

ecological changes that the CWF may have on the Bay-Delta ecosystem. Currently, little information is known about what, when, where, and how these effects will be adaptively managed, and much less is known about the adaptive management options that may be available and decisions about adaptive management measures that may be made. Information about when, where and how adaptive management measures will occur is important to determining the extent, frequency, and duration of adverse effects, if any, to listed species and critical habitat. Therefore, the BA and this Opinion do not analyze how or if activities associated with adaptive management would affect listed species or designated critical habitat. Addressing effects resulting from the implementation of the AMP would be speculative at this time. The AMP and associated agreement and schedule do, however, commit the Five Agencies (with Reclamation and DWR ultimately responsible for implementation of the AMP) and SWP/CVP Contractors to the adaptive management process, detailing the governance structure, annual reporting and funding commitments as well as identifying an initial set of key uncertainties regarding listed species and CVP/SWP water operations. NMFS retains the authority to assess the effects on listed species and critical habitat resulting from the implementation of the adaptive management plan as required under the ESA. Furthermore, if activities that are identified as part of the AMP may adversely affect listed species or designated critical habitat, Reclamation and DWR will evaluate the scope of effects and work with NMFS to determine if the scope of effects are not analyzed in this Opinion. If not, and the activities are not subject to subsequent consultation under ESA section 7, or the activities are not subject to a permit under ESA section 10, then reinitiation of this consultation will likely be required to address those effects.

2.5.1.5 Southern Resident Killer Whale Effects Analysis

The primary potential impact of the PA on Southern Residents that has been identified in the BA (Reclamation 2016) and in this Opinion is through potential reductions in availability of preferred prey, Chinook salmon, in the coastal waters where Chinook salmon from the Central Valley of California may be encountered by Southern Residents. Because the PA also may expose Chinook salmon to contaminants, NMFS considers the potential impact of this exposure for the preferred prey of Southern Residents.

Section 2.4.5.2 Factors Affecting the Prey of Southern Residents in the Action Area describes the evaluation by the Science Panel (Hilborn et al. 2012) of the state of the science regarding the effects of salmon fisheries on Southern Residents. While there is uncertainty in the extension of the statistical correlations to precise predictions of the effect of Chinook salmon abundance on the Southern Resident population, to date there are no data or alternative explanations that contradict fundamental principles of ecology that wildlife populations respond to prey availability in a manner generally consistent with the analyses that link Chinook salmon abundance and Southern Residents. As a result, and based on evidence discussed in Section 2.2.5 Rangewide Status of Southern Resident Killer Whale and Section 2.4.5.2 Factors Affecting the Prey of Southern Residents in the Action Area, NMFS concludes that the best available science suggests that relative changes in Chinook salmon abundances are likely to influence the Southern Resident population.

2.5.1.5.1 Impacts to the Abundance of Chinook as a Result of the Proposed Action

In terms of productivity and abundance, Central Valley Chinook salmon is largely comprised of the non-ESA listed fall-run and, to a much lesser degree, non-ESA listed late fall-run. This is

reflected in annual spawning escapement estimates for the Sacramento River and its associated tributaries; fall-run Chinook salmon escapement estimates are typically on the order of several hundred thousand adults, compared to several thousand for winter- and spring-run Chinook salmon combined (PFMC 2016b). As a result, NMFS' approach in this Opinion to analyzing the effects of the PA on Southern Residents includes analysis of fall-run and late fall-run similar to the analyses of the ESA-listed species of salmon. In addition, the effects analysis for Southern Residents also considers the impact to ESA-listed winter-run and spring-run Chinook in the Central Valley since they are also potential prey for Southern Residents along the coast.

Detailed descriptions regarding the exposure, response, and risk of each of the Chinook salmon ESUs found in the action area and affected by the PA (winter-, spring-, fall-/late fall-run) to stressors associated with the PA are presented in Section 2.5 Effects of the Action (and summarized in Section 2.7 Integration and Synthesis). The PA-related effects to Chinook salmon are separated into those related to construction and those related to operations. Given that the potential effect to Southern Residents as a result of the PA is reduced prey availability associated with effects to Chinook salmon, the effects to Southern Residents are similarly separated. As a result, the analysis will look at potential reduced Southern Resident prey for the duration of construction and in the future when project operations are expected to commence.

