Clear Creek.

13.5.2.1 Adult Migration and Holding

The Proposed Action is expected to incidentally take migrating and holding adult steelhead through:

1. Exacerbating water temperature stressors due to seasonal operations in Clear Creek. HEC-5Q modeling can identify when water temperatures in Clear Creek may cause pre-spawning mortality of steelhead.

2. Intensifying pathogens and disease from decreased flows and increased water temperature, thereby increasing pathogen concentration, horizontal transmission, and pathogen virulence.

13.5.2.2 Adult Spawning

The Proposed Action is expected to have a beneficial effect on steelhead in Clear Creek throughout their spawning season due to a decrease in pathogens and disease resulting from a reduction in water temperatures. The Proposed Action also would have a beneficial effect from increasing the available spawning habitat in Clear Creek; thus, reducing the potential for redd superimposition.

13.5.2.3 Kelt Emigration

The Proposed Action, while maintenance of Whiskeytown storage may increase the stressor in the winter and spring, is expected to have an insignificant impact on the water temperature stressor for kelt emigration. In the summer, releases of storage are expected to increase flows which may decrease the stressor.

The Proposed Action is expected to incidentally take steelhead kelt rearing and emigrating through:

2. Exacerbating water temperatures due to blending water from Shasta Reservoir and importing water from Trinity Reservoir to manage temperatures below Keswick Dam.

2. Intensifying pathogens and disease from decreased flows and increased water temperature, thereby increasing pathogen concentration, horizontal transmission, and pathogen virulence.

13.5.2.4 Egg Incubation and Fry Emergence

The Proposed Action is expected to have a beneficial effect on steelhead egg incubation and fry emergence in Clear Creek as stranding and redd dewatering is decreased from a lower rate of flow reductions.

The Proposed Action is expected to incidentally take steelhead during egg incubation and fry emergence through:

1. Exacerbating water temperatures due to blending water from Shasta Reservoir and importing water from Trinity Reservoir to manage temperatures below Keswick Dam, as steelhead eggs in Clear Creek require cool water temperature to incubate and develop.

13.5.2.5 Juvenile Rearing and Outmigration

The Proposed Action is expected to have a beneficial effect on steelhead juvenile rearing and outmigration in Clear Creek by reducing water temperatures. During the steelhead juvenile rearing and outmigration period in Clear Creek, historic water temperatures have been below the preferred threshold for juvenile growth. The Proposed Action also is expected to have a beneficial effect on steelhead juvenile rearing and outmigration by increasing the quantity and quality of food from an increase in flows resulting in an increase in inundated habitat, food availability and quality.

The Proposed Action is expected to incidentally take juvenile steelhead rearing and outmigrating through:

1. Intensifying pathogens and disease from maintenance of storage from Whiskeytown Reservoir resulting in decreased Clear Creek flows and increased water temperature; thus increasing pathogen concentration, horizontal transmission, and pathogen virulence

2. Altering steelhead outmigration rhythms due to increased water temperatures on Clear Creek making them more susceptible to predation

3. Decreasing refuge habitat from a reduction in flows in Clear Creek

4. Increasing stranding due to changes in flows

13.5.3 American River

The Proposed Action may affect the stressors described below resulting in potential adverse effects on steelhead in the lower American River.

13.5.3.1 Adult Migration and Holding

The Proposed Action is expected to have a beneficial effect on steelhead adult migration and holding through a reduction of water temperatures achieved by releasing water from Folsom Reservoir and increasing flows below Nimbus Dam.

The Proposed Action is expected to incidentally take migrating and holding adult steelhead in the American River by:

1. Resulting in occasionally and temporarily unsuitable water temperatures for migration and holding adult steelhead in the lower American River. Although the Proposed Action generally may result in beneficial effects on steelhead adults by

aiming to provide suitable water temperatures, Reclamation may operate the Folsom Dam shutters to release warmer water temperatures to preserve water for egg incubation later in the year and those temperatures may not be colder than would occur without the Proposed Action.

2. Intensifying pathogens and disease from maintenance of storage at Folsom Reservoir resulting in decreased lower American River flows and increased water temperature, thereby increasing pathogen concentration, horizontal transmission, and increasing pathogen virulence.

Because of the ongoing nature of the Proposed Action, the effects of operations for water management under the Proposed Action cannot be separated from the environmental baseline. Therefore, Reclamation is requesting incidental take coverage for water temperature management as a whole, without attempting to parse out the specific effects of the Proposed Action. HEC-5Q modeling can identify when water temperatures in the lower American River may cause pre-spawning mortality.

13.5.3.2 Adult Spawning

The Proposed Action is expected to have a beneficial effect on steelhead spawning in the American River through increasing the available spawning habitat on the American River. Increasing the available spawning habitat on the American River may minimize redd superimposition. In addition, the Proposed Action is expected to have a beneficial effect on steelhead spawning through a reduction of water temperatures achieved by releasing water from Folsom Reservoir and increasing flows below Nimbus Dam.

The Proposed Action is expected to incidentally take spawning adult steelhead through:

1. Resulting in occasionally and temporarily unsuitable water temperatures for steelhead spawning in the lower American River, especially towards the tail end of the spawning period. Although the Proposed Action generally may result in beneficial effects on steelhead adults by aiming to provide suitable water temperatures, Reclamation may operate the Folsom Dam shutters to release warmer water temperatures to preserve water for egg incubation later in the year and those temperatures may not be colder than would occur without the Proposed Action.

