Independent Review Panel Report for the 2016-2017 California WaterFix Aquatic Science Peer Review Phase 2A

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Scope and Purpose of the Review: This report presents the Phase 2A findings of the 2016-2017 California WaterFix (CWF) Aquatic Science Peer Review. An Independent Review Panel (Panel; Appendix 1) was convened by the Delta Science Program to provide the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), and California Department of Fish and Wildlife (CDFW) to obtain the views of experts not involved in the CWF Endangered Species Act (ESA) consultation and 2081(b) permit on the use of best available scientific information as it pertains to analyses of effects on aquatic California ESA (CESA)-listed species in the California WaterFix Incidental Take Permit Application [2081(b) application]. The agencies further requested review of the Adaptive Management Framework proposed to integrate future scientific research, monitoring, and decision making during construction and operations of CWF. Accordingly, the Panel was charged specifically with reviewing: (1) the draft Adaptive Management Framework for CWF and (2) the 2081(b) application analyses of the CWF impacts of take for winter-run Chinook Salmon, spring-run Chinook Salmon, Delta Smelt, and Longfin Smelt. After reviewing the charge (Appendix 2) and a set of prescribed documents (Appendix 3), the Panel participated in a public meeting in Sacramento, California on December 8-9, 2016. On the first day of this meeting, the Panel interacted with agency representatives following their presentations on the topics above. On the second day, the Panel communicated and discussed its preliminary findings to agency representatives and the public (Appendix 4).

1 Executive Summary

The new water conveyance facilities (North Delta diversion, NDD) proposed as part of the California WaterFix Project would create substantial changes in the aquatic environment of the lower San Joaquin and Sacramento Rivers, a major portion of their estuary (Delta), and downstream in San Francisco Bay. The construction and operation of the WaterFix facilities must comply with U.S. Endangered Species Act (ESA) Section 7(a)(2) in addition to California Endangered Species Act (CESA) authorization under Fish and Game Code Section 2081(b). As part of the CWF ESA consultation, the US Bureau of Reclamation (Reclamation) and the California Department of Water Resources (DWR) have written an extensive Biological Assessment (BA) that projects the future effects of the new facilities on ESA-listed species and their designated critical habitats.

The purpose of the California WaterFix (CWF) Aquatic Science Peer Review Phase 2A is to provide the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), and California Department of Fish and Wildlife (CDFW) with an independent scientific evaluation of the Adaptive Management Framework which will inform CWF operations to reduce uncertainty and improve the performance of Central Valley water operations under current and future BiOps. In addition, the Phase 2A review provides independent scientific peer review on the use of best available scientific information as it pertains to analyses of effects on aquatic CESA-listed species in the CDFW 2081(b) Incidental Take Permit Application.

Adaptive Management (AM) Framework: The AM Framework represents a significant improvement in articulation of the agency-based oversight committee's (Five Agencies') vision, including the four-phase AM model, a section on structured decision making, and a description of a new decision-making entity, the Interagency Implementation and Coordination Group (IICG). However, there are some details regarding plans for AM that still need to be provided. These details include: (1) more clarification of the relationship between AM and real-time operations, including details about which safeguards and interventions belong in the real-time operational monitoring and which belong in the AM Framework; (2) a better portrayal and description of AM "triggers" in the AM Framework (ICF 2016, Appendix 1); (3) information and assurances regarding the funding mechanism for both monitoring and research; (4) more details regarding how research priorities will be established; (5) specific delegation of responsibilities among the entities that will oversee the AM program (i.e., IICG and Five Agencies); and (6) plans for independent review.

The four phases of AM are well described and are in alignment with the core principles of AM (ICF 2016, Figure 5-X). Assuming the "intent and objectives" of the AM Framework are to assist with ESA Section 7 compliance (i.e., protect the fish), then the decision-making processes regarding what research and monitoring gets funded and carried out should be primarily based on best available science. While the Panel supports the inclusion of stakeholders in the implementation of AM in the Delta, we are concerned about stakeholders' influence on the research prioritization since decisions associated with "Phase 4: Adapt" may have significant positive or negative implications for different stakeholders. The Panel is also concerned about links between possible sources of funding for the AM program and decision-making authority regarding what science is prioritized. More attention needs to be paid to setting up an adaptive governance structure with clearly defined authority, boundaries, and criteria for intervention to support a robust and effective AM program (e.g., one that avoids conflict of interest) akin to the two-tiered program structure of the Collaborative Science and Adaptive Management Program (CSAMP) and the Collaborative Adaptive Management Team (CAMT), with a scientific/technical committee and a separate management/policy committee. Also, if stakeholders are going to be involved in decision-making regarding research, then the Five Agencies must ensure that all stakeholders are represented, not just the water users, as currently envisioned in the IICG.

Monitoring needs to be designed with the capability to assess the outcomes of AM and mitigation actions and their implications for the survival and recovery of ESA-listed species. The criteria for determining "effectiveness of management actions" need to be explicitly described. While tracking the effects of CWF and associated management actions in an effective manner is certainly critical, the Panel's greater concern is transparency and accountability regarding how decisions will be made in response to what is monitored.

CDWF 2081(b): The application recognizes where uncertainty limits the type of analyses that can be defended. For those analyses that can be defended, the methods are generally sound and are scientifically supported. In general, the best available science has been used, but the Panel emphasizes the need for additional information and analyses in order to effectively evaluate the impact of the Proposed Action (PA).