2.5.1.5.1.1 Construction-related Impacts to Chinook Abundance

The construction-related effects on fall-run and late fall-run Chinook salmon in the Central Valley that are expected to occur during the 8-year construction period are described in Section 2.5.1.1 Construction Effects (and summarized in Table 2-264 of Section 2.7.9 Integration and Synthesis of Fall-run and Late Fall-run Chinook Salmon). The table characterizes the relative magnitude and certainty of individual stressors in general relative terms of “low”, “medium”, and “high”,¹ along with the anticipated types of responses and rationale for the characterization. These characterizations represent a qualitative assessment of the expected impacts to Chinook salmon at an individual fitness level in combination with the extent of the impact at the population level.

Several activities associated with the PA – including pile driving, barge operations, geotechnical analysis, clearing and grubbing, and use of temporary in-water structures – are expected to mostly affect a small proportion of juvenile and adult stages of fall-run and late fall-run Chinook salmon but a medium proportion during pile driving and for increased predation. Adverse impacts to juveniles and adults resulting from exposure to pile-driving and increased barge traffic that include injury and mortality, as well as physical stress from acoustics and turbidity, are likely. In total, various stressors will reduce the fitness and survival of a small proportion of fall-run and late fall-run Chinook salmon ESUs as a result of construction, although most impacts described are expected to be limited to sublethal effects. The summation of the impacts from all construction activities on fall-run and late fall-run Chinook salmon is expected to reduce the number of juvenile Chinook salmon migrating out of the Central Valley and adult Chinook salmon returning to spawning grounds during the construction period. This will reduce the abundance of fall-run and late fall-run Chinook salmon in ocean and consequently reduce prey

¹ High: Lethal effect due to stressor that has a broad effect on the population at significant frequency.

Medium: Effect between high and low definitions.

Low: Generally, sublethal effect, or lethal effect on a very small percentage of one population at a very infrequent interval.

for Southern Residents during the construction period. However, chapter 3 of the BA, and the revised PA (Appendix A2 of this Opinion), include a commitment of 80 acres of expanded rearing habitat through restoration in the upper Sacramento River between Keswick Dam and RBDD, and 1,800 acres of tidal rearing habitat restoration in the Delta. Although these additional habitat restoration activities will have short-term impacts to habitat from ground and in-water disturbance the restoration is expected to improve these PBFs for all salmonids in the long-term, resulting in improved survival.

Section 2.7 Integration and Synthesis also summarizes effects from the proposed construction activities on winter-run and spring-run Chinook salmon. The relative magnitude of effects of construction-related impacts to these Chinook ESUs are very similar to the effects on fall-run and late fall-run Chinook salmon. Although impacts resulting from pile driving and increased barge traffic are expected to reduce winter-run and spring-run Chinook salmon relative abundance, productivity, spatial structure, and diversity as a result of construction-related impacts (Table 2-242 and Table 2-248), the revised PA is expected to minimize impacts to a minimal level.

2.5.1.5.1.2 Operational Impacts to Chinook Abundance

A number of effects related to operations of the PA are expected to reduce the abundance and/or productivity of a small proportion of fall-run and late fall-run Chinook salmon. The post-construction operational effects of the action on fall-run and late fall-run Chinook salmon are described in Section 2.5.1.2 Operations Effects and summarized in Table 2-264 in the Integration and Synthesis. The operational-related impacts describe no to low impact in terms of increased temperatures upstream of the NDD; dewatering and scour impacts to redds and stranding of young fish, as well as juvenile outmigration survival. Impacts of impingement or entrainment and increased risk of predation at the NDD, and increased predation risks associated with permanent structures are expected to result in a medium level of impact, as is routing, and south Delta impacts.

For impacts associated with upstream temperature influences on egg survival, fry rearing and outmigration that influence the survival rates of early stages of fall-run and late fall-run Chinook, there is a small or marginal difference in the expected effect of the PA compared to the NAA (Table 2-265). The information presented and analyzed in Section 2.5.1.2 Operations Effects shows that egg and early life stage survival rates are currently limited and reduced by water temperatures in the action area, which has the potential to reduce survival and fitness of a small proportion of fall-run and late fall-run Chinook salmon in some years.

The analyses of redd dewatering, scouring, and stranding described in Section 2.5.1.2 Operations Effects show a small difference in the expected effect for the PA compared to the NAA; this difference would affect the survival, reproductive success, and fitness of fall-run and late fall-run Chinook salmon (Table 2-265).