2. Intensifying pathogens and disease from maintenance of storage in Folsom Reservoir resulting in decreased lower American River flows and increased water temperature, thereby increasing pathogen concentration and horizontal transmission, and also by increasing pathogen virulence.

Because of the ongoing nature of the Proposed Action, the effects of operations for water management under the Proposed Action cannot be separated from the environmental baseline. Therefore, Reclamation is requesting incidental take coverage for water temperature management as a whole, without attempting to parse out the specific effects of the Proposed Action. HEC-5Q modeling can identify when water temperatures in the lower American River may cause pre-spawning mortality.

13.5.3.3 Kelt Emigration

The Proposed Action is expected to result in warmer water temperatures in the spring which may impair emigration or become too energetically taxing for kelts if water temperatures reach the threshold. The water temperature stressor is expected to be beneficial in the American River in the summer. Cooler water temperatures may reduce overall harm to kelts emigrating back to the ocean.

The Proposed Action is expected to incidentally take steelhead kelt rearing and emigrating through:

1. Exacerbating water temperatures by storing water and reducing flows below Nimbus Dam and increasing water temperatures.

2. Intensifying pathogens and disease from storing water and decreased flows and increased water temperature, thereby increasing pathogen concentration, horizontal transmission, and pathogen virulence.

13.5.3.4 Egg Incubation and Fry Emergence

The Proposed Action is expected to have a beneficial effect on steelhead egg incubating in the American River through increasing the available spawning habitat on the American River. Increasing the available spawning habitat on the American River may minimize redd superimposition. In addition, the Proposed Action is expected to have a beneficial effect on steelhead egg incubation and fry emergence through a reduction of water temperatures achieved by releasing water from Folsom Reservoir and increasing flows below Nimbus Dam. The Proposed Action is also anticipated to result in a beneficial effect on steelhead egg incubation and fry emergence by including a redd dewatering adjustment.

The Proposed Action is expected to incidentally take steelhead during egg incubation and fry emergence by:

1. Resulting in occasionally and temporarily unsuitable water temperatures for steelhead egg incubation and fry emergence in the lower American River, especially towards the tail end of the spawning period. Although the Proposed Action generally may result in beneficial effects on steelhead eggs and fry by aiming to provide suitable water temperatures, Reclamation may operate the Folsom Dam shutters to balance water temperatures during all of the life stages of steelhead present in the lower American River.

   Because of the ongoing nature of the Proposed Action, the effects of operations for water management under the Proposed Action cannot be separated from the environmental baseline. Therefore, Reclamation is requesting incidental take coverage for water temperature management as a whole, without attempting to parse out the specific effects of the Proposed Action.

2. Intensifying pathogens and disease from maintenance of storage in Folsom Reservoir resulting in decreased lower American River flows and increased water

temperature, thereby increasing pathogen concentration, horizontal transmission and pathogen virulence.

3. Occasionally resulting in redd dewatering by increasing the rate of flow reduction, particularly early in the steelhead egg incubation and fry emergence period.

13.5.3.5 Juvenile Rearing and Outmigration

The Proposed Action is expected to incidentally take juvenile steelhead rearing and outmigrating through:

1. Exacerbating water temperatures by storing water and diverting water reducing flows below Folsom Dam.

2. Intensifying pathogens and disease from decreased flows and increased water temperature, thereby increasing pathogen concentration, horizontal transmission, and pathogen virulence.

3. Decrease emigration cue by storing water and diverting water resulting in decreasing flows below Folsom Dam.

4. Increasing stranding by decreasing flows below Folsom Dam.

5. Decreasing refuge habitat from a storing and diverting water resulting in a reduction in American River flows.

6. Decreasing quality and quantity of food for foraging juvenile steelhead by a reduction in flow from the storage of water. The decrease in quality and quantity of food may impact growth rates and have sub-lethal physiological effects on individuals.

13.5.4 Delta

The Proposed Action may affect the stressors described below resulting in potential adverse effects on steelhead in the Delta Division.

13.5.4.1 Juvenile Rearing and Migration

The Proposed Action is expected to incidentally take juvenile rearing and migrating steelhead in the Delta through:

1. Entraining rearing and outmigrating juveniles by altering the hydrodynamic conditions in the Delta through storing water and diversion through exports and also by steering fish into the central and south Delta. Once in the central and south Delta, entrainment into the Jones and Banks pumping plants may occur.

13.5.5 Stanislaus River

The Proposed Action may affect the stressors described below resulting in potential adverse effects on steelhead in the Stanislaus River.

13.5.5.1 Adult Migration and Holding

The Proposed Action is expected to have a beneficial effect on steelhead adult migration and holding through a reduction of water temperatures achieved by releasing water from New Melones Reservoirs and increasing flows below Goodwin Dam. In addition, the Proposed Action is expected to have a beneficial effect on steelhead migration and holding by decreasing the pathogens and disease stressor as cooler waters diminish the occurrence of pathogen virulence.

The Proposed Action is expected to incidentally take migrating and holding adult steelhead in the Stanislaus River by:

1. Resulting in occasional and temporary unsuitable water temperatures for steelhead spawning in the Stanislaus River. Although the Proposed Action generally may result in beneficial effects on steelhead adult migration and holding by aiming to provide suitable water temperatures, managing water temperatures as part of the Proposed Action results in tradeoffs that may result in pre-spawning mortality.