Salmon: The effects analyses for salmon are comprehensive and objectively written in most (but not all) sections. Evaluation of impacts to salmon by life stage is important to help identify mechanisms and potential solutions, but it is critical to evaluate cumulative impacts on evolutionary significant unit populations that propagate through the entire life history of salmon. Cumulative effects analyses, including interactive effects of the salmon's life at sea, on spawning abundances are critical for expressing what may be incrementally small effects within each life stage. Life cycle models can facilitate evaluation of cumulative impacts. Although the 2081(b) application did not incorporate the new winter-run Chinook Salmon life cycle model and other analyses that will be forthcoming in the NMFS Biological Opinion, the 2081(b) application did present one model (Interactive Object-oriented Salmon Simulation; IOS) that indicated significant adverse impacts on salmon, especially during drier years. The large projected impacts from this model were not considered when evaluating take and jeopardy. In addition, take and jeopardy conclusions underestimated adverse effects of the NDD operations and overestimated benefits of reduced exports from the south Delta.

Quantitative analyses involving salmon only considered climate effects through 2030. The 2081(b) application should justify why it concluded that climate change beyond 2030 will not differentially impact salmon via the PA versus the No Action Alternative (NAA). An adverse effect of the PA on Chinook Salmon viability in the future, when overall conditions are less favorable, may have greater consequences than at present.

An even more substantial issue is that survival analyses were based on tagging of large, hatchery, late-fall Chinook smolts that might bias survival patterns with respect to wild salmon, a significant portion of which are typically much smaller. The Panel's concern is that water-removal effects on survival of wild juvenile salmon may be underestimated by that approach.

Furthermore, the analyses likely underestimate potential effects of NDD operations on juvenile salmon habitat because they only focus on dewatering of the artificial wetland “bench” habitat rather than other important aspects, such as changes in salinity, access to rearing habitats, and other benefits of tidal wetland habitats throughout the Delta. The analysis did not consider changes to habitat characteristics associated with NDD operations over the long-term. More research is needed to adequately characterize migration chronologies and pathways, use of tidal habitats, and survival of smaller life-history stages of salmonids in the Delta.

Longfin Smelt: Statistical analyses and modeling of available data that compares PA versus NAA maintenance of spring outflow equivalent to existing conditions indicate that averaging March through May is a cogent approach. However, the extensive uncertainty about the underlying mechanisms behind the Longfin Smelt abundance-Delta outflow relationship suggests that this averaging window may not necessarily reflect Longfin Smelt ecology and population viability. This could particularly be the case if diverse life history stages and metapopulations are not accounted for in this restricted three-month averaging window. Given this level of uncertainty, the Panel believes that the three-month averaging window should be contingent upon and adjusted according to the results of the proposed, and hopefully high-priority, Longfin Smelt research program under the AM Framework (ICF 2016, Appendix 6).

Delta Smelt: In the absence of parameterized life-cycle models, the methods used to characterize take and associated impacts to Delta Smelt populations were scientifically valid. With one major caveat, the beach seine surveys from the Delta Juvenile Fish Monitoring Program and Freeport diversion monitoring data are appropriate for assessing Delta Smelt habitat use near the NDD. The beach seines are deployed throughout the year, and the geographic range of deployment extends long distances both upstream and downstream of the NDD, using a reasonable number of stations. However, the beach seines are almost entirely deployed where there is minimal chance of snagging on subsurface obstructions. The result is that these monitoring data are likely representative of Delta Smelt geographic occurrence along obstruction-free shorelines and at boat ramps, but are much less representative of more typical shoreline types across the Delta.

The effects of climate change on Delta Smelt did not consider climate conditions beyond 2030 due to uncertainty in predictions beyond that point in time (i.e., unknown future concentrations of atmospheric greenhouse gasses). Impacts related to future climate-related changes in X2 are based on 2025. Given that Delta Smelt are already near the NDD (as indicated by beach seines), and that most Delta Smelt habitat is downstream of the NDD, sea-level rise is expected to cause a larger proportion of the Delta Smelt population to be impacted by the NDD. Higher water temperatures are also expected to cause comparable habitat compression and reduced reproductive potential under both the PA and NAA. Higher air temperatures are expected to shift precipitation away from snow and towards rainfall, changing seasonal and spatial snowmelt patterns, and thus altering the freshwater inflow patterns that affect Delta Smelt habitat availability and quality.

Delta Smelt population dynamics were not modeled due to widely recognized uncertainties in model parameterization. Year-to-year variation in individual effects (entrainment, X2, abiotic habitat index) was classified by water-year type. However, water-year type cannot represent monthly conditions because it is based on differently weighted flows during particular seasons plus the weighted index for the previous year. In reality, wet months can occur during dry years and vice versa. Given that the Delta

Smelt is an annual species (i.e., each year class must survive continuously and then successfully reproduce), additional analyses should be based on months that were independent of water-year type. It appears that averaging months within water-year classes diminished the numerical difference between the PA and NAA. Furthermore, as an annual species, Delta Smelt must successfully reproduce even during what are classified as “critical” water years by the water-year index. That is, survival to reproduction requires survival during all months and all years by every year-class of fish.

Even with the diminishment of apparent differences caused by averaging, there appears to be a meaningful difference in X2 between the PA and NAA, particularly during August and September, when X2 has a large likelihood of extended into the river channels upstream of Chipps Island. Specifically, as noted in more detail in the FWS BiOp, there appears to be a difference of several km within important river reaches that separate the river channels from critical shallow-water habitats downstream that are used as rearing habitat by early juveniles during August and September. Separation of X2 from critical shallow-water habitats near Suisun Marsh, Honker Bay, and Montezuma Slough is cause for concern.

Cumulative System Effects: The Panel recognizes that this 2081(b) application is designed as species-level and life-stage-specific analyses that are appropriate for maximal protection of CESA-listed species. However, by taking this narrow approach, the analysis ignores the fact that many of these species directly or indirectly interact over common Delta and Bay ecosystems, and that their vulnerability to PA effects may be a function of cumulative effects of the project on physical and ecological processes across Delta ecosystems. The Panel suggests that cumulative, Delta-scale ecosystem effects of the PA need to be evaluated within the context of populations of listed species and potentially significant competitor species and predator species (e.g., Striped Bass) that overlap to various degrees of space and time in the Delta. Furthermore, collateral changes in potent interactions among the focus species and other (non-ESA) species’ responses should be assessed for significant competitor (e.g., invasive bivalves) and predator species (e.g., Striped Bass) that may benefit further from the PA changes to the Delta and eastern San Francisco Bay. Examples of cumulative or collateral, large-scale effects could include, but not be limited to, PA effects on: (1) tidal hydrology; (2) responses of mitigation actions, particularly tidal wetland restoration; (3) suspended sediment diversion; and, (4) interaction among targeted and other non-ESA species.

