4.2 Take of Longfin Smelt

Take estimation is based upon the likelihood of physical injury or mortality to individuals of longfin smelt. It is not possible to predict the number of individuals that would be subject to such take; in general, that would be a density-dependent phenomenon, e.g., with more fish subject to take in years when the population was relatively high in the project area. Instead, the risk of take is assessed through proxies such as the area of habitat affected, the duration of impact pile driving, or the probability of a contaminant release. Each section of the take analysis identifies the mechanisms by which take could occur and the probability that take would occur. If that probability is substantial, so that some individuals are likely to suffer mortality, then factors influencing the magnitude of take are detailed; typically these include take minimization measures, as well as the take proxies mentioned above. Mitigation is described (in Chapter 5 *Mitigation*) that is proportionate to the take, so as to show full mitigation for the take. The take analysis considers mechanisms of take for which authorization is needed (such as, conveyance facility construction and operations), as well as mechanisms of take for which authorization is not here requested (such as, maintenance activities or construction of mitigation sites) or is not needed (such as, CVP operations, cumulative effects, or climate change), because all such mechanisms are considered in determining whether the PP[1] is likely to jeopardize longfin smelt.

The potential for the PP to cause take of longfin smelt is evaluated in this section for each of five life stages: migrating adults (December–March), spawning adults (December–March), eggs/embryos (December–April), larvae/young juveniles (January–May), and juveniles (year-round). Please refer to Section 2.2 *Longfin Smelt* for supporting information on geographic distribution, life history, habitat requirements, and species threats to longfin smelt.

4.2.1 Construction Effects

The proposed timing of in-water construction activities within the potential range of longfin smelt (NDD: June 1-October 31; HOR gate and barge landings: August 1-October 31; Clifton Court Forebay and associated facilities: July 1–November 30) will avoid or minimize potential overlap with the occurrence of longfin smelt adults, eggs/embryos, larvae/young juveniles, and juveniles in the project area. Please refer to Section 4.1.1.1 *Preconstruction Studies (Geotechnical Exploration)*, Section 4.1.1.2 *North Delta Diversions*, Section 4.1.1.3 *Barge Landings*, Section 4.1.1.4 *Head of Old River Gate*, and Section 4.1.1.5 *Clifton Court Forebay* for additional information on construction activities for each of the facilities.

4.2.1.1 Preconstruction Studies (Geotechnical Exploration)

Geotechnical exploration in open water at the proposed locations for the water conveyance facilities, including approximately 100 over-water borings, have the potential to affect longfin smelt. Restricting in-water drilling to August 1 to October 31 will avoid periods when longfin smelt may be present in the areas of proposed geotechnical exploration. In addition, a number of take minimization measures will be implemented to avoid or minimize potential turbidity, suspended sediment, and other water quality impacts (e.g., bentonite or contaminant spills) on

[1] The figures presented in this section, as well as those of the other listed fishes, often use the acronym ‘PA’ when referring to the PP. This reflects material originally developed for the biological assessment (ICF International 2016), which used the term “proposed action” (PA), equivalent to the PP.

listed species and aquatic habitat during geotechnical exploration, as described in Section 4.1.1.1 *Preconstruction Studies (Geotechnical Exploration).* Therefore, no effects on longfin smelt are anticipated.

4.2.1.2 North Delta Diversions

Construction of the north Delta diversions (NDDs) is described in Section 4.1.1.2 *North Delta Diversions*. Construction of the NDDs will potentially affect longfin smelt over a period of 5 years, and will permanently affect approximately 500.6 acres of shallow water habitat.

4.2.1.3 Turbidity and Suspended Sediment

As described in Section 4.1.1.2.1 *Turbidity and Suspended Sediment*, NDD construction will disturb riverbed and bank sediments, temporarily increasing turbidity and suspended sediment levels in the Sacramento River. These activities will be restricted to a June 1 through October 31 in-water work window, at which time longfin smelt are least likely to occur in the project area. In addition to limiting activities to the in-water work window, the following take minimization measures will be implemented to avoid or minimize impacts due to increases in turbidity and suspended sediment levels on water quality and direct and indirect affects to listed fish species resulting from sediment-disturbing activities: AMM1 *Worker Awareness Training;* AMM2 *Construction Best Management Practices and Monitoring;* AMM3 *Stormwater Pollution Prevention Plan;* AMM4 *Erosion and Sediment Control Plan;* AMM5 *Spill Prevention, Containment, and Countermeasure Plan;* AMM14 *Hazardous Material Management Plan;* AMM6 *Disposal and Reuse of Spoils, Reusable Tunnel Material, and Dredged Material;* and AMM7 *Barge Operations Plan* (Appendix 3.F *General Avoidance and Minimization Measures*).

Some potential exists for construction-related turbidity and suspended sediment to occur during winter and spring due to increased erosion and mobilization of sediment in runoff from disturbed levee surfaces. However, with implementation of the proposed erosion and sediment control measures (AMM4) and other BMPs to ensure the effectiveness of these measures (AMM2 *Construction Best Management Practices and Monitoring*), no adverse water quality effects are anticipated outside of the in-water construction season.

4.2.1.3.1 Migrating Adults (December–March)

The timing of in-water construction activities (June 1–October 31) will avoid the longfin smelt adult migration season. Therefore, migrating adults will be unaffected by increases in turbidity and suspended sediment during construction of the intake facilities. No take of migrating adults is expected.

4.2.1.3.1.1 Spawning Adults (December–March)

The timing of in-water construction activities (June 1–October 31) will avoid the spawning period of longfin smelt. Therefore, spawning adults will be unaffected by increases in turbidity and suspended sediment during construction of the intake facilities. No take of spawning adults is expected. Similar to Delta Smelt (Section 4.1.1.2.1.2 *Spawning Adults*), modification of potential spawning habitat as a result of sediment deposition is not expected to appreciably affect the availability and quality of existing spawning habitat for longfin smelt because of the low utilization and quality of existing spawning habitat at the intake locations. No population-level effects are expected.

4.2.1.3.1.2 Eggs/Embryos (December–April)

Based on the low likelihood of spawning adults at the intake locations during in-water construction activities, eggs/embryos will likely be unaffected by temporary increases in turbidity and suspended sediment. No take of eggs/embryos is expected. Because modification of potential spawning habitat at the intake sites is not expected to appreciably affect the availability and quality of existing spawning habitat (or distribution of spawning adults), these modifications are unlikely to affect eggs/embryos. No population-level effects are expected.

4.2.1.3.1.3 Larvae/Young Juveniles (January–May)

The timing of in-water construction activities (June 1–October 31) will avoid the primary months when longfin smelt larvae/young juveniles may be present in the project area. Therefore, larvae/young juveniles will likely be unaffected by temporary increases in turbidity and suspended sediment. No take of larvae/young juveniles is expected.

4.2.1.3.1.4 Juveniles (Year-Round)

Juvenile longfin smelt rear downstream of the proposed intake locations and therefore will be unaffected by elevated turbidity and suspended sediment during in-water construction activities. No take of juveniles is expected.

4.2.1.3.2 Contaminants

As described in Section 4.1.1.2.2 *Contaminants*, construction of the NDDs could result in accidental spills of contaminants such as oil, fuel, hydraulic fluids, concrete, and paint that can cause localized water quality degradation and adverse effects on longfin smelt. The risk of such effects is highest during in-water construction activities because of the proximity of construction equipment to the Sacramento River. Contaminants may also enter the aquatic environment through the disturbance, resuspension, or discharge of contaminated soil and sediments from construction sites, resulting in adverse effects on fish that encounter sediment plumes, come into contact with deposited or newly exposed sediment, or consume contaminated food sources.

Because the timing of in-water construction activities will avoid the primary months when longfin smelt may be present in the project area, there is little or no risk of direct exposure of longfin smelt to accidental spills. In addition, implementation of Appendix 3.F *General Avoidance and Minimization Measures,* AMM5 *Spill Prevention, Containment, and Countermeasure Plan* and AMM14 *Hazardous Material Management* will minimize the potential for contaminant spills and guide rapid and effective response in the case of inadvertent spills of hazardous materials throughout the construction period (both during and outside the in-water work window). With implementation of these and other required construction BMPs (e.g., AMM3 *Stormwater Pollution Prevention Plan*), the risk of exposure of longfin smelt to contaminant spills or discharges to the Sacramento River from in-water or upland sources will be minimized.

The potential for introduction of contaminants from disturbed sediments will be addressed through the implementation of specific measures addressing containment, handling, storage, and disposal of contaminated sediments, as described under AMM6 *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material* in Appendix 3.F *General Avoidance and Minimization Measures*. These measures include the preparation and implementation of a pre-construction sampling and analysis plan (SAP) to characterize contaminants and determine appropriate BMPs to minimize or avoid mobilization of contaminated sediments during in-water construction activities. Because potential mobilization of contaminants is closely linked to sediment disturbance and associated increases in turbidity and suspended sediment, turbidity monitoring and control measures (e.g., silt curtains) to achieve compliance with existing Basin Plan objectives will be an important measures for limiting dispersal of contaminated sediments during dredging and other in-water construction activities.

4.2.1.3.2.1 Migrating Adults (December–March)

The timing of in-water construction activities (June 1–October 31) will avoid the longfin smelt adult migration season, minimizing the risk of direct exposure of migrating adults to potential spills and resuspension of contaminated sediments. Some exposure risk will continue to exist during periods outside the in-water work window. With implementation of take minimization measures AMM3 *Stormwater Pollution Prevention Plan;* AMM5 *Spill Prevention, Containment, and Countermeasure Plan;* AMM6 *Disposal and Reuse of Spoils, Reusable Tunnel Material, and Dredged Material;* and AMM14 *Hazardous Materials Management* (Appendix 3.F *General Avoidance and Minimization Measures*), the potential for take of migrating adults to contaminants will be minimized. No population-level effects are expected.

4.2.1.3.2.2 Spawning Adults (December–March)

Based on the timing of in-water construction activities (June 1–October 31), the risk of direct exposure of spawning adults to potential contaminant spills or sediment-born contaminants will be minimized. Implementation of take minimization measures AMM3 *Stormwater Pollution Prevention Plan;* AMM5 *Spill Prevention, Containment, and Countermeasure Plan;* AMM6 *Disposal and Reuse of Spoils, Reusable Tunnel Material, and Dredged Material;* and AMM14 *Hazardous Material Management* (Appendix 3.F *General Avoidance and Minimization Measures*) will minimize the potential for take of spawning adults to contaminants throughout the construction period. No population-level effects are expected.

4.2.1.3.2.3 Eggs/Embryos (December–April)

Based on the absence of spawning adults at the intake locations during in-water construction activities, the risk of direct exposure of eggs/embryos to potential contaminant spills or sediment-born contaminants will be minimized. During the incubation season, eggs/embryos may come into contact with contaminants in re-suspended or newly exposed sediment. Implementation of take minimization measures AMM3 *Stormwater Pollution Prevention Plan;* AMM5 *Spill Prevention, Containment, and Countermeasure Plan;* AMM6 *Disposal and Reuse of Spoils, Reusable Tunnel Material, and Dredged Material;* and AMM14 *Hazardous Material Management* (Appendix 3.F *General Avoidance and Minimization Measures*) will minimize the potential for take of eggs/embryos to contaminants throughout the construction period. No population-level effects are expected.

4.2.1.3.2.4 Larvae/Young Juveniles (January–May)

Increases in the risk of contaminant spills associated with in-water construction activities will be limited primarily to June 1–October 31, minimizing the risk of direct exposure of larvae/young juveniles to potential spills and sediment-born contaminants. Implementation of take minimization measures AMM3 *Stormwater Pollution Prevention Plan;* AMM5 *Spill Prevention, Containment, and Countermeasure Plan;* AMM6 *Disposal and Reuse of Spoils, Reusable Tunnel Material, and Dredged Material;* and AMM14 *Hazardous Material Management* (Appendix 3.F *General Avoidance and Minimization Measures*) will minimize the potential for take of larvae/young juveniles throughout the construction period. No population-level effects are expected.

4.2.1.3.2.5 Juveniles (Year-Round)

Longfin smelt juveniles rear downstream of the proposed intake sites and therefore will be unaffected by contaminant spills or sediment-borne contaminants during construction of the intakes. No take of juveniles is expected.

4.2.1.3.3 Underwater Noise

During construction of the north Delta intakes, activities that are likely to generate underwater noise include pile driving, riprap placement, dredging, and barge operations. Pile driving in or near open water poses the greatest risk to fish because the levels of underwater noise produced by impulsive types of sounds can reach levels of sufficient intensity to injure or kill fish within a certain radius of the source piles (Popper and Hastings 2009). Other activities such as riprap placement, dredging, and barge operations generally produce more continuous, lower energy sounds below the thresholds associated with direct injury but may cause avoidance behavior or temporary hearing loss or physiological stress if avoidance is not possible or exposure is prolonged (Popper and Hastings 2009).

As described in Section 4.1.1.2.3 *Underwater Noise*, impact pile driving during installation of the cofferdam sheetpiles and foundation piles for the intake facilities are predicted to produce underwater noise of sufficient intensity to injure or kill fish within a certain radius of the source piles. Restriction of impact pile driving activities at the intake facilities to June 1-October 31 will avoid the primary months when longfin smelt may be present at the proposed intake locations. In addition, as described in Section 4.1.1.2.3 *Underwater Noise*, DWR will develop and implement an underwater sound control and abatement plan outlining specific measures that will be implemented to avoid and minimize the effects of underwater construction noise on listed fish species (Appendix 3.F *General Avoidance and Minimization Measures*, AMM9 *Underwater Sound Control and Abatement Plan*). Where impact pile driving is required, hydroacoustic monitoring will be performed to determine compliance with established objectives (e.g., distances to cumulative noise thresholds) and corrective actions that will be taken should the thresholds be exceeded.

4.2.1.3.3.1 Migrating Adults (December–March)

The proposed timing of impact pile driving activities (June 1–October 31) will avoid the adult migration season. Consequently, there will be no risk of exposure of migrating adults to impact pile driving noise. No take of migrating adults is expected.

4.2.1.3.3.2 Spawning Adults (December–March)
The proposed timing of impact pile driving activities (June 1–October 31) will avoid the longfin smelt spawning season. Consequently, there will be no risk of exposure of spawning adults to impact pile driving noise. No take of spawning adults is expected.

4.2.1.3.3.3 Eggs/Embryos (December–April)
Based on the absence of spawning adults at the intake locations during impact pile driving activities, there will be no risk of exposure of eggs/embryos to impact pile driving noise. No take of eggs/embryos is expected.

4.2.1.3.3.4 Larvae/Young Juveniles (January–May)
The proposed timing of impact pile driving activities (June 1–October 31) will avoid the primary months when longfin smelt larvae/young juveniles may be present at the proposed intake locations. Consequently, there will be little or no risk of take from exposure of larvae/young juveniles to impact pile driving noise.

4.2.1.3.3.5 Juveniles (Year-Round)
Longfin smelt juveniles rear downstream of the proposed intake sites and therefore are unlikely to be exposed to impact pile driving noise. No take of juveniles is expected.

4.2.1.3.4 Fish Stranding

As described in Section 4.1.1.2.4 *Fish Stranding*, installation of cofferdams to isolate the construction areas for the proposed intakes has the potential to strand fish, resulting in direct mortality of fish that become trapped inside the cofferdams. Restriction of cofferdam installation to June 1-October 31 will avoid the primary months when longfin smelt may be present at the proposed intake locations. In addition, DWR will prepare and submit a fish rescue and salvage plan (Appendix 3.F *General Avoidance and Minimization Measures*, AMM8 *Fish Rescue and Salvage Plan*) to the fish and wildlife agencies (NMFS, USFWS, CDFW) for review and approval prior to implementation. The plan will include detailed procedures for fish rescue and salvage, including collection, holding, handling, and release, that will apply to all in-water activities with the potential to entrap fish.

4.2.1.3.4.1 Migrating Adults (December–March)
The proposed timing of in-water cofferdam installation (June 1–October 31) will avoid the adult migration season. Consequently, there will be no risk of stranding of migrating adults. No take of migrating adults is expected.

4.2.1.3.4.2 Spawning Adults (December–March)
The proposed timing of in-water cofferdam installation (June 1–October 31) will avoid the longfin smelt spawning season. Consequently, there will be no risk of stranding of spawning adults. No take of spawning adults is expected.

4.2.1.3.4.3 Eggs/Embryos (December–April)
Because spawning adults will not likely be present at the proposed intake locations during cofferdam installation, there will be no risk of stranding of eggs/embryos. No take of eggs/embryos is expected.

4.2.1.3.4.4 Larvae/Young Juveniles (January–May)

The proposed timing of cofferdam installation (June 1–October 31) will avoid the primary period when longfin smelt larvae/young juveniles may be present at the proposed intake locations. Consequently, there will be little or no risk of stranding and potential take of larvae/young juveniles associated with stranding and/or fish rescue/salvage activities.

4.2.1.3.4.5 Juveniles (Year-Round)

Juvenile longfin smelt rear downstream of the proposed intake locations and therefore are unlikely to be present during cofferdam installation (June 1–October 31). Therefore, juveniles are not at risk of being stranded. No take of juveniles is expected.

4.2.1.3.5 Direct Physical Injury

During in-water construction activities at the intake sites, longfin smelt could be injured or killed by direct contact with equipment or materials that enter open waters of the Sacramento River. Potential mechanisms include fish being crushed by falling rock (riprap), impinged by sheetpiles, entrained by dredges, or struck by propellers. In addition to the proposed in-water work window (June 1–October 31), the potential for injury of listed fish species during construction of the intake facilities will be minimized by limiting the duration of in-water construction activities to the extent practicable and implementing the following take minimization measures (described in Appendix 3.F *General Avoidance and Minimization Measures*): AMM1 *Worker Awareness Training;* AMM4 *Erosion and Sediment Control Plan;* AMM6 *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material;* AMM7 *Barge Operations Plan*; and AMM9 *Fish Rescue and Salvage Plan*.

4.2.1.3.5.1 Migrating Adults (December–March)

The timing of in-water construction activities (June 1–October 31) will avoid the adult migration season. Therefore, migrating adults are not at risk of being injured. No take of migrating adults is expected.

4.2.1.3.5.2 Spawning Adults (December–March)

The proposed timing of in-water cofferdam installation (June 1–October 31) will avoid the period when spawning adults may be present at the proposed intake locations. Consequently, there will be no risk of direct injury of spawning adults. No take of spawning adults is expected.

4.2.1.3.5.3 Eggs/Embryos (December–April)

Because spawning adults will not likely be present at the proposed intake locations during cofferdam installation, there will be no risk of direct injury of eggs/embryos. No take of eggs/embryos is expected.

4.2.1.3.5.4 Larvae/Young Juveniles (January-May)

The proposed timing of in-water construction activities (June 1–October 31) will avoid the primary period when longfin smelt larvae/young juveniles may be present at the proposed intake locations. Consequently, there will be little or no risk of injury for larvae/young juveniles.

4.2.1.3.5.5 Juveniles (Year-Round)

Juvenile longfin smelt rear downstream of the proposed intake sites and therefore are unlikely to come into direct contact with construction equipment or materials during in-water construction activities (June 1–October 31). No take of juveniles is expected.

4.2.1.3.6 Loss or Alteration of Habitat

As described in Section 4.1.1.2.6 *Loss or Alteration of Habitat*, construction of the NDDs will result in permanent loss or alteration of aquatic habitat in areas where longfin smelt could occur. The effects of construction activities on water quality, including turbidity and suspended sediment, underwater noise, and contaminants, were previously discussed. Construction of the proposed intakes will result in the loss or alteration of 5.6 acres of shallow water habitat that will be permanently replaced by the intake structures, transition walls, and bank protection, or altered by sediment deposition (assumed to extend 1,000 feet downstream from the construction sites).

During construction activities, DWR will implement AMM2 *Construction Best Management Practices and Monitoring* (Appendix 3.F *General Avoidance and Minimization Measures*) to protect listed fish, wildlife, and plant species, and other sensitive natural communities. These BMPs include a number of measures to limit the extent of disturbance of aquatic and riparian habitat during construction, and, following construction, to restore temporarily disturbed areas to pre-construction conditions. All construction and site restoration BMPs will be subject to an approved construction and post-construction monitoring plan to ensure their effectiveness. DWR will offset unavoidable habitat impacts at the proposed intake sites through on-site and/or off-site mitigation, including the purchase of conservation credits at an approved conservation bank.

The potential effects of habitat loss/alteration on longfin smelt will be similar to those described for Delta Smelt given similarities in habitat use, foraging behavior, and general life history characteristics.

4.2.1.3.6.1 Migrating Adults (December–March)

The potential effects of habitat loss/alteration on migrating adults will be similar to those described for Delta Smelt. Potential predation on migrating adults related to changes in passage conditions at the sites are expected to have negligible effects on spawning population size because of the small fraction of shoreline to be affected and the low proportion of the population that migrates and spawns in the reaches upstream of the intake locations.

4.2.1.3.6.2 Spawning Adults (December–March)

Similar to Delta Smelt, there appears to be little or no suitable spawning habitat for longfin smelt within the footprints of the proposed intake facilities. Consequently, permanent losses or alteration of nearshore habitat during construction will have little or no effect on spawning site utilization or reproductive success of adults. No population-level effects are expected because of the small proportion of the population spawning in the project area, low utilization of the intake sites by spawning adults, and negligible contribution of this habitat to the overall spawning capacity of the upper estuary.

4.2.1.3.6.3 Eggs/Embryos (December–April)

Based on the small proportion of the population spawning in the project area and low likelihood of spawning adults at the proposed intake sites, there is little risk of direct or indirect effects on egg/embryo production or survival. No population-level effects are expected.

4.2.1.3.6.4 Larvae/Young Juveniles (January–May)

As described for Delta Smelt, some potential exists for localized increases in predation mortality as larvae and juveniles pass the intake construction sites. However, similar to Delta Smelt, potential predation on larvae/young juveniles is expected to have negligible effects on longfin smelt abundance because of the low proportion of the population that migrates and spawns in the reaches upstream of the intake locations.

4.2.1.3.6.5 Juveniles (Year-Round)

Juvenile longfin smelt rear downstream of the proposed intake sites and therefore are unlikely to be affected by losses or alteration of habitat. No population-level effects are expected.

4.2.1.4 Barge Landings

Construction of the barge landings is described in Section 4.1.1.3 *Barge Landings*. Barge landings are proposed at seven locations near the TBM launch shaft sites in the east and south Delta (see Appendix 3.A *Map Book for the Proposed Project*) although additional barge landings may also be needed, at contractors' discretion, at Intake 3 and Intake 5 construction sites, Staten Island TBM retrieval shaft, and Banks and Jones Connections construction sites).

Construction of the barge landings could potentially affect longfin smelt over a period of 2 years and permanently affect up to 22.4 acres of tidal perennial aquatic habitat. Estimates of the amount of shallow water habitat potentially affected by construction are not currently available. Each dock will be in use for the duration of construction activities (5-6 years) at the TBM shaft sites and other construction sites (e.g., NDDs) as needed, and will be removed at the completion of construction. Barge operations are projected to result in 15,000 barge trips during the 5-6-year construction period, resulting in an overall average increase of 7.5 barge trips per day (1.1 per landing) (see Section 4.1.1.3 *Barge Landings*). To protect aquatic habitat and listed fish species, a barge operations plan (AMM7) will require barges and towing vessels to comply with standard navigation and operating rules to avoid or minimize physical disturbances and water quality impacts in the navigable waterways of the Delta. Where avoidance is not possible, the plan will include provisions to minimize effects as described in Appendix 3.F *General Avoidance and Minimization Measures*, Section 3.F.2.7.4 *Environmental Training* and Section 3.F.2.7.5 *Dock Approach and Departure Protocol*.

4.2.1.4.1 Turbidity and Suspended Sediment

Pile driving, barge operations, and levee armoring will be the principal sources of turbidity and suspended sediment during construction of the barge landings. As described in Section 4.1.1.3.1 *Turbidity and Suspended Sediment*, potential turbidity and sediment impacts on listed fish species will be minimized by restricting in-water construction activities to August 1–October 31 at most locations[2]. In addition to the timing restriction for in-water activities, the following take minimization measures (described in Appendix 3.F *General Avoidance and Minimization Measures*) will be implemented to avoid or minimize impacts due to increases in turbidity and suspended sediment levels on water quality and aquatic habitat during construction of the barge landings and subsequent barge operations: AMM1 *Worker Awareness Training;* AMM2 *Construction Best Management Practices and Monitoring;* AMM3 *Stormwater Pollution Prevention Plan;* AMM4 *Erosion and Sediment Control Plan;* AMM5 *Spill Prevention, Containment, and Countermeasure Plan;* AMM14 *Hazardous Material Management Plan;* AMM6 *Disposal and Reuse of Spoils, Reusable Tunnel Material, and Dredged Material;* and AMM7 *Barge Operations Plan*.

Some potential exists for construction-related turbidity and suspended sediment to occur during winter and spring due to increased erosion and mobilization of sediment in runoff from disturbed levee surfaces. However, with implementation of the proposed erosion and sediment control measures (AMM4) and other BMPs to ensure the effectiveness of these measures (AMM2 *Construction Best Management Practices and Monitoring*), no adverse water quality effects are anticipated outside of the in-water construction season.

4.2.1.4.1.1 Migrating Adults (December-March)

The timing of in-water construction at the barge landings (August 1–October 31) will avoid the longfin smelt adult migration season. Therefore, migrating adults will be unaffected by increases in turbidity and suspended sediment during construction of the barge landings. Similar to Delta Smelt, it is unlikely that the levels of turbidity and suspended sediment generated by year-round barge operations will have adverse effects on migrating adults (see 4.1.1.2.1 *Turbidity and Suspended Sediment*). No take of migrating adults is expected.

4.2.1.4.1.2 Spawning Adults (December-March)

The timing of in-water construction at the barge landings (August 1–October 31) will avoid the longfin smelt spawning season. Therefore, spawning adults will be unaffected by increases in turbidity and suspended sediment during construction of the barge landing sites. No take of spawning adults is expected. However, it is possible that the deposition of suspended sediment generated by construction activities could degrade potential spawning habitat through burial of suitable substrates. Similar to Delta Smelt (see Section 4.1.1.3.1 *Turbidity and Suspended Sediment*), potential sedimentation of nearshore areas at the barge landings is not expected to affect spawning habitat utilization or reproductive success of longfin smelt because of the low quality and likely low utilization of these sites for spawning. Increases in turbidity and suspended sediment in nearshore areas from year-round barge operations could adversely affect spawning habitat at other locations along the barge transport routes but such effects will be minimized by implementing the barge operations plan (AMM7), which includes specific measures to minimize bed scour, bank erosion, loss of submerged and emergent vegetation, and disturbance of benthic communities (Appendix 3.F *General Avoidance and Minimization Measures*). Furthermore, potential effects on the overall quantity and quality of spawning habitat will be minimal because increases in barge traffic levels are predicted to average 7.5 trips

[2] In-water construction activities at the north Delta intakes (Intake 3 and 5) and CCF, which may include barge landings, will be conducted June 1-October 31 and July 1-November 30, respectively.

per day over the entire project area and primarily affect the channels of the east and south Delta (where much of the barge activity will be focused). No population-level effects are expected.