   Because of the ongoing nature of the Proposed Action, the effects of operations under the Proposed Action cannot be separated from the environmental baseline. Therefore, Reclamation is requesting incidental take coverage for water temperature management as a whole, without attempting to parse out the specific effects of the Proposed Action.

13.5.5.2 Adult Spawning

The Proposed Action is expected to have a beneficial effect on steelhead adult spawning through a reduction of water temperatures achieved by releasing water from New Melones reservoirs and increasing flows below Goodwin Dam. Historical data suggests water temperatures have been above the threshold for successful spawning in the Stanislaus River towards the tail ends of the spawning period.

The Proposed Action is expected to incidentally take spawning adult steelhead by:

1. Resulting in occasional and temporary unsuitable water temperatures for steelhead spawning in the Stanislaus River. Although the Proposed Action generally may result in beneficial effects on steelhead adult spawning by aiming to provide suitable water temperatures, managing water temperatures as part of the Proposed Action results in tradeoffs that may result in pre-spawning mortality.

   Because of the ongoing nature of the Proposed Action, the effects of operations under the Proposed Action cannot be separated from the environmental baseline. Therefore, Reclamation is requesting incidental take coverage for water temperature management as a whole, without attempting to parse out the specific effects of the Proposed Action.

13.5.5.3 Kelt Emigration

The Proposed Action is expected to have a beneficial effect on steelhead kelts in the Stanislaus River in the summer by reducing water temperatures. Cooler water temperatures may reduce overall harm to kelts emigrating back to the ocean. While maintenance of New Melones storage

may increase the stressor in the winter and spring, it is expected to have an insignificant impact on the water temperature stressor for kelt emigration.

The Proposed Action is expected to incidentally take steelhead kelt rearing and emigrating through:

1. Exacerbating water temperatures by operations of New Melones Dam from storing water and decreasing flows.

2. Intensifying pathogens and disease from decreased flows and increased water temperature, thereby increasing pathogen concentration, horizontal transmission, and pathogen virulence.

13.5.5.4 Egg Incubation and Fry Emergence

The Proposed Action is expected to have a beneficial effect on steelhead egg incubation and fry emergence through a reduction of water temperatures achieved by releasing water from New Melones reservoirs and increasing flows below Goodwin Dam.

The Proposed Action is expected to incidentally take steelhead eggs and fry during egg incubation and fry emergence through:

1. Resulting in occasional and temporary unsuitable water temperatures for steelhead egg incubation and fry emergence in the Stanislaus River. Although the Proposed Action generally may result in beneficial effects on incubating eggs and emergent fry by aiming to provide suitable water temperatures, managing water temperatures as part of the Proposed Action results in tradeoffs that may result in mortality.

   Because of the ongoing nature of the Proposed Action, the effects of operations under the Proposed Action cannot be separated from the environmental baseline. Therefore, Reclamation is requesting incidental take coverage for water temperature management as a whole, without attempting to parse out the specific effects of the Proposed Action.

13.5.5.5 Juvenile Rearing and Outmigration

The Proposed Action is expected to increase flows in the summer and fall seasons. This increase in flows during the summer and fall will have a beneficial effect on the steelhead juvenile rearing and outmigration dissolved oxygen stressor, pathogen and disease stressor, stranding risk stressor, refuge habitat stressor and the food availability and quality stressor. The beneficial decreases in these stressors are a result of the increased water flows and lower temperature that is being released from New Melones Reservoir in the applicable months. See Chapter 7, Section 7.2.5, *Juvenile Rearing and Outmigration*, for a detailed breakdown of the individual stressors identified in this section.

The Proposed Action is expected to incidentally take steelhead juveniles during the juvenile rearing and outmigration through:

1. Increasing the dissolved oxygen stressor though the reduction in flows in winter and spring that may lead to decreases to dissolved oxygen in the Stanislaus River potentially increasing the juvenile steelhead vulnerability to predation and competition.

2. Increase the pathogens and disease stressor due to the reduction in flows in winter and spring which may result in increased disease transfer from hatchery to natural-origin juveniles and decreased immune responses when water temperature is above 60°F in the spring.

3. Increase the outmigration cues stressor through more stable flows that could decrease the prevalence of juvenile steelhead outmigration.

4. Increase the stranding risk stressor in winter and spring as the reduction in flows may result in a reduction in available habitats or result in disconnected pools.

5. Increase the refuge habitat stressor in the winter and spring as the reduction in flows may result in a decrease in available refuge habitat for cover or to stop and hold during outmigration.

6. Increase the food availability and quality stressor in winter and spring as the reduction in flows that will result in less inundated habitats and less food as a result.

13.5.6 San Joaquin River

The Proposed Action may exacerbate the stressors described below resulting in potential adverse effects on steelhead in the San Joaquin River.

13.5.6.1 Adult Migration and Holding

The Proposed Action is expected to have a beneficial effect on steelhead adult migration and holding through a reduction of water temperatures achieved by releasing water from Friant Dam. Historical data suggests water temperatures have been above the thermal limit of 69.8°F for adult steelhead migration and holding throughout this period in the San Joaquin River.

The Proposed Action is expected to incidentally take steelhead during adult migration and holding by:

1. Resulting in occasional and temporary unsuitable water temperatures for steelhead spawning in the San Joaquin River. Although the Proposed Action generally may result in beneficial effects on steelhead adult migration and holding by aiming to provide suitable water temperatures, managing water temperatures as part of the Proposed Action results in tradeoffs that may result in pre-spawning mortality.