2 Contents

3 Introduction

The new water conveyance facilities (North Delta diversion, NDD) proposed as part of the California WaterFix Project would create substantial changes in the aquatic environment of the lower San Joaquin and Sacramento Rivers, a major portion of their estuary (Delta), and downstream in San Francisco Bay. The construction and operation of the WaterFix facilities must comply with ESA Section 7(a)(2) in addition to California Endangered Species Act (CESA) authorization under Fish and Game Code Section 2081(b). The purpose of the California WaterFix (CWF) Aquatic Science Peer Review Phase 2A is to provide the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), and California Department of Fish and Wildlife (CDFW) with an independent scientific evaluation of the Adaptive Management (AM) Framework which will inform CWF operations to reduce uncertainty and improve the performance of Central Valley water operations under current and future BiOps. In addition, the Phase 2A review provides independent scientific peer review on the use of best available scientific information as it pertains to analyses of effects on aquatic CESA-listed species in the CDFW 2081(b) Incidental Take Permit Application.

3.1 Background

As part of its formal charge**,** the Panel was given the following Background for its review, which is quoted here in its entirety:

"*The California Department of Water Resources (DWR) and the Bureau of Reclamation (Reclamation) coordinate the operation of the Central Valley Project (CVP) and the State Water Project (SWP). As a part of California Water Fix (CWF), DWR proposes to construct and operate new water conveyance facilities in the Sacramento-San Joaquin River Delta, including three intakes, two tunnels, associated facilities, and a permanent head of Old River gate; as well as operate existing south Delta facilities in coordination with these new facilities.*

DWR intends to obtain California Endangered Species Act (CESA) authorization under Fish and Game Code Section 2081(b) for incidental take related to the construction and operation of the CWF and modified operations of the SWP. DWR submitted an Incidental Take Permit application [2081(b) application] to California Department of Fish and Wildlife (CDFW) on October 5, 2016. This application includes analyses of the effects of the proposed action on CESA listed species. CDFW is reviewing the analyses of perceived impacts on state-listed species and may issue a permit if conditions in Fish and Game Code sections 2081(b) and (c) are met.

The construction and operation of the new dual conveyance facilities will need to comply with Section 7(a)(2) of the Endangered Species Act (ESA). As a part of the CWF ESA consultation, Reclamation and DWR have written a Biological Assessment (BA) that summarizes the effects of the action on ESA-listed species and their designated critical habitats. A Draft of the BA analyses and the draft analytical approach to the Biological Opinion were reviewed in Phase 1 of this review.

The analyses of CWF impacts of take for winter-run Chinook, spring-run Chinook, and Delta smelt in the 2081(b) application may be similar to what is expected as part of the Biological Opinions to be reviewed *during Phase 2B. We expect that the Biological Opinion's effects analyses for these species will be an additional, potentially more detailed source of analysis, supporting what is in the 2081(b) application.*

Current CVP/SWP operations require scientific research and monitoring to support real-time operations, decision making, and to fill in gaps in the understanding of the relationship between the CVP/ SWP operations and ESA and CESA listed fish species. Moving forward, adaptive management will be utilized to integrate real-time operations, ongoing scientific research, monitoring, and long term operations of CWF within the SWP and CVP.

The purpose of this independent scientific peer review is to obtain the views of experts not involved in the CWF ESA consultation and 2081(b) permit on the use of best available scientific information as it pertains to analyses of effects on aquatic CESA-listed species in the 2081(b) application and the Adaptive Management Framework proposed to integrate future scientific research, monitoring, and decision making during construction and operations of CWF."

End of Quote

3.2 A Comment on Nomenclature

In this Phase 2A report, this Panel review addresses elements of both the ESA Section 7(a)(2) of the Endangered Species Act (ESA) application and the CDFW 2081(b) application. ESA Section 7(a)(2) documents refer to California WaterFix as the Proposed Action (PA) while the CDFW 2081(b) refers to California WaterFix as the Proposed Project (PP). For clarity and consistency, the Panel refers to the California WaterFix as the Proposed Action (PA) throughout this report.

3.3 Overview of Panel Findings

Adaptive Management Framework: The AM Framework represents a significant improvement in articulation of the agency-based oversight committee's (Five Agencies') vision, including the four-phase AM model, a section on structured decision making, and a description of a new decision-making entity, the Interagency Implementation and Coordination Group (IICG). However, there are some details regarding plans for AM that still need to be provided.

The Panel's review for the CDWF 2081(b) application covered multiple topics related to salmon, Delta Smelt and Longfin Smelt.

Salmon: The effects analyses for salmon are comprehensive and objectively written in most (but not all) sections. Evaluation of impacts to salmon by life stage is important to help identify mechanisms and potential solutions, but it is critical to evaluate cumulative impacts on evolutionary significant unit populations that propagate through the entire life history of salmon.

Longfin Smelt: The extensive uncertainty about the underlying mechanisms behind the Longfin Smelt abundance-Delta outflow relationship suggests that the March through May averaging window may not necessarily reflect Longfin Smelt ecology and population viability. Given this level of uncertainty, the Panel believes that the three-month averaging window should be contingent upon and adjusted according to the results of the proposed, and hopefully high-priority, Longfin Smelt research program under the AM Framework (ICF 2016, Appendix 6).