4.2.1.4.1.3 Eggs/Embryos (December–April)

The timing of in-water construction at the barge landings (August 1–October 31) will avoid the longfin smelt incubation season. Therefore, eggs/embryos will be unaffected by increases in turbidity and suspended sediment during construction of the barge landing sites. Year-round barge operations could increase the frequency of sediment disturbance in nearshore areas along the barge routes, resulting in potential adverse effects on spawning habitat and burial of eggs/embryos. This represents a potential source of take of longfin smelt. However, as discussed above, no population-level effects would be expected based on the small incremental increase in barge traffic levels and implementation of the barge operations plan.

4.2.1.4.1.4 Larvae/Young Juveniles (January–May)

The timing of in-water work at the barge landings (August 1–October 31) will avoid the period when longfin smelt larvae/young juveniles may be present at the barge landing sites. Therefore, larvae/young juveniles will be unaffected by increases in turbidity and suspended sediment during construction of the barge landings. Similar to Delta Smelt, it is unlikely that the levels of turbidity and suspended sediment generated by year-round barge operations will have adverse effects on larvae/juveniles (see 4.1.1.2.1 *Turbidity and Suspended Sediment*). No take of larvae/young juveniles is expected.

4.2.1.4.1.5 Juveniles (Year-Round)

Juvenile longfin smelt rear downstream of the proposed barge landing sites and therefore will be unaffected by increases in turbidity and suspended sediment during construction of the barge landings. Similar to Delta Smelt, it is unlikely that the levels of turbidity and suspended sediment generated by year-round barge operations will have adverse effects on juveniles (see 4.1.1.2.1 *Turbidity and Suspended Sediment*). No take of juveniles is expected.

4.2.1.4.2 Contaminants

The risk of accidental spills of contaminants and other hazardous materials during construction and operation of the barge landings will be similar to that described previously (Section 4.1.1.2 *North Delta Diversions*), due to the proximity of construction activities and barge operations to the waters of the Delta. Implementation of Appendix 3.F *General Avoidance and Minimization Measures*, AMM5 *Spill Prevention, Containment, and Countermeasure Plan*, AMM8 *Barge Operations Plan*, and AMM14 *Hazardous Materials Management* will minimize the potential for introduction of contaminants into surface waters and guide rapid and effective response in the case of inadvertent spills of hazardous materials. With implementation of these and other required construction BMPs (e.g., AMM 3 *Stormwater Pollution Prevention Plan*), the risk of contaminant spills or discharges to Delta waters from in-water and overwater sources will be minimized.

The potential for introduction of contaminants from disturbed sediments will be addressed through the implementation of specific measures addressing containment, handling, storage, and disposal of contaminated sediments, as described under AMM6 *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material* in Appendix 3.F *General Avoidance and Minimization*

Measures. These measures include the preparation and implementation of a pre-construction sampling and analysis plan (SAP) to characterize contaminants and determine appropriate BMPs to minimize or avoid mobilization of contaminated sediments during in-water construction activities. Because potential mobilization of contaminants is closely linked to sediment disturbance and associated increases in turbidity and suspended sediment, turbidity monitoring and control measures (e.g., silt curtains) to achieve compliance with existing Basin Plan objectives will be an important measures for limiting dispersal of contaminated sediments during dredging and other in-water construction activities.

4.2.1.4.2.1 Migrating Adults (December-March)

The timing of in-water construction activities (August 1–October 31) will avoid the longfin smelt adult migration season, minimizing the risk of direct exposure of migrating adults to potential spills and resuspension of contaminated sediments. Barge operations will result in an increased risk of take from potential exposure to contaminants throughout the year at the barge landing sites and along the barge transport routes, but implementation of proposed take minimization measures, including pollution prevention, erosion and sediment control, and barge operations measures, will minimize this risk. No population-level effects are expected.

4.2.1.4.2.2 Spawning Adults (December-March)

The timing of in-water construction at the barge landing (August 1–October 31) will avoid the longfin smelt spawning season. Therefore, the risk of direct exposure of spawning adults to potential contaminant spills or sediment-born contaminants will be minimized during construction of the barge landing sites. Barge operations will result in an increased risk of take of spawning adults from potential exposure to contaminants throughout the year at the barge landing sites and along the barge transport routes, but implementation of proposed take minimization measures, including pollution prevention, erosion and sediment control, and barge operations measures, will minimize this risk. No population-level effects are expected.

4.2.1.4.2.3 Eggs/Embryos (December–April)

In-water construction activities at the barge landings will occur between August 1 and October 31, minimizing the risk of direct exposure of eggs/embryos to potential contaminant spills or sediment-born contaminants during construction of the barge landings. During the incubation season, eggs/embryos may come into contact with contaminants in re-suspended or newly exposed sediment resulting from construction activities and year-round barge operations. This represents a potential source of take of longfin smelt. With implementation of the proposed take minimization measures, including pollution prevention, erosion and sediment control, and barge operations measures, the potential for exposure of eggs/embryos to contaminated sediments will be minimized. No population-level effects are expected.

4.2.1.4.2.4 Larvae/Young Juveniles (January–May)

The risk of contaminant spills will be limited primarily to the in-water work window (August 1–October 31), minimizing the risk of direct exposure of larvae/young juvenile to potential contaminant spills or sediment-born contaminants during construction of the barge landings. Barge operations will result in an increased risk of take from potential exposure of larvae/young juveniles to contaminants throughout the year at the barge landing sites and along the barge transport routes, but implementation of proposed take minimization measures, including pollution prevention, erosion and sediment control, and barge operations measures, will minimize this risk. No population-level effects are expected.

4.2.1.4.2.5 Juveniles (Year-Round)

Longfin smelt juveniles rear downstream of the barge landing sites and therefore will be unaffected by potential contaminant spills or sediment-borne contaminants during construction of the intakes. An increased risk of take from potential exposure of juveniles to contaminants will exist year-round along the barge transport routes that extend to downstream rearing areas but implementation of proposed take minimization measures, including pollution prevention, erosion and sediment control, and barge operations measures, will minimize this risk. No population-level effects are expected.

4.2.1.4.3 Underwater Noise

During construction of the barge landings, activities that are likely to generate underwater noise include pile driving, riprap placement, and barge operations. Pile driving in or near open water poses the greatest risk to fish because the levels of underwater noise produced by impulsive types of sounds can reach levels of sufficient intensity to injure or kill fish within a certain radius of the source piles (Popper and Hastings 2009). Other activities such as barge operations generally produce more continuous, lower energy sounds below the thresholds associated with direct injury but may cause avoidance behavior or temporary hearing loss or physiological stress if avoidance is not possible or exposure is prolonged (Popper and Hastings 2009). Currently, it is estimated that each barge landing would require vibratory and/or impact driving of 107 steel pipe piles (24-inch diameter) to construct the dock and mooring facilities. Based on the concurrent operation of 4 impact pile drivers at each site and an estimated installation rate of 60 piles per day, pile driving noise would be expected to occur over a period of 2 days at each barge landing.

Based on the general timing and abundance of longfin smelt in the east and south Delta, restriction of pile driving activities to August 1 through October 31 will avoid the primary months when longfin smelt may be present at the barge landing sites. In addition, as described in Section 4.1.1.2.3 *Underwater Noise*, DWR will develop and implement an underwater sound control and abatement plan outlining specific measures that will be implemented to avoid and minimize the effects of underwater construction noise on listed fish species (Appendix 3.F *General Avoidance and Minimization Measures,* AMM9 *Underwater Sound Control and Abatement Plan*). Where impact pile driving is required, hydroacoustic monitoring will be performed to determine compliance with established objectives (e.g., distances to cumulative noise thresholds) and corrective actions that will be taken should the thresholds be exceeded.

4.2.1.4.3.1 Migrating Adults (December–March)

The proposed timing of impact pile driving activities at the barge landings (August 1–October 31) will avoid the longfin smelt adult migration season. Consequently, there will be no risk of exposure of migrating adults to impact pile driving noise. No take of migrating adults is expected.

4.2.1.4.3.2 Spawning Adults (December–March)

The proposed timing of impact pile driving activities at the barge landings (August 1–October 31) will avoid the longfin smelt spawning season. Consequently, there will be no risk of exposure of spawning adults to impact pile driving noise. No take of spawning adults is expected.

4.2.1.4.3.3 Eggs/Embryos (December–April)

Based on the timing of impact pile driving at the barge landings, there will be no risk of exposure of eggs/embryos to potentially harmful underwater noise levels. No take of eggs/embryos is expected.

4.2.1.4.3.4 Larvae/Young Juveniles (January–May)

Based on the absence of spawning adults at the barge landings during impact pile driving activities, there will be no risk of exposure of eggs/embryos to impact pile driving noise. No take of eggs/embryos is expected.

4.2.1.4.3.5 Juveniles (Year-Round)

Juvenile longfin smelt rear downstream of the proposed barge landing sites and therefore are unlikely to be exposed to impact pile driving noise. No take of juveniles is expected.

4.2.1.4.4 Fish Stranding

No actions are proposed at the barge landings that could result in stranding of longfin smelt or require fish rescue and salvage activities.

4.2.1.4.5 Direct Physical Injury

During in-water construction activities at the barge landings, fish could be injured or killed by direct contact with equipment or materials that are operated or placed in open waters of the Delta. Potential mechanisms include fish being crushed by falling rock (riprap), impinged by piles, or struck or entrained by vessels or propellers. Physical injury of fish may also occur as a result propeller entrainment and shoreline disturbances (e.g., dewatering) associated with year-round operation of barges within the Delta channels used by barges to transport construction equipment and materials between the loading and unloading facilities.

In addition to the proposed in-water work window (August 1–October 31), the potential for injury of listed fish species during construction of the barge landings will be minimized by limiting the duration of in-water construction activities to the extent practicable and implementing the following take minimization measures (described in Appendix 3.F *General Avoidance and Minimization Measures*): AMM1 *Worker Awareness Training;* AMM4 *Erosion and Sediment Control Plan;* AMM6 *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material;* AMM7 *Barge Operations Plan; and Fish Rescue and Salvage Plan*. Operational effects of barges and towing vessels, including effects that could take place along the routes between the barge loading and unloading facilities, include propeller entrainment and wave-induced shoreline impacts that could injure or kill fish (e.g., dewatering). To protect aquatic habitat and listed fish species, the barge operations plan (AMM7) will require barges and towing vessels to comply with standard navigation and operating rules to avoid or minimize physical disturbances and water quality impacts in the navigable waterways of the Delta. Where avoidance is not possible, the plan will include provisions to minimize effects as described in Appendix 3.F *General Avoidance and Minimization Measures*, Section 3.F.2.7.4 *Environmental Training* and Section 3.F.2.7.5 *Dock Approach and Departure Protocol*.

4.2.1.4.5.1 Migrating Adults (December–March)

The timing of in-water construction activities (August 1–October 31) will avoid the longfin smelt adult migration season. Therefore, migrating adults will not be subject to direct physical injury during construction of the barge landings. However, as described in Section 4.1.1.3 *Barge Landings*, barge operations will continue year-round for 5-6 years following construction, potentially affecting migrating adults at the barge landings and in the Delta channels used to transport construction equipment and materials between the barge loading and unloading facilities. Potential effects include direct injury or mortality of fish from entrainment by the propellers of the towing vessels. There are few direct observations of fish being seriously injured or killed by boat traffic (Rosen and Hales, 1980; Gutreuter et al. 2003), although there is general agreement that juveniles and adults are less susceptible to injury than early life stages (eggs and larvae) because of their greater swimming ability and resistance to shear stresses caused by propellers (Morgan et al., 1976; Holland, 1986; Killgore et al., 2001; Wolter and Arlinghaus 2003).

No information exists on the potential for vessel interactions with longfin smelt or other Delta fishes. Although implementation of the barge operations plan (AMM7) is expected to minimize potential interactions, the frequency of such interactions with migrating adults may increase and result in an elevated risk of injury. However, with an average increase of 7.5 trips per day over the entire action area and relatively low densities of adults in the east and south Delta (where much of the barge activity will be focused), any increases in injury would be expected to be small. No population-level effects are expected.

4.2.1.4.5.2 Spawning Adults (December–March)

The timing of in-water construction activities (August 1–October 31) will avoid the longfin smelt spawning season. However, as discussed above for migrating adults, year-round operation of barges at the barge landings and along the barge transport routes could result in direct injury of longfin smelt. Spawning adults may be less vulnerable to direct interactions with vessels because of their presumed utilization for shallow areas or shoal habitat for spawning. However, some risk of take exists for spawning adults because of potential disturbance of nearshore areas (e.g., wave scour, dewatering) caused by the passage of barges and towing vessels. Similar to Delta Smelt, no population-level effects would be expected because of the low utilization of the east and south Delta channels by spawning adults, the small incremental increases in barge traffic levels, and implementation of the barge operations plan (see Section 4.1.1.3.5.2 *Spawning Adults*).

4.2.1.4.5.3 Eggs/Embryos (December–April)

In-water construction activities at the barge landings will occur between August 1 and October 31, and therefore will avoid the incubation period of longfin smelt. However, year-round barge operations could increase suspended sediment along nearshore areas at the landings and along the barge routes, resulting in potential adverse effects on spawning habitat and potential take resulting from burial of eggs/embryos. Similar to Delta Smelt, no population-level effects would be expected because of the low utilization of the east and south Delta channels by spawning adults, the small incremental increases in barge traffic levels, and implementation of the barge operations plan (see Section 4.1.1.3.5.3 *Eggs/Embryos*).

4.2.1.4.5.4 Larvae/Young Juveniles (January–May)

The timing of in-water work at the barge landings (August 1–October 31) will avoid the period when longfin smelt larvae/young juveniles may be present at the barge landing sites. However, as discussed above, year-round operation of barges at the barge landings and along the barge transport routes could result in direct injury of longfin smelt. Longfin smelt larvae/young juveniles may be particularly vulnerable to injury because of their limited swimming ability and sensitivity to shear stresses caused by propellers. However, similar to Delta Smelt, no population-level effects are expected based on the small proportion of adults that spawn in the east and south Delta (and resulting low densities of larvae/young juveniles), the small incremental increases in barge traffic levels, and implementation of the barge operations plan (see Section 4.1.1.3.5.4 *Larvae/Young Juveniles*).

4.2.1.4.5.5 Juveniles (Year-Round)

Juvenile longfin smelt rear downstream of the proposed barge landings and therefore are unlikely to be injured by construction activities at the barge landing sites. As discussed above, an increased risk of injury will exist year-round at the barge landings and along the barge transport routes (which may extend to downstream rearing areas) but population-levels effects are not expected because of the small incremental increases in barge traffic levels and implementation of the barge operations plan (see Section 4.1.1.3.5.5 *Juveniles*).

4.2.1.4.6 Loss or Alteration of Habitat

Construction of the barge landings will result in temporary and permanent losses or alteration of aquatic habitat in several channels of the east and south Delta that could be occupied by longfin smelt. Temporary effects of construction activities on water quality, including turbidity and suspended sediment, underwater noise, and contaminants, were previously discussed. Permanent impacts on aquatic habitat include the loss or alteration of up to 22.4 acres of tidal perennial aquatic habitat (approximately 3.2 acres per landing). At each site, approximately 0.34 acre of tidal perennial aquatic habitat will be covered by the permanent dock or alternatively, floating docks supported by temporary piles. During construction and year-round operation of the barge landings, the channel banks, bed, and waters adjacent to the dock will be frequently disturbed by propeller wash and scour from barges and tidal action, resulting in changes in water depths, benthic substrates, and loss of submerged and emergent vegetation that may be present. Estimates of the amount of shallow water habitat that could be affected by construction are not currently available.

During construction activities, DWR will implement AMM2 *Construction Best Management Practices and Monitoring*, to protect listed fish, wildlife, and plant species, and other sensitive natural communities (Appendix 3.F *General Avoidance and Minimization Measures*). These BMPs include a number of measures to limit the extent of disturbance of aquatic and riparian habitat during construction, and, following construction, to restore temporarily disturbed areas to pre-construction conditions. All construction and site restoration BMPs will be subject to an approved construction and post-construction monitoring plan to ensure their effectiveness. To further minimize adverse effects to aquatic habitat associated with barge operations, DWR will also implement AMM7 *Barge Operations Plan*, which includes specific measures to minimize bed scour, bank erosion, loss of submerged and emergent vegetation, and disturbance of benthic communities (Appendix 3.F *General Avoidance and Minimization Measures*). Unavoidable impacts to habitat of listed fish species will be offset through on-site and/or off-site mitigation, including the purchase of conservation credits at an approved conservation bank.

4.2.1.4.6.1 Migrating Adults (December–March)

Although affecting a small proportion of the population, migrating longfin smelt adults may be subject to an elevated risk of predation as they pass the barge landing sites because of potential increases in predator habitat. Population-level effects of permanent losses or alteration of nearshore habitat at the barge landing sites are expected to be similar to those described for Delta Smelt (see Section 4.1.1.3.6.1 *Migrating Adults*). Potential increases in predation on migrating adults related to changes in passage conditions at the sites are expected to have negligible population-level effects because of the small proportion of the population spawning in the east and south Delta.

4.2.1.4.6.2 Spawning Adults (December–March)

Similar to Delta Smelt, loss or alteration of habitat resulting from construction of the barge landings is not expected to have an adverse effect on longfin smelt spawning adults or spawning habitat because the landings will likely be sited in areas with steep, riprapped levees and deep nearshore areas with little or no suitable shallow water habitat for spawning. Year-round barge operations following construction will result in increased disturbance of nearshore areas at the landing sites and along the barge transport routes which could affect the suitability of these areas for spawning. However, no population-level effects would be expected because of the low utilization of the east and south Delta channels by spawning adults, the small incremental increases in barge traffic levels, and implementation of the barge operations plan (see Section 4.1.1.3.1.2 *Spawning Adults*).

4.2.1.4.6.3 Eggs/Embryos (December–April)

Based on the small proportion of the population spawning in the project area and expected low utilization of the barge landing sites by spawning adults, there is little or no risk of adverse effects on eggs or embryos during construction of the barge landings. Year-round barge operations following construction will result in increased disturbance of nearshore areas and potential adverse effects of eggs/embryos (e.g., displacement, dewatering). However, no population-level effects would be expected because of the low utilization of the east and south Delta channels by spawning adults, the small incremental increases in barge traffic levels, and implementation of the barge operations plan.

4.2.1.4.6.4 Larvae/Young Juveniles (January–May)

Similar to Delta Smelt, longfin smelt larvae or young juveniles dispersing from upstream spawning areas to estuarine rearing areas (e.g., in the low salinity zone) may be subject to an elevated risk of predation as they pass the barge landings because of the presence of in-water and overwater structures and the loss of shallow, low-velocity nearshore areas. However, as discussed for Delta Smelt (see Section 4.1.1.3.6.4 *Larvae/Young Juveniles*), potential predation on larvae and early juveniles are expected to have negligible effects on longfin smelt abundance because of the small proportion of the population that migrates and spawns in the east and south Delta.

4.2.1.4.6.5 Juveniles (Year-Round)

Juvenile longfin smelt rear downstream of the proposed barge landing sites and therefore are unlikely to be affected by losses or alteration of habitat. No population-level effects are expected.

4.2.1.5 Head of Old River Gate

Construction activities at the HOR gate are described in Section 4.1.1.4 *Head of Old River Gate*. Construction of the HOR gate will take 2 years. The HOR gate will be constructed in two phases using cofferdams to isolate and dewater half the channel during the first phase and the other half during the second phase. All in-water construction work, including cofferdam installation, riprap placement, dredging, and barge operations, will be restricted to an August 1 to October 31 work window to minimize or avoid potential effects on listed fish species, including longfin smelt. In addition, all pile driving entailing the use of an impact pile driver in or near open water (cofferdams and foundation piles) will be restricted to this period to avoid or minimize exposure of listed species to potentially harmful underwater noise levels. Construction of the HOR gate will entail dredging approximately 500 feet of channel (150 feet upstream to 350 feet downstream from the proposed gate) and removal of up to 1,500 cubic yards of material with a barge-mounted hydraulic or a sealed clamshell dredge. There will be minimal need for additional clearing and grading of the site for construction, staging, and other support facilities because of the presence of existing access roads and staging areas that have been used in the past for installation of a temporary rock barrier.

Construction of the HOR gate will result in permanent impacts to approximately 2.9 acres of tidal perennial aquatic habitat that includes the footprint of the gate and the channel segments upstream and downstream of the structure that will be affected by dredging. Estimates of the amount of shallow water habitat potentially affected by construction are not currently available.

4.2.1.5.1 Turbidity and Suspended Sediment

In-water construction activities will disturb the channel bed and banks, resulting in temporary increases in turbidity and suspended sediment levels in Old River and potentially the San Joaquin River. These activities include cofferdam construction (sheet pile installation), dredging, riprap placement, and barge operations. All other sediment-disturbing activities will be outside or isolated from the active channel and will not result in the discharge of sediment to the river. Water pumped from the cofferdams will be treated, removing all sediment using settling basins or Baker tanks, and returned to the river. Dredging, foundation pile driving, and other construction activities will proceed within the confines of the cofferdams.

In addition to the in-water work window, a number of take minimization measures are proposed to avoid or minimize potential impacts on water quality and listed fish species during construction of the HOR gate. These include AMM1 *Worker Awareness Training;* AMM2 *Construction Best Management Practices and Monitoring;* AMM3 *Stormwater Pollution Prevention Plan;* AMM4 *Erosion and Sediment Control Plan; Spill Prevention, Containment, and Countermeasure Plan;* AMM14 *Hazardous Material Management;* and AMM6 *Disposal and Reuse of Spoils, Reusable Tunnel Material, and Dredged Material* (Appendix 3.F *General Avoidance and Minimization Measures*).

Some potential exists for construction-related turbidity and suspended sediment to occur during winter and spring due to increased erosion and mobilization of sediment in runoff from disturbed levee surfaces. However, with the timing restrictions on in-water activities and implementation of the proposed erosion and sediment control take minimization measures, no adverse water effects are anticipated during this period.

4.2.1.5.1.1 Migrating Adults (December–March)

The timing of in-water construction activities at the HOR gate (August 1–October 31) will avoid the primary longfin smelt adult migration season. Therefore, migrating adults will likely be unaffected by increases in turbidity and suspended sediment during construction of the HOR gate.

4.2.1.5.1.2 Spawning Adults (December–March)

The timing of in-water construction activities (August 1–October 31) will avoid the primary longfin smelt spawning season. Therefore, spawning adults will likely be unaffected by increases in turbidity and suspended sediment during construction of the HOR gate. However, increases in suspended sediment during in-water construction activities may result in localized sediment deposition, degrading potential spawning habitat through burial of suitable substrates. Similar to Delta Smelt (see Section 4.1.1.5.1.2 *Spawning Adults*), potential sedimentation of Old River in the vicinity of the HOR gate is not expected to significantly affect spawning habitat utilization or reproductive success of longfin smelt because of the low quality and likely low utilization of this area for spawning. No population-level effects are expected.

4.2.1.5.1.3 Eggs/Embryos December–April)

Based on the timing of in-water construction activities at the HOR gate (August 1–October 31) and low quality and utilization of this area for spawning, there will be little or no risk of take of longfin smelt eggs/embryos from temporary increases in turbidity and suspended sediment.

4.2.1.5.1.4 Larvae/Young Juveniles (January–May)

The timing of in-water construction activities at the HOR gate (August 1–October 31) will avoid the period when longfin smelt larvae/young juveniles may be present. Therefore, larvae/young juveniles will be unaffected by temporary increases in turbidity and suspended sediment. No take of larvae/young juveniles is expected.

4.2.1.5.1.5 Juveniles (Year-Round)

Juvenile longfin smelt rear downstream of the HOR gate and therefore will be unaffected by temporary increases in turbidity and suspended sediment during in-water construction activities. No take of juveniles is expected.

4.2.1.5.2 Contaminants

Construction of the HOR gate poses an exposure risk to longfin smelt from potential spills of hazardous materials from construction equipment, barges and towing vessels, and other machinery, and from potential mobilization of contaminated sediment. The risk of accidental spills of contaminants and other potentially hazardous materials will be similar to that described for the NDDs (Section 4.2.1.2.2 Contaminants) due to the proximity of construction activities to the waters of the Delta. Implementation of the following take minimization measures will minimize the potential for introduction of contaminants into surface waters and guide rapid and effective response in the case of inadvertent spills of hazardous materials: AMM1 Worker Awareness Training; AMM2 Construction Best Management Practices and Monitoring; AMM3 Stormwater Pollution Prevention Plan; Erosion and Sediment Control Plan; AMM14 Hazardous Materials Management Plan; AMM5 Spill Prevention, Containment, and Countermeasure Plan; AMM6 Disposal of Spoils, Reusable Tunnel Material, and Dredged Material; and AMM7 Barge Operations Plan (Appendix 3.F General Avoidance and Minimization Measures).

Contaminants can also enter the aquatic environment through disturbance, resuspension, or discharge of contaminated soil and sediments from construction sites. As described in Section 4.2.1.2.2 Contaminants, sediments act as a sink or source of contaminant exposure, and resuspension of contaminated sediments may have adverse effects on fish that encounter sediment plumes or come into contact with deposited or newly exposed sediment. In addition to direct exposure, contaminated sediments can adversely affect fish through accumulation of contaminants in the food web.

Contaminated sediments may be present in Old River and within the footprint of the proposed HOR gate because of the proximity of the site to major municipal, industrial, and agricultural areas. The potential for introduction of contaminants from disturbed sediments will be addressed through the implementation of specific measures addressing containment, handling, storage, and disposal of contaminated sediments, as described under AMM6 Disposal of Spoils, Reusable Tunnel Material, and Dredged Material in Appendix 3.F General Avoidance and Minimization Measures. These measures include the preparation and implementation of a pre-construction SAP to characterize contaminants and determine appropriate BMPs to minimize or avoid mobilization of contaminated sediments during in-water construction activities. Because the potential mobilization of contaminants is closely linked to sediment disturbance and associated increases in turbidity and suspended sediment, turbidity monitoring and control measures (e.g., silt curtains) to achieve compliance with existing Basin Plan objectives will be important measures for limiting dispersal of contaminated sediments during dredging and other in-water construction activities.