   Because of the ongoing nature of the Proposed Action, the effects of operations under the Proposed Action cannot be separated from the environmental baseline. Therefore, Reclamation is requesting incidental take coverage for water

temperature management as a whole, without attempting to parse out the specific effects of the Proposed Action

13.5.7 Life Cycle Analyses

The Proposed Action is expected to result in incidental take of CVV steelhead. Steelhead face a number of stressors in their current environment, including habitat loss and climate change. Once the effects of the Proposed Action are isolated from baseline conditions that include ongoing effects from construction of the CVP and SWP facilities and other non-discretionary activities, most effects on steelhead associated with the Proposed Action are beneficial.

13.5.8 Summary

The Proposed Action provides necessary cold water and flow to ensure adequate conditions for steelhead. The Proposed Action will improve flows and water temperatures for spawning and incubation in the American River, upper and middle Sacramento River along with Clear Creek. Operating the temperature control devices on Shasta and Folsom dams would have beneficial effects under the Proposed Action. With higher reservoir storage and water temperature management actions, suitable water temperatures would be maintained through the primary steelhead spawning and incubation period (January through April).

Despite the beneficial effects associated with the Proposed Action, the Proposed Action is expected to result in incidental take of steelhead, as described above and in Chapter 7. The Proposed Action provides for key operational measures to minimize salvage and other effects related to exports, including water temperature and OMR management.

13.6 Critical Habitat for Central Valley Steelhead

The Proposed Action may affect and is likely to adversely affect critical habitat for CV steelhead by changing river flow, water temperature, food availability and quality, entrainment risk, and spawning and rearing habitat. The Proposed Action will not alter or destroy physical and biological features of the critical habitat to the extent that the survival and recovery of steelhead would be appreciably reduced.

The physical and biological features for steelhead critical habitat are freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and estuarine areas. For an explanation of the specific components of each physical and biological feature see Chapter 7.

The Proposed Action is expected to have an adverse effect on freshwater spawning sites due to flow and water temperature modifications in the Sacramento River, Clear Creek, American River, Stanislaus River and San Joaquin River. Decreased flows due to storage of water and water temperature management may increase redd stranding and dewatering during part of the egg incubation and fry emergence period; except for redd quality which is expected to be beneficial due to increased releases in the fall.

The Proposed Action will result in adverse effects on freshwater rearing sites as the storage and release of water may increase in the spring and decrease in the summer the refuge habitat and

food availability and quality stressors. The decreased flows in the spring due to storage may reduce suitable margin and off-channel habitats available and may modify food web processes and cause a decrease in quality food available. During the summer increased flows are expected to be beneficial for refuge habitat and food availability and quality.

The Proposed Action will result in adverse effects on freshwater migration corridors for the juvenile and yearling life stage as the proposed diversion of water alters hydrodynamic conditions which may influence fish travel time and migration routing in the Sacramento River mainstem and the central and south Delta. Once in the central and south Delta, entrainment into the Jones and Banks pumping plants may occur. This entrainment can result in indirect mortality by routing fish into areas of poor survival (increased predation, reduced habitat quality) or direct mortality during salvage in the Delta fish collection facilities. For the adult life stage, there are no water quality, water quantity, water temperature, or water velocity related stressors that are anticipated to adversely affect adult migration.

13.7 Southern Distinct Population Segment of North American Green Sturgeon

The Proposed Action may affect, and is likely to adversely affect, the sDPS of North American green sturgeon. The Proposed Action is also likely to have some beneficial effects on the sDPS green sturgeon.

By deconstructing the seasonal operations of the Proposed Action, Reclamation and DWR systematically evaluated each stressor identified by the green sturgeon SAIL conceptual model (Heublein et al. 2017b). Stressors not linked to the Proposed Action were identified as "are not anticipated to change." Stressors influenced by the Proposed Action in an insignificant or discountable manner were documented. Stressors in the Proposed Action that are anticipated to result in incidental take of green sturgeon, or that are beneficial, are summarized below, and the Proposed Action includes conservation measures.

13.7.1 Shasta and Sacramento Division

The Proposed Action may result in the beneficial effects for green sturgeon in the Shasta and Sacramento Division.

13.7.1.1 Egg Incubation

The Proposed Action is expected to have a beneficial effect on egg incubation of green sturgeon through the general decrease of water temperatures in the spring and summer months by releasing water from Trinity and Shasta reservoirs, in compliance with water right terms and conditions. The Proposed Action is anticipated to maintain an optimal thermal range during the green sturgeon egg incubation period.

13.7.1.2 Larvae

The Proposed Action is expected to have a beneficial effect on green sturgeon larvae through the general decrease of water temperatures achieved by releasing water from Trinity and Shasta

reservoirs. Increased water temperatures under the Proposed Action that may occur in March are anticipated to be more suitable for larvae, while decreased water temperatures in May fall below thresholds where deformities are observed. Decreased summer water temperatures indicate more suitable temperature thresholds for larvae.

13.7.2 Delta

The Proposed Action may result in potential adverse effects described below for green sturgeon in the Delta.