Delta Smelt: In the absence of parameterized life-cycle models, the methods used to characterize take and associated impacts to Delta Smelt populations were scientifically valid. With one major caveat, the beach seine surveys from the Delta Juvenile Fish Monitoring Program and Freeport diversion monitoring data are appropriate for assessing Delta Smelt habitat use near the NDD. There appears to be a meaningful difference in X2 between the PA and NAA, particularly during August and September, when X2 has a large likelihood of extending into the river channels upstream of Chipps Island. Specifically, as noted in more detail in the FWS BiOp, there appears to be a difference of several km within important river reaches that separate the river channels from critical shallow-water habitats downstream that are used as rearing habitat by early juveniles during August and September. Separation of X2 from critical shallow-water habitats near Suisun Marsh, Honker Bay, and Montezuma Slough is cause for concern.

Cumulative System Effects: The Panel recognizes that this 2081(b) application is designed as species-level and life-stage-specific analyses that are appropriate for maximal protection of CESA-listed species. However, by taking this narrow approach, the analysis ignores the fact that many of these species directly or indirectly interact over common Delta and Bay ecosystems, and that their vulnerability to PA effects may be a function of cumulative effects of the project on physical and ecological processes across Delta ecosystems. Examples of cumulative or collateral, large-scale effects could include, but not be limited to, PA effects on: (1) tidal hydrology; (2) responses of mitigation actions, particularly tidal wetland restoration; (3) suspended sediment diversion; and, (4) interaction among targeted and other non-ESA species.

3.4 AM Framework Addendum

On February 13, 2017, CDFW submitted to the Panel a revised version of the AM Framework that incorporated Panel comments contained in a draft version of this Phase 2A Panel Report. That draft Phase 2A report was submitted by the Panel to the Delta Science Program on January 20, 2017, prior to the Phase 2B public meeting.

CDFW requested that the Panel review the revised version of the AM Framework. Since the final version of the Phase 2A Panel Report was already near completion, the Panel agreed to review the revised Framework but additional feedback would be provided in an appendix rather than integrating it into the main body of the report. See Appendix 6 for Panel comments on the revised AM Framework.

4 Charge Question-Specific Comments and Additional Comments from the Panel

The panel charge questions (Appendix 2) concerned two broad categories. The first set of questions related to the CWF Adaptive Management (AM) Framework. The second set of questions pertained to the 2081(b) permit application including winter- and spring-run Chinook Salmon, Delta Smelt, and Longfin Smelt analyses. The following report sections provide in-depth Panel responses to each of the panel charge questions.

4.1 CWF Adaptive Management Framework Questions

The AM Framework (ICF 2016) included in the California WaterFix Proposed Action (PA) is an important component in the Five Agencies' approach to complying with state and federal endangered species legislation. Without its provisions for adjusting management in response to new information about the listed species' needs, there would be no guarantee that uncertainties will be reduced over time in a systematic manner. Even though the AM Framework cannot guarantee future actions, the Panel suggests that it can be usefully thought of as an "insurance policy" for the fish.

We suggest that this warrants a specialized approach to AM that may differ in significant ways from AM practiced in contexts where it is not associated with a Biological Opinion (BiOp). While the AM Framework envisioned in the draft BiOp will likely benefit a broad cross section of conservation interests in the Delta, its primary purpose will be narrower—specifically, to help ensure, on an ongoing and long-term basis, that listed species are not jeopardized by the PA (in conjunction with the SWP/CVP facilities) and that critical habitat is not adversely modified by the PA. The AM Framework must also help ensure that conservation measures in the PA are achieving their intended purposes in mitigating or compensating for take and other fish losses. As such, there would seem to be a higher duty to respond to results of monitoring than there might be within other contexts, and a higher duty to err on the side of the species when there is uncertainty about results (i.e., the precautionary principle or institutionalized caution). Due to the nature of this link between AM and ESA Section 7, attention to the difference between active and passive AM in the BiOp, and a commitment to practicing active AM where possible, will be critical.

The AM Framework should be precautionary and proactive to protect against uncertainties related to the effects of the PA, including the effects of climate change that may affect smelt, salmon, steelhead, sturgeon, killer whale and their habitats. It should also provide clear guidance for setting priorities for science that will progressively reduce uncertainty about the species' needs, along with assurances that the necessary research and monitoring will be funded and carried out.

It is worth noting that in a review of AM and the law, Benson and Schultz (2015) observed that without adequate legal grounding, AM provides responsible agencies with an undesirable amount of discretion. Citing Schultz and Nie (2012), they warn that

> "*Unless adaptive management is given some legal definition and its application is enforceable in some way, the approach can be used as a smokescreen for open-ended and discretionary decision making that fails to meet legal standards, lacks accountability, and fails to incorporate some of the most important aspects of the paradigm, including rigorous monitoring and feedback loops that inform an adaptive planning cycle.*"

AM plans associated with Section 7 of the ESA should: (1) clearly articulate measurable goals and quantitative objectives; (2) identify testable hypotheses (or some other method of structured learning from conceptual models); (3) state exactly which criteria should apply in evaluating the management experiments; and (4) be explicit about how the results from AM research and monitoring are to be tied to operational or project-based changes (Ruhl and Fischman 2010, Stern et al 2011).

It is with these general principles and standards in mind that the Panel evaluated the AM Framework in our answers below.

4.1.1 Are the compliance monitoring, collaborative science, and adaptive management approaches in the Framework appropriate for addressing the uncertainties associated with the implementation of CWF, specifically related to CWF operations in conjunction with SWP and CVP facilities?