Impacts associated with impingement and entrainment and increased predation at NDD for fall-run and late fall-run Chinook salmon described in Section 2.5.1.2 Operations Effects are expected as a result of PA operations. Mortality rates of 7% for fish passing the NDD screen (impingement), along with additional mortality resulting from increased predation around the new permanent structures, is expected to reduce survival and fitness of fall-run and late fall-run Chinook salmon (Table 2-265). However, the PA describes the incorporation of refugia along the

NDD structure that may provide additional minimization to screen impingement and associated predation risk. Phased testing and operation of the three NDD intakes will ensure that the screens are functioning to NMFS screening criteria or if not, impacting PBFs or fish beyond the analysis in this Opinion would trigger subsequent consultation or reinitiation of consultation.

As described in Section 2.5.1.2 Operations Effects, reduced in-Delta flows resulting from PA operations are expected to result in mortality caused by increased migration times and changes to Delta routing and entrainment that increase exposure of juvenile fall-run and late fall-run Chinook salmon to predators, reducing the survival of a small proportion of juvenile fall-run and late fall-run Chinook salmon compared to the NAA (Table 2-265).

An array of significant stressors to fall-run and late fall-run Chinook salmon are expected to decrease abundance as a result of PA operations. For some stressors, such as reduced survival of early life stages associated with increased water temperatures and redd dewatering and stranding, there is only a small difference between the effects of the PA compared to the effect of the NAA. Impacts associated with impingement and entrainment at the NDD, along with impacts from reduced Delta flows, are adverse compared to the NAA for fall-run and late fall-run Chinook salmon. Because these impacts result in mortality and reduced fitness for early life stage and juvenile fall-run and late fall-run Chinook salmon, survival of juvenile fall-run and late fall-run Chinook salmon transiting through the Delta will be reduced. As these impacts are expected to reduce the abundance of fall-run and late fall-run Chinook salmon in the ocean, they also consequently reduce the prey in the ocean for Southern Residents. While it is difficult to distinguish between the ongoing limitations to the abundance of Chinook salmon entering the ocean resulting solely from operations of the PA, some operational impacts such as impingement and entrainment at the NDD are clearly attributable to PA operations.

However, Chapter 3 of the BA, and the revised PA (Appendix A2), describes a commitment to 80 acres of expanded rearing habitat through restoration in the upper Sacramento River between Keswick Dam and RBDD, and 1,800 acres of tidal rearing habitat restoration in the Delta. Although these additional habitat restoration activities will have short-term impacts to habitat from ground and in-water disturbance the restoration is expected to improve these PBFs for all salmonids in the long-term, and increase survival of fish.

Based on the PA and the analyses and information that is currently available, we expect impacts from PA operations will reduce prey for Southern Residents by reducing a small proportion of fall-run and late fall-run Chinook salmon in the ocean throughout the duration of operations, however reductions of abundance analyzed is expected to be minimized through the revised PA including the commitment to implement an adaptive management program.

Effects of the PA operations on winter-run and spring-run Chinook salmon are similar to the effects on fall-run and late fall-run Chinook salmon. The relative abundance and productivity of these ESUs are not expected to be reduced or diminished beyond a minimal amount (Table 2-264 and Table 2-265). Furthermore, the revised PA is expected to minimize impacts to listed Chinook salmon to a minimal level, through RTOs, adaptive management, and mitigation and restoration improvements to habitat.

2.5.1.5.1.3 Effect of Reduced Prey Base for Southern Residents

The information described above suggests that the population dynamics of Southern Residents are related to the abundance of Chinook salmon available as prey throughout the range of

Southern Residents. As a result, reductions in availability of preferred prey (Chinook salmon) may affect the survival and reproductive success of Southern Residents. As described in Section 2.2.5 Rangewide Status of Southern Resident Killer Whale and Section 2.4.5.2 Factors Affecting the Prey of Southern Residents in the Action Area, during the winter and spring, Southern Residents (particularly members of K and L pod) are likely spend at least some time in coastal waters where they would be affected by reductions in Central Valley Chinook salmon abundance due to the PA. As described in Section 2.4.5.2 Factors Affecting the Prey of Southern Residents in the Action Area, Chinook salmon from the Central Valley, especially fall-run Chinook salmon, constitute a significant proportion of the total abundance of Chinook salmon that is available throughout the coastal range of Southern Residents (~ 20% on average based on the SI, but varying substantially during any given year). As described in Section 2.4.5.2 Factors Affecting the Prey of Southern Residents in the Action Area, Central Valley Chinook salmon become an increasingly significant portion of Chinook present along the southern portion of the Southern Resident range in Oregon and California. As described in Section 2.4.5.2 Factors Affecting the Prey of Southern Residents in the Action Area, Southern Residents (particularly members of K and L pod) have also been linked to consumption of Chinook salmon from California based on the contaminant signatures discussed above.