4.2.1.5.2.1 Migrating Adults (December–March)

The timing of in-water construction activities (August 1–October 31) will avoid the primary longfin smelt adult migration season. With implementation of proposed pollution prevention and erosion and sediment control take minimization measures, little or no risk of take from contaminant exposure will exist throughout the construction period. No population-level effects are expected.

4.2.1.5.2.2 Spawning Adults (December–March)

The timing of in-water construction activities (August 1–October 31) will avoid the longfin smelt adult migration season. With implementation of proposed pollution prevention and erosion and sediment control take minimization measures, little or no risk of take from contaminant exposure will exist throughout the construction period. No population-level effects are expected.

4.2.1.5.2.3 Eggs/Embryos (December–April)

The timing of in-water construction activities (August 1-October 31) will avoid the longfin smelt incubation season. With implementation of proposed pollution prevention and erosion and sediment control take minimization measures, little or no risk of take from contaminant exposure will exist throughout the construction period. No population-level effects are expected.

4.2.1.5.2.4 Larvae/Young Juveniles (January–May)

The timing of in-water construction activities (August 1–October 31) will avoid the period when longfin smelt larvae/young juveniles may be present. With implementation of proposed pollution prevention and erosion and sediment control take minimization measures, little or no risk of take from contaminant exposure will exist throughout the construction period. No population-level effects are expected.

4.2.1.5.2.5 Juveniles (Year-Round)

Juvenile longfin smelt rear downstream of the proposed HOR gate and therefore are unlikely to be affected by contaminant spills or sediment-borne contaminants during construction of the intakes. No take of juveniles is expected.

4.2.1.5.3 Underwater Noise

Impact pile driving at the HOR gate would potentially produce underwater noise levels of sufficient intensity and duration to injure or kill fish. Currently, it is estimated that the HOR gate would require the installation of 550 temporary sheet piles (275 piles per season) to construct the cofferdams and 100, 14-inch steel pipe or H-piles (50 piles per season) to construct the foundation. Based on an assumed installation rate of 15 piles per day, pile driving would be expected to occur up to 19 days per season during installation of the sheet piles, and up to 4 days per season during installation of the foundation piles. DWR will avoid or minimize exposure of longfin smelt to pile driving noise by conducting all in-water construction activities between August 1 and October 31.

4.2.1.5.3.1 Migrating Adults (December–March)

The timing of impact pile driving (August 1–October 31) will avoid the longfin smelt adult migration season. There will be no risk of exposure of migrating adults to impact pile driving noise. No take of migrating adults is expected.

4.2.1.5.3.2 Spawning Adults (December–March)

The timing of impact pile driving (August 1–October 31) will avoid the longfin smelt spawning season. There will be no risk of exposure of spawning adults to impact pile driving noise. No take of spawning adults is expected.

4.2.1.5.3.3 Eggs/Embryos (December–April)

The timing of impact pile driving (August 1–October 31) will avoid the longfin smelt incubation season. There will be no risk of exposure of eggs/embryos to impact pile driving noise. No take of eggs/embryos is expected.

4.2.1.5.3.4 Larvae/Young Juveniles (January–May)

The timing of impact pile driving (August 1–October 31) will avoid the period when longfin smelt larvae/young juveniles may be present. There will be no risk of exposure of larvae/young juveniles to impact pile driving noise. No take of larvae/young juveniles is expected.

4.2.1.5.3.5 Juveniles (Year-Round)
Juvenile Delta longfin smelt rear downstream of the HOR gate and therefore are unlikely to be affected by pile driving noise. Nxo take of juveniles is expected.

4.2.1.5.4 Fish Stranding

The use of cofferdams to construct the HOR gate will exclude fish from active construction areas but could also strand fish that are not able to avoid these areas, resulting in direct injury and mortality from dewatering, dredging, and pile driving activities within the enclosed cofferdams. To minimize fish stranding losses, DWR will implement a fish rescue and salvage plan (Appendix 3.F *General Avoidance and Minimization Measures*, AMM8 *Fish Rescue and Salvage Plan*). The plan will be submitted to the fish and wildlife agencies (NMFS, USFWS, CDFW) for review and approval prior to implementation. The plan will include detailed procedures for fish rescue and salvage, including collection, holding, handling, and release, that will apply to all in-water activities with the potential to entrap fish. All fish rescue and salvage operations will be conducted under the guidance of a qualified fish biologist. The biologist, in consultation with a designated agency biologist, will determine the appropriate fish collection and relocation methods based on site-specific conditions and construction methods. Collection methods may include seines, dip nets, and electrofishing if permitted. DWR will minimize the potential for stranding of listed fish species by conducting all in-water construction activities between August 1 and October 31. This will avoid the periods when longfin smelt adults, eggs/embryos, larvae, and juveniles may be present.

4.2.1.5.4.1 Migrating Adults (December–March)
The timing of cofferdam construction (August 1–October 31) will avoid the longfin smelt adult migration season. There will be no risk of stranding of migrating adults. No take of migrating adults is expected.

4.2.1.5.4.2 Spawning Adults (December–March)
The timing of cofferdam construction (August 1–October 31) will avoid the longfin smelt spawning season. There will be no risk of stranding of spawning adults. No take of spawning adults is expected.

4.2.1.5.4.3 Eggs/Embryos December–April)
The timing of cofferdam construction (August 1–October 31) will avoid the longfin smelt incubation season. There will be no risk of stranding of eggs/embryos. No take of eggs/embryos is expected.

4.2.1.5.4.4 Larvae/Young Juveniles (January–May)
The timing of cofferdam construction (August 1–October 31) will avoid the period when longfin smelt larvae/young juveniles may be present. There will be no risk of stranding of larvae/young juveniles. No take of larvae/young juveniles is expected.

4.2.1.5.4.5 Juveniles (Year-Round)
Juvenile longfin smelt rear downstream of the HOR gate and therefore are unlikely to be stranded in the cofferdams. No take of juveniles is expected.

4.2.1.5.5 Direct Physical Injury

During construction of the HOR gate, fish could be injured or killed by direct contact with equipment or materials that are operated or placed in open waters of Old River. Potential mechanisms include fish being impinged by sheetpiles, entrained by dredges, or struck by propellers during barge operations. DWR will minimize the potential for injury of listed fish species by conducting all in-water construction between August 1 and October 31. This will avoid the periods when longfin smelt adults, eggs/embryos, larvae, and juveniles may be present. In addition to the proposed work window, the potential for injury of listed fish species will be minimized to the extent practicable by limiting the duration of in-water construction activities and implementing AMM1 *Worker Awareness Training;* AMM4 *Erosion and Sediment Control Plan;* AMM6 *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material;* AMM7 *Barge Operations Plan;* and AMM8 *Fish Rescue and Salvage Plan* (Appendix 3.F *General Avoidance and Minimization Measures*).

4.2.1.5.5.1 Migrating Adults (December–March)

The timing of in-water construction activities (August 1–October 31) will avoid the primary longfin smelt adult migration season. There will be little or no risk of injury of migrating adults.

4.2.1.5.5.2 Spawning Adults (December–March)

The timing of in-water construction activities (August 1–October 31) will avoid the primary longfin smelt spawning season. There will be little or no risk of injury of spawning adults.

4.2.1.5.5.3 Eggs/Embryos (December–April)

The timing of in-water construction activities (August 1–October 31) will avoid the primary longfin smelt incubation season. There will be little or no risk of injury of eggs/embryos.

4.2.1.5.5.4 Larvae/Young Juveniles (January–May)

The timing of in-water construction activities (August 1–October 31) will avoid the period when longfin smelt larvae/young juveniles may be present. There will be no risk of injury of larvae/young juveniles.

4.2.1.5.5.5 Juveniles (Year-Round)

Juvenile longfin smelt rear downstream of the HOR gate and therefore are unlikely to be injured by in-water construction activities. No take of juveniles is expected.

4.2.1.5.6 Loss or Alteration of Habitat

Construction of the HOR gate will result in temporary and permanent losses or alteration of aquatic habitat in Old River. Temporary effects of construction activities on water quality were previously discussed. With implementation of the proposed water quality and sound abatement and control take minimization measures, in-water construction activities will result in temporary, localized increases in turbidity, suspended sediment, and noise in the vicinity of construction sites. These parameters will return to baseline levels following cessation of construction activities and will not result in long-term impacts on aquatic habitat.

Construction of the HOR gate will result in permanent impacts to approximately 2.9 acres of tidal perennial aquatic habitat, including the footprint of the gate and the channel segments upstream and downstream of the structure that will be affected by dredging. Estimates of the amount of shallow water habitat potentially affected by construction are not currently available.

During construction activities, DWR will implement AMM2 *Construction Best Management Practices and Monitoring* (Appendix 3.F *General Avoidance and Minimization Measures*) to protect listed fish, wildlife, and plant species, and other sensitive natural communities. These BMPs include a number of measures to limit the extent of disturbance of aquatic and riparian habitat during construction, and, following construction, to restore temporarily disturbed areas to pre-construction conditions. All construction and site restoration BMPs will be subject to an approved construction and post-construction monitoring plan to ensure their effectiveness. DWR will offset unavoidable impacts to habitat through on-site and/or off-site mitigation, including the purchase of conservation credits at an approved conservation bank.

4.2.1.5.6.1 Migrating Adults (December–March)

Longfin smelt have been reported from the San Joaquin River as far inland as Lathrop near the HOR (Merz et al. 2013) and therefore may occur in the project area. Although utilization of Old River and San Joaquin River by the population for spawning is expected to be low, adults may occasionally migrate to areas upstream of the HOR gate. If these adults are able to spawn successfully, larvae may also occur in the project area during their downstream dispersal to the estuary. During construction of the HOR gate, migrating longfin smelt adults may be subject to potential delays in migration and increased predation as they attempt to pass the cofferdams during the two-year construction period. Cofferdams that constrict the flow to half the channel's width will increase water velocities and potentially impede the migration of adults attempting to pass the site. The presence of in-channel cofferdams and/or the partially competed HOR gate may also increase the amount of predatory fish habitat and create hydraulic conditions that improve their ability to prey on longfin smelt. Based on the likely low utilization of this portion of their range, potential adverse effects on migration and survival of migrating adults will be limited to a very small proportion of the population, resulting in insignificant effects on the spawning stock of longfin smelt.

4.2.1.5.6.2 Spawning Adults (December–March)

Loss or alteration of aquatic habitat within the footprints of the cofferdams, riprapped banks, and dredged channel areas will reduce the amount of shallow water habitat potentially available to spawning adults. Under baseline conditions, this portion of the Old River channel is frequently disturbed by the annual installation of a temporary rock barrier and is dominated by steep levee slopes, riprap, and low quantities of riparian and aquatic vegetation. Consequently, little or no spawning habitat will be affected by construction of HOR gate and thus there is little likelihood of adverse effects on spawning adults. No population-level effects are expected.

4.2.1.5.6.3 Eggs/Embryos (January–April)

Based on the low potential for spawning of longfin smelt in the footprint of the HOR gate, the potential for adverse effects on eggs/embryos is negligible. No population-level effects are expected.

4.2.1.5.6.4 Larvae/Young Juveniles (January–May)

Similar to migrating adults, longfin smelt larvae/young juveniles may be subject to an elevated risk of predation as they pass the cofferdams and/or partially completed HOR gate. Based on the likely low utilization of this portion of their range, potential adverse effects on survival of longfin smelt larvae/young juveniles will be limited to a very small proportion of the population, resulting in insignificant effects on juvenile and adult recruitment.

4.2.1.5.6.5 Juveniles (Year-Round)

Juvenile longfin smelt rear downstream of the HOR gate and therefore are unlikely to be affected by losses or alteration of habitat during construction. No population-level effects are expected.

4.2.1.6 Clifton Court Forebay

Construction activities at CCF are described in Section 4.1.1.5 *Clifton Court Forebay*. Construction of the water conveyance facilities at CCF could potentially affect longfin smelt for up 7 years, and permanently affect up to 258 acres of tidal perennial aquatic habitat that will be replaced by permanent fill and structures associated with the new CCPP, perimeter and divider embankments, outlet canals and siphons, and intake structure and spillway. Estimates of the amount of shallow water habitat potentially affected by construction are not currently available.

4.2.1.6.1 Turbidity and Suspended Sediment

During construction of CCF and associated water conveyance facilities, the principal sources of increased turbidity and suspended sediment are dredging, cofferdam construction (sheet pile installation and removal), levee clearing and grading, and riprap placement. Minor increases in turbidity and suspended sediment in CCF and Old River are also expected during construction of the CCPP, embankments, outlet canal and siphons, SSCF intake structure, and North CCF (NCCF) emergency spillway. All other sediment-disturbing activities within cofferdams, dewatered areas of the forebay (NCCF), upland areas, or non-fish-bearing waters that pose little or no risk to listed fish species or aquatic habitat.

The potential for adverse effects of elevated turbidity and suspended sediment on listed fish species will be minimized by restricting all in-water construction activities to July 1–November 30, limiting the duration of these activities to the extent practicable, and implementing AMM1 *Worker Awareness Training;* AMM2 *Construction Best Management Practices and Monitoring;* AMM3 *Stormwater Pollution Prevention Plan;* AMM4 *Erosion and Sediment Control Plan;* AMM5 *Spill Prevention, Containment, and Countermeasure Plan;* AMM14 *Hazardous Material Management Plan*, and AMM6 *Disposal and Reuse of Spoils, Reusable Tunnel Material, and Dredged Material* (Appendix 3.F *General Avoidance and Minimization Measures*).

Some potential exists for construction-related turbidity and suspended sediment to occur during winter and spring due to increased erosion and mobilization of sediment in runoff from disturbed levee surfaces. However, with the timing restrictions on in-water activities and implementation of the proposed erosion and sediment control take minimization measures, no adverse water effects are anticipated during this period.

4.2.1.6.1.1 Migrating Adults (December–March)

The timing of in-water construction activities at CCF (July 1–November 30) will avoid the primary longfin smelt adult migration season. Therefore, there will be little or no effect on migrating adults from temporary increases in turbidity and suspended sediment. No take of migrating adults is expected.

4.2.1.6.1.2 Spawning Adults (December–March)

The timing of in-water construction activities (July 1–November 30) will avoid the primary months when spawning adults may be present at CCF and the adjacent south Delta channels. No take of spawning adults is expected. However, it is possible that the deposition of suspended sediment generated by construction activities could degrade potential spawning habitat through burial of suitable substrates. Similar to Delta Smelt (see Section 4.1.1.5.1.2 *Spawning Adults*), potential sedimentation of CCF and the adjacent Old River channel is not expected to affect spawning habitat utilization or reproductive success of longfin smelt because of the low quality and likely low utilization of these sites for spawning, and the low likelihood of survival of larvae, juveniles, and adults in CCF. No population-level effects are expected.

4.2.1.6.1.3 Eggs/Embryos (December–April)

Based on the timing of in-water construction activities (July 1–November 30) and low probability of successful spawning of longfin smelt, eggs/embryos are not likely to be affected by increases in turbidity and suspended sediment from in-water construction activities. No take of eggs/embryos is expected.

4.2.1.6.1.4 Larvae/Young Juveniles (December–May)

The timing of in-water construction activities at CCF (July 1–November 30) will avoid the primary months when longfin smelt larvae/young juveniles may be present in CCF and the adjacent south Delta channels. Therefore, there will likely be no effect on larvae/young juveniles from temporary increases in turbidity and suspended sediment. No take of larvae/young juveniles is expected.

4.2.1.6.1.5 Juveniles (Year-Round)

Juvenile longfin smelt rear downstream of CCF and the adjacent south Delta channels and therefore will be unaffected by increases in turbidity and suspended sediment during in-water construction activities. No take of juveniles is expected.

4.2.1.6.2 Contaminants

Dredging and expansion of the CCF and construction of new water conveyance facilities presents an exposure risk to longfin smelt from potential spills of hazardous materials from construction equipment and from potential mobilization of contaminated sediment. The risk of accidental spills of oil, fuel, hydraulic fluids, concrete, paint, and other potentially hazardous substances will be similar to that described for the NDDs (Section 4.1.1.2.2 Contaminants) due to the proximity of construction activities to the waters of the Delta. Implementation of the following take minimization measures (described in Appendix 3.F General Avoidance and Minimization Measures) will minimize the potential for introduction of contaminants into surface waters and guide rapid and effective response in the case of inadvertent spills of hazardous materials: AMM1Worker Awareness Training; AMM2 Construction Best Management Practices and Monitoring; AMM3 Stormwater Pollution Prevention Plan; Erosion and Sediment Control Plan; AMM5 Spill Prevention, Containment, and Countermeasure Plan;

AMM14 Hazardous Material Management Plan, AMM6 Disposal and Reuse of Spoils, Reusable Tunnel Material, and Dredged Material Plan, and AMM7 Barge Operations Plan.

Proposed dredging, excavation, and expansion of CCF will potentially result in the release of contaminants from disturbance or exposure of sediments. As described in Section 4.1.1.2.2 Contaminants, contaminants may also enter the aquatic environment through the disturbance, resuspension, or discharge of contaminated soil and sediments from construction sites, resulting in adverse effects on fish that encounter sediment plumes and come into contact with deposited or newly exposed sediment. Resuspension of sediments during in-water construction could also lead to adverse effects on fish through reductions in the abundance of their food sources (e.g., zooplankton) or consumption of contaminated food sources. Prior to dredging and excavation activities, DWR will evaluate the risk of contamination from sediment sources and determine appropriate testing and remediation procedures through the implementation of AMM6 Disposal and Reuse of Spoils, Reusable Tunnel Material, and Dredged Material and the preparation and implementation of a pre-construction sampling and analysis plan (SAP) to characterize contaminants and determine appropriate BMPs to minimize or avoid mobilization of contaminated sediments during in-water construction. Because potential mobilization of contaminants is closely linked to sediment disturbance and associated increases in turbidity and suspended sediment, turbidity monitoring and control measures (e.g., silt curtains) to achieve compliance with existing Basin Plan objectives will be important measures for limiting dispersal of contaminated sediments during dredging and other in-water construction activities.

4.2.1.6.2.1 Migrating Adults (December–March)

The timing of in-water construction activities (July 1–November 30) will avoid the primary longfin smelt adult migration season, minimizing the risk of take from exposure of adults to contaminants in the event of a spill. Implementation of the proposed pollution prevention and erosion and sediment control take minimization measures (AMM3, AMM5, and AMM 14) and SAP (AMM6) will minimize this risk throughout the construction period.

4.2.1.6.2.2 Spawning Adults (December–March)

The timing of in-water construction activities (July 1–November 30) will avoid the primary longfin smelt spawning season, minimizing the risk of take from exposure of adults to contaminants in the event of a spill. Implementation of the proposed pollution prevention and erosion and sediment control take minimization measures (AMM3, AMM5, and AMM 14) and SAP (AMM6) will minimize this risk throughout the construction period.

4.2.1.6.2.3 Eggs/Embryos (December–April)

The timing of in-water construction activities (July 1–November 30) will avoid the primary longfin smelt incubation season, minimizing the risk of exposure of eggs/embryos to contaminants in the event of a spill. Implementation of the proposed pollution prevention and erosion and sediment control take minimization measures (AMM3, AMM5, and AMM 14) and SAP (AMM6) will minimize this risk throughout the construction period.

4.2.1.6.2.4 Larvae/Young Juveniles (January–May)

The timing of in-water construction activities (July 1–November 30) will avoid the period when longfin smelt larvae/young juveniles may be present in CCF and the adjacent south Delta channels, minimizing the risk of take from exposure of eggs/embryos to contaminants in the event of a spill. Implementation of the proposed pollution prevention and erosion and sediment control take minimization measures (AMM3, AMM5, and AMM 14) and SAP (AMM6) will minimize this risk throughout the construction period.

4.2.1.6.2.5 Juveniles (Year-Round)

Longfin smelt juveniles rear downstream of CCF and the adjacent south Delta channels and therefore will be unaffected by potential contaminant spills or sediment-borne contaminants during construction of the intakes. No take of juveniles is expected.

4.2.1.6.3 Underwater Noise

During construction of the water conveyance facilities at CCF, activities that are likely to generate underwater noise include pile driving, riprap placement, dredging, and barge operations. Pile driving in or near open water poses the greatest risk to fish because the levels of underwater noise produced by impulsive types of sounds can reach levels of sufficient intensity to injure or kill fish within a certain radius of the source piles (Popper and Hastings 2009). Other activities such as riprap placement, dredging, and barge operations generally produce more continuous, lower energy sounds below the thresholds associated with direct injury but may cause avoidance behavior or temporary hearing loss or physiological stress if avoidance is not possible or exposure is prolonged (Popper and Hastings 2009).

As described in Section 4.1.1.2.3 *Underwater Noise*, impact pile driving will likely be required for installation of the sheetpiles for the embankments, divider wall, and NCCF siphons, and for installation of the concrete or steel piles for the NCCF siphon. Restriction of impact pile driving activities at the intake facilities to July 1-November 30 will avoid the primary months when longfin smelt may be present at the proposed intake locations. In addition, as described in Section 4.1.1.2.3 *Underwater Noise*, DWR will develop and implement an underwater sound control and abatement plan outlining specific measures that will be implemented to avoid and minimize the effects of underwater construction noise on listed fish species (Appendix 3.F *General Avoidance and Minimization Measures*, AMM9 *Underwater Sound Control and Abatement Plan*). Where impact pile driving is required, hydroacoustic monitoring will be performed to determine compliance with established objectives (e.g., distances to cumulative noise thresholds) and corrective actions that will be taken should the thresholds be exceeded.

4.2.1.6.3.1 Migrating Adults (December–March)

The proposed timing of impact pile driving activities (July 1–November 30) will avoid the primary months when longfin smelt adult migration season. Therefore, there will be little or no risk of take from exposure of migrating adults to impact pile driving noise.

4.2.1.6.3.2 Spawning Adults (December–March)

The proposed timing of impact pile driving activities (July 1–November 30) will avoid the primary longfin smelt spawning season. Therefore, there will be little or no risk of take from exposure of migrating adults to impact pile driving noise.

4.2.1.6.3.3 Eggs/Embryos (December–April)

The proposed timing of impact pile driving activities (July 1–November 30) will avoid the primary longfin smelt incubation season. Therefore, there will be little or no risk of take from exposure of eggs/embryos to impact pile driving noise.

4.2.1.6.3.4 Larvae/Young Juveniles (January–May)

The proposed timing of impact pile driving activities (July 1–November 30) will avoid the period when larvae/young juveniles may be present in CCF or the adjacent south Delta channels. Therefore, there will be no risk of take from exposure of larvae/young juveniles to impact pile driving noise.

4.2.1.6.3.5 Juveniles (Year-Round)

Juveniles rear downstream of CCF and the adjacent south Delta channels and therefore are unlikely to be exposed to impact pile driving noise. Therefore, there will be no risk of take from exposure of juveniles to impact pile driving noise.

4.2.1.6.4 Fish Stranding

Installation of cofferdams or silt curtains to isolate construction and dredging areas in CCF and the adjacent Old River channel has the potential to strand fish, resulting in direct injury and mortality of fish that become trapped inside the cofferdams or silt curtains. To minimize potential fish stranding losses, DWR will implement a fish rescue and salvage plan (Appendix 3.F *General Avoidance and Minimization* Measures, AMM8 *Fish Rescue and Salvage Plan*). This plan will be submitted to the fish and wildlife agencies (NMFS, USFWS, CDFW) for review and approval prior to implementation. The plan will identify appropriate procedures for excluding fish from the construction zones, where feasible, and procedures for collecting, holding, handling, and release for all in-water activities with the potential to entrap fish. All fish rescue and salvage operations will be conducted under the guidance of a qualified fish biologist. The biologist, in consultation with a designated agency biologist, will determine the appropriate fish collection and relocation methods based on site-specific conditions and construction methods. Collection methods may include seines, dip nets, and electrofishing if permitted.

4.2.1.6.4.1 Migrating Adults (December–March)

The timing of cofferdam and silt curtain installation (July 1–November 30) will avoid the primary longfin smelt adult migration season. Therefore, there will be little or no risk of stranding and potential take of migrating adults associated with stranding and/or fish rescue/savage activities.

4.2.1.6.4.2 Spawning Adults (Winter/Spring: December-March)

The timing of cofferdam and silt curtain installation (July 1–November 30) will avoid the primary longfin smelt spawning season. Therefore, there will be little or no risk of stranding and potential take of spawning adults associated with stranding and/or fish rescue/salvage activities.

4.2.1.6.4.3 Eggs/Embryos (December–April)

The timing of cofferdam and silt curtain installation (July 1–November 30) will avoid the primary longfin smelt incubation season. Therefore, there will be little or no risk of stranding and potential take of eggs/embryos associated with stranding.

4.2.1.6.4.4 Larvae/Young Juveniles (January–April)
The timing of cofferdam and silt curtain installation (July 1–November 30) will avoid the period when longfin smelt larvae/young juveniles may be present in CCF and the adjacent Old River channel. Therefore, there is no risk of stranding of larvae/young juveniles.

4.2.1.6.4.5 Juveniles (Year-Round)
Juvenile longfin smelt rear downstream of CCF and the adjacent south Delta channels and therefore are unlikely to be present during sheet pile installation (July 1-November 30). Therefore, there is no risk of stranding of juveniles.

4.2.1.6.5 Direct Physical Injury

Fish could be injured or killed by direct contact with equipment or materials during in-water construction activities in CCF and the adjacent Old River channel. Potential mechanisms include fish being crushed by rock (riprap), impinged by sheetpiles, entrained by dredges, or struck by propellers. In addition to the proposed in-water work period, DWR will implement a number of take minimization measures (described in Appendix 3.F *General Avoidance and Minimization Measures*) to minimize the potential for impacts on listed fish species, including AMM1 *Worker Awareness Training;* AMM4 *Erosion and Sediment Control Plan;* AMM6 *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material;* AMM7 *Barge Operations Plan;* AMM9 *Underwater Sound Control and Abatement Plan*, and AMM8 *Fish Rescue and Salvage Plan*.

4.2.1.6.5.1 Migrating Adults (December–March)
The timing of in-water construction activities (July 1–November 30) will avoid the primary longfin smelt adult migration season. Therefore, there is little or no risk of injury of migrating adults.

4.2.1.6.5.2 Spawning Adults (December–March)
The timing of in-water construction activities will avoid the primary longfin smelt spawning season. Therefore, there is little or no risk of injury of spawning adults.