This overarching question has several components, but focuses on the degree to which the AM Framework addresses and attempts to reduce uncertainty. Given that the key uncertainties associated with the implementation of CWF have to do with whether it will likely jeopardize ESA-listed species and/or adversely modify listed species' critical habitats, the Panel suggests the following rewording to enable a clearer response: *Does the AM Framework appropriately address and seek to reduce the uncertainties about: (1) whether the CWF (in conjunction with the SWP/CVP facilities) will likely jeopardize fish and/or adversely modify critical habitat; and, (2) whether the plans to minimize and mitigate impact will be adequate to avoid jeopardy and adverse modification of critical habitat?* We answer this question by focusing on the three key aspects of the AM Framework that were highlighted in the original question: compliance monitoring, collaborative science, and the overall approach to AM, which the Panel interprets as "governance and decision-making."

Compliance Monitoring/Effectiveness Monitoring

Overall, the Panel's impression is that monitoring needs to be updated, improved, and tied to triggers that will initiate change when monitoring indicates noncompliance.

For professionals associated with the Clean Water Act, the term "compliance monitoring," which is also called "implementation monitoring," refers to monitoring to ensure that the responsible agencies have constructed and implemented a management action as designed or promised. These terms basically refer to the operational performance of the action. Alternatively, "effectiveness monitoring" refers to monitoring to ensure that the objectives of the management action (e.g., animal population maintenance or increase, ecosystem restoration, etc.) are being met. The Panel assumes "effectiveness monitoring" is the intended type of monitoring referred to in this charge question.

In this section, the Panel considers whether future effectiveness monitoring will be sufficient for detecting jeopardy and/or adverse modification of critical habitat associated with the project facilities and operations, such that the PA remains in compliance with ESA Section 7. As part of this, consideration should be given to whether monitoring of activities permitted under the Incidental Take Permit is adequate for detecting excessive take. Consideration should also be given to whether future effectiveness monitoring will be sufficient for determining whether conservation measures are working to reduce jeopardy and/or adverse modification of critical habitat.

We begin with a review of literature and case law related to the role and design of monitoring strategies in AM frameworks associated with ESA Section 7 compliance, and then evaluate the proposed AM Framework while considering recommended principles and features.

Court cases related to the use of AM in ESA Section 7 BiOps have focused on the adequacy of monitoring and mitigation strategies in AM frameworks. In an oft-cited 2002 case, the court explained that “mitigation measures must be reasonably specific, certain to occur, and capable of implementation; they must be subject to deadlines or otherwise-enforceable obligations; and, most important, they must address the threats to the species in a way that satisfies the jeopardy and adverse modification standards” (*Center for Biological Diversity v. Rumsfeld* 2002).

As cited in our Phase 1 review, AM frameworks designed by FWS and NMFS for operation of the CVP/SWP were viewed differently by the same judge in 2007 and 2008. The AM framework designed by FWS for the Delta Smelt was considered inadequate, while the AM framework designed by NMFS for the anadromous fish species was upheld. The difference had to do with the degree of enforceability associated with monitoring and mitigation.

In the FWS AM plan, management changes would be triggered based on factors such as estimates of number of fish killed in water facilities and spawning rates. If thresholds were crossed, a working group could meet and submit recommendations that could potentially be undertaken by a separate management team. The court found this too uncertain and unenforceable to support a No Jeopardy opinion.

In contrast, the court determined that mitigation measures in the NMFS AM plan were adequately specific, since they required action if a certain water temperature “triggers” were exceeded, and were included under “Terms and Conditions” of the Incidental Take Statement, which is enforceable by law and therefore binding.

The key point is that monitoring and mitigation commitments made as part of an AM framework must be based on enforceable standards, which trigger a non-discretionary mandate to reinitiate consultation with the regulatory agency before proceeding to survive a legal challenge:

> “*Generally speaking, in order to be enforceable, a plan must include specific monitoring requirements and timelines tied to the use of explicit trigger points, to clear mitigation requirements, along with specific implementation timelines. When such a monitoring/mitigation program is part of a legally binding agreement, such as in the case of a permit issued under the ESA, enforcement is more possible, especially where monitoring serves as a precondition for renewal.*” (Benson and Schultz 2015).

As Benson and Schulz (2015) observe, “enforceability within the parameters of administrative law is a significant challenge and one that requires concerted attention to the details of the adaptive management strategy and the legal context within which commitments are made.”

The Panel finds that, while acknowledged aspects of uncertainty about salmon and steelhead population viability parameters are sufficiently known to inform AM monitoring and requisite antecedent research, critical information about Delta Smelt and Longfin Smelt population remains too unidentified to define AM effectiveness monitoring for those species.

Given (1) the very low catches of Delta Smelt in the Fall Midwater Trawl Survey during recent years, and (2) the possibility that a modified survey design for the Spring Kodiak Trawl Survey (i.e., a design that is inclusive of one or more preceding, additional months) may be a superior monitoring approach for this species, an established and adequate program for effectiveness monitoring does not exist for Delta Smelt. The new Enhanced Delta Smelt Monitoring Program may serve this purpose in the future, but its performance in regard to effectiveness monitoring has not been established.

Collaborative Science

In this section, the Panel considers whether the planned science will reduce uncertainty and answer questions about: (1) whether the project is likely to cause jeopardy and/or adverse modification of critical habitat; (2) whether the conservation measures are working to reduce the likelihood of jeopardy and/or adverse modification of critical habitat; and, (3) how research gaps and key uncertainties are identified, prioritized and funded. Ultimately, details of the planned science need to be described, starting with key questions that need to be addressed to support evaluation of goals and objectives.

According to the AM Framework, during “Phase 1: Plan” (ICF 2016, Figure 5-X) science research priorities will be developed collaboratively using the Collaborative Science and Adaptive Management Program (CSAMP) and the Collaborative Adaptive Management Team (CAMT) process, and the science will undergo independent review coordinated by the Delta Science Program. The Framework reflects best practices for collaborative science in many places, and articulates a plan for integrating with other, ongoing AM efforts in the Delta, including CSAMP/CAMT and other efforts associated with the IEP. We comment on this further under Question 1C, below. Where the AM Framework appears to depart from the envisioned collaborative model is in the design of the IICG, which will play an important role in the implementation of the AM program. Water users participate in science planning, but stakeholders representing other interest groups are not represented. The Panel comments on this below, and also in our response to Question 1D.