13.7.2.1 Juveniles

The Proposed Action is expected to incidentally take green sturgeon juveniles by:

1. Entraining rearing and outmigrating juveniles by altering the hydrodynamic conditions in the Delta through storage of water and diversion by exports, and also by steering fish into the central and south Delta. Once in the central and south Delta, entrainment into the Jones and Banks pumping plants may occur.

13.7.3 Life Cycle Analyses

The Proposed Action is expected to result in incidental take of green sturgeon. Green sturgeon face a number of stressors in their current environment, including habitat loss, low reproduction rate and climate change. Once the effects of the Proposed Action are isolated from baseline conditions that include ongoing effects from construction of the CVP and SWP facilities and other non-discretionary activities, most effects on sDPS green sturgeon associated with the Proposed Action are beneficial.

13.7.4 Summary

The Proposed Action provides necessary cold water and flow to ensure adequate conditions for green sturgeon. The Proposed Action will improve flows and water temperatures.

Despite the beneficial effects associated with the Proposed Action, the Proposed Action is expected to result in incidental take of green sturgeon from entrainment, as described above and in Chapter 8, *Green Sturgeon.* The Proposed Action provides for key operational measures to minimize salvage, including OMR management.

13.8 Critical Habitat for Southern Distinct Population Segment of North American Green Sturgeon

The Proposed Action may affect and is not likely to adversely affect critical habitat for green sturgeon. The Proposed Action will not alter or destroy constituent elements of the critical habitat to the extent that the survival and recovery of green sturgeon would be appreciably reduced.

The freshwater riverine systems PCEs for the green sturgeon critical habitat are food resources, substrate type or size, water flow, water quality, migratory corridor, depth, and sediment quality.

For estuarine habitats, the PCEs are food resources, water flow, water quality, migratory corridor, depth and sediment quality. For nearshore coastal marine areas, the PCEs are migratory corridor, water quality, and food resources. For an explanation of the specific components of each PCEs, see Chapter 8.

The Proposed Action is not anticipated to affect the estuarine habitats PCEs of food resources, migratory corridor, and depth, the nearshore coastal marine areas PCEs of migratory corridor, water quality, and food resources, and the freshwater riverine systems PCEs of migratory corridor and depth.

The Proposed Action is expected to have an insignificant effect on the estuarine PCEs of water quality and sediment quality. Reduced flows through the Proposed Action may concentrate contaminants if and when, contaminants are present and increased flows may dilute contaminants. CVP and SWP operations are not a proximate cause of contaminants mobilized from the watershed, agricultural lands, and urban effluent. Water quality monitoring has not shown contaminants at levels likely to affect juveniles and no fish effects have been observed in fish monitoring in the Delta, while adult green sturgeon do not spend a substantial portion of their life foraging in the Bay-Delta (Heublein et al. 2017a).

Dissolved oxygen less than 5.0mg/L may affect migration of other large bodied anadromous fishes (Carter 2005). Reclamation's water quality monitoring has not shown dissolved oxygen at levels below this in the winter, spring, summer, or fall in the Bay Delta.

Increased inflows in September and October and decreased inflows in November, winter months, and spring months from the Proposed Action may alter the amount of brackish habitat in the Delta. Adult green sturgeon are hypothesized to use a broad range of habitats and water quality conditions. A telemetry study in the Delta detected green sturgeon at salinities between 8.8-32.1 ppt, with no specific salinity preferences (Kelly et al. 2007). While exposure of young juveniles (<170 dph) to brackish water can negatively impact growth and survival, growth effects occur at salinities > 10 ppt, and survival effects occur at 20-30 ppt (Allen et al. 2011, Allen and Cech, 2007). Juvenile green sturgeon have a broad tolerance for salinity and are strong enough swimmers to move to acceptable habitat.

The Proposed Action is expected to have an insignificant effect on the estuarine PCE of water flow. The Proposed Action may increase or decrease the *flow* stressor. During the juvenile rearing and outmigration period, the Proposed Action will decrease Delta outflow. Although decreased outflow and increased diversions may change the duration of juvenile residency, juvenile green sturgeon may occupy brackish and freshwater habitats in the Delta for up to one and a half years until they can tolerate seawater (Allen 2005, Poletto et al. 2013). Juveniles may remain in the Delta for up to three years based on capture of fish of this age in fish monitoring surveys and salvage. The long Delta residency of green sturgeon juveniles is unlikely to be influenced by seasonal changes in delta flows.

The Proposed Action is expected to have an insignificant effect on the freshwater riverine systems PCE of food resources. The Proposed Action may increase or decrease the food stressor for larvae and juvenile green sturgeon. During the larval period, releases of Shasta storage may increase flows in the summer. During the spring, the Proposed Action will store and divert water

resulting in decreased flows. Increased flows on the Sacramento River have been observed to decrease prey taxon richness and abundance in diets of early life stage green sturgeon, especially the presence of cyclopoid copepods. Copepod abundance in the Sacramento River has been found to be inversely associated with discharge (Sommer et al. 2004). Green sturgeon larvae smaller than 30mm rely on benthic macroinvertebrates and zooplankton prey with a strong reliance on cyclopoid copepods. However, green sturgeon are also reliant on benthic macroinvertebrates through the larval life stage, including baetid mayflies (*Ephemeroptera baetidae*), chironomids (*Diptera chironomidae*), and simulids (*Diptera simuliidae*). Additionally, larval diet richness increases with total length, widening the prey selection (Zarri and Palkovacs 2018).