4.2.1.6.5.3 Eggs/Embryos (December–April)
The timing of in-water construction activities will avoid the primary longfin smelt incubation season. Therefore, there is little or no risk of injury of eggs/embryos.

4.2.1.6.5.4 Larvae/Young Juveniles (January–May)
The timing of in-water construction activities will avoid the period when longfin smelt larvae/young juveniles may be present in CCF or the adjacent Old River channel. Therefore, there is no risk of injury of larvae/young juveniles.

4.2.1.6.5.5 Juveniles (Year-Round)
Juveniles rear downstream of CCF and the adjacent Old River channel and therefore are unlikely to come into direct contact with construction equipment or materials during in-water construction activities (July 1–November 30). Therefore, there is no risk of injury of juveniles.

4.2.1.6.6 Loss or Alteration of Habitat

As described in Section 4.1.1.5.6 *Loss or Alteration of Habitat*, potential impacts on aquatic habitat resulting from dredging and expansion of CCF and construction of the new water conveyance facilities at CCF include an estimated 1,932 acres of tidal perennial aquatic habitat that will be altered through changes in water quality, water depths, vegetation, and other physical components, and an estimated 258 acres of tidal perennial aquatic habitat in CCF that will be replaced by permanent fill and structures associated with the new CCPP, perimeter and divider embankments, outlet canals and siphons, and intake structure and spillway. Estimates of the amount of shallow water habitat potentially affected by construction are not currently available.

During construction, DWR will implement AMM2 *Construction Best Management Practices and Monitoring* (Appendix 3.F *General Avoidance and Minimization Measures*) to protect listed fish, wildlife, and plant species, and other sensitive natural communities. These BMPs include a number of measures to limit the extent of disturbance of aquatic and riparian habitat during construction, and, following construction, to restore temporarily disturbed areas to pre-construction conditions. All construction and site restoration BMPs will be subject to an approved construction and post-construction monitoring plan to ensure their effectiveness. Compensation for unavoidable impacts on aquatic habitat in CCF is not proposed because CCF is not considered suitable habitat for longfin smelt.

4.2.1.6.6.1 Migrating Adults (December–March)

The potential effects of habitat loss or alteration on migrating adult longfin smelt are expected to be similar to those described for Delta Smelt (Section 4.1.1.5.6.1 *Migrating Adults*). Potential increases in predation mortality of migrating adults are expected to have negligible effects on individual spawning success because of the low quality of existing habitat and limited spawning success of longfin smelt in CCF and the adjacent south Delta channels under existing conditions. Therefore, no population-level effects are expected.

4.2.1.6.6.2 Spawning Adults (December-March)

Similar to Delta Smelt, losses or alteration of aquatic habitat associated with dredging and expansion of CCF and construction of the new water conveyance facilities are expected to have negligible effects on individual spawning success of longfin smelt because of the low quality of existing habitat and limited spawning success of longfin smelt in CCF and the adjacent south Delta channels under existing conditions. No population-level effects are expected.

4.2.1.6.6.3 Eggs/Embryos (December–April)

Losses or alteration of aquatic habitat associated with dredging and expansion of CCF and construction of the new water conveyance facilities are expected to have negligible effects on individual spawning success of longfin smelt or the viability of eggs/embryos because of the low quality of spawning habitat and low likelihood of survival of longfin smelt in CCF and the adjacent south Delta channel under existing conditions. No population-level effects are expected.

4.2.1.6.6.4 Larvae/Young Juveniles (January–April)

Similar to Delta Smelt, losses or alteration of aquatic habitat associated with dredging and expansion of CCF and construction of the new water conveyance facilities are expected to have negligible effects on the survival of longfin smelt larvae/young juveniles because of the low likelihood of survival of longfin smelt in CCF and the adjacent south Delta channels under existing conditions. Therefore, no population-level effects are expected.

4.2.1.6.6.5 Juveniles (Year-Round)

Juvenile longfin smelt rear downstream of CCF and the adjacent south Delta channels and therefore are unlikely to be affected by losses or alteration of habitat. No population-level effects are expected.

4.2.2 Maintenance Effects

In-water maintenance of water facilities is not proposed for coverage under this Application (Section 3.1.6 *Take Authorization Requested*), and the only on-land maintenance activity proposed for coverage, transmission line maintenance, has no potential to affect longfin smelt. Thus, the following information is provided for context.

4.2.2.1 North Delta Diversions

Maintenance activities at the NDDs are described in Section 4.1.2.1 *North Delta Diversions*.

4.2.2.1.1 Migrating Adults (December–March)

The timing of in-water maintenance activities at the NDDs (June 1–October 31) will avoid the longfin smelt adult migration season. Therefore, no take of migrating adults is expected. Similar to Delta Smelt, potential predation on migrating adults related to changes in passage conditions at the sites (water depths and hydraulic conditions) are expected to have negligible effects on spawning population size because of the small fraction of shoreline that will be affected and the low proportion of the population that migrates and spawns in the reaches upstream of the intake locations.

4.2.2.1.2 Spawning Adults (December-March)

The timing of in-water maintenance activities at the NDDs (June 1–October 31) will avoid the longfin smelt spawning season. Therefore, no take of spawning adults is expected. Similar to Delta Smelt, spawning adults may be affected by loss or degradation of spawning habitat from sedimentation and modification of channel areas adjacent to the intakes that are periodically disturbed by dredging or levee repair activities. These changes are expected to have negligible effects on spawning success because of the low proportion of the population utilizing the north Delta, the low quality of spawning habitat in the affected reaches, and implementation of the take minimization measures described in Appendix 3.F *General Avoidance and Minimization Measures*.

4.2.2.1.3 Eggs/Embryos (December-April)

The timing of in-water maintenance activities at the NDDs (June 1–October 31) will avoid the longfin smelt incubation season. Therefore, no take of eggs/embryos is expected. Similar to Delta Smelt, eggs/embryos could be adversely affected by degradation of spawning habitat from sedimentation and modification of adjacent channel areas that are periodically disturbed by dredging or levee repair activities. These changes are expected to have negligible effects on spawning success because of the low proportion of the population utilizing the north Delta, the low quality of spawning habitat in the affected reaches, and implementation of the take minimization measures described in Appendix 3.F *General Avoidance and Minimization Measures*.

4.2.2.1.4 Larvae/Young Juveniles (January–May)

The timing of in-water maintenance activities at the NDDs (June 1–October 31) will avoid the primary months when longfin smelt larvae/young juveniles may be present in the lower Sacramento River. Therefore, there is little or no risk of take of larvae/young juveniles. Similar to Delta Smelt, potential predation on larvae/young juveniles related to changes in passage conditions at the intake sites (water depths and hydraulic conditions) are expected to have negligible population-level effects because of the small fraction of shoreline that will be affected and the low proportion of the population that migrates and spawns in the reaches upstream of the intake locations.

4.2.2.1.5 Juveniles (Year-Round)

Juvenile longfin smelt rear downstream of the proposed intakes and therefore will be unaffected by maintenance activities. No take of juveniles is expected.

4.2.2.2 Barge Landings

Maintenance activities at the barge landings are described in Section 4.1.2.2 *Barge Landings*.

4.2.2.2.1 Migrating Adults (December–March)

The timing of in-water maintenance activities at the barge landings (August 1–October 31) will avoid the longfin smelt adult migration season. Therefore, no take of migrating adults is expected. Similar to Delta Smelt, potential predation on migrating adults related to changes in passage conditions at the sites (water depths and hydraulic conditions) are expected to have negligible effects on spawning population size because of the low proportion of the population that migrates and spawns in the east and south Delta.

4.2.2.2.2 Spawning Adults (December-March)

The timing of in-water maintenance activities at the barge landings (August 1–October 31) will avoid the longfin smelt spawning season. Therefore, no take of spawning adults is expected. Similar to Delta Smelt, spawning adults may be affected by loss or degradation of spawning habitat from sedimentation and modification of channel areas adjacent to the intakes that are periodically disturbed by dredging or levee repair activities. These changes are expected to have negligible effects on spawning success because of the small proportion of adults that spawn in the east and south Delta, the low quality of spawning habitat at preferred sites for the barge landings, and implementation of the take minimization measures described in Appendix 3.F *General Avoidance and Minimization Measures*.

4.2.2.2.3 Eggs/Embryos (December–April)

The timing of in-water maintenance activities at the barge landings (August 1–October 31) will avoid the longfin smelt incubation season. Therefore, no take of eggs/embryos is expected. Similar to Delta Smelt, eggs/embryos could be adversely affected by degradation of potential spawning habitat from sedimentation and modification of adjacent channel areas that are periodically disturbed by dredging or levee repair activities. These changes are expected to have negligible effects on spawning success because of small proportion of adults that spawn in the east and south Delta, the low quality of spawning habitat at preferred sites for the barge landings, and implementation of the take minimization measures described in Appendix 3.F *General Avoidance and Minimization Measures*.

4.2.2.2.4 Larvae/Young Juveniles (January–May)

The timing of in-water maintenance activities at the barge landings (August 1–October 31) will avoid the period when longfin smelt larvae/young juveniles may be present in the east and south Delta. Therefore, no take of larvae/young juveniles is expected. Similar to Delta Smelt, potential predation on migrating adults related to changes in passage conditions at the sites (water depths and hydraulic conditions) are expected to have negligible effects on spawning population size because of the low proportion of the population that migrates and spawns in the east and south Delta.

4.2.2.2.5 Juveniles (Year-Round)

Juvenile longfin smelt rear downstream of the proposed barge landings and therefore will be unaffected by maintenance activities. No take of juveniles is expected.

4.2.2.3 Head of Old River Gate

Maintenance activities at the HOR gate are described in Section 4.1.2.3 *Head of Old River Gate*.

4.2.2.3.1 Migrating Adults (December–March)

The timing of in-water maintenance activities (August 1–November 30) will avoid the primary longfin smelt adult migration season. Therefore, there will be little or no risk of take of migrating adults. Potential adverse effects associated with habitat modification from dredging and other in-water maintenance activities will have a negligible effect on population abundance based on the small proportion of adults that may occur in this portion of their range, the low quality of existing habitat for spawning, and implementation of the take minimization measures described in Appendix 3.F *General Avoidance and Minimization Measures*.

4.2.2.3.2 Spawning Adults (December–March)

The timing of in-water maintenance activities (August 1–November 30) will avoid the primary longfin smelt spawning season. Therefore, there will be little or no risk of take of spawning adults. However, spawning adults may be affected by loss or degradation of spawning habitat from changes in water depths, substrate, and hydraulic conditions from sedimentation and direct disturbance of channel areas that are periodically disturbed by dredging or levee repair activities.

However, as described in Section 4.2.1.4.6 *Loss or Alteration of Habitat*, projected losses and alteration of aquatic habitat within the footprint of the HOR gate are not expected to significantly affect spawning habitat utilization or reproductive success of longfin smelt because of the low quality and likely low utilization of this area for spawning. No population-level effects are expected.

4.2.2.3.3 Eggs/Embryos (December–April)

The timing of in-water maintenance activities (August 1–November 30) will avoid the primary longfin smelt incubation season. Therefore, there will be little or no risk of take of eggs/embryos. Population-level effects will be insignificant based on the potential for exposure of spawning adults and habitat described above.

4.2.2.3.4 Larvae/Young Juveniles (January–May)

The timing of in-water maintenance activities (August 1–November 30) will avoid the potential occurrence of longfin smelt larvae/young juveniles within the vicinity of the HOR gate. Therefore, no take of larvae/young juveniles is expected. Potential adverse effects associated with habitat modification from dredging and other in-water maintenance activities will have an insignificant effect on population abundance based on the small proportion of adults that spawn in this portion of their range and implementation of the take minimization measures described in Appendix 3.F *General Avoidance and Minimization Measures*.

4.2.2.3.5 Juveniles (Year-Round)

Juvenile longfin smelt rear downstream of the HOR gate and therefore will be unaffected by maintenance activities. Not take of juveniles is expected.

4.2.2.4 Clifton Court Forebay

Maintenance activities at CCF are described in Section 4.1.2.4 *Clifton Court Forebay*.

4.2.2.4.1 Migrating Adults (December–March)

The timing of in-water maintenance activities at CCF (July 1–November 30) will avoid the primary longfin smelt adult migration season. Therefore, there will be little or no risk of take of migrating adults. Similar to Delta Smelt, potential adverse effects on migrating adults associated with habitat modification from dredging and other in-water maintenance activities will have a negligible effect on population abundance because of the small proportion of adults that spawn in the east and south Delta, the low likelihood of survival of longfin smelt in CCF, and implementation of the take minimization measures described in Appendix 3.F *General Avoidance and Minimization Measures*.

4.2.2.4.2 Spawning Adults (December–March)

The timing of in-water maintenance activities at CCF (July 1–November 30) will avoid the primary longfin smelt adult migration season. Therefore, there will be little or no risk of take of spawning adults. Similar to Delta Smelt, potential adverse effects on spawning adults associated with habitat modification from dredging and other in-water maintenance activities will have a negligible effect on population abundance because of the small proportion of adults that spawn in the east and south Delta, the low likelihood of survival of longfin smelt in CCF, and implementation of the take minimization measures described in Appendix 3.F *General Avoidance and Minimization Measures*.

4.2.2.4.3 Eggs/Embryos (December–April)

The timing of in-water maintenance activities at CCF (July 1–November 30) will avoid the primary longfin smelt incubation season. Therefore, there will be little or no risk of take of eggs/embryos. Similar to Delta Smelt, potential adverse effects on eggs/embryos associated with habitat modification from dredging and other in-water maintenance activities will have a negligible effect on population abundance because of the small proportion of adults that spawn in the east and south Delta, the low likelihood of survival of longfin smelt in CCF, and implementation of the take minimization measures described in Appendix 3.F *General Avoidance and Minimization Measures*.

4.2.2.4.4 Larvae/Young Juveniles (January–May)

The timing of in-water maintenance activities at CCF (July 1–November 30) will avoid the period when longfin smelt larvae/young juveniles may be present in the east and south Delta. Therefore, no take of larvae/young juveniles is expected. Similar to Delta Smelt, potential adverse effects on larvae/young juveniles associated with habitat modification from dredging and other in-water maintenance activities will have a negligible effect on population abundance because of the small proportion of adults that spawn in the east and south Delta, the low likelihood of survival of longfin smelt in CCF, and implementation of the take minimization measures described in Appendix 3.F *General Avoidance and Minimization Measures*.

4.2.2.4.5 Juveniles (Year-Round)

Juvenile longfin smelt rear downstream of CCF and therefore will be unaffected by maintenance activities. No take of juveniles is expected.

4.2.3 Operations Effects

This section focuses on operations of the PP related to two categories of important potential effects on Longfin Smelt: Delta outflow/X2 effects and entrainment/south Delta entry effects. Other operational effects on Longfin Smelt, such as those discussed for Delta Smelt in Section 4.1.3 *Operations Effects*, are addressed in Section 4.2.6 *Take Analysis*.

4.2.3.1 Delta Outflow/X2 Effects

Freshwater flow influences the physical, chemical, and biological characteristics of estuarine environments (Kimmerer 2002). In the upper San Francisco Estuary, ecosystem services that have been found to vary with flow include primary production (Jassby et al. 2008), secondary production (Kimmerer et al. 2009), and habitat for pelagic fishes (Feyrer et al. 2007). Additionally, flow has been found to be positively related to survival, growth, and population levels of many key estuarine species, including Chinook salmon (Newman and Brandes 2010), Longfin Smelt (Rosenfield and Baxter 2007), and Delta Smelt (Feyrer et al. 2007; Feyrer et al. 2011).

For Longfin Smelt, focus on estuarine inflow has centered on the positive relationship found between winter/spring outflow (January to June) and juvenile abundance during the fall (Rosenfield and Baxter 2007; Kimmerer et al. 2009). Specifically, as X2 (the position of the 2-ppt near-bottom salinity isohaline from the Golden Gate Bridge; see Jassby et al. [1995]) shifts downstream during the winter/spring, the abundance index of Longfin Smelt in the following Fall Midwater Trawl (FMWT) survey increases (Kimmerer 2002; Kimmerer et al. 2009). The mechanisms underlying this relationship are poorly understood; however, the significant X2-abundance relationship suggests that higher outflow (lower X2) or conditions associated with wetter hydrological conditions produce conditions that enhance recruitment to juvenile life stages. Hypotheses about underlying mechanisms to this X2-abundance relationship include transport of larval Longfin Smelt out of the Delta to downstream rearing habitats (Moyle 2002; Rosenfield and Baxter 2007); increased extent of rearing habitat as X2 moves seaward (Kimmerer et al. 2009); retention of larvae in suitable rearing habitats (Kimmerer et al. 2009); increased food abundance under higher flows (California Department of Fish and Game 2009a); and reduced clam grazing effects on primary and secondary production (California Department of Fish and Game 2009a). With respect to habitat size for early life stages, new information indicates that the distribution of spawning and early life stages may be broader than previously thought, including low-salinity areas (Grimaldo et al. in review). It has also been recognized that abundance of adults (spawners) is an important factor driving Longfin Smelt population dynamics (Baxter et al. 2010), with recent studies examining this link in detail (Maunder et al. 2015; Nobriga and Rosenfield 2016); this factor is discussed further following the analysis of potential outflow/X2 effects.

Changes in outflow associated with the proposed project (PP) could affect Longfin Smelt in accordance with X2-abundance relationships (Kimmerer et al. 2009; recently updated by Mount et al. 2013). Specifically, the log abundance values represent a relative survival index which, when reverse log-transformed, indicates how the PP might influence numbers of Longfin Smelt surviving until the following fall (expressed as a relative abundance index). For this analysis of potential PP effects, an update of the X2-abundance regression conducted by Kimmerer et al. (2009) and Mount et al. (2013) was undertaken; the regression (general linear model, GLM) predicts the $\log_{10}$ (Longfin Smelt fall midwater trawl index) as a function of mean January-June X2 and step changes for the introduction of *Potamocorbula amurensis* and the Pelagic Organism Decline (POD). The method and detailed results of the analysis are presented in Appendix 4.A *Longfin Smelt Quantitative Analyses*[3]. Overall, the analysis finds that relative abundance indices do not differ greatly between the baseline condition (NAA) and PP scenarios (Appendix 4.A: Figure 4.A-2, Figure 4.A-3, and Table 4.A-2). The mean relative abundance indices in wet, above normal, and below normal years were very similar (1% higher or lower under PP), whereas there were slightly greater differences in mean relative abundance in critical years (3% less under PP) and dry years (4% less under PP). These results reflect similar or slightly higher mean X2 (slightly less Delta outflow) under the PP during the January–June period (see ICF International [2016]: Table 5.A.6-29 and Figures 5.A.6.29-1 to 5.A.6.29-19 in Appendix 5.A

[3] CalSim modeling methods and results for the NAA and PP are presented in ICF International (2016), Appendix 5.A *CalSim II Modeling and Result*s.

*CalSim II Modeling and Result*s). Note that the differences in relative abundance index between NAA and PP in all years were small compared to the range in the 95% prediction intervals for the X2-abundance GLM; the 95% prediction intervals in the relative abundance indices overlapped in all years (Appendix 4.A: Figure 4.A-4). This suggests that the small magnitude of difference in relative abundance index between NAA and PP scenarios would be challenging to detect statistically. However, as noted in the independent review panel report for the working draft BA, it is possible that the true annual values for the fall midwater trawl index could lie near the bottom boundary of the prediction interval for PP and near the top boundary of the prediction interval for NAA (Simenstad et al. 2016). This would result in greater differences than suggested by the comparison of annual mean values. By the same rationale, it is also possible that the true annual values could lie near the top boundary of the prediction intervals for both PP and NAA, in which case the differences would be more similar to the differences between means.

Although the differences in mean relative abundance predicted from applying the X2-abundance GLM suggested at most small negative effects of the PP relative to NAA, in theory small differences could accumulate over time: as previously noted, adult abundance affects subsequent juvenile abundance (stock-recruitment relationships; Nobriga and Rosenfield 2016), so an effect of outflow/X2 on juvenile and subsequent adult abundance could then affect the number of recruits derived from those adults. Ideally, population dynamics (life cycle) models would be applied to investigate the potential for this type of effect. Two recent published works have investigated such models. A state-space modeling study by Maunder et al. (2015) found that multiple factors (flow, ammonium concentration, and water temperature) and density dependence influenced the survival of Longfin Smelt (represented by Bay Study abundance indices during 1980–2009). However, the flow terms included in their best models are not affected by the PP: Sacramento River October–July unimpaired runoff and Napa River runoff. A quantitative forward stepwise selection procedure found that the Longfin Smelt response data better supported these flow terms over others that were initially considered, including mean Old and Middle River flows (January–March), mean X2 (April–June), mean Delta outflow (January–March), and Delta outflow threshold indicators (March–May mean >34,500 cfs and >44,500 cfs) (Maunder and Deriso 2013). Therefore, the state-space modeling of Maunder et al. (2015) would not be useful for investigating year-over-year effects of the PP because the best supported models suggested general hydrological conditions, as opposed to specific Delta conditions that could be affected by operations, better supported the pattern of Longfin Smelt survival in 1980–2009.

The other recently published Longfin Smelt population dynamics modeling study is that of Nobriga and Rosenfield (2016), who examined various formulations of a Ricker (1954) stock-recruitment model to simulate fall midwater trawl indices through time. They found that Delta outflow had a positive association with recruits per spawner and that juvenile survival was density-dependent (lower survival with greater numbers of juveniles), possibly as a result of processes occurring in the mesohaline or marine environments where juveniles predominantly rear. Nobriga and Rosenfield (2016: 54) suggested that the density-dependent term in their models was too strong, and the propagated prediction error in the models was large. In the context of potential use in the present take analysis of the PP, this latter issue would be likely to generate highly overlapping estimates of Longfin Smelt indices between the NAA and PP. Nobriga and Rosenfield (2016: 56) discussed their findings in relation to density dependence as follows:

> The results suggest that the general life cycle model for Longfin Smelt is very similar to striped bass *Morone saxatilis* (Kimmerer et al. 2000). For each of these species, freshwater flow variation has been linked to productivity early in the life cycle—an effect that is subsequently tempered by density-dependent survival during the juvenile life stage. Density-dependent survival may seem paradoxical in a declining fish species like the Longfin Smelt, but fisheries recruitment theory has demonstrated how a spawner–recruit relationship that appears to reflect density dependence can arise from food-web-related mechanisms that are unrelated to a population's limitation of its own resource base (Walters and Juanes 1993).

The "tempering" of the Delta outflow effect referred to by Nobriga and Rosenfield (2016) suggests that the small differences in Longfin Smelt abundance indices (i.e., recruitment) between NAA and PP that were estimated in the present take analysis may not accumulate over time; rather, the differences would be lessened by density-dependent effects during the juvenile life stage. Nevertheless, given the species' current historic low fall midwater trawl abundance index (the 2015 index was the lowest yet recorded), there remains concern regarding the potential for somewhat higher winter/spring X2 under the PP to jeopardize the species. To address this concern, spring outflow criteria for the PP have been developed in collaboration with DFW. These criteria are discussed in Section 4.2.7.2 *Potential to Jeopardize Continued Existence of the Species*.

4.2.3.2 Entrainment and South Delta Entry

There is potential for the PP to take Longfin Smelt through entrainment by water diversions in the Delta, including the south Delta export facilities and the proposed NDD, and to alter Delta channel hydrodynamics such that there is a changed likelihood of entry into the south Delta, where survival may be lower. Of particular concern is the potential for take of Longfin Smelt larvae during winter (January–March). With respect to the NDD, survey data suggest that the frequency of occurrence of Longfin Smelt near the NDD is very low (Table 4.2-1, Table 4.2-2, Table 4.2-3, and Table 4.2-4), although there are no suitable recent data to provide an estimate of the relative density of Longfin Smelt larvae near the NDD compared to other areas of the Delta and downstream of the Delta.

As with Delta Smelt, additional data from Kodiak trawling were considered to provide perspective on Longfin Smelt occurrence near the NDD. Data considered for the intake reach include the USFWS Sacramento River trawl location at Sherwood Harbor, as well as the DFW Spring Kodiak Trawl (SKT) survey station in the Sacramento River at Ryde. The remaining SKT stations were considered as downstream comparison stations, and were grouped into geographic areas, described further below. It is acknowledged that the locations of Sherwood Harbor (~river mile 55) and Ryde (~river mile 24) are quite far upstream and downstream from the proposed NDD locations (~river miles 38–41), and that the Ryde sampling intensity is low (once per month), but these data may be more representative of Longfin Smelt distribution than the seine surveys because of the open-water nature of the species[4]. Kodiak trawl data were examined for

[4] As discussed for Delta Smelt, Longfin Smelt may need to use the margins of the river channel more in riverine areas; this could make them more susceptible to capture by seines in the vicinity of the NDD.

December–February (January–February for the SKT) to reflect the seasonality of upstream Longfin Smelt occurrence, and no size restriction was placed in the summary of the data because the gear captures principally adult Longfin Smelt. Sherwood Harbor data for 2002–2016 showed that during December–February Longfin Smelt were caught infrequently in each year (0 percent–1 percent of trawls), with low mean density (0.00–0.03 fish per 10,000 m^3 trawled) (Table 4.2-5). The same was true at Ryde, for which Longfin Smelt were never caught (Table 4.2-6). In contrast, the density and frequency of occurrence in some of the other areas was greater, although frequency of occurrence was relatively low in most areas. Longfin Smelt were collected in a number of years in the Confluence/Honker Bay and lower Sacramento River; occurrence and density was greatest in the Suisun Marsh/Grizzly Bay and West Suisun Bay areas, suggesting a relatively downstream distribution. The low density and frequency of occurrence at Ryde and Sherwood Harbor was of similar magnitude to density and frequency of occurrence in the East/South Delta and lower San Joaquin River.