Adaptive Management Approach: Governance and Decision Making

In this section, the Panel considers whether the AM program is set up to be able to respond to signals that: (1) the project is likely to cause jeopardy and/or adverse modification of critical habitat; and, (2) the conservation measures are not working to reduce the likelihood of jeopardy and/or adverse modification of critical habitat. For AM to be successful, it needs to be embedded within an adaptive governance structure. The responsible agencies for ESA Section 7 compliance must recognize that AM occurs within “contested and power-laden social contexts,” and that the approach to decision making (and the allocation of power) will influence how trade-offs between multiple, competing objectives are made (Armitage et al. 2015). While best available science should be the primary guide in decision making to ensure compliance with ESA Section 7, it will be important to supplement scientific knowledge with other sources of information from diverse sources to ensure legitimacy and accountability. One of the key challenges in adaptive governance is how to best incorporate non-agency interests into the deliberations.

Literature on adaptive governance supports the two-committee approach, with the typical arrangement being a technical committee consisting of scientists and practitioners (similar to CAMT), and a management committee with oversight authority that includes citizens, NGOs, and other interest groups (similar to CSAMP). In this model, the technical aspects of the AM program can be evaluated by people who know the ecology, hydrology, biology, and other required scientific disciplines, while the political body would determine whether and how to act on the information within the regulatory contexts of the

BiOps, 2081(b) permit, and other relevant authorizations (e.g., USACE permits, State Board authorizations).

Perhaps because of its explicit connection to ESA Section 7 compliance, the AM Framework features an agency-based oversight committee (Five Agencies) with the IICG underneath it. An agency-based oversight committee, as opposed to a politically based one like CSAMP, is acceptable, provided there are clear guidelines on the criteria for adjustment and clear boundaries within which it can take place. The oversight committee also needs to have authority to engage in (sometimes controversial) experimentation and must provide the leadership and legitimacy that supports novel investigations, including investigations that are part of active AM. The oversight committee also needs a political mechanism to fall back on if monitoring results are outside the set bounds (e.g., a trigger for re-initiation of ESA Section 7 consultation). Without these features, the oversight committee is likely to make either meaningless adjustments, or be vulnerable to litigation every time they take action.

The current arrangement does not appear to be embedded within adaptive governance, which does not bode well for truly responding to feedback from monitoring. However, a good alternative is to be very clear up front about: (1) criteria for adjustment (e.g., triggers, performance measures, actionable metrics that dictate when management changes will be implemented and/or when consultation will be reinitiated); and, (2) boundaries within which adjustment can take place. The oversight committee can then resort to a legal or political decision-making process (likely leading to re-initiation of consultation) if results of monitoring fall outside the range expected.

The organizational structure outlined in the AM Framework describes a model where managers representing the Five Agencies are ultimately responsible for decision making, but much of the work of implementing the AM program falls to the IICG, which is comprised of a mix of agency scientists and water users. It is important to note that while the agency personnel may consist of a mixture of scientists and managers, the local water authorities are likely to be political, resulting in difficulty in determining their own criteria for making decisions, especially if they are connected to funding sources for the research and monitoring.

An important governance role for the IICG and the Five Agencies relates to decisions about what science and monitoring is funded and carried out. Given the large number of uncertainties associated with this project (highlighted in ICF 2016, Section 4 and ICF 2016, Appendices 2 through 5), it will be important for the AM Framework to have a clearly articulated strategy for prioritizing which science gets done (i.e., research, monitoring) and which habitat restoration is undertaken, and in what order.

As Runge (2011) noted "*while uncertainty abounds in the management of threatened and endangered species, not all uncertainty is relevant to decision making. The uncertainty that matters is the uncertainty that would lead to different management policies, and it is useful to make sure that uncertainty matters before embarking on its reduction*." We suggest the Five Agencies, in collaboration with CSAMP/CAMT, undertake efforts to distinguish between different kinds of uncertainty to the extent possible—e.g., uncertainty that is relevant to fish survival and recovery and can practically be acted upon versus uncertainty that is not as critical to reduce at a given stage in the PA and/or uncertainty that cannot actually be acted upon, including actions that are irreversible. An important subset of scientific endeavors that would reduce the first kind of uncertainty include corresponding actions which are actionable and promising for fish survival and recovery, but are not politically palatable. Those, in a nutshell, are the decisions that will be the hardest to make, and the AM Framework should be explicit about how the IICG will handle those kinds of decisions.

The Panel recognizes the challenges associated with prioritizing uncertainties, and notes that in the case of Delta Smelt and Longfin Smelt, for example, we may not yet have the information that would be required to weigh the relative value of various uncertainties. However, there would be merit in prioritizing research that would enable estimating vital rates and generating space-stage specific life-history models for the smelts, as is being done for salmon, over trying to reduce uncertainty about how climate change will affect the fish (e.g., inundation rates in the inner Delta).

The Panel did not find explicit mention about how this kind of prioritization for the key monitoring and research would take place, but did note that in ICF 2016, Fig 5-1, part of the “Research and Monitoring” cycle includes "Science teams ID science needs." The nearby box lists “Delta Science Plan Independent Science Review including LOBO and CSAMP Plans” but it is not clear exactly how decision making will take place with coordination between IICG and these other entities. There needs to be further clarification about who will be involved in making recommendations regarding funding and timing of various science endeavors.