During the juvenile rearing and outmigration period, Shasta Reservoir storage may decrease flows in the winter and spring and releases may increase flows in the summer and fall. Changes in water velocities in response to Sacramento River flows have been observed to change benthic macroinvertebrate community composition (Nelson and Lieberman 2002). Zarri and Palkovacs (2019) found that diet richness increases with total length in larval green sturgeon. It can be inferred that juvenile green sturgeon have increased diet richness as they increase in total length. Additionally, juvenile green sturgeon are strong enough swimmers to move into parts of the river that have wider prey availability.

The Proposed Action is expected to have an insignificant effect on the freshwater riverine systems PCE of substrate type or size. During the egg incubation period, the Proposed Action will store and divert water in the spring and decrease flows in the Sacramento River below Keswick Dam. During the summer, the Proposed Action will release water and increase flows in the Sacramento River between Keswick Dam and Bend Bridge. Decreased flows may be occasionally low near Keswick Dam to maintain winter-run Chinook salmon habitat quality, although green sturgeon have only been documented to spawn as far north as the confluence with Cow Creek, south of Clear Creek. Increased flows in the summer may provide environmental conditions favorable to eggs and developing embryos. Flows between 269-396 cubic meters per second are sufficient to maintain clean gravel and reduce the risk of suffocation by sand deposition (Poytress et al. 2015). The Proposed Action results in flows within this range**.**

The Proposed Action is expected to have an insignificant effect on the freshwater riverine systems PCE of water flow. During the adult migration, spawning, and holding period, the Proposed Action will store and divert water in the winter resulting in decreased flows. In the summer, the Proposed Action will release water and increase flows in the Sacramento River below Keswick Dam. Increased flows in the Sacramento River during the summer could affect adult holding and cue riverine outmigration. River discharge is hypothesized to cue “late” outmigrating adult green sturgeon in the winter, meaning lower minimum daily flows in the winter could impact the duration of post spawning holding or timing of adult outmigration. However, adult green sturgeon have been observed in the Sacramento River year round, with some individuals holding in the river for over a year. This behavior indicates the species’ ability to change outmigration strategies based on river discharge patterns (Colborne et al. 2022). If flows decrease in the winter, sturgeon may hold until the following year or be cued based on precipitation rather than managed flows. If flows increase during the summer it may cue sturgeon to outmigrate. It is likely green sturgeon adjust their holding times based on minimum discharge rates regardless of season (Colborne et al. 2022).

During the larval period, the Proposed Action will store and divert water in the spring and decrease flows. During the summer, the Proposed Action will release water and increase flows. Body condition in larval green sturgeon is negatively correlated with discharge (Zarri et al 2019). Larval body condition was positive when discharges at Keswick were less than 8,000 cfs (Zarri et al. 2019). However, flow at the Red Bluff Diversion Dam has been positively correlated with larval abundance (Heublein et al. 2017b). It has been observed that larval green sturgeon can benefit from reduced flows and increased flows. Information on flow and requirements for rearing green sturgeon larvae is limited and not well understood.

The Proposed Action is expected to have an insignificant effect on the freshwater riverine systems PCEs of water quality and sediment quality. During the juvenile rearing and outmigration period, the Proposed Action will release water and increase flows on average in the Sacramento River below Keswick Dam. During the spring, the proposed storage under the Proposed Action in Shasta Reservoir may decrease flows, thereby increasing temperatures. Juvenile green sturgeon growth may increase with increased temperatures and decreased flows. On the other hand, increased releases of Shasta Reservoir storage may decrease temperatures in the summer, and juvenile growth may decrease with lower temperatures and increased flows (Zarri et al. 2019). The combination of higher discharge and lower temperatures appears to reduce larval sturgeon body condition (Zarri et al. 2019)) and may similarly impact juveniles during the summer months. However, rapid growth generally occurs in the juvenile life stage (Heublein et al. 2017a), and juvenile green sturgeon are strong enough swimmers to move to acceptable habitat.

Dissolved oxygen less than 5.0mg/L may affect migration of other large bodied anadromous fishes (Carter 2005). Reclamation's water quality monitoring has not shown dissolved oxygen at levels below this in the winter, spring, summer, or fall in the Sacramento River. Water quality monitoring in the upper Sacramento River has not shown contaminants or dissolved oxygen at levels likely to affect eggs and no fish effects have been observed in Red Bluff Diversion Dam fish monitoring, where juvenile green sturgeon are annually observed. During incubation, the embryos obtain nutrition from the yolk sac, which reduces their exposure to contaminants in prey during this life stage. Very little is known about dissolved oxygen stressors in eggs.

Water quality monitoring has not shown contaminants at levels likely to affect larvae and no fish effects have been observed in fish monitoring. Water quality monitoring has not shown dissolved oxygen at low levels in the spring and summer. Very little is known about dissolved oxygen stressors in larvae.

13.9 Delta Smelt

The Proposed Action may affect, and is likely to adversely affect, Delta smelt.

By deconstructing the seasonal operations of the Proposed Action, Reclamation and DWR systematically evaluated each stressor identified by the Management, Analysis, and Synthesis Team conceptual models. Stressors not linked to the Proposed Action were identified as "are not anticipated to change." Stressors influenced by the Proposed Action in an insignificant or discountable manner were documented. Stressors exacerbated by the Proposed Action that are

anticipated to result in incidental take of Delta smelt are summarized below, and the Proposed Action includes conservation measures.