Southern Residents could abandon particular areas in search of more abundant prey or expend substantial effort to find prey resources in response to a decrease in the amount of available Chinook salmon due to the PA. These changes in behavior can result in increased energy demands for foraging individuals as well as reductions in overall energy intake, increasing the risks of being unable to acquire adequate energy and nutrients from available prey resources (i.e., nutritional stress). Southern Residents are known to consume other species of fish, including other salmon, but the relative energetic value of these species is substantially less than that of Chinook salmon. Reduced availability of Chinook salmon would likely increase predation activity on other species (and energy expenditures) and/or reduce energy intake. Numerous studies have demonstrated the effects of energetic stress (caused by incremental increases in energy expenditures or incremental reductions in available energy) leading to reduced body size and condition and lower reproductive and survival rates for adults (e.g., Daan et al. 1996; Gamel et al. 2005) and juveniles (e.g., Trites and Donnelly 2003; Noren et al. 2009). In the absence of sufficient food supply, adult females may not successfully become pregnant or give birth and juveniles may grow more slowly. Any individual may lose vitality, succumb to disease or other factors as a result of decreased fitness, and subsequently die or not contribute effectively to future productivity of offspring necessary to avoid extinction and promote recovery of a population. Small, incremental increases in energy demands are expected to have the same effect on an animal's energy budget as small, incremental reductions in available energy, such as reduced prey availability.

2.5.1.5.1.3.1 Construction-related Impacts of Reduced Prey Base for Southern Residents

Based on the analyses of expected impacts to Chinook salmon populations in the Central Valley affected by the proposed construction activities, minimal reductions in the survival and productivity of Chinook salmon populations are expected to last the duration of construction. These reductions would decrease the abundance of Chinook salmon populations in the ocean and subsequent availability as prey for Southern Residents. In particular, although some construction-related impacts are expected for fall-run Chinook salmon from the Central Valley, which is likely an important prey source for Southern Residents in portions of their coastal range,

the revised PA is expected to reduce these impacts. While the available analytical tools are best used in a comparative approach, limiting their application to a determination of absolute magnitude, construction-related impacts are expected to affect a small proportion of Chinook salmon populations. These impacts would likely reduce the number of Chinook salmon available in the ocean in some years in the southern portion of the coastal range of Southern Residents. The reduced abundance of prey could be detected by all members of K and L pod during foraging on a reduced prey field, leading to increased expenditures of energy during foraging. The exposure of members of J pod to reduced Chinook salmon abundance in coastal waters is not as clear based on the current understanding of their distributions and contaminant signatures as described in Section 2.4.5.2 Factors Affecting the Prey of Southern Residents in the Action Area, but available data considered here suggest their exposure may be much more limited or nonexistent. The expected consequences of significant reductions in the abundance of preferred prey for these Southern Residents are reductions in the fitness of individuals because of increased energy expended to find sufficient prey and nutritional stress, which can lower reproductive rates and increase mortality rates. Based on the general relative analyses that have been described, all members of K and L pod are expected to be at risk of reduced fitness due to decreased Chinook salmon abundance in the ocean resulting from project-related construction.

2.5.1.5.1.3.2 Operational-related Impacts of Reduced Prey Base for Southern Residents

Based on the analyses of expected impacts to Central Valley Chinook salmon populations exposed to the operations of the PA, and including the revised PA (Appendix A2), and the RTO and adaptive management and monitoring provisions included in the PA, which provide additional opportunities to refine the operating criteria and make adjustments to CVP/SWP Delta operations to minimize the risks of incidental take while maximizing water supply, the conditions for Chinook salmon during operations of the PA will likely still result in a small proportion of decreased abundances for Chinook salmon populations in some years.