Given that a No Jeopardy Opinion might rely on assumptions about the effectiveness of certain mitigation measures, it will be critical to monitor that effectiveness. For example, the PA does not seem to attempt to mitigate for NDD operational impacts on salmon except for the non-physical barrier at Georgianna Slough, 1.26 acres of habitat restoration, and perhaps reduced entrainment at the south Delta. A recent study of non-physical barriers at Georgianna Slough shows some promise for reducing numbers of salmon diverted into the interior Delta, which should enhance overall survival to some degree, but it will be important for the responsible agencies to monitor barrier effectiveness. If the non-physical barrier works, then perhaps it could be applied in other locations. If monitoring determines that it is not working, then there should be a clearly articulated contingency plan.

Also, the effectiveness of habitat mitigation and other conservation measures designed to compensate for relatively short-term loss of salmon and smelt habitat at the NDD, and ultimately by long-term NDD operations, should be tested and monitored. As presented to the Panel, the present plan simply involves calculating acres of damaged habitat and proposes to compensate for that damage with a 3:1 mitigation ratio (ICF 2016, Table 5.4-1). Is this ratio sufficient to protect the ESA-listed species after existing habitat has been damaged? Also, as discussed below, the Panel suspects that the reported impact of 0.42 acres caused by PA operations is vastly different from the amount of habitat that will be affected by removing up to 40% of Sacramento River water in some months and water years. Given uncertainty in PA effects on salmon, a precautionary approach may be needed when setting mitigation targets and seeking scientific assurance that those targets compensate for PA operations effects (in other words, additional mitigation may be needed). Many uncertainties regarding the effects of the PA on listed species will need to be resolved through adaptive management. For example, ICF 2016 Table 5.4-1 shows calculations of total compensation and restoration by impact areas by species, but it does not consider salmon size. The key problem is that smaller juveniles may have a different, perhaps more adverse, response to water diversion in the north Delta compared with big yearling smolts because smaller salmon use habitat differently. Therefore, defining the amount and location of additional high quality habitat that can be utilized by different salmon sizes needs to be an iterative design process guided by monitoring and adaptive management. This particular salmon size issue is discussed in more detail in Section 4.5.

Question 1A: Does the Framework adequately reflect comments and issues raised in Phase 1 of this review?

The Panel raised several concerns in the Phase 1 review about the approach to AM, including the need for: more clarity on structured decision making; plans for monitoring; articulation of key uncertainties; development of a new decision-making entity; identification of triggers ("performance measures" and "actionable metrics") for initiating changes; an explanation of the relationship between AM and real-time operations; and more details regarding funding and external independent review. We also asked for details about how research priorities would be set and suggested they be driven by gaps in conceptual models (e.g., the Longfin Smelt abundance to Delta outflow relationship).

The AM Framework represents a significant improvement in articulation of the vision, including the four-phase AM model, a section on structured decision making, and a description of a new decision making entity, the IICG. However, there are some details regarding AM plans that still need to be provided.

First, the Panel would like to see more clarification of the relationship between AM and real-time operations. One of our recommendations in Phase 1 was that the real-time operational decision-making process be linked more explicitly to a formal AM program. In the cover letter accompanying the AM Framework as part of Phase 2A, the responsible agencies commented that "[n]o such linkage is currently proposed, and this topic is expected to be further reviewed prior to issuance of the BiOps and Incidental Take Permit." This statement seems to contradict background information that was provided to the Panel as part of the its charge for Phase 2A, which states that *"moving forward, adaptive management will be utilized to integrate real-time operations, ongoing scientific research, monitoring, and long term operations of CWF within the SWP and CVP."* The assertion that AM will be utilized to integrate real-time operations with research, monitoring and long-term operations seems to contradict the Five Agencies' comments and the contents of the AM Framework. Therefore, the Panel is still unsure which actions are associated with future real-time operational monitoring and which belong in the AM Framework under the new CWF facilities. The Panel believes that the AM Framework needs to include more details regarding which safeguards and interventions belong in the real-time operational monitoring and which belong in the AM Framework. We suggest that there should be a connection between the two in the sense that real-time actions help to achieve key fish performance metrics (e.g., through-Delta survival of salmonids). Survival is a good metric if it can be accurately measured, because it reflects all factors within the survival period, including climate.

The issue of triggers is related to the issue of linking feedback from AM to real-time operations. The Framework claims to include a list of triggers (ICF 2016, Appendix 1), but much of what is listed in that table does not consist of triggers that would adaptively respond to factors affecting the covered species. Rather, they are mitigation measures. Mitigation should be monitored, of course (both mitigation effectiveness and fish performance should be monitored), but each issue should have quantitative, measurable benchmarks (and many do not). For example, the AM Framework should identify actions that might be taken if salmon performance targets are not achieved. Some salmon performance metrics are quantitative; are they measurable?

The Panel asked for more information and assurances regarding the funding mechanisms for both monitoring and research; but that has been deferred to later deliberations. The Panel would also like to see more details regarding how research priorities will be established, whether they will be driven by gaps in conceptual models (e.g., Longfin Smelt abundance-Delta outflow relationship); and plans for independent review. As stated above, the Panel would like to know more about the specific delegation of responsibilities among the entities that will oversee the AM program (e.g., IICG and Five Agencies, CSAMP/CAMT).

Question 1B: Is the Framework sufficient to address the uncertainties associated with the current analyses and provide a timely mechanism for addressing future changes in operations based on new understanding of listed species distribution and abundance?