13.9.1 Delta Division

The Proposed Action may affect the stressors described below resulting in potential adverse effects on Delta smelt.

13.9.1.1 Adult Migration and Spawning

The Proposed Action is expected to incidentally take migrating and spawning adult Delta smelt through:

1. Changing food availability processes by reducing Delta inflows and outflows through the storage and diversion of water. Relevant prey species for Delta smelt adults have a positive correlation with Delta outflows in the spring.

2. Entraining adult Delta smelt by exporting water from the Delta, increasing OMR flows towards the central and south Delta. The exports can entrain Delta smelt adults directly in the diversions or by steering Delta smelt presence in areas with poor survival. Incidental take of Delta smelt entrained can be quantified by the Delta Smelt Life Cycle Model with Entrainment (LCME).

13.9.1.2 Eggs and Larvae

The Proposed Action is expected to incidentally take Delta smelt larvae by:

1. Changing food availability processes by reducing Delta inflows and outflows through the storage and diversion of water. Relevant prey species for Delta smelt larvae have a positive correlation with Delta outflows in the spring.

2. Entraining Delta smelt larvae by exporting water from the Delta, increasing OMR flows towards the central and south Delta. The exports can entrain Delta smelt larvae directly in the diversions or by steering Delta smelt presence in areas with poor survival. Incidental take of Delta smelt entrained can be quantified by the LCME.

13.9.1.3 Juveniles

The Proposed Action is expected to incidentally take Delta smelt juveniles by:

1. Changing food availability processes by reducing Delta inflows and outflows through the storage and diversion of water. Relevant prey species for Delta smelt juveniles have a positive correlation with Delta outflows in the Spring.

2. Entraining Delta smelt juveniles by exporting water from the Delta, increasing OMR flows towards the central and south Delta. Exports can entrain Delta smelt juveniles directly in the diversions or by altering migratory pathways leading to presence in areas with poor survival. Incidental take of Delta smelt entrained can be quantified by the LCME.

3. Decreasing the size and changing the location of the low-salinity zone by storing, diverting, and releasing water.

13.9.2 Life Cycle Analyses

The Proposed Action is expected to result in incidental take of Delta smelt. In addition to the Proposed Action, Delta smelt face a number of stressors in their current environment, including habitat loss, introduced species and climate change.

Modeling the Proposed Action's effect on the population growth rate of Delta smelt demonstrates that the population can experience positive and negative population growth rates depending on water year type and the main mechanisms affecting the population. The Maunder and Deriso in R modelling showed hen population growth rates were separated into wetter (wet/above normal) and drier (below normal/dry/critically dry) year groups the geometric mean of projected λ values remained below 1 for all Proposed Action phases and groups, though in wetter years the values approached 1. Differences between the Proposed Action phases were driven primarily by December-February OMR, with relatively minor influence from June-August outflow. The lack of difference in projected population growth between the Proposed Action phases; therefore, results from the very similar OMR values during this period across each of the CalSim outputs.

The Delta Smelt Life Cycle Model with Entrainment modeling showed that Delta smelt could have positive population growth rates in wet and above normal years. The various phases of the Proposed Action may have produced higher λ during drier years due to the more positive OMR values for multiple months and higher zooplankton estimates in February. Meanwhile, the Proposed Action components may have produced lower λ than the empirical data during wetter years because of the lower June-August Delta Outflow values and more negative OMR values for some months. The Proposed Action phases did not produce higher λ despite OMR restrictions that should reduce entrainment of Delta smelt. This may be due to the apparent trade-off between OMR flow and summer Delta outflow that somehow occurred between Proposed Action phases and the empirical data.

13.9.3 Summary

The Proposed Action effects on Delta smelt are described in further detail in Chapter 9, *Delta Smelt.* The Proposed Action provides for key operational measures to minimize entrainment and other effects related to export including OMR and Suisun Marsh Salinity Gates Management, Tidal Habitat Restoration and a Summer and Fall Habitat Action.

13.10 Critical Habitat for Delta Smelt

The Proposed Action may affect, and is likely to adversely affect, critical habitat for Delta smelt by changing river flow, food availability and quality and salinity. The Proposed Action will not alter or destroy constituent elements of the critical habitat to the extent that the survival and recovery of Delta smelt would be appreciably reduced.

The PCEs for the Delta smelt critical habitat are physical habitat, water quality, river flow and salinity. For an explanation of the specific components of each PCE see Chapter 9.

The Proposed Action is expected to have an insignificant effect on the water quality PCE; except for food availability and quality, which is positively correlated with Delta outflow in the spring. The Proposed Action also will result in an adverse effect on the river flow PCE as the diversion of water that may increase the entrainment risk stressor. The risk of entrainment is reduced and minimized through the implementation of Old and Middle River export restrictions and reductions during specific time frames, in response to specific abiotic factors and associated with the salvage of adult Delta smelt.

The Proposed Action will store and divert water that may result in position of the low-salinity zone being further landward which would reduce the size of the low-salinity zone and thus available habitat for juvenile Delta Smelt. The impact of this stressor is reduced through the implementation of the Delta Smelt Summer and Fall Habitat Action which results in additional Suisun Marsh Salinity Control Gate operation in certain year types to reduce the salinity of portions of the Suisun Marsh.

The Proposed Action is not anticipated to affect the structural components of physical habitat.