An analysis was undertaken based on Smelt Larval Survey (SLS) data from 2009-2014, combined with DSM2-PTM (particle tracking modeling) results, in order to compare potential Longfin Smelt potential entrainment loss for the NAA and PP scenarios. The method and detailed results are provided in Section 4.A.2 *Particle Tracking Modeling of Larval Entrainment and South Delta Entry* in Appendix 4.A[5]. Note that the estimates of entrainment from the analysis are not predictions of actual percentages of the larval Longfin Smelt population that will be entrained, but instead are a comparison of potential relative differences between two operational scenarios, which is assumed to be a surrogate for risk of take. Discussion of the potential absolute percentage of larvae entrained is provided in Section 4.2.6.3.1 *North Delta Exports* and Section 4.2.6.3.2 *South Delta Exports*. It is important to recognize that operational adjustments could be further evaluated once more information is gathered about the relative proportions of larvae entrained. Based on methods applied in Section 4.A.2 of Appendix 4.A, where the distribution of newly hatched larvae from the Smelt Larval Survey were analyzed, the relative proportion of larval Longfin Smelt hatching and rearing in the south and north Delta is smaller than previously assumed in the SWP Incidental Take Permit effects analysis (California Department of Fish and Game 2009b); the latter analysis focused on distribution only in the Delta (based on 1991-1994 and 2005 California Department of Fish and Game larval sampling), whereas the present analysis includes consideration of more locations based on SLS data. Operational adjustments would be made in order to minimize the potential for take of Longfin Smelt and other fishes, based on real-time biological and physical monitoring; such adjustments cannot be readily simulated in this analysis. The results of the DSM2-PTM analysis indicate that larval Longfin Smelt entrainment under PP would be less than under NAA, particularly in wetter years when the NDD would be less constrained in terms of operations (Appendix 4.A: Figure 4.A-7 and Figure 4.A-8; Figure 4.A-9 and Figure 4.A-10; Figure 4.A-11 and Figure 4.A-12). Predicted mean annual total entrainment under PP ranges from 1% less than NAA in February of dry years and March of critical years to 35% less than NAA in January of below normal years (Appendix 4.A: Table 4.A-7). As described in Section 4.A.2.2.1 *Entrainment* of Appendix 4.A, most entrainment is estimated to occur at the NBA because of the larval distribution assumed in the analysis, whereas the relative differences in entrainment by the south Delta export facilities between NAA and PP are considerably greater than the relative differences in total entrainment.

[5] In addition, DSM2 modeling methods and results for the NAA and PP are provided in ICF International (2016: Appendix 5.B *DSM2 Modeling and Results*).

The analysis of the potential for Longfin Smelt larvae to enter the south Delta, where survival is expected to be low, suggests that there would be appreciably less entry into the south Delta under PP than under NAA (Appendix 4.A: Figure 4.A-13, Figure 4.A-14, and Table 4.A-8; Figure 4.A-15 and Figure 4.A-16; Figure 4.A-17 and Figure 4.A-18). Thus the PP is expected to provide improved hydrodynamic conditions for Longfin Smelt larvae occurring in the Delta as a result of less south Delta exports. This general pattern was also confirmed by an analysis of the percentage of particles reaching Chipps Island, for which a greater percentage of particles reached Chipps Island under the PP in January, with less difference between PP and NAA in February and March. The extent of the differences between NAA and PP is difficult to accurately predict given the real-time operational decisions involving fish distribution and other factors (e.g., prevailing flows and operations) that would occur.

As discussed in Section 4.A.2.1.3, *Note on Proportion of Larval Population Outside the Delta and Suisun Bay/Marsh*, in Appendix 4.A, the SLS likely samples a narrow window of the actual Longfin Smelt hatching distribution, especially during wetter years. Thus, the effects of entrainment are likely smaller than previously suggested (e.g., in species status assessments such as that by California Department of Fish and Game 2009a), but not non-existent. Because there is little difference in X2 between NAA and the PP during winter spawning months (see Table 5.A.6-29 and Figures 5.A.6.29-1 to 5.A.6.29-19 in ICF International [2016] Appendix 5.A *CalSim II Modeling and Result*s), the PP is not likely to affect spawning habitat distribution during most years and, as previously noted, there is little evidence for considerable differences in larval distribution between the recent years included in the SLS (Table 4.A-5 in Appendix 4.A). With increasing sea level, adult Longfin Smelt moving upstream to spawn could be distributed farther upstream in response to a salinity field that is farther upstream. However, Grimaldo et al. (2009) found that adult Longfin Smelt salvage at the south Delta export facilities was significantly negatively related to mean December–February Old and Middle River flows, but not to X2 (or other variables that were examined). Given that Old and Middle River flows during December–February would be less negative/more positive under the PP than under NAA (see ICF International [2016], Appendix 5.A *CalSim Modeling and Results*, specifically Table 5.A.6-25 and Figures 5.A.6-25-1 to 5.A.6-25-7), any take of Longfin Smelt adults during this time period would be expected to be less under the PP than NAA. In addition, and as previously noted, both NAA and PP would, as now, include real-time management of south Delta exports and Old and Middle River flows in order to limit the potential for entrainment of Longfin Smelt and other listed fishes; such adjustments cannot be readily simulated.

As shown in Section 4.A.2.2.4, *Particles Remaining in the Modeling Domain*, of Appendix 4.A, the percentage of particles remaining in the DSM2-PTM modeling domain after the 45-day simulation period ranged from around 2 to 20% or more, reflecting particles that were not entrained or did not reach Martinez, the downstream extent of the domain, for example. Some of these particles remain in the south Delta area and indicate that conditions could occur wherein larvae and young juveniles remain in areas where they are susceptible to entrainment as they transition to become juveniles. Grimaldo et al. (2009) found that juvenile Longfin Smelt salvage principally occurred in April–May, and was significantly negatively related to mean April–May Old and Middle River flow (and was not related to other factors such as X2). An analysis of potential differences between NAA and PP in terms of entrainment (salvage) was undertaken by recreating and applying the Grimaldo et al. (2009) relationship between salvage and Old and Middle River flows (see Section 4.A.3 *Salvage-Old and Middle River Flow Regression*). From this analysis, salvage was estimated to be lower in wetter water years under the PP than NAA, whereas salvage in drier years under the PP was estimated to be similar to NAA or greater (Table 4.A-11, Figure 4.A-31, and Figure 4.A-32 in Section 4.A.3 *Salvage-Old and Middle River Flow Regression*). Note that the differences in estimated salvage between NAA and PP in all years were small compared to the range in the 95% prediction intervals for the salvage-Old and Middle River flow GLM; the 95% prediction intervals in the relative abundance indices overlapped in all years (Appendix 4.A: Figure 4.A-33). As noted in the independent review panel report for the working draft BA, it is possible that the true annual values for the salvage could lie near the top boundary of the prediction interval for PP and near the bottom boundary of the prediction interval for NAA (Simenstad et al. 2016). This would result in greater differences than suggested by the comparison of annual mean values. By the same rationale, it is also possible that the true annual values could lie near the top boundary of the prediction intervals for both PP and NAA, in which case the differences would be more similar to the differences between means.

The reasons for potential juvenile Longfin Smelt salvage being estimated to be greater under the PP than NAA in drier years are explored in Appendix 4.A, Section 4.A.3 *Salvage-Old and Middle River Flow Regression*. This shows that for years where April and May Old and Middle River flows are less under the PP than NAA, HOR gate operations (which reduce Old River flow under the PP) drive the Old and Middle River flow differences in most years; only in April of two years (1960 and 1987) did appreciably greater south Delta exports occur under the PP (~2,000 cfs, compared to ~1,000 cfs under NAA), likely as a result of different San Luis rule curve assumptions between NAA and PP. As previously noted in the discussion of larval and adult Longfin Smelt entrainment, both NAA and PP would include real-time management of south Delta exports and Old and Middle River flows in order to limit the potential for entrainment of Longfin Smelt and other listed fishes; this management would include consideration of HOR gate operations. As noted for Delta Smelt in Section 4.1.3.4.1 *Migrating Adults (December–March)*, the general improvements to OMR flows because of less south Delta exports, combined with the flexibility to manage the proposed HOR gate in real time will limit the potential for take of Longfin Smelt. If necessary, opening and closing of the HOR gate could be done in consideration of the most recent fish distribution information (e.g., Spring Kodiak Trawl or 20-mm Survey) as well as simulation (e.g., PTM) modeling of the likely effects of the HOR gate operational switches; adjustments to south Delta exports could then be done accordingly to avoid short-term increases in entrainment.

As noted in the DFG (2009b) effects analysis for the SWP ITP, flow in the San Joaquin River past Jersey Point (QWEST) is an important factor influencing the potential for entrainment at the SWP/CVP south Delta export facilities, and QWEST flows may influence the position of Longfin Smelt spawning and rearing in the Delta. Flows in the San Joaquin River at Jersey Point (as represented by DSM2-HYDRO output for RSAN018) generally would be similar or greater under the PP compared to NAA during the winter/spring period of relevance to Longfin Smelt occurrence in the Delta (Table 4.2-7). This suggests that under the PP the potential effects on Longfin Smelt generally would be more favorable with respect to QWEST flows.

Table 4.2-1. Number of Longfin Smelt Collected and Catch per Trawl during the Fall Midwater Trawl Survey (September–December)

	Number of Samples		Total Caught		Proportion	Mean Catch Per Trawl	
Year	Intake Area	Downstream Area	Intake Area	Downstream Area	(Intake Area/Total)	Intake Area	Downstream Area
1991	9	590	0	223	0.00	0.00	0.38
1992	21	685	0	74	0.00	0.00	0.11
1993	18	875	0	668	0.00	0.00	0.76
1994	24	805	0	1006	0.00	0.00	1.25
1995	21	713	0	2799	0.00	0.00	3.93
1996	22	719	0	1943	0.00	0.00	2.70
1997	18	626	0	604	0.00	0.00	0.96
1998	6	509	0	4958	0.00	0.00	9.74
1999	12	532	0	2644	0.00	0.00	4.97
2000	13	581	0	2472	0.00	0.00	4.25
2001	21	628	0	1122	0.00	0.00	1.79
2002	9	356	0	473	0.00	0.00	1.33
2003	12	359	0	322	0.00	0.00	0.90
2004	12	357	0	115	0.00	0.00	0.32
2005	12	359	0	46	0.00	0.00	0.13
2006	8	351	0	275	0.00	0.00	0.78
2007	12	360	0	9	0.00	0.00	0.03
2008	12	356	0	78	0.00	0.00	0.22
2009	12	382	0	49	0.00	0.00	0.13
2010	12	384	0	50	0.00	0.00	0.13

Source: California Department of Fish and Game unpublished data. Note: Intake Area includes all stations on the Sacramento River upstream of the Delta Cross Channel. Downstream Area includes all other stations.

Table 4.2-2. Number of Longfin Smelt (<60 mm Fork Length) Collected and Catch per Seine during USFWS Seine Sampling in the Plan Area (January–December)

Year	Number of Samples		Total Caught (Intake Area)	Total Caught (Downstream Area)	Proportion Caught (Intake Area/Total)	Catch per Seine (Intake Area)	Catch per Seine (Downstream)
	Intake Area	Down-stream					
1976	29	126	0	0	–	0.00	0.00
1977	118	190	0	0	–	0.00	0.00
1978	72	147	0	0	–	0.00	0.00
1979	95	363	0	0	–	0.00	0.00
1980	104	440	0	31	0.00	0.00	0.07
1981	93	308	0	0	–	0.00	0.00
1982	101	321	0	0	–	0.00	0.00
1983	66	267	0	0	–	0.00	0.00
1984	66	256	0	0	–	0.00	0.00
1985	59	230	0	0	–	0.00	0.00
1986	33	168	0	0	–	0.00	0.00
1987	44	172	0	0	–	0.00	0.00
1988	43	164	0	0	–	0.00	0.00
1989	49	202	0	0	–	0.00	0.00
1990	19	52	0	0	–	0.00	0.00
1991	44	152	0	0	–	0.00	0.00
1992	103	338	0	0	–	0.00	0.00
1993	149	413	0	9	0.00	0.00	0.02
1994	215	731	1	1	0.50	0.00	0.00
1995	497	645	0	7	0.00	0.00	0.01
1996	646	782	0	0	–	0.00	0.00
1997	444	693	0	0	–	0.00	0.00
1998	360	782	0	2	0.00	0.00	0.00
1999	323	854	0	0	–	0.00	0.00
2000	372	826	0	1	0.00	0.00	0.00
2001	364	924	0	0	–	0.00	0.00
2002	331	1070	1	3	0.25	0.00	0.00
2003	332	1014	0	1	0.00	0.00	0.00
2004	359	1015	0	0	–	0.00	0.00
2005	386	1006	0	3	0.00	0.00	0.00
2006	324	928	0	0	–	0.00	0.00
2007	360	994	0	1	0.00	0.00	0.00
2008	341	950	0	0	–	0.00	0.00
2009	358	970	0	0	–	0.00	0.00
2010	359	850	0	0	–	0.00	0.00
2011	347	852	0	0	–	0.00	0.00
Mean	222	561	0	2	0.08	0.00	0.00
5th percentile	32	142	0	0	0.00	0.00	0.00
25th percentile	66	223	0	0	0.00	0.00	0.00
Median	182	543	0	0	0.00	0.00	0.00
75th percentile	359	872	0	1	0.00	0.00	0.00
95th percentile	457	1014	0	8	0.39	0.00	0.01

Source: U.S. Fish and Wildlife Service Delta Juvenile Fish Monitoring Program (Speegle pers. comm.). Note: Intake Area includes all stations on the Sacramento River upstream of the Delta Cross Channel. Downstream Area includes all other stations.

Table 4.2-3. Number of Longfin Smelt (≥60 mm Fork Length) Collected and Catch per Seine during USFWS Seine Sampling in the Plan Area (January–December)

Year	Number of Samples: Intake Area	Number of Samples: Downstream	Total Caught (Intake Area)	Total Caught (Downstream Area)	Proportion Caught (Intake Area/Total)	Catch per Seine (Intake Area)	Catch per Seine (Downstream)
1976	29	126	0	0	–	0.00	0.00
1977	118	190	0	0	–	0.00	0.00
1978	72	147	0	0	–	0.00	0.00
1979	95	363	0	15	0.00	0.00	0.04
1980	104	440	0	1	0.00	0.00	0.00
1981	93	308	0	0	–	0.00	0.00
1982	101	321	0	1	0.00	0.00	0.00
1983	66	267	0	0	–	0.00	0.00
1984	66	256	0	0	–	0.00	0.00
1985	59	230	0	0	–	0.00	0.00
1986	33	168	0	0	–	0.00	0.00
1987	44	172	0	0	–	0.00	0.00
1988	43	164	0	0	–	0.00	0.00
1989	49	202	0	0	–	0.00	0.00
1990	19	52	0	0	–	0.00	0.00
1991	44	152	0	0	–	0.00	0.00
1992	103	338	0	0	–	0.00	0.00
1993	149	413	0	0	–	0.00	0.00
1994	215	731	1	0	1.00	0.00	0.00
1995	497	645	0	0	–	0.00	0.00
1996	646	782	0	8	0.00	0.00	0.01
1997	444	693	0	0	–	0.00	0.00
1998	360	782	1	0	1.00	0.00	0.00
1999	323	854	0	0	–	0.00	0.00
2000	372	826	0	0	–	0.00	0.00
2001	364	924	0	0	–	0.00	0.00
2002	331	1070	0	0	–	0.00	0.00
2003	332	1014	0	0	–	0.00	0.00
2004	359	1015	0	0	–	0.00	0.00
2005	386	1006	0	0	–	0.00	0.00
2006	324	928	0	0	–	0.00	0.00
2007	360	994	0	0	–	0.00	0.00
2008	341	950	0	0	–	0.00	0.00
2009	358	970	0	0	–	0.00	0.00
2010	359	850	0	0	–	0.00	0.00
2011	347	852	0	0	–	0.00	0.00
Mean	222	561	0	1	0.33	0.00	0.00
5th percentile	32	142	0	0	0.00	0.00	0.00
25th percentile	66	223	0	0	0.00	0.00	0.00
Median	182	543	0	0	0.00	0.00	0.00
75th percentile	359	872	0	0	0.75	0.00	0.00
95th percentile	457	1014	0	3	1.00	0.00	0.00

Source: U.S. Fish and Wildlife Service Delta Juvenile Fish Monitoring Program (Speegle pers. comm.). Note: Intake Area includes all stations on the Sacramento River upstream of the Delta Cross Channel. Downstream Area includes all other stations.

Table 4.2-4. Number of Longfin Smelt Larvae Collected and Catch per Cubic Meter during the Striped Bass Egg and Larval Survey (February–July)

Water Year	Number of Samples		Total Caught (Intake Area)	Total Caught (Downstream Area)	Proportion Caught (Intake Area/Total)	Catch per Cubic Meter (Intake Area)	Catch per Cubic Meter (Downstream)
	Intake Area	Downstream					
1991	217	1371	38	2333	0.02	0.17	9.65
1992	355	2064	2	2497	0.00	0.01	10.18
1993	261	2160	3	2632	0.00	0.01	12.30
1994	312	2348	2	22233	0.00	0.01	97.17
Mean	286	1986	11	7424	0.00	0.05	32.32

Source: California Department of Fish and Game unpublished data. Note: Intake Area includes all stations on the Sacramento River upstream of the Delta Cross Channel. Downstream Area includes all other stations.

Table 4.2-5. Density and Frequency of Occurrence of Longfin Smelt in Kodiak Trawls at Sherwood Harbor (December–February).

Year	Number of Trawls	Density (Number Per 10,000 m^3 ± S.D.)	Frequency of Occurrence
2002	330	0.03 (± 0.32)	1%
2003	335	0.00 (± 0.00)	0%
2004	332	0.00 (± 0.05)	0%
2005	394	0.00 (± 0.00)	0%
2006	292	0.00 (± 0.00)	0%
2007	454	0.00 (± 0.00)	0%
2008	362	0.00 (± 0.00)	0%
2009	349	0.00 (± 0.00)	0%
2010	317	0.00 (± 0.00)	0%
2011	325	0.00 (± 0.00)	0%
2012	376	0.00 (± 0.07)	0%
2013	373	0.00 (± 0.00)	0%
2014	520	0.00 (± 0.00)	0%
2015	380	0.00 (± 0.00)	0%
2016	431	0.00 (± 0.00)	0%

Source: Speegle (pers. comm.) and https://www.fws.gov/lodi/juvenile_fish_monitoring_program/data_management/Sacramento_Trawls_CHN_&_POD_Species_2012-2016.xlsx. Accessed: September 14, 2016.

Table 4.2-6. Density and Frequency of Occurrence of Longfin Smelt in Spring Kodiak Trawls (January–February).

Area	Year	Number of Trawls	Density (Number Per 10,000 m^3 ± S.D.)	Frequency of Occurrence
Confluence/ Honker Bay (stations 501, 504, 508, 513, 519, 520)	2002	12	5.74 (± 10.95)	75%
	2003	12	0.46 (± 1.14)	17%
	2004	12	1.06 (± 2.22)	25%
	2005	12	0.00 (± 0.00)	0%
	2006	12	0.00 (± 0.00)	0%
	2007	12	0.46 (± 1.14)	17%
	2008	12	0.17 (± 0.57)	8%
	2009	12	0.16 (± 0.54)	8%
	2010	12	0.28 (± 0.66)	17%
	2011	12	0.00 (± 0.00)	0%
	2012	12	0.22 (± 0.77)	8%
	2013	12	0.00 (± 0.00)	0%
	2014	12	0.00 (± 0.00)	0%
	2015	12	0.12 (± 0.43)	8%
	2016	12	0.00 (± 0.00)	0%
East/South Delta (stations 902, 906, 910, 912, 914, 915, 919, 920, 921, 922, 923)	2002	19	0.00 (± 0.00)	0%
	2003	22	0.00 (± 0.00)	0%
	2004	17	0.00 (± 0.00)	0%
	2005	22	0.00 (± 0.00)	0%
	2006	22	0.00 (± 0.00)	0%
	2007	22	0.00 (± 0.00)	0%
	2008	22	0.00 (± 0.00)	0%
	2009	21	0.00 (± 0.00)	0%
	2010	22	0.00 (± 0.00)	0%
	2011	22	0.00 (± 0.00)	0%
	2012	22	0.00 (± 0.00)	0%
	2013	22	0.00 (± 0.00)	0%
	2014	22	0.00 (± 0.00)	0%
	2015	21	0.00 (± 0.00)	0%
	2016	22	0.00 (± 0.00)	0%
Lower Sacramento River (stations 704, 706, 707)	2002	6	1.50 (± 3.67)	17%
	2003	6	0.00 (± 0.00)	0%
	2004	6	0.22 (± 0.54)	17%
	2005	6	0.00 (± 0.00)	0%
	2006	6	0.29 (± 0.70)	17%
	2007	6	0.00 (± 0.00)	0%
	2008	6	1.05 (± 1.27)	50%

Area	Year	Number of Trawls	Density (Number Per 10,000 m^3 ± S.D.)	Frequency of Occurrence
	2009	6	0.23 (± 0.57)	17%
	2010	6	0.00 (± 0.00)	0%
	2011	6	1.80 (± 3.23)	33%
	2012	6	0.00 (± 0.00)	0%
	2013	6	0.00 (± 0.00)	0%
	2014	6	0.00 (± 0.00)	0%
	2015	6	0.00 (± 0.00)	0%
	2016	6	0.00 (± 0.00)	0%
Lower San Joaquin River (stations 801, 804, 809, 812, and 815)	2002	10	0.00 (± 0.00)	0%
	2003	10	0.00 (± 0.00)	0%
	2004	10	0.00 (± 0.00)	0%
	2005	10	0.00 (± 0.00)	0%
	2006	10	0.00 (± 0.00)	0%
	2007	10	0.00 (± 0.00)	0%
	2008	10	0.00 (± 0.00)	0%
	2009	10	0.00 (± 0.00)	0%
	2010	10	0.00 (± 0.00)	0%
	2011	10	0.00 (± 0.00)	0%
	2012	10	0.00 (± 0.00)	0%
	2013	10	0.18 (± 0.58)	10%
	2014	10	0.00 (± 0.00)	0%
	2015	10	0.00 (± 0.00)	0%
	2016	10	0.00 (± 0.00)	0%
North Delta (stations 711, 712, 713, 715, 716, and 719)	2002	10	1.96 (± 4.62)	30%
	2003	10	0.00 (± 0.00)	0%
	2004	10	0.13 (± 0.42)	10%
	2005	11	0.00 (± 0.00)	0%
	2006	12	0.00 (± 0.01)	0%
	2007	12	0.00 (± 0.00)	0%
	2008	12	0.00 (± 0.00)	0%
	2009	13	0.00 (± 0.00)	0%
	2010	14	0.00 (± 0.00)	0%
	2011	12	0.00 (± 0.00)	0%
	2012	13	0.00 (± 0.00)	0%
	2013	15	0.53 (± 1.55)	13%
	2014	12	0.00 (± 0.00)	0%
	2015	12	0.00 (± 0.00)	0%
	2016	12	0.00 (± 0.00)	0%

Area	Year	Number of Trawls	Density (Number Per 10,000 m^3 ± S.D.)	Frequency of Occurrence
Napa River (station 340)	2002	2	0.00 (± 0.00)	0%
	2003	2	31.17 (± 44.08)	50%
	2004	2	1.42 (± 2.01)	50%
	2005	2	0.00 (± 0.00)	0%
	2006	2	0.00 (± 0.00)	0%
	2007	1	38.59	100%
	2008	1	0.00	0%
	2009	2	0.00 (± 0.00)	0%
	2010	2	0.00 (± 0.00)	0%
	2011	2	0.00 (± 0.00)	0%
	2012	2	0.00 (± 0.00)	0%
	2013	2	0.00 (± 0.00)	0%
	2014	2	0.00 (± 0.00)	0%
	2015	2	0.00 (± 0.00)	0%
	2016	2	0.00 (± 0.00)	0%
Ryde (station 724)	2005	1	0.00	0%
	2006	2	0.00 (± 0.00)	0%
	2007	2	0.00 (± 0.00)	0%
	2008	2	0.00 (± 0.00)	0%
	2009	2	0.00 (± 0.00)	0%
	2010	2	0.00 (± 0.00)	0%
	2011	2	0.00 (± 0.00)	0%
	2012	2	0.00 (± 0.00)	0%
	2013	1	0.00	0%
	2014	2	0.00 (± 0.00)	0%
	2015	1	0.00	0%
	2016	1	0.00	0%
Suisun Marsh/Grizzly Bay (stations 602, 606, 609, and 610)	2002	8	2.47 (± 2.47)	75%
	2003	8	3.22 (± 6.22)	38%
	2004	8	9.72 (± 26.45)	38%
	2005	8	2.68 (± 4.83)	38%
	2006	8	0.00 (± 0.00)	0%
	2007	8	3.78 (± 6.62)	50%
	2008	8	0.00 (± 0.00)	0%
	2009	10	2.77 (± 3.01)	60%
	2010	8	0.23 (± 0.64)	13%
	2011	10	0.24 (± 0.75)	10%
	2012	11	0.53 (± 1.76)	9%
	2013	8	0.33 (± 0.61)	25%

Area	Year	Number of Trawls	Density (Number Per 10,000 m^3 ± S.D.)	Frequency of Occurrence
	2014	8	0.38 (± 0.75)	25%
	2015	8	0.74 (± 1.03)	38%
	2016	8	0.00 (± 0.00)	0%
West Suisun Bay (stations 405, 411, and 418)	2002	6	1.02 (± 1.83)	33%
	2003	6	8.84 (± 10.55)	67%
	2004	6	1.39 (± 2.78)	33%
	2005	6	1.89 (± 3.82)	33%
	2006	6	0.24 (± 0.58)	17%
	2007	6	0.30 (± 0.74)	17%
	2008	6	0.00 (± 0.00)	0%
	2009	6	0.00 (± 0.00)	0%
	2010	6	0.62 (± 0.96)	33%
	2011	6	0.19 (± 0.47)	17%
	2012	6	0.00 (± 0.00)	0%
	2013	6	0.63 (± 1.54)	17%
	2014	6	0.00 (± 0.00)	0%
	2015	6	0.46 (± 1.12)	17%
	2016	6	0.00 (± 0.00)	0%

Source: ftp://ftp.dfg.ca.gov/Delta%20Smelt/SKT.mdb. Accessed: September 14, 2016.

Table 4.2-7. Monthly Water-year-type Mean of Flows in the San Joaquin River at Jersey Point (Cubic Feet per Second), from the 1922–2003 DSM2-HYDRO Simulation.