Any reductions and limitations in juvenile Chinook salmon survival and fitness occurring in the action area under PA operations, are expected to reduce the abundance of Central Valley Chinook salmon populations in the ocean. Any reductions in available prey are most likely to be detected by all members of K and L pod, during foraging on a reduced prey field, leading to increased expenditures of energy during foraging. The expected consequences of reduced abundance of preferred prey for Southern Residents are reduced fitness of individual Southern Residents through increased energy expended to find sufficient prey and nutritional stress, which can lower reproductive rates and increase mortality rates. Based on the general relative analyses that have been described, members of K and L pod are expected to be at risk of reduced fitness due to the small proportion of decreased Chinook salmon abundance in the ocean in some years resulting from PA-related operations. However, the revised PA is expected to reduce impacts to a minimal level.

2.5.1.5.1.4 Conclusion of Reduced Prey Base Effects for Southern Residents

Based on the analysis above, NMFS expects that the PA will reduce the amount of a small proportion of Central Valley Chinook salmon (especially fall-run Chinook salmon) available in the ocean for Southern Residents to forage in some years. The result of reduced ocean abundance of Central Valley Chinook salmon, is that at least some individuals will be required to spend more time foraging, which increases energy expenditures and the potential for nutritional stress,

which can lead to reduced body size and condition, and potentially contribute to lower reproductive and survival rates, especially for K and L pod whales.

Members of K and L pod constitute a sizeable portion of the entire Southern Resident population, with 54 of the 78 members. As a result, the potential risk of reduced fitness and decreased survival and reproductive rates for members of K and L pod presents a risk for the Southern Resident population as a whole. Because the PA is likely to increase the risks of nutritional stress in some years, potentially reducing reproductive and survival rates for a large portion of the individuals in the Southern Resident population, the population growth and recovery potential of the Southern Resident population could be affected by the increased risks to survival and reproduction that may be associated with decreased abundances of preferred prey in the ocean.

As it is described in Section 2.4.5.2 Factors Affecting the Prey of Southern Residents in the Action Area, it is clear that Chinook salmon from the Central Valley are expected to constitute a component of the diet of Southern Residents in coastal waters, but the extent of the contribution of Central Valley Chinook salmon to the diet or the expected reliance on them by Southern Residents is less clear. Southern Residents are expected to detect and respond to reduced Central Valley Chinook salmon abundance and a reduced prey field during foraging, likely resulting in Southern Residents searching for more abundant prey fields in other parts of their range where Chinook salmon from the Central Valley may not constitute much, if any, of the available prey. While Chinook salmon are expected to be the preferred prey with high nutritional value, Southern Residents are capable of taking advantage of other prey sources to supplement their nutritional needs and are assumed to do so in the immediate absence of sufficient Chinook salmon resources. Based on the distribution of Central Valley Chinook salmon described in Section 2.4.5.2 Factors Affecting the Prey of Southern Residents in the Action Area, any nutritional and energetic stress impacts caused by the PA are most likely to occur in the more southerly range of Southern Residents. Based on research and the known distribution of Southern Residents described in Section 2.2.5 Rangewide Status of Southern Resident Killer Whale and Section 2.4.5.2 Factors Affecting the Prey of Southern Residents in the Action Area, we conclude that while Southern Residents are known to occasionally use the southerly end of their range during some years, it is also likely that this population may limit or avoid use of this area altogether during some years.

Ford and Ellis (2006) report that Southern Residents engage in prey sharing about 76% of the time during foraging activities. Prey sharing presumably would distribute more evenly any effects of prey limitation across individuals of the population than would otherwise be the case (i.e., if the most successful foragers did not share with other individuals). Considering this, along with their ability to take advantage of other prey sources to supplement their nutritional needs in the immediate absence of sufficient Chinook salmon resources, we conclude that relatively small reductions in Central Valley Chinook salmon prey compared to the several millions of Chinook that are expected to be available to Southern Residents in the ocean each year over the duration of the PA would likely not alter the fitness of individuals enough to further reduce survival and reproduction rates, assuming Southern Residents only spend part of their time foraging in the southern portion of their range in the ocean where Central Valley Chinook salmon would occur in relative abundance during that time period. However, larger reductions in prey likely could alter the fitness of individuals enough to compromise survival and reproduction rates at any time over the duration of the PA. During times when Chinook salmon populations are not doing well

and abundances are relatively low in the ocean, it is likely that reductions in Central Valley Chinook are more noticeable to Southern Residents as additional energy expenditures and potential nutritional stress resulting from moving around to find areas where prey resources maybe more abundant are more likely to occur.