13.11 Longfin Smelt

Longfin smelt is proposed for listing under the Endangered Species Act (ESA). Although longfin smelt have not yet been federally listed, Reclamation and DWR are requesting a formal conference be conducted in accordance with the procedures for formal Section 7 consultation (50 CFR 402.10(d)). USFWS is anticipated to develop a Conference Opinion that would be adopted after the species is federally listed. The associated incidental take statement in the Conference Opinion would not become effective until longfin smelt is federally listed and the Conference Opinion adopted.

The Proposed Action may affect, and is likely to adversely affect, longfin smelt.

By deconstructing the seasonal operations of the Proposed Action, Reclamation and DWR systematically evaluated each stressor identified. Stressors influenced by the Proposed Action in an insignificant or discountable manner were documented. Stressors exacerbated by the Proposed Action that are anticipated to result in incidental take of longfin smelt are summarized below and the Proposed Action includes conservation measures.

13.11.1 Delta Division

The Proposed Action may affect the stressors described below resulting in potential adverse effects on longfin smelt in the Delta Division.

13.11.1.1 Adult Holding and Spawning

The Proposed Action is expected to incidentally take adult holding and spawning longfin smelt by:

1. Entraining longfin smelt adults through exporting water from the Delta, thereby increasing OMR flows towards the central and south Delta. The exports can entrain longfin smelt adults directly in the diversions or by steering longfin smelt to areas with poor survival.

2. Changing freshwater flow by exporting water from the Delta, thereby reducing the size and position of the low salinity zone.

3. Changing food availability by reducing Delta inflows and outflows through the storage and diversion of water. Relevant prey species for longfin smelt adults have a positive correlation with Delta outflows in the spring.

13.11.1.2 Juveniles Rearing and Migration

The Proposed Action is expected to incidentally take longfin rearing and migrating juveniles by:

1. Entraining longfin smelt juveniles through exporting water from the Delta, thereby increasing OMR flows towards the central and south Delta. The exports can entrain longfin smelt juveniles directly in the diversions or by steering juveniles to areas with poor survival.

2. Changing freshwater flow by exporting water from the Delta, thereby reducing the size and position of the low salinity zone.

3. Changing food availability and quality by reducing Delta inflows and outflows through the storage and diversion of water. Relevant prey species for longfin smelt juveniles have a positive correlation with Delta outflows in the spring.

13.11.1.3 Eggs and Larvae

The Proposed Action is expected to incidentally take longfin larvae by:

1. Entraining longfin smelt larvae through exporting water from the Delta increasing OMR flows towards the central and south Delta. The exports can entrain longfin smelt larvae directly in the diversions or by steering larvae to areas with poor survival.

2. Decreasing the size and changing the location of the low-salinity zone by storing and diverting water.

3. Changing food availability by reducing Delta inflows and outflows through the storage and diversion of water. Relevant prey species for longfin smelt larvae have a positive correlation with Delta outflows in the spring.

13.11.2 Life Cycle Analyses

The Proposed Action is expected to result in incidental take of longfin smelt. In addition to the Proposed Action, longfin smelt face a number of stressors in their current environment, including habitat loss, introduced species and climate change.

13.11.3 Summary

The Proposed Action effects on longfin smelt are described in further detail in Chapter 10, *Longfin Smelt.* The Proposed Action provides for key operational measures to minimize salvage and other effects related to export including OMR and Suisun Marsh Salinity Gates management, tidal habitat restoration and a Summer and Fall habitat action.

13.12 Southern Resident Distinct Population Segment of Killer Whale

The Proposed Action may affect, but is not likely to adversely affect, southern resident killer whale.

Effects of the Proposed Action to southern resident killer whale are examined within the context of changes to availability of its preferred prey species, Chinook salmon. Reclamation determined that the Proposed Action may affect and is likely to adversely affect CV winter-run and spring-run Chinook salmon. However, the Proposed Action is also likely to have beneficial effects on winter-run and spring-run Chinook salmon from water temperature management. Moreover, CV Chinook salmon make up a small percentage of southern resident killer whale Chinook diet, mainly for K and L pods. This small percentage of southern resident killer whale diet is dominated by hatchery-produced Chinook salmon. The Proposed Action does not have an effect on hatchery production of Chinook salmon. Even if some of these hatchery-produced fish are entrained in the pumping facilities or in areas of poor survival in the Delta, the targets for production hatcheries do not change and may be adjusted through separate processes. Additionally, year to year variability in ocean conditions and the management of ocean harvest exceed the potential changes in the production of natural spawning Chinook salmon.

13.13 Critical Habitat for Southern Resident Killer Whale Distinct Population Segment

The Proposed Action may affect but is not likely to adversely affect critical habitat for southern resident killer whale by impacting a small proportion of prey availability. Critical habitat is not designated in the action area. The Proposed Action will not alter or destroy features of the critical habitat to the extent that the survival and recovery of southern resident killer whale would be appreciably reduced.

The physical and biological features PBFs for southern resident killer whale critical habitat are water quality, prey availability, and passage conditions. For further explanation of the PBFs, see Chapter 11, Killer Whale. The Proposed Action will have no effect on the water quality and passage condition PBFs.

The Proposed Action is likely to have an insignificant effect on prey availability PBF 2. As explained in the previous section, the Proposed Action would only impact naturally occurring

salmon and would not alter hatchery production. Natural-origin CV salmon make up a small proportion of the southern resident killer whale.

13.14 References

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