Month	WYT	NAA	PP	PP vs. NAA[1]
Jan	W	19,054	21,307	2,253 (12%)
	AN	9,626	10,766	1,140 (12%)
	BN	2,794	5,217	2,423 (87%)
	D	2,334	3,480	1,146 (49%)
	C	1,377	2,115	738 (54%)
Feb	W	22,177	26,089	3,912 (18%)
	AN	13,152	14,441	1,289 (10%)
	BN	7,901	8,759	858 (11%)
	D	4,992	5,544	553 (11%)
	C	3,393	3,518	124 (4%)
Mar	W	18,919	23,238	4,319 (23%)
	AN	10,351	14,160	3,809 (37%)
	BN	3,673	4,755	1,082 (29%)
	D	4,901	5,051	150 (3%)
	C	3,218	3,333	115 (4%)
Apr	W	16,363	17,757	1,394 (9%)
	AN	9,353	10,056	704 (8%)
	BN	5,790	5,789	-1 (0%)
	D	5,111	5,240	129 (3%)
	C	2,936	2,790	-146 (-5%)
May	W	13,740	15,214	1,474 (11%)
	AN	7,023	7,465	443 (6%)
	BN	4,532	4,660	127 (3%)
	D	3,680	3,885	206 (6%)
	C	2,224	2,210	-14 (-1%)
Dec	W	8,104	8,514	410 (5%)
	AN	2,971	3,805	834 (28%)
	BN	-433	342	775 (179%)
	D	-199	180	380 (190%)
	C	612	671	59 (10%)

[1]Positive values indicate greater flow under the proposed project (PP) than under the no action alternative (NAA).
Green shading indicates differences that are > +5%.

4.2.4 Mitigation Measure Effects

4.2.4.1 Tidal and Channel Margin Habitat Restoration

Construction at habitat restoration sites will be undertaken during approved in-water work windows (summer/fall) and therefore will not affect individual migrating adult Longfin Smelt. To the extent that individual Longfin Smelt encounter restoration sites it is assumed that they will attain benefits and potential adverse effects similar to Delta Smelt (Section 4.1.4.1.1.1), although the timing of life stages are earlier and benefits and effects could be lessened or enhanced due to abiotic conditions during earlier timing. The intention of habitat restoration projects is to improve habitat conditions so the population-level effect on spawning adult Longfin Smelt, if there is one, should be beneficial.

4.2.4.1.1 Migrating Adults (December–March)

Similar to Delta Smelt, construction at habitat restoration sites will be undertaken during approved in-water work windows (summer/fall) and therefore will not affect individual migrating Longfin Smelt, as discussed in Section 4.1.4.1.1. The intention of habitat restoration projects is to improve habitat conditions so the population-level effect on migrating adult Delta Smelt, if there is one, should be beneficial.

4.2.4.1.2 Spawning Adults (December–March)

Similar to Delta Smelt (Section 4.1.4.1.2), construction at habitat restoration sites will be undertaken during approved in-water work windows (summer/fall) and therefore individual spawners will not be affected by construction *per se*. Benefits and possible adverse effects will be similar to those for Delta Smelt, although the timing of the life stage (earlier) may alter the benefits and other effects because of abiotic conditions associated with the season. The intention of habitat restoration is to improve habitat conditions so the population-level effect on migrating adult Longfin Smelt, if there is one, should be beneficial.

4.2.4.1.3 Eggs/Embryos (~January–April)

As stated above and as discussed for Delta Smelt in Section 4.1.4.1.3, construction at habitat restoration sites will be undertaken during approved in-water work windows (summer/fall) and therefore will not affect eggs/embryos in winter/early spring. When construction is completed, and if suitable spawning microhabitat was successfully provided, individual Longfin Smelt may spawn eggs at the site, producing a positive individual impact. The intention of habitat restoration projects is to improve habitat conditions so the population-level effect on Longfin Smelt eggs/embryos, if there is one, should be beneficial.

4.2.4.1.4 Larvae/Young Juveniles (~January–May)

Similar to Delta Smelt, summer/fall in-water work windows will minimize the potential for Longfin Smelt larvae and young juveniles to experience the effects of habitat restoration construction. The intention of habitat restoration projects is to improve habitat conditions so the population-level effect on Longfin Smelt larvae/young juveniles, if there is one, should be beneficial.

4.2.4.1.5 Juveniles (~June–December)

Construction of habitat restoration projects are unlikely to affect juvenile Longfin Smelt because during this life stage the Longfin Smelt population moves downstream. Positive effects once habitat restoration is complete would be more likely to occur during other life stages, which occur farther upstream than juvenile Longfin Smelt.

4.2.4.2 Georgiana Slough Nonphysical Fish Barrier

Individual Longfin Smelt migrating upstream via Georgiana Slough or the Sacramento River will not be affected by the construction of the NPB because construction will occur in one season before any Longfin Smelt move this far upstream. The operational effects will be similar in nature to those described for Delta Smelt (Section 4.1.4.2), although a smaller proportion of the Longfin Smelt population would be expected to occur sufficiently far upstream to experience these effects. Most Longfin Smelt spawn in places distant from the junction of Georgiana Slough and the Sacramento River. On the basis of the spatial distribution of the NPB in relation to the distribution of Longfin Smelt, any take from operation of the NPB would be very limited.

4.2.5 Monitoring Effects

Similar to Delta Smelt (Section 4.1.5), Longfin Smelt will be monitored by continuation of existing monitoring at the south Delta export facilities coupled with entrainment monitoring at the NDD. Monitoring at restoration sites is not expected to cause any potential harm to Longfin Smelt. Similar to Delta Smelt, monitoring is expected to be inconsequential to Longfin Smelt population status at both the NDD and the south Delta export facilities.

4.2.5.1 Migrating Adults (December–March)

Similar to Delta Smelt (Section 4.1.5.1), monitoring at the NDD will have essentially no effect on Longfin Smelt. At the south Delta export facilities, entrainment has the potential to decline under the PP versus the NAA, resulting in less lethal take during salvage monitoring.

4.2.5.2 Spawning Adults (December–March)

The potential effects of monitoring for spawning adults would be similar to those for migrating Longfin Smelt, resulting in limited potential for take at the NDD and potentially less take at the south Delta export facilities under the PP compared to NAA during salvage monitoring.

4.2.5.3 Eggs/Embryos (~January–April)

Similar to Delta Smelt (Section 4.1.5.3), Longfin Smelt eggs/embryos will not be affected by proposed monitoring activities.

4.2.5.4 Larvae/Young Juveniles (~January–May)

As described for Delta Smelt (Section 4.1.5.4), entrainment monitoring at the NDD and south Delta export facilities will be lethal; however, any larval/young juvenile Longfin Smelt taken during entrainment monitoring would have died in any event as a result of entrainment.

4.2.5.5 Juveniles (Summer/Fall: ~June–December)

The downstream distribution of Longfin Smelt juveniles during summer/fall would mean there would be no take of this life stage during monitoring activities.

4.2.6 Take Analysis

Take estimation for the purposes of the direct effects, cumulative effects, and climate change assessments is based upon the likelihood of physical injury or mortality to individuals of Longfin Smelt. It is not possible to predict the number of individuals that would be subject to such take; in general, that would be a density-dependent phenomenon, e.g., with more fish subject to take in years when the population was relatively high in the project area. Instead, the risk of take is assessed through proxies such as the area of habitat affected, the duration of impact pile driving, or the probability of a contaminant release. Each foregoing section of the take analysis has identified the mechanisms by which take could occur and the probability that take would occur. If that probability is substantial, so that some individuals are likely to suffer mortality, then factors influencing the magnitude of take have been detailed, including take minimization measures (more fully described in Chapter 5 *Mitigation*), as well as the take proxies mentioned above. Mitigation is described (in Chapter 5 *Mitigation*) that is proportionate to the take, so as to show full mitigation for the take. The following take analysis considers mechanisms of take for which authorization is needed (such as, conveyance facility construction and operations), as well as mechanisms of take for which authorization is not here requested (such as, maintenance activities or construction of mitigation sites) or is not needed (such as, CVP operations, cumulative effects, or climate change), because all such mechanisms are considered in determining whether the PP is likely to jeopardize Longfin Smelt.

4.2.6.1 Effects of Water Facility Construction

The greatest potential for take of Longfin Smelt associated with PP facilities is the construction of the north Delta diversions, temporary barge landings, Head of Old River gate, and Clifton Court Forebay. Longfin Smelt are rarely found in the vicinity of the HOR gate (see Section 4.2.1.3, *Head of Old River Gate*), and also are not found often near the NDD (Section 4.2.1.3 *North Delta Diversions*), so construction of these facilities has less potential of take than the other facilities previously mentioned. Construction activities would include cofferdam installation, levee clearing and grading, riprap placement, dredging, and barge operations and could cause turbidity and sedimentation, contaminant spills, underwater noise, fish stranding, direct contact with construction equipment, and loss or alteration of habitat. Underwater noise associated with pile driving, which is needed for construction of all the facilities, is of concern because of uncertainty in the effectiveness of available mitigation measures. A detailed discussion of underwater noise effects and mitigation measures is given in Sections 4.2.1.2.3, 4.2.1.2.9, and 4.2.1.4.3.

Take associated with construction activities will be reduced by restricting construction to in-water work windows when there would generally be even less potential for overlap with Longfin Smelt life stages than there is for Delta Smelt. The work windows differ somewhat for the different facilities: June 1 to October 31 for the NDDs; August 1 to October 31 for the barge landings; July 1 to November 30 for the CCF modifications; and August 1 to November 30 for the HOR gate. The overlap of construction at the NDDs with the late spring period (June) means that there is the potential for take of Longfin Smelt.

In addition to restricting construction to periods when Longfin Smelt generally would be expected to be absent or in lower abundance, take associated with the construction activities will be minimized by using a number of different take minimization measures. The specific take minimization measures that would be implemented to minimize potential take of each of the construction activities and their effects are discussed in Section 4.1.1 *Construction Effects* and are described in detail in Appendix 3.F *General Avoidance and Minimization Measures.*

Restricting construction activities to work windows would not minimize take resulting from loss and alteration of Longfin Smelt habitat. Expected effects on Longfin Smelt habitat are considered permanent because of the species' primarily two-year life cycle (see Table 5.4-1 *Summary of Maximum Direct Impact, Proposed Compensation, and Potential Location of Restoration for State Listed Fish Species* for a summary of these effects associated with each species, at each construction site). With regard to habitat acres affected, construction will result in the loss of 5.6 acres of shallow water habitat at the NDD (in addition to 495 acres affected by potential loss of access to upstream habitat), 2.9 acres of tidal perennial habitat at the HOR gate, and 22.4 acres of tidal perennial habitat at the barge landings, all of which is considered permanent from the perspective of Delta Smelt, the species for which mitigation requirements were determined[6]. Much of the habitat affected, especially at the barge landings, HOR gate, and CCF locations, is currently in a degraded condition (e.g., rip-rapped banks), so alteration and loss of this habitat may have little effect on the habitat's quality for Longfin Smelt. However, the creation of new predator habitat at the facilities is expected to lead to an increase in predation mortality of Longfin Smelt, for example. Take resulting from construction activities and from habitat loss and alteration will be fully mitigated by shallow water and tidal perennial habitat restoration~~ at 5:1 or 3:1 mitigation ratios (depending on the proposed work window)~~, as described in Section 5.4.0.3 *Spatial Extent, Location, and Design of Restoration for Fish Species*. The total area of habitat restoration for full mitigation of water facility construction is ~~102~~1827.7 acres (~~28~~ 1,753 acres of shallow water habitat mitigating for NDD construction and potential reduced access to upstream habitat; 7.5 acres of tidal perennial habitat mitigating for HOR gate construction; and 67.2 acres of tidal perennial habitat mitigating for barge landing construction).

Overall, the impact of take on Longfin Smelt resulting from construction activities will be limited and less than that for Delta Smelt because of the work windows used to avoid or minimize temporal overlap with Longfin Smelt, the location of the work (often well outside the species' main range), the many take minimization measures that would be implemented, the low quality of most habitat affected, and the use of habitat restoration to mitigate losses of suitable habitat.

4.2.6.2 Effects of Water Facility Maintenance

Regular and unscheduled maintenance will be needed for each of the four principal PP facilities. The maintenance activities with the most potential to result in take of Longfin Smelt are dredging and levee maintenance. These activities will be scheduled within the same work windows as are proposed for construction. Potential adverse effects will be further minimized by implementing take minimization measures to limit the extent and duration of activities. With implementation of the work windows and take minimization measures, together with the location of the work (often well outside the species' main range), take of Longfin Smelt resulting from

[6] It is assumed that mitigation proposed for Delta Smelt is also applicable to Longfin Smelt.

water facility maintenance activities will be minimal. Note, however, that take is not being sought for maintenance activities.

4.2.6.3 Effects of Water Facility Operations

Water facility operations have the potential to result in take of Longfin Smelt by mechanisms that include entrainment, impingement, catch/capture during salvage at the south Delta export facilities, or by Delta outflow/X2 effects. The following subsections address potential for take from operational effects at different facilities.

4.2.6.3.1 North Delta Exports

Take at the NDD could occur as a result of entrainment, impingement/screen contact, and predation, as well as reduced access to upstream spawning habitat. Given the location of the NDD, the take will affect only a very small proportion of the population (see discussion in Section 4.2.3.2 *Entrainment and South Delta Entry*). Given the screen specifications designed for Delta Smelt, only small (larval and pre-juvenile) Longfin Smelt (less than 20-21 mm) would be susceptible to entrainment. As discussed previously in Section 4.2.3.2 with respect to the NDD, survey data suggest Longfin Smelt spawning is not common in the area, therefore the frequency of occurrence of Longfin Smelt near the NDD is very low (Table 4.2-1, Table 4.2-2, Table 4.2-3, and Table 4.2-4), and there are no suitable recent data to provide an estimate of the relative density of Longfin Smelt larvae near the NDD compared to other areas of the Delta. However, for the data that do exist (from the 1991–1994 egg and larval survey; Table 4.2-4), the greatest ratio of Longfin Smelt larvae density in the NDD intake area to density in the downstream area was ~0.02 (in 1991). Following the logic presented in Section 4.1.3.2.1.4.1 *Population-Level Effects* for Delta Smelt, if the downstream area is ~20 times greater than the intake area (taken to be the Sacramento River upstream of Georgiana Slough and Delta Cross Channel), then approximately 0.001 (0.1%) of the larval population could occur in the intake reach. With diversion of up to 35% of Freeport flow by the NDD during January–March (Table 4.2-6), and if all larvae were upstream of the NDD, then 0.035% of the population could be entrained, based on proportion of flow diverted. This illustrative analysis likely provides a worst case because it was based on 1) the greatest ratio of Longfin Smelt density in the intake area to the downstream density, 2) the maximum diversion of flow during January–March, and 3) that all Longfin Smelt in the intake area (upstream of Georgiana Slough/Delta Cross Channel) would be susceptible to entrainment (whereas this would be the case only for those originating near or upstream the NDD, moving past the intakes; diversions at the NDD would be considerably constrained in low flow years when reverse flows could occur in the reach and might allow upstream movement of weak-swimming Longfin Smelt larvae, limiting the influence of the PP on reverse flows [see ICF International 2016; Figure 5.D-28 in Appendix 5.D *Quantitative Methods and Detailed Results for Effects Analysis of Chinook Salmon, Central Valley Steelhead, Green Sturgeon, and Killer Whale*]).

Table 4.2-8. Summary Statistics of CalSim-Modeled Average Monthly North Delta Diversion as a Percentage of Sacramento River at Freeport Flows for the Proposed Project, January–March.

Water Year Type		January	February	March
Wet	Maximum	25%	35%	35%
	75th percentile	16%	19%	26%
	Mean	14%	16%	20%
	Median	13%	14%	17%
	25th percentile	12%	12%	13%
	Minimum	6%	7%	6%
Above Normal	Maximum	23%	34%	34%
	75th percentile	17%	19%	24%
	Mean	15%	17%	21%
	Median	16%	14%	19%
	25th percentile	14%	12%	15%
	Minimum	6%	4%	13%
Below Normal	Maximum	23%	24%	31%
	75th percentile	9%	17%	24%
	Mean	9%	14%	16%
	Median	7%	14%	13%
	25th percentile	6%	9%	9%
	Min	5%	6%	6%
Dry	Max	21%	29%	32%
	75th percentile	8%	17%	22%
	Mean	8%	13%	18%
	Median	6%	12%	20%
	25th percentile	6%	6%	13%
	Minimum	5%	5%	6%
Critical	Maximum	23%	12%	17%
	75th percentile	7%	8%	6%
	Mean	8%	7%	7%
	Median	6%	7%	6%
	25th percentile	6%	6%	6%
	Minimum	0%	6%	6%

Take of larger Longfin Smelt could occur at the NDD as a result of impingement and screen contact, resulting in injury and subsequent mortality. The potential for impingement is uncertain and will be addressed with monitoring and targeted studies following construction of the intakes. There is potential for predation of Longfin Smelt along the NDDs, which would constitute take. As described in Section 3.2.2.2 *Fish Screen Design*, 22-foot-wide refugia are currently part of the design to be provided between each of the six screen bay groups at the three intakes, which, if effective, could provide resting areas and predator refuge for Longfin Smelt occurring near the intakes. However, given that the refugia are still in the conceptual design phase and there is uncertainty as to their effectiveness for Longfin Smelt, it is uncertain if they will provide escape and refugia from facility-induced predation and other effects. As previously discussed, any such take will be limited to a small proportion of the population and Longfin Smelt would be even less susceptible to take than Delta Smelt.

As discussed for Delta Smelt in Section 4.1.6.3.1 *North Delta Diversions*, the NDD could also result in take of migrating adult Longfin Smelt by reducing the probability of access to upstream spawning habitat, by creating a relatively high-velocity nearshore habitat that will be challenging for Longfin Smelt to pass with active swimming; the overall magnitude of this potential effect on individual Longfin Smelt would depend on the ability of Longfin Smelt to use lower velocity habitat on the right bank of the river, near the channel bottom, or within the refugia along the intakes (see Section 4.1.3.2.2.1 for Delta Smelt). This effect will be fully mitigated by restoring 245 1,753 acres of shallow water habitat as compensation for the estimated extent of this type of habitat that may be less accessible upstream of the NDD. Of the 245 acres, 108 acres must be sandy beach spawning habitat (a 3:1 mitigation ratio for the estimated 36 acres of such habitat that would be affected; or that would be within the construction footprint (see Table 5.4-1 *Summary of Maximum Direct Impact, Proposed Compensation, and Potential Location of Restoration for State Listed Fish Species*).

4.2.6.3.2 South Delta Exports

Take at the south Delta export facilities will occur in the form of kill, either directly (e.g., fish passing through the louvers of the fish screens) or as a result of predation (particularly pre-screen loss in CCF; shown for Delta Smelt by Castillo et al. 2012); take in the form of catch/capture will also occur during salvage, which is generally regarded as resulting in high mortality. However, it is possible that relatively high survival of adult Longfin Smelt could occur during collection, handling, transport, and release when adult Longfin Smelt are salvaged during cool temperature conditions, similar to what was shown for Delta Smelt (Morinaka 2013). As described for Delta Smelt, high pre-screen predation loss makes catch/capture during salvage a small component of overall take. Salvage of Longfin Smelt over water years 1993 to 2016 has varied from zero to almost 300 adults and from zero to almost 100,000 juveniles (based on the temporal conventions of greatest occurrence from Grimaldo et al. (2009): adults in December–February; juveniles in April–May (Table 4.2-7). Entrainment loss, which extrapolates salvage to account for prescreen loss, louver efficiency, and other factors, is likely to be several times greater than salvage: Fujimura (2009) estimated that entrainment loss is 17-21 times greater than salvage for the SWP and four times greater than salvage for the CVP, based on studies of other species.

Table 4.2-9. Salvage of Longfin Smelt, Together with Prior Fall Midwater Trawl (FMWT) Index, Water Years 1993-2016.

Water Year	Prior FWMT Index	Adult Longfin Smelt (December–February)		Juvenile Longfin Smelt (April–May)	
		Salvage	Salvage/FMWT	Salvage	Salvage/FMWT
1993	76	12	0.2	346	4.6
1994	798	32	0.0	6,126	7.7
1995	545	78	0.1	16	0.0
1996	8,205	108	0.0	109	0.0
1997	1,346	12	0.0	1,092	0.8
1998	690	126	0.2	0[1]	0.0
1999	6,654	12	0.0	617	0.1
2000	5,243	69	0.0	1,716	0.3
2001	3,437	108	0.0	6,372	1.9
2002	247	177	0.7	94,947	384.4
2003	707	297	0.4	4,953	7.0
2004	467	252	0.5	600	1.3
2005	191	30	0.2	45	0.2
2006	129	0	0.0	0	0.0
2007	1,949	24	0.0	60	0.0
2008	13	68	5.2	1,388	106.8
2009	139	4	0.0	47	0.3
2010	65	0	0.0	35	0.5
2011	191	4	0.0	0	0.0
2012	477	8	0.0	1,944	4.1
2013	61	4	0.1	731	12.0
2014	164	4	0.0	8	0.0
2015	16	0	0.0	122	7.6
2016	4	0	0.0	0	0.0

Sources:
FMWT indices: http://www.dfg.ca.gov/delta/data/fmwt/indices.asp
Salvage data: https://www.wildlife.ca.gov/Conservation/Delta/Salvage-Monitoring
Note: [1]Following Grimaldo et al. (2009), salvage of 616 juvenile Longfin Smelt in this year was changed to zero.

There have been few estimates of the proportion of the Longfin Smelt population that is lost to entrainment at the south Delta export facilities. Estimates of December Longfin Smelt population abundance—which would equate to adult abundance based on the temporal life stage classification of Grimaldo et al. (2009)—derived from catches in midwater trawl surveys were made by stakeholders responding to DFW requests for comments on the status of the species, and are included in Appendix C of DFG (2009a). These population abundance estimates can be related to estimates of adult entrainment loss from Fujimura (2009) (Table 4.2-8). This suggests that, in general, entrainment loss of adult Longfin Smelt at the south Delta export facilities was well below 1% of the population during 1994 to 2008. The highest estimates were ~0.7% (95% confidence interval: ~0.4–1.2%) in 2002 and ~2.7% (95% confidence interval: ~1.3–9.1%) in 2008. In these two years, the ratios of salvage to previous FMWT index were 0.7 and 5.2 (Table

4.2-7). Following the implementation of the USFWS (2008) biological opinion for Delta Smelt, the ratio of salvage to previous FMWT index has been 0.0 to 0.1. This suggests that the percentage loss of the adult Longfin Smelt population in recent years has been similar in magnitude to years with ratios of salvage to previous FMWT index of 0.0 to 0.1 (i.e., 1994–1997; 2000–2001; 2006–2007; Table 4.2-7); the estimated loss in these years ranged from 0% up to ~0.3% (based on upper 95% confidence intervals) (Table 4.2-8). As described in Section 4.2.3.2 *Entrainment and South Delta Entry*, given that Old and Middle River flows during December–February would be less negative/more positive under the PP than under NAA (see ICF International [2016], Appendix 5.A *CalSim Modeling and Results*, Table 5.A.6-25 and Figures 5.A.6-25-1 to 5.A.6-25-7), any take of Longfin Smelt adults during December-February would be expected to be less under the PP than NAA, recognizing that real-time operational adjustments make the magnitude of difference difficult to accurately predict; this suggests that proportional loss of Longfin Smelt adults under the PP would be considerably lower than 1% of the population.

Table 4.2-10. Entrainment Loss of Adult Longfin Smelt In Relation to December Population Abundance.

		Population Abundance			Entrainment Loss as % of Population Abundance		
Water Year	**Entrainment Loss**	**Mean**	**Lower 95% Confidence Limit**	**Upper 95% Confidence Limit**	**Mean**	**Lower 95% Confidence Limit**	**Upper 95% Confidence Limit**
1994	515	2,121,299	1,539,453	2,923,767	0.02%	0.02%	0.03%
1995	1,256	762,931	492,457	1,185,366	0.16%	0.11%	0.26%
1996	794	1,897,507	1,280,158	2,626,755	0.04%	0.03%	0.06%
1997	43	2,505,703	1,707,191	3,556,312	0.00%	0.00%	0.00%
1998	86	356,804	169,092	623,598	0.02%	0.01%	0.05%
1999	43	There were insufficient trawl samples for an estimate.					
2000	333	893,531	548,077	1,371,856	0.04%	0.02%	0.06%
2001	601	6,261,994	4,538,034	8,417,526	0.01%	0.01%	0.01%
2002	1,648	252,942	142,355	422,206	0.65%	0.39%	1.16%
2003	3,429	1,627,699	1,038,290	2,369,905	0.21%	0.14%	0.33%
2004	2,102	1,145,721	801,008	1,605,858	0.18%	0.13%	0.26%
2005	183	475,231	271,314	756,977	0.04%	0.02%	0.07%
2006	0	159,244	90,862	257,436	0.00%	0.00%	0.00%
2007	0	83,311	26,826	159,348	0.00%	0.00%	0.00%
2008	570	21,376	6,255	43,048	2.67%	1.32%	9.11%

Sources:
Entrainment loss: Fujimura (2009).
Population abundance: DFG (2009a: Appendix C, Attachment 2, Table 2).

Although the estimates of larval entrainment from the DSM2-PTM analysis (Appendix 4.A, Section 4.A.2 *Particle Tracking Modeling of Larval Entrainment*) are not intended to be predictions of actual percentages of the larval Longfin Smelt population that could be entrained, the weightings applied in the modeling are intended to represent a realistic distribution of larvae in the Delta and downstream and as such may provide some perspective on the magnitude of larval population loss. Combined mean entrainment at the SWP and CVP south Delta export facilities under the NAA ranged from 0.9% in March of critical water years to 4.5% in January of dry water years; whereas, mean entrainment under the PP ranged from 0.01% in March of wet and above normal years to 3.2% in January of critical water years (calculated by summing estimates from Table 4.A-7 in Appendix 4.A). Mean combined SWP/CVP entrainment under the PP ranged from 0.05% less (a 4% relative change) than NAA in March of dry years to 2.4% less (a 60% relative change) than NAA in January of below normal years. This suggests that take of larval Longfin Smelt would be less under the PP than NAA, and in absolute terms may be on the order of 0–3% of the larval population, although this is uncertain.