2.5.1.5.2 Effects of Chinook Exposure to Contaminants for Southern Residents

Benthic sediments in the Delta are known to contain toxic contaminants including heavy metals, pesticides, and other toxic organic compounds. These contaminants will be released when sediments are disturbed and resuspended into the water column during numerous construction activities such as pile driving and dredging. In Section 2.5 Effects of the Action and Section 2.7 Integration and Synthesis, the analyses describe how the contaminant exposure effects of the PA will adversely affect all Chinook salmon populations throughout the Delta through consumption of contaminated prey during their Delta migratory phase, particularly zooplankton or small invertebrates that reside in the areas affected by the PA. These effects are generally expected to be limited to sublethal effects that are constrained to small proportions of Chinook salmon populations. However, the nature of outcomes for Chinook salmon regarding exposure is unpredictable owing to uncertainty regarding sediment composition and extent of exposure that may occur based on the details of proposed construction that are available. As described in Section 2.7 Integration and Synthesis, the exposure duration to any potential contaminants will be transitory and the concentration of those contaminants in the water column are expected to be below levels that will cause acute or lethal responses in exposed fish that could affect the abundance of Chinook salmon in the action area. As a result, the risk for Southern Residents from exposure to contaminants resulting from the PA is associated with the consumption of Chinook salmon that are carrying increased contaminant loads, ultimately bioaccumulating these contaminants over the course of their lifetime, rather than a risk to abundance of their prey species.

Legacy contaminants such as mercury, methyl mercury, polychlorinated biphenyls (PCBs), heavy metals, and persistent organochlorine pesticides continue to be found in watersheds throughout the Central Valley. One of the contaminants potentially present throughout sediments in the action area in relatively large quantities is selenium, which was identified as one of the pollutants in San Francisco Bay and the western Delta on the Clean Water Act Section 303(d) List (State Water Resources Control Board 2011). However, most metals (with the exception of methylmercury), do not appear to bioaccumulate, and are regulated and excreted by many marine organisms (Gray 2002, EPA 2007). Consequently, we do not anticipate that selenium and most other metals would bioaccumulate in Southern Residents as a result of the PA. However, there may be a number of organic pollutants present in the action area that have the ability to bioaccumulate. PCBs and other persistent organic pollutants can cause endocrine disruption, reproductive disruption, or failure, immunotoxicity, neurotoxicity, neurobehavioral disruption, and cancer, and are known to already be present in high concentration in Southern Residents (see Mongillo et al. 2016 for a review).

There is little information available specific to the PA regarding the composition of sediments that may be resuspended or levels of persistent organic pollutants that may be introduced into the environment and food chain for Southern Residents during proposed construction or operational activities. As a result, the nature of outcomes from any potential bioaccumulation that may result from the release of contaminated sediments into the environment for Southern Residents is

unknown. It is expected that the geotechnical exploration described in the PA will provide analysis of sediment composition and that consideration of potential exposure to toxic contaminants from resuspended sediments will occur in line with criteria set by the EPA for water quality standards. Increases in the accumulation of persistent organic pollutants by Southern Residents as a result of the PA could lead to increases in probabilities of the types of effects on individual health described above, although the potential exposure of Southern Residents to any increased contaminant levels in Central Valley Chinook salmon is expected to be moderated by some degree based on information described above that they most likely only encounter Central Valley Chinook salmon while foraging in the southern portion of their range in the ocean, and not consistently throughout the year.

2.5.2 Effects of the Action to Critical Habitat

The PA is expected to result in numerous adverse impacts to designated critical habitat within the action area for the species addressed in this Opinion. The critical habitat designations for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon list the physical or biological features (PBFs) for critical habitat for these species, and these PBFs are described in Appendix B. Section 2.5.2.1 provides a description of general impacts to critical habitat that are expected to occur as a result of the PA, and then Sections 2.5.2.2. and 2.5.2.3 describe specific impacts to each PBF for each ESA-listed anadromous fish species analyzed in this Opinion.

2.5.2.1 General Habitat Impacts

2.5.2.1.1 Sedimentation and Turbidity

The PA includes construction and maintenance activities that are likely to result in adverse effects to critical habitat through re-suspension and deposition of sediments already existing in river reaches within the action area or from PA activities along river banks that will disturb sediments and release them into the water. Specific activities include: construction dredging; geotechnical borings; clearing and grubbing at construction sites; pile driving at intake sites, HOR, CCF, and at barge landings; increased vessel traffic during construction; and periodic maintenance dredging at new water diversion facilities and habitat restoration.