On the basis of the estimated magnitude of take at the south Delta export facilities for adult and larval Longfin Smelt, it is expected that the proportional loss of juvenile Longfin Smelt would be of similar magnitude to that of adults and larvae, i.e., at most, a few percent of the population. This was examined by relating estimates of juvenile (20-79 mm) Longfin Smelt loss (Fujimura 2009) to estimates of total juvenile (20-79 mm) population size extrapolated from 20-mm Survey density data. The lower size threshold reflects the size at which fish count and length data are recorded for salvage sampling. In brief, to make estimates of population abundance, catch data of Longfin Smelt 20-79 mm long in the 20-mm Survey were first adjusted for gear efficiency based on the equation provided in Attachment 3 of Appendix C within DFG (2009a):

$$\text{Net Efficiency} = 1 / (1 + \text{EXP}(-0.27 * (\text{Fork Length} - 14)))$$

The density per station during each survey was calculated based on the volume of water sampled (all three replicate tows combined). The abundance of Longfin Smelt 20-79 mm represented by the catch at each station was extrapolated based on the density multiplied by the volume of the estuary attributed to each station by Saha (2008). Means and confidence intervals were generated by resampling with replacement (bootstrapping) the abundance estimates for all trawls in a given survey for 10,000 replicates. Similar to the pattern observed for Delta Smelt (Kimmerer 2008: his Figure 13), the absolute estimates of abundance generally increased to a maximum in April or May, before declining; this likely reflects increasing recruitment to the sampling gear, followed by a decline with mortality, emigration, or improved ability to avoid capture. The survey with peak estimated juvenile Longfin Smelt abundance (generally occurring in April or May) was used to provide perspective on loss from entrainment. The population abundance estimates are only intended to provide an order-of-magnitude perspective on potential entrainment loss of juveniles and do not account for areas potentially inhabited by Longfin Smelt that were not sampled during the 20-mm Survey; the estimates also do not account for the different number of stations sampled during each survey, which varied somewhat (although not considerably). Abundance estimates of 20-79 mm Longfin Smelt ranged from 3.4 million fish in 2008 to over 150 million fish in 2001, with wide confidence intervals (Table 4.2-9). Relating these to juvenile loss estimates from Fujimura (2009) suggests that losses during 1994–2008 generally were well below 1% of the population, with the maximum estimated to be 3.6% (2.2-7.5%) in 2003. However, as noted by Kimmerer (2008: see in particular his Figure 6), the 20-mm Survey net efficiency is likely to be considerably greater than salvage collection efficiency for small fish (e.g., five times more efficient for 20-mm fish). To provide an upper bookend on juvenile Longfin Smelt entrainment loss, the estimates of percentage loss to entrainment in Table 4.2-9 can be multiplied by five to reflect lower sampling efficiency of salvage. This gives a maximum juvenile entrainment loss of ~18% (95% CI: 11-37%) in 2002, although the range in other years was considerably lower (means of 0-2%). The maximum estimate (in 2002) occurred in a year during which the salvage/FMWT ratio was extremely high (>380), whereas in other years the salvage/FMWT ratio was one or two orders of magnitude lower, including recent years after the implementation of the 2009 ITP and the USFWS (2008) Delta Smelt BiOp (Table 4.2-7). This suggests that juvenile Longfin Smelt proportional loss to south Delta entrainment is low (1% or less of the population) in most years.

As previously described, salvage of juvenile Longfin Smelt was estimated to be lower in wetter water years under the PP than NAA, whereas salvage under the PP in drier years was estimated to be similar to NAA or greater (Table 4.A-11, Figure 4.A-31, and Figure 4.A-32 in Section 4.A.3 *Salvage-Old and Middle River Flow Regression*). As described in Section 4.2.3.2 *Entrainment and South Delta Entry*, this pattern is in most part a result of HOR gate operations. Both NAA and PP would include real-time management of south Delta exports and Old and Middle River flows in order to limit the potential for entrainment of Longfin Smelt and other listed fishes; this management would include consideration of HOR gate operations. Therefore it is anticipated that take under the PP would be limited to low levels (< 1% of the juvenile Longfin Smelt population).

Table 4.2-11. Entrainment Loss of Juvenile Longfin Smelt (20-79 mm) In Relation to Population Abundance (Extrapolated from 20-mm Survey Data).

		Population Abundance			Entrainment Loss as % of Population Abundance		
Water Year	**Entrainment Loss**	**Mean**	**Lower 95% Confidence Limit**	**Upper 95% Confidence Limit**	**Mean**	**Lower 95% Confidence Limit**	**Upper 95% Confidence Limit**
1995	690	28,533,241	646,582	83,446,706	0.00%	0.00%	0.11%
1996	2,329	55,551,678	2,952,507	160,930,326	0.00%	0.00%	0.08%
1997	16,224	53,124,330	27,786,879	81,514,564	0.03%	0.02%	0.06%
1998	13,151	67,816,816	430,480	201,955,221	0.02%	0.01%	3.05%
2000	14,061	105,680,968	23,624,089	227,525,445	0.01%	0.01%	0.06%
2001	29,779	155,878,920	29,659,827	397,513,090	0.02%	0.01%	0.10%
2002	59,250	14,788,919	6,268,759	27,156,527	0.40%	0.22%	0.95%
2003	1,250,100	34,788,791	16,739,707	57,544,906	3.59%	2.17%	7.47%
2004	25,609	12,690,736	2,456,744	31,824,070	0.20%	0.08%	1.04%
2005	6,274	11,953,747	3,049,485	25,527,635	0.05%	0.02%	0.21%
2006	3,633	20,103,627	3,154,146	53,010,040	0.02%	0.01%	0.12%
2007	0	95,376,388	835,562	280,036,933	0.00%	0.00%	0.00%
2008	1,338	3,401,228	1,296,730	6,933,677	0.04%	0.02%	0.10%

Sources:
Entrainment loss: Fujimura (2009).
20-mm Survey data: ftp://ftp.dfg.ca.gov/Delta%20Smelt/20-mm.mdb

The absolute estimates of take of adult, larval, and juvenile Longfin Smelt by entrainment provided above are uncertain. As previously noted, both NAA and PP would, as now, include real-time management of south Delta exports and Old and Middle River flows in order to limit the potential for entrainment of Longfin Smelt and other listed fishes; such adjustments cannot be readily simulated. However, the various analyses presented herein suggest the potential for less take of adults and larvae in winter/early spring under the PP than the NAA. The potential for greater entrainment (salvage) of juveniles in April/May under the PP largely reflects HOR gate operations and emphasizes the need for consideration of this factor, in association with real-time fish distribution information, to minimize the risk of entrainment.

4.2.6.3.3 Head of Old River Gate Operations

As described for Delta Smelt in Section 4.1.3.4.1 *Migrating Adults (December–March)*, take of Longfin Smelt at the HOR gate could occur as a result of factors such as increased predation caused by creation of more suitable predatory fish habitat. Trawling at Mossdale on the San Joaquin River, just upstream of the HOR gate, during 1994–2016 yielded a total of 17 Longfin Smelt (all in 2012 and 2013; USFWS 2016). This suggests that any take of Longfin Smelt at the HOR gate would be limited. As previously discussed for south Delta exports, far-field effects of the HOR gate on south Delta hydrodynamics have the potential to affect the risk of entrainment at the south Delta export facilities for juvenile Longfin Smelt. Real-time operations under the PP would be undertaken to limit the potential for take, particularly with respect to the consideration of Longfin Smelt distribution, OMR flows, and other factors (including HOR gate operations).

4.2.6.3.4 Delta Outflow/X2 Effects

As described in Section 4.2.3.1 *Delta Outflow/X2 Effects*, estimates of potential differences in Longfin Smelt fall midwater trawl relative abundance indices as a result of differences in mean January–June X2 found that the mean relative abundance indices in wet, above normal, and below normal years were very similar (1% higher or lower under PP), whereas there were slightly greater differences in mean relative abundance in critical years (3% less under PP) and dry years (4% less under PP). These results reflect similar or slightly higher mean X2 (slightly less Delta outflow) under the PP during the January–June period (see ICF International [2016]: Table 5.A.6-29 and Figures 5.A.6.29-1 to 5.A.6.29-19 in Appendix 5.A CalSim II Modeling and Results). As noted in Section 4.2.3.1 *Delta Outflow/X2 Effects*, there is appreciable uncertainty in these estimates (illustrated by the width of the prediction intervals). Nevertheless, given that the fall midwater trawl indices may provide an index of overall population abundance, on the basis of the mean estimates the population-level take associated with the PP could be up to ~4% less abundance than under the NAA. To address the concern regarding the potential for somewhat higher X2 under the PP to jeopardize Longfin Smelt, spring outflow criteria minimizing this risk for the PP have been developed in collaboration with DFW. These criteria are discussed in Section 4.2.7.2 *Potential to Jeopardize Continued Existence of the Species*.

4.2.6.3.5 Delta Cross Channel

As described in Section 4.1.3.6 *Delta Cross Channel* for Delta Smelt, the PP is expected to result in little to no difference in the number of days that the DCC gates are closed relative to NAA.

The extent of take of Longfin Smelt as a result of DCC operations is not known, but would not be expected to differ under the PP relative to NAA.

4.2.6.3.6 Suisun Marsh Facilities

Consistent with the analysis for Delta Smelt in Section 4.1.3.7 *Suisun Marsh Facilities*, there is potential for take of Longfin Smelt as a result of entrainment (at RRDS and MIDS), predation near facilities (at SMSCG), and effects on X2/habitat extent (at SMSCG). Take from habitat changes because of SMSCG effects on X2 would be limited because of operations meeting D-1641 criteria, and the PP would include a continuation of the existing operations, resulting in no more than around 10-20 days of operations. Take by entrainment of Longfin Smelt is expected at the MIDS intake on the basis of entrainment observed during previous studies (2004-2006; Enos et al. 2007). As summarized by DFG (2009a: 26): "…124 longfin juveniles and adults were found in 2.3 million m^3 water diverted from Goodyear Slough in the western Suisun Marsh (Enos et al. 2007). When larvae were included, the total increased to 284 Longfin Smelt (all life stages) over the same period. Entrainment was periodic with most entrainment of adults in December 2004, larvae in April 2005, and juveniles in May 2005. Entrainment was likely influenced by the large proportion (1/3 of the volume) of Goodyear Slough diverted when the intakes were open and operating on a flood tide. Longfin Smelt larvae were abundant in Suisun Marsh starting in February (when annual sampling commenced) through April (Meng and Matern 2001). Though present in small numbers throughout the year, older juveniles and adults were primarily present from October-February (Rosenfield and Baxter 2007)." Overall, very little entrainment of larvae is expected at MIDS based on PTM studies (Culberson et al. 2004). As described in Section 4.1.3.7.2 *Roaring River Distribution System*, the screens on the RRDS intake minimize take of Delta Smelt (and therefore Longfin Smelt, based on similar body proportions) to entrainment of larvae or smaller juveniles (< 30 mm). There are apparently no monitoring data from which to infer the level of take of larvae; as described in Section 4.1.3.7.2.4 *Larvae/Young Juveniles* for Delta Smelt, the entrainment risk appears limited given that that DSM2-PTM modeling for the California Department of Fish and Game (2009b) Longfin Smelt incidental take permit did not observe any particles entering RRDS. As described for Delta Smelt in Section 4.1.3.7 *Suisun Marsh Facilities*, there is the potential for take of Longfin Smelt during October–May as a result of predation near the SMSCG, although the extent of this is not known and may be limited because of the relatively few days of operations.

4.2.6.3.7 North Bay Aqueduct

As described in Section 4.1.3.8 *North Bay Aqueduct* for Delta Smelt, the North Bay Aqueduct fish screen at the Barker Slough pumping plant was designed to exclude fish larger than 25 mm and as such will exclude smelt larger than this from being entrained by the North Bay Aqueduct (U.S. Fish and Wildlife Service 2008: 217). As described in Section 3.3.2.6 *Operational Criteria for the North Bay Aqueduct Intake*, the intake is screened to comply with Delta Smelt screening criteria, which limits the potential for entrainment and impingement, and would thus also be expected to effective for Longfin Smelt. If predatory fish are concentrated near the fish screen, Longfin Smelt that are effectively screened could be susceptible to increased predation. Pumping rates at the North Bay Aqueduct Barker Slough Intake generally would be similar under the NAA and PP (see ICF International [2016], Appendix 5.B *DSM2 Modeling and Results*, Table

5.B.5-35), so the potential take of larger (juvenile/adult) Longfin Smelt impingement and predation may also be similar between NAA and PP.

As discussed for Delta Smelt in Section 4.1.3.8.4 *Larvae/Young Juveniles (Spring: ~March–June)* larval and young juvenile Longfin Smelt could be entrained at the Barker Slough pumping plant, given that the fish screen excludes smelt of 25 mm and greater; as noted for the NDD, individuals slightly larger than 25 mm could experience adverse effects from impingement. However, as described by U.S. Fish and Wildlife Service (2008: 217) in relation to Delta Smelt, a study of a fish screen built to Delta Smelt standards in Horseshoe Bend on the Sacramento River found that over 99% of fish were excluded from entrainment, even though most fish were only 15-25 mm long (Nobriga *et al.* 2004); U.S. Fish and Wildlife Service (2008: 217) concluded on that basis that the fish screen at the North Bay Aqueduct may protect many, if not most, of the Delta Smelt larvae that hatch and rear in Barker Slough. Such a conclusion would also apply to Longfin Smelt. However, DFG (2009b: 47) noted that the effectiveness of fish screens to exclude larval fishes smaller than their design criteria has not been demonstrated for screens placed at the back of a dead-end slough, such as where the Barker Slough Pumping Plant is located. As described in Section 4.2.3.2 *Entrainment and South Delta Entry,* and detailed in Section 4.A.2.2.1 *Entrainment* of Appendix 4.A *Longfin Smelt Quantitative Analyses*, nearly all of the relatively high (2.9%) percentage of particles (representing Longfin Smelt larvae) released in Lindsey Slough at Barker Slough were often entrained under the PP and NAA scenarios, with little difference between PP and NAA (e.g., Table 4.A-7 in Appendix 4.A). It seems unlikely that the percentages of particles entrained in the DSM2-PTM are reasonable representations of the absolute percentage of all Longfin Smelt larvae entrained at the Barker Slough intake, as the estimates are of similar magnitude to the estimates for the SWP and CVP south Delta export facilities; the estimates seem more likely to be lower for the Barker Slough intake. There are apparently no estimates of absolute entrainment of larval/young juvenile Longfin Smelt at the Barker Slough intake (< 25 mm, i.e., the size at which entrainment could occur, based on screen specifications); such estimates were made for Delta Smelt during 1995 to 2004 based on extrapolation of weighted catch density at three nearby larval fish survey stations (USFWS 2008: 170). It is possible to use the larval fish survey database to provide a preliminary estimate of the abundance of Longfin Smelt < 25 mm that were entrained in 1995–2004, using a similar method to that used for Delta Smelt (DFW 2016):

([0.5*(density of larvae at station 721) + 0.3*(density of larvae at station 727) + 0.2*(density of larvae at station 720)]*volume pumped on day of sampling)

\+

([0.5*(density of larvae at station 721) + 0.3*(density of larvae at station 727) + 0.2*(density of larvae at station 720)]*volume pumped on day following sampling)

The volume pumped on each day was obtained from the DAYFLOW database. This gives estimates of Longfin Smelt < 25 mm entrained by the North Bay Aqueduct during February to June ranging from zero in several years to nearly 1 million fish in 2002 (Table 4.2-10). These estimates are uncertain and do not reflect the potential for the screens to limit entrainment of some larvae/young juveniles below 25 mm. Nevertheless, the estimates illustrate that the absolute numbers of Longfin Smelt entrained probably varied widely, primarily as a result of the density of Longfin Smelt in the vicinity of Barker Slough varying considerably (between 0 and 529 larvae per 1,000 m^3 sampled). In most years, the estimates were low (and often zero), whereas high values were estimated in 2001–2003, which DFG (2009b: 22) suggested was because of relatively low Delta outflow. Extrapolation of the 20-mm Survey Longfin Smelt catch, as undertaken for the south Delta export facilities in Section 4.2.6.3.2, gives estimates of total Longfin Smelt < 25 mm abundance for the years in which the North Bay Aqueduct larval fish survey was undertaken ranging from around 13 million fish in 1995 to over 500 million fish in 2000, with wide confidence intervals around the estimates (Table 4.2-10). As noted previously, these estimates are only intended to provide an order-of-magnitude perspective on potential entrainment loss and do not account for areas potentially inhabited by Longfin Smelt that were not sampled during the 20-mm Survey. The proportional loss of Longfin Smelt to entrainment at the Barker Slough intake was estimated to generally be very low (mostly 0.00%), with the highest estimate in 2002 amounting to 0.40% (95% CI: 0.23-0.82%). Given the lower population abundance in recent years, it seems likely that absolute entrainment of larval Longfin Smelt at present would be less than occurred in the high-entrainment years between 1995 and 2004 (i.e., 2001 to 2003, based on the preliminary analysis above). The take associated with the North Bay Aqueduct Barker Slough Pumping Plant entrainment for the PP and NAA is uncertain, but as previously stated, would be expected to be similar for PP and NAA because of the generally similar pumping rates between PP and NAA. Proportional entrainment is likely to be considerably less than 1% of the < 25 mm Longfin Smelt population in most years, based on the estimates for 1995-2005.

Table 4.2-12. Estimated Entrainment of Longfin Smelt < 25 mm at the North Bay Aqueduct Barker Slough Pumping Plant In Relation to Estimates of Longfin Smelt < 25 mm Population Abundance (Extrapolated from 20-mm Survey Data), Water Years 1995-2004.

		Population Abundance			Entrainment Loss as % of Population Abundance		
Water Year	Entrainment Loss	Mean	Lower 95% Confidence Limit	Upper 95% Confidence Limit	Mean	Lower 95% Confidence Limit	Upper 95% Confidence Limit
1995	391	12,694,770	2,880,472	27,724,889	0.00%	0.00%	0.01%
1996	0	436,840,112	222,421,096	683,703,946	0.00%	0.00%	0.00%
1997	4,949	122,818,910	67,832,966	190,921,902	0.00%	0.00%	0.01%
1998	0	73,198,295	7,379,642	174,115,762	0.00%	0.00%	0.00%
1999	0	288,110,345	127,000,833	497,663,601	0.00%	0.00%	0.00%
2000	0	541,835,049	234,627,632	942,389,187	0.00%	0.00%	0.00%
2001	95,775	212,642,712	119,226,105	324,895,736	0.05%	0.03%	0.08%
2002	970,315	243,004,460	118,956,495	430,398,147	0.40%	0.23%	0.82%
2003	41,695	98,766,407	49,567,072	160,579,034	0.04%	0.03%	0.08%
2004	0	105,412,110	40,827,244	192,603,970	0.00%	0.00%	0.00%
2005	0	87,853,433	29,271,032	194,338,958	0.00%	0.00%	0.00%

Sources:
North Bay Aqueduct Monitoring Data: ftp://ftp.dfg.ca.gov/Delta%20Smelt/NBA.mdb
20-mm Survey Data: ftp://ftp.dfg.ca.gov/Delta%20Smelt/20-mm.mdb

4.2.6.3.8 Other Facilities

4.2.6.3.8.1 Contra Costa Canal Rock Slough Intake

As described by DFG (2009a: 25), during 1994–1996 entrainment sampling at the Rock Slough intake, four Longfin Smelt juveniles were collected. No Longfin Smelt were observed during 1999-2002 entrainment sampling at the Contra Costa Canal headworks where water is first diverted from Rock Slough. Three adult Delta Smelt and one juvenile Delta Smelt were collected at the pumping plant from 1994 to 1996. One Delta Smelt larva was collected during the 1999–2002 entrainment sampling at the headworks (see references cited by DFG 2009a). Collection of Delta Smelt suggests Longfin Smelt are at risk of entrainment (DFG 2009a: 25). However, during 18 years of monitoring at the Rock Slough intake (including sampling behind and in front of the screens during many years), only approximately 19 Longfin Smelt total were collected (D. Sereno, pers. comm.). This suggests that take of Longfin Smelt at this location is low and would be expected to remain low under the PP compared to NAA. As described for Delta Smelt in Section 4.1.3.9.1 *Contra Costa Canal Rock Slough Intake*, modeled pumping of the Rock Slough intake suggested that diversions under the PP generally would be similar to NAA in February, March and June, but not in April and May, when diversions were modeled to be greater under the PP (see ICF International [2016], Table 5.B.5-36 in Appendix 5.B, *DSM2 Modeling and Results*). The overall diversions for the Rock Slough intake and the other CCWD intakes on Old River and Middle River do not differ greatly between NAA and PP, suggesting that Rock Slough may have been favored in the modeling of PP for operational reasons, e.g., Old and Middle River flow criteria, for example. Although the modeled diversions at Rock Slough were somewhat greater under PP in some months, the low observed entrainment of Longfin Smelt suggests that this facility constitutes a minimal source of take for the species.

4.2.6.3.8.2 Clifton Court Forebay Aquatic Weed Control Program

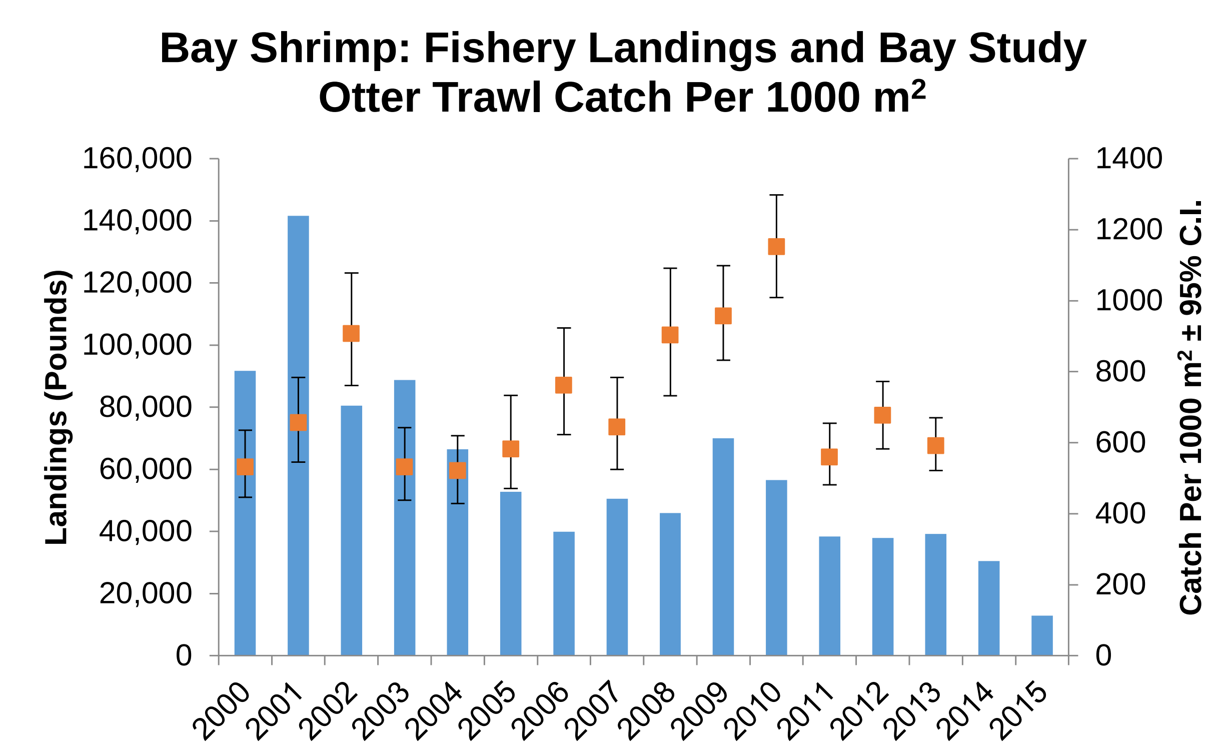
As discussed previously for Delta Smelt in Section 4.1.6.3.8 *Other Facilities*, the Clifton Court Forebay Aquatic Weed Control Program uses copper-based herbicides in CCF, which could result in injury and mortality of Longfin Smelt if they were exposed. However, the herbicide is used during July and August, when few Longfin Smelt are expected in CCF (see Figure 5 in Grimaldo et al. 2009). Mechanical removal of aquatic weeds would occur on an as-needed basis and therefore may overlap with the occurrence of Longfin Smelt in CCF, potentially resulting in injury, but take resulting from mechanical weed removal might be offset by a reduction in abundance of predatory fishes that inhabit the weed mats. The removal of weeds also reduces mortality resulting from smothering of the fish during salvage operations, thereby further offsetting the take. It is not possible to provide quantitative estimates of take as a result of the Clifton Court Forebay Aquatic Weed Control Program.

4.2.7 Analysis of Potential for Jeopardy

4.2.7.1 Cumulative Effects

The cumulative effects described for Delta Smelt in Section 4.1.7.1, *Cumulative Effects*, generally are also relevant to Longfin Smelt: specific projects and programs (e.g., California EcoRestore), water diversions (e.g., relatively small in-Delta agricultural intakes), agricultural practices (e.g., nutrient inputs to Delta waterways), increased urbanization, waste water treatment plants (particularly the scheduled upgrades to the SRWTP), and other activities (dumping of domestic and industrial garbage; oil and gas development and production; levee maintenance; and cooling water withdrawal and discharge). In addition to these factors, Longfin Smelt are directly taken by scientific collections (monitoring). For example, the USFWS 12-month finding on the petition to list Longfin Smelt under the ESA summarized the available information (77 FR 19756): Between the years of 1987 to 2011, combined take of Longfin Smelt less than 20 mm (0.8 in) in length ranged from 2,405 to 158,588 annually. All of these fish were preserved for research or assumed to die in processing. During the same time period, combined take for juveniles and adults (fish greater than or equal to 20 mm) ranged from 461 to 68,974 annually.

Longfin Smelt are also taken as bycatch in the commercial fishery for bay shrimp (DFG 2009a). As summarized by DFG (2009a: 29), commercial shrimp fishers are required to return most trawl-caught fishes to the water, including Longfin Smelt; the only available information on mortality during capture in the bay shrimp fishery is for striped bass, for which young-of-the-year mortality averaged 22% of fish caught during a study by Reilly (1991). The available information on bycatch in the bay shrimp fishery was summarized in the USFWS 12-month finding on the petition to list Longfin Smelt under the ESA, which suggests that the total Longfin Smelt bycatch from the shrimp fishery in 1989 and 1990 was 15,539 fish, and in 2004 was 18,815–30,574 fish (77 FR 19756). Based on the previously described estimates of adult population abundance (Table 4.2-8), the 2004 bycatch would have amounted to 1.2–3.8% of the Longfin Smelt December population. Note that this is likely to be a high estimate because it does not account for adults occurring outside of the range of the midwater trawl survey area and also does not account for Longfin Smelt population mortality that would have occurred between the time that shrimp trawling occurred and the month (December) in which the midwater trawl survey used to estimate population abundance occurred. Bay shrimp trawling effort in 2004 was ~33% of the effort applied 1989/1990, indicating a decrease in effort over time. A decrease in effort is also suggested by a comparison of bay shrimp fishery landings to fishery-independent catch data from the San Francisco Bay Study (Figure 4.2-1). Between 2000 and 2015, landings were generally higher from 2000 to 2004 than from 2005 to 2015. In contrast, the catch per 1,000 m^2 sampled with the otter trawl fluctuated, with the highest values in 2002 and 2008 to 2010. Low fishery landings in 2015 to some extent may have reflected unfavorable spring recruitment conditions, with relatively low outflow and relatively high X2 (mean = 81 km; the highest value during 2000 to 2015, per the DAYFLOW database); California bay shrimp abundance is negatively correlated with X2, possibly as a result of increased residual circulation with greater Delta outflow leading to more rapid or more complete entrainment of early life stages into the estuary, or more rapid transport to their rearing grounds (Kimmerer et al. 2009). Nevertheless, the lack of correspondence between the fishery-independent Bay Study data and the landings data, together with a general decline in the latter, suggests that there is a general downward trend in commercial fishing effort. This reduction in fishing effort presumably has resulted in less bycatch of Longfin Smelt in recent years, and a lower proportion of the Longfin Smelt population taken as bycatch.



Source: California Department of Fish and Game (2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009c, 2010, 2011, 2012; California Department of Fish and Wildlife 2013, 2014, 2015); and ftp://ftp.dfg.ca.gov/BayStudy/CatchMatrices/BayStudy_ShrimpMatrix_1980-2013.zip. Notes: Bay study trawl catch included four species: *Crangon franciscorum* (California bay shrimp), *C. nigricauda* (blacktail bay shrimp), *C. nigromaculata* (blackspotted bay shrimp), and *Palaemon macrodactylus* (oriental shrimp). Mean catch per 1,000 m^2 and 95% confidence interval (C.I.) were generated by bootstrapping of data (1,000 resamples).

Figure 4.2-1. Commercial Landings of Bay Shrimp, 2000–2015, and Bay Shrimp Catch Per 1,000 m^2 in the San Francisco Bay Study Otter Trawl.

As discussed in Section 4.1.7.1.8, *Conclusion for Cumulative Effects*, a number of factors discussed for cumulative effects will have neutral or potentially positive effects on Delta Smelt, and therefore also would be expected to have neutral or potentially positive effects on Longfin Smelt. In contrast to Delta Smelt, there have been no quantitative projections of potential climatic effects on Longfin Smelt at the broad, estuary-wide scale. However, there has been examination of climate variability effects on fluctuations in fish communities in the San Francisco Estuary, with Longfin Smelt among the key species differentiating climatic regimes propagating from both the land (outflow) and the ocean (North Pacific Gyre Oscillation, NPGO) (Feyrer et al. 2015). Age-0 and age-1 Longfin Smelt were found in higher abundance during the high outflow regime, so that future conditions with decreased precipitation and outflow could potentially negatively affect Longfin Smelt (Feyrer et al. 2015). Age-0 Longfin Smelt abundance was greater during the warm NPGO regime, so that cooler conditions (positive NPGO values) could negatively affect populations of Longfin Smelt (Feyrer et al. 2015); however, expected changes to the North Pacific Ocean are uncertain and may include increased temperature (Furtado et al. 2011, as cited by Feyrer et al. 2015: 3618). Thus climate change could produce mixed effects on Longfin Smelt, particularly with respect to rising sea level potentially changing the distribution of the species within the Bay-Delta, and associated effects on outflow from shifts in the timing of precipitation (more rain compared snowmelt). Within the Bay-Delta, increasing water temperature because of climate change could reduce the amount of habitat available for larvae and small juveniles, which are rarely found in water warmer than 22°C (DFG 2009a). Jeffries et al. (2016) examined physiological performance in larval/young juvenile Longfin Smelt and Delta Smelt in relation to water temperature in a laboratory study. They found that Longfin Smelt exhibited a pronounced cellular stress response, with an upregulation of heat shock proteins, after exposure to 20°C water; such a response was not observed in Delta Smelt. They also detected an increase in metabolic rate in Delta Smelt at 20°C and increased expression of genes involved in metabolic processes and protein synthesis, with such patterns not observed in Longfin Smelt. Jeffries et al. (2016) concluded that Longfin Smelt may be more susceptible than Delta Smelt to increases in temperature, and therefore that Longfin Smelt may have little tolerance for future warming in California under climate change.

4.2.7.2 Potential to Jeopardize Continued Existence of the Species

The issuance of the ITP is not expected to jeopardize the continued existence of Longfin Smelt for the following reasons.

4.2.7.2.1 Level of Take

The overall potential for take is high, prior to consideration of the effects of implementing take minimization measures. Covered activities have a high likelihood of resulting in mortality of individuals. As described for Delta Smelt in Section 4.1.7.2 4.1.7.2 *Potential to Jeopardize Continued Existence of the Species*, the covered activities will result in permanent impacts to nearly 526 acres of aquatic habitat: 500.6 acres for the NDD (shallow water habitat), 245 acres near and upstream of the NDD (shallow water habitat within the construction footprint or upstream, for which access could be reduced), ~~A described for Delta Smelt in Section 4.1.7.2 4.1.7.2 *Potential to Jeopardize Continued Existence of the Species*, the covered activities will result in permanent impacts to ~276 acres of aquatic habitat: 5.6 acres for the NDD (shallow water habitat), 245 acres near and upstream of the NDD (shallow water habitat, including 36 acres of spawning beach habitat[7]),~~ 2.9 acres at the HOR gate (tidal perennial habitat), and 22.4 acres at barge landings (tidal perennial habitat). These habitat losses are small relative to the overall area of habitat available to Longfin Smelt, and therefore will not have a population-level effect. Entrainment losses at the south Delta export facilities (i.e., the main source of entrainment) will be similar or lower to the entrainment under the NAA. Based on the estimates provided in Section 4.2.6.3.2 for historic levels of entrainment, the population-level estimate of take generally would be expected to be well below 1% of adults, larvae, and juveniles. The PP includes OMR criteria that are the same or more restrictive than those from the U.S. Fish and Wildlife Service (2008) BiOp, which were implemented to avoid jeopardy to Delta Smelt from entrainment, and would also be protective for Longfin Smelt, consistent with the DFG (2009b) ITP for the SWP/CVP. Take of larval/young juvenile Longfin Smelt by entrainment at the NDD could occur; estimates of the take in quantitative population-level terms is challenging, but in the worst case scenario previously discussed might represent well below 0.1% of the larval/young juvenile population (see Section 4.2.6.3.1, *North Delta Exports*); a similar level of take may occur for adult Longfin Smelt occurring at the NDD. Take from entrainment at the Suisun Marsh facilities (RRDS and MIDS) and CCC Rock Slough intake would be would be maintained at the

~~[7] It is assumed for the purposes of this application that putative spawning habitat for Delta Smelt could also be used by longfin smelt, although the species generally occurs farther downstream than Delta Smelt.~~

apparently low levels currently occurring at these facilities, which have not received detailed levels of quantification. As described in Section 4.2.6.3.7 *North Bay Aqueduct*, take by entrainment at the Barker Slough Pumping Plant is estimated to have historically (1995–2005) ranged from zero to nearly one million Longfin Smelt < 25 mm annually, which is likely to be representative of the range in potential take for the PP; of greater relevance is the proportional take, which was estimated to generally be 0.01% or less of the population, and always well below 1% of the population. On the basis of the foregoing analyses of take, differences in winter-spring Delta outflow and X2 under the PP relative to the NAA perhaps contribute most to a population-level take mechanism that, without minimization, would have potential to jeopardize the Longfin Smelt population. As described in Section 4.2.6.3.4 *Delta Outflow/X2 Effects*, differences in mean relative abundance predicted by the X2-abundance GLM in critical years (3% less under PP than NAA) and dry years (4% less under PP than NAA) are of concern. Although the estimates have appreciable uncertainty, as illustrated with the prediction intervals for annual relative abundance estimates, DWR has collaborated with DFW to develop a take minimization measure comprised of spring Delta outflow criteria to limit potential effects, described below.

4.2.7.2.2 Effect of Take Minimization Measures

The take minimization measures described in Section 5.3.2 *Longfin Smelt* greatly reduce the potential for mortality of individuals from construction and maintenance of the PP, which makes it unlikely that such activities will affect reproductive rates of the population or survivorship of individuals. Operational criteria also will minimize the potential for take of Longfin Smelt (see Section 3.3.2, *Operation Criteria*): for entrainment, this includes having NDD fish screens meeting agency requirements (1.75-mm opening, 0.2-ft/s approach velocity) and having OMR criteria for south Delta exports that are the same or more restrictive than those from the U.S. Fish and Wildlife Service (2008) BiOp. As previously noted, the risk for entrainment will moreover be carefully managed in real time; such management will occur under both the NAA and PP, incorporating the latest information gained from the results of coordinated monitoring and research under the Collaborative Science and Adaptive Management Program about fish distribution and other factors that affect entrainment risk.

As previously described, the slightly lower Delta outflow/greater X2 in winter/spring under the PP relative to NAA has provided cause for concern to DFW with respect to the potential for this change to cause an incompletely mitigated impact to Longfin Smelt. To avoid this risk, DWR and DFW have collaborated to develop Longfin Smelt spring (March–May)[8] outflow criteria that are consistent with existing water conveyance/operations and climate conditions. As described in Section 5.3.2 *Longfin Smelt* in Chapter 5 *Take Minimization and Mitigation Measures*, the Longfin Smelt spring outflow criteria determine March outflow targets based on the Eight River Index and achieve the targets with export curtailments down to a minimum of 1,500-cfs exports; the March outflow target is capped at 44,500 cfs at an Eight River Index of 4,217 TAF and greater. April and May outflow targets are based on the San Joaquin River inflow:export ratio included in the NMFS (2009) BiOp, up to a maximum outflow target of 44,500 cfs; this again

[8] Focus on spring was based on unpublished analyses suggesting that spring may be of greater importance than winter (discussed by Hanson [2014] in supporting material for Maunder et al. [2015]). However, the relative importance of flows during these seasons would remain a focus of research and adaptive management.

involves curtailment of exports as necessary. The effects of the Longfin Smelt spring outflow criteria were assessed with the X2-abundance GLM previously used to compare PP to NAA (see Section 4.2.3.1 *Delta Outflow/X2 Effects*). This illustrates that the Longfin Smelt spring outflow criteria have the potential to give population-level effects under the PP that are similar to those under the NAA (Table 4.2-11; Figure 4.2-2, Figure 4.2-3, and Figure 4.2-4). In addition, curtailments of exports have the potential to distribute Longfin Smelt further downstream on the lower San Joaquin River, as described for the PP in Section 4.2.3.2 *Entrainment and South Delta Entry* for the discussion of San Joaquin River at Jersey Point flows, as well as resulting in slightly less potential for entrainment during March (as reflected by less negative Old and Middle River flows in March, with little difference compared to PP in April and May; see Table 4.D-5 in Appendix 4.D *Comparison of Key Hydrological Variables for Proposed Project with Longfin Smelt Spring Outflow Criteria to No Action Alternative and Proposed Project Scenarios*).

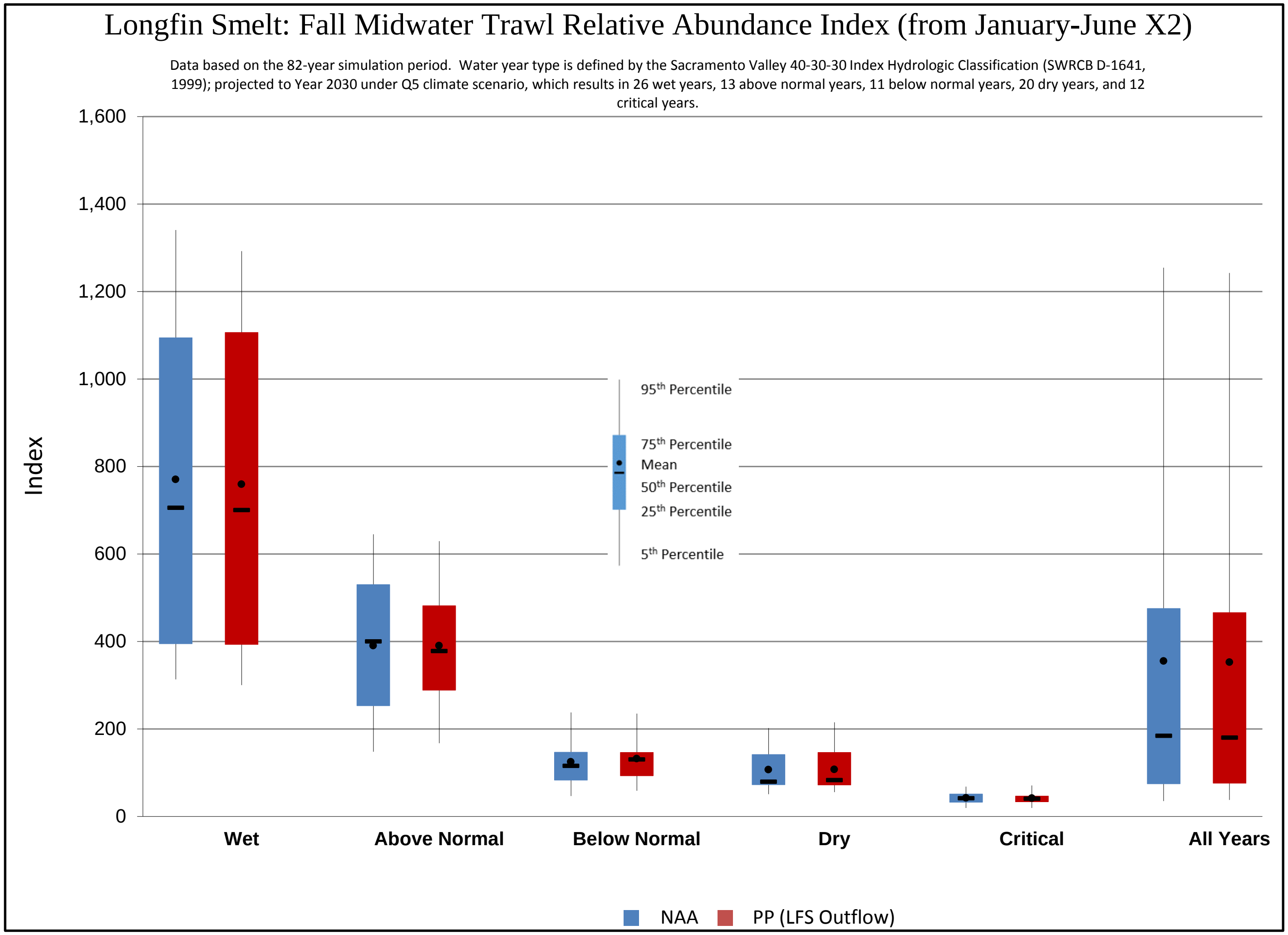
As is clear from the wide prediction intervals for both the PP with Longfin Smelt spring outflow criteria and the NAA in Figures 4.2-3 and 4.2-4, there is uncertainty in the estimates and therefore the potential extent of differences between NAA and PP. Outflow criteria and the mechanisms underlying the importance of outflow will be a key component of the proposed scientific research program for Longfin Smelt. The scientific research program will be a component of the adaptive management program described in Chapter 6 Monitoring Plan and Appendix 6.A Adaptive Management Framework, which, as summarized in Section 5.3.2 *Longfin Smelt*, will be funded by DWR to improve understanding of:

- Longfin Smelt biology;
- Mechanisms behind the Delta outflow-Longfin Smelt abundance relationship, particularly with respect to evidence for critical time periods (e.g., winter vs. spring) and potential annual variation in these time periods;
- Longfin Smelt's use of tidal wetlands and potential for benefit from food production exported from restoration sites;
- Longfin Smelt occurrence in the Delta, Bay, and nearshore coastal ocean.

Table 4.2-13. Mean Annual Longfin Smelt Relative Abundance Index (Fall Midwater Trawl Survey), Estimated from General Linear Model Based on Mean January–June X2[1], Grouped by Water Year Type, Comparing PP with Longfin Smelt Spring Outflow Criteria to NAA.

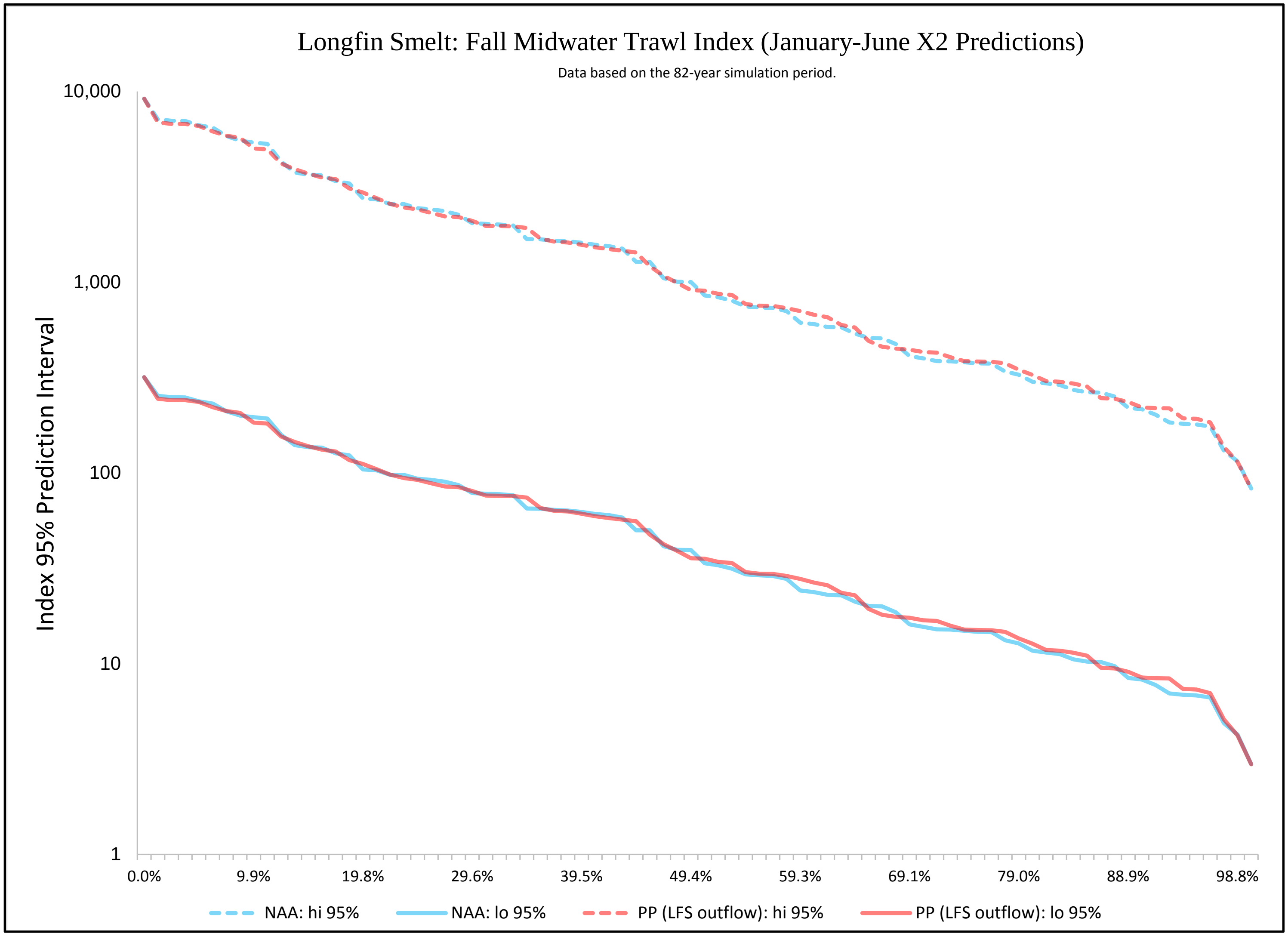
Water Year Type	NAA	PP (With Longfin Smelt Spring Outflow Criteria)	PP (With Longfin Smelt Spring Outflow Criteria) vs. NAA[2]
Wet	770	759	-11 (-1%)
Above Normal	390	390	0 (0%)
Below Normal	125	132	7 (6%)
Dry	107	107	1 (0%)
Critical	42	42	0 (-1%)

[1]A step change for the Pelagic Organism Decline (POD) was also included in the General Linear Model.
[2]Negative values indicate lower abundance index under the proposed project (PP with Longfin Smelt spring outflow criteria) than under the no action alternative (NAA).



Note: Plot only includes mean responses and does not consider model uncertainty.

Figure 4.2-2. Box Plot of Longfin Smelt Fall Midwater Trawl Relative Abundance Index, Estimated from the General Linear Model Including Mean January–June X2, Grouped by Water Year Type, Comparing PP with Longfin Smelt Spring Outflow Criteria to NAA.



Note: Data are sorted by mean estimate, with only 95% prediction intervals shown.

Figure 4.2-3. Exceedance Plot of Longfin Smelt Fall Midwater Trawl Relative Abundance Index, Estimated from the General Linear Model Including Mean January–June X2, Comparing PP with Longfin Smelt Spring Outflow Criteria to NAA.

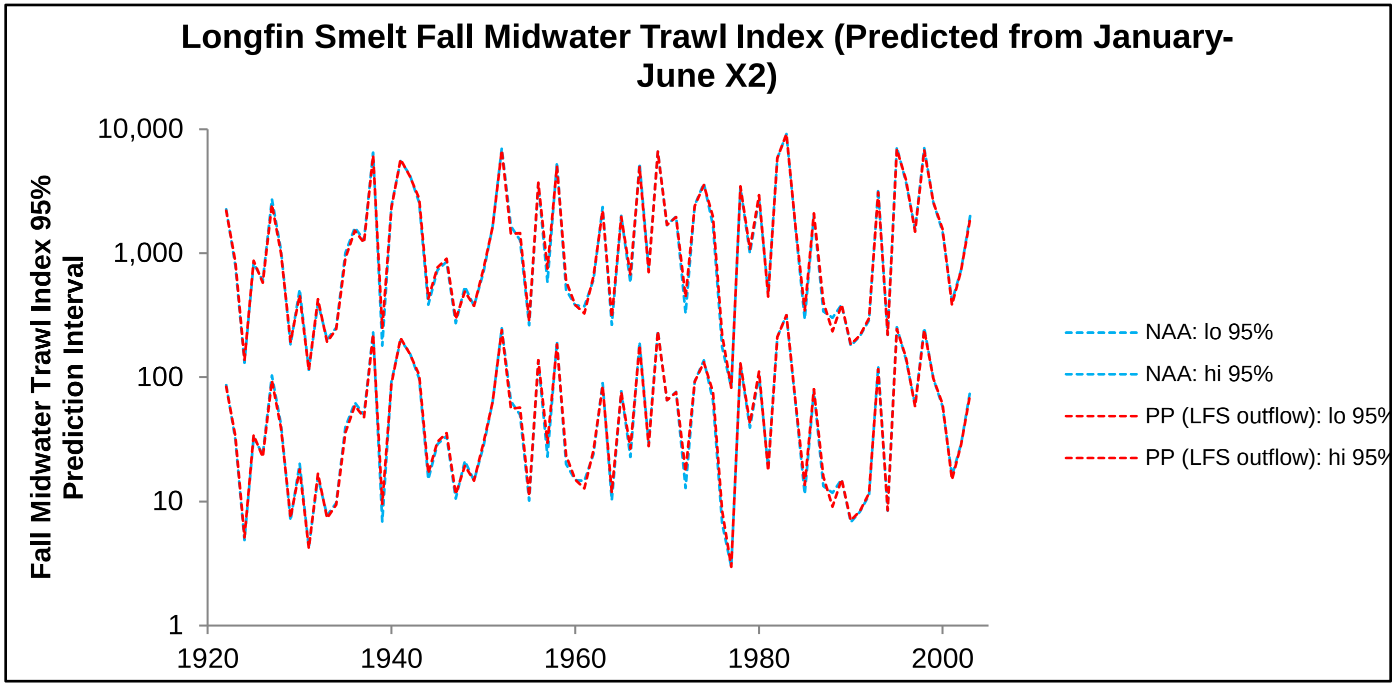


Figure 4.2-4. Time Series of 95% Prediction Interval Longfin Smelt Bay Midwater Trawl Index, from the General Linear Model Including Mean January–June X2, Comparing PP with Longfin Smelt Spring Outflow Criteria to NAA.

4.2.7.2.3 Effect of Mitigation

Mitigation will fully mitigate habitat loss and any loss of individuals associated with habitat loss. High-quality, larger-scale, intact habitat will be acquired, enhanced, and managed in perpetuity, at ratios ranging from 1:1 for potential reduced access to the shallow water habitat near and upstream of the NDD (with the exception of a 3:1 ratio for the sandy beach spawning habitat), to 5:1 for the shallow water habitat at the NDD. In total, 1827.7 acres will be provided as mitigation (1,753 acres of shallow-water habitat for NDD mitigation, and In total, 347.7 acres will be provided as mitigation (273 acres of shallow-water habitat, of which 108 acres will be sandy spawning beach habitat, for NDD mitigation; 74.7 acres of tidal perennial habitat for HOR gate and barge landings mitigation). Mitigation details are summarized in Section 5.4.0.3 *Summary of Restoration for Fish Species* and Section 5.4.2 *Longfin Smelt* in Chapter 5, *Take Minimization and Mitigation Measures*.

4.2.7.2.4 Conclusions

While the Bay-Delta Longfin Smelt population appears to be in decline (77 FR 19756), the PP will not exacerbate this decline. The applicant's take minimization measures will ensure impacts on habitat and individuals are minimized, and the mitigation will ensure an appropriate extent of habitat is restored.

For Longfin Smelt, factors recently examined as being of potential importance to the population include reduced freshwater flow, climate change, channel disturbances, bycatch in commercial fishing, take in monitoring surveys, disease, predation, entrainment losses, and contaminants (77 FR 19756). The potential effects of the PP on these factors, as relevant, have been described in the analyses presented in Section 4.2.1 *Construction Effects*, Section 4.2.2 *Maintenance Effects*, Section 4.2.3 *Operations Effects*, Section 4.2.5 *Monitoring Effects*, and Section 4.2.6 *Take Analysis*. The PP will not threaten the survival of Longfin Smelt because, by inclusion of appropriate minimization and mitigation measures, the covered activities will not result in significant losses of individuals of the species or habitat. The PP also will not substantially contribute to the fragmentation of remaining habitat because the potential for creation of barriers to movement (principally at the NDD, for upstream migrants) will be mitigated as necessary.

Considering the level of take described previously, the take minimization measures described in Section 5.3.2 *Longfin Smelt*, and that the loss of habitat will be fully mitigated (Section 5.4.0.3 *Summary of Restoration for Fish Species* and Section 5.4.2 *Longfin Smelt*), the PP will not adversely affect the reproduction and survival of Longfin Smelt, and the issuance of the ITP will not jeopardize the continued existence of the species.

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