The AM Framework is a good start, assuming the scientific questions will be appropriately prioritized and promote restoration and recovery. The AM Framework includes a representative list of uncertainties and potential research topics, but it is unclear how and which uncertainties will be targeted for reduction through experimentation and learning, and how the IICG will coordinate with CSAMP/CAMT to make those determinations. Critical uncertainties are well-elucidated in AM Framework (ICF 2016, Appendices 1 through 6), but are sometimes confused with “critical data and information gaps” that might not improve understanding of water operations’ effects on species of concern. We recommend stronger links to conceptual models. It is difficult to extract where critical short-term actions (experiments) will be essential versus when “gaining knowledge to improve future management decisions” (adaptive learning) will be acceptable. It is somewhat unclear how the “best needed science” will be identified and implemented to support and advance AM. Regarding uncertainties about salmon (ICF 2016, Appendix 1, 2), the salmonid survival metrics are a good start, although survival is complicated by the variety of life-history types passing through the Delta. For instance, are the near-field survival performance metrics identified in 2081(b) Application, Section 4.3.7.2.3.1, which limited the near-field effects to 0.25 miles above and below the intakes, considered in development of the research actions? In addition to Delta survival metrics, additional quantitative metrics could be developed that reflect viable salmon population criteria (e.g., adult abundance of natural salmonids, spawner recruitment relationships, spawning distribution). Currently, viable salmon population is mentioned in AM Framework (ICF 2016, Section 5.4.6), but no metrics are discussed. See discussion above under AM Governance and Decision Making for more thoughts on how the AM Framework should handle uncertainty and some of the gaps in the current approach. Also, the AM Framework should be explicit about how the responsible agencies will handle uncertainties that cannot be reduced (e.g., how the precautionary principle will be implemented to ensure species viability and potential for recovery).

In terms of a “timely mechanism” for addressing needed changes in operations, it is unclear whether there will be an AM mechanism for responding to unanticipated events on a timescale of less than 1-2 years, e.g., from results indicating the need to adjust to new plans for real-time operations. Because the AM Framework is tied to ESA Section 7, the Panel suggests it may be even more important to have safeguards and sideboards than in other AM programs. The Four-Phase Plan (ICF 2016, Figure 5-X) gives a general idea of how the IICG will respond to new information, but the details regarding difficult decision making involving changing operations as warranted are not clear. How and when are the "adaptive limits of operations" established?

The AM Framework seems like a cumbersome process with a 3-5-year turnover rate in evaluations (because of research funding cycles), with implementation possibility taking up to 7-10 years. The Panel suggests that there should be shorter feedback loops and more responsiveness and flexibility built into the AM approach. The Panel would need to review plans for real-time operations in the BiOps before coming to any final conclusions because the AM Framework only allows for annual adjustments. The issue of whether the AM program should be connected to real-time operations also depends on the policies regarding experimentation. If there are plans for pulse-type experiments, then AM should be linked to real-time operations. The operations are key to designing and carrying out experiments, but a longer-term approach is needed for evaluation and feedback.

Question 1C: How well does the Framework build off and incorporate existing adaptive management or related efforts? Does the Framework adequately address areas or gaps not currently covered by existing efforts?

The AM Framework builds on several other initiatives (IEP-MAST/SAIL/CSAMP/CAMT) to develop an AM process and management-relevant science that incorporate the most relevant research. However, the major task presently unaddressed is how the wide array of potential research and monitoring activities will be prioritized even further and readily implemented into active and passive AM actions.

The AM Framework accurately encapsulates the basic tenets of the AM concept that emerged in the late 1970s, which has since been evolving as a major decision-making tool in resource management. In the context of California water and at-risk species management, the AM Framework appropriately emphasizes the need for a management regime that is "transparent, collaborative, and responsive to changes in scientific understanding," and specifically for improving management of the Delta's resources under federal and state water operations, including California WaterFix. The AM Framework translates the fundamental components and their interactions into a structured, four-phase, decision-making process. This process recognizes the importance of using conceptual models to relate physical and biological processes that influence the condition of targeted resources and to identify the key uncertainties that constrain our current understanding of management actions' effects on focal species and other ecosystem services. It also acknowledges the important distinction between "active" and "passive" AM, although as noted later in this review, the explicit experimentation involved in active AM is seldom described in the AM Framework.

In identifying the major scientific and technical uncertainties, the AM Framework takes advantage of several other regional reports (MAST/SAIL) to develop an inventory of the most urgent research needs. While the AM Framework acknowledges the many gaps and uncertainties, it does not always address them in the sense of providing a path forward that would resolve them. Rather, it defers to "ensure CESA authorization compliance as new scientific and operational information becomes available." The major task that is presently unaddressed will be how the wide array of potential research and monitoring activities will be prioritized even further and readily implemented in active and passive adaptive management actions. Simply advertising the current complete list will populate the patchwork of science required to assess the effects of the PA, but we do not believe that approach will progress the science effort as a whole. It is also unclear which instruments will form the foundational research on which everything else will be built. Ultimately, the Framework would benefit from a more proactive 'strategic gaps' assessment of the critical information needs and experiments that would need to be conducted in the very short term. The new Interagency Implementation and Coordination Group (IICG) would be a significant improvement over existing efforts (CSAMP/CAMT), with the potential to provide better articulation of uncertainties and a mechanism for identifying specific teams of people that would be appropriate for each research effort. It remains to be seen, however, whether the IICG will provide a strategic plan for monitoring, experimentation, and learning through both active and passive AM.

Question 1D: How thoroughly do the steps and decision making processes outlined in the Framework support its intent and objectives?

The four phases of AM are well described and are in alignment with the core principles in the AM literature. The decision-making process appears to support the stated intent and objectives. (ICF 2016) As stated earlier, however, the Panel has some concerns about implementation of this decision-making process. Assuming the AM Framework's "Intent and objectives" of the AM Framework are to comply with ESA Section 7 (e.g., to protect the fish), then an AM Framework needs to be embedded within an adaptive governance structure that will ensure that the responsible agencies truly implement and respond to feedback from monitoring. See general comments above regarding governance and decision making.

It was evident from the 2081(b) application that the AM Framework would follow a similar model to the two-tiered organizational structure of CSAMP/CAMT, but the IICG appears to be based on a different approach. How will authority be distributed between IICG and CSAMP/CAMT? Given that the mission of CSAMP was to develop a robust science and AM program to inform BiOps, why not use CSAMP and CAMT to implement this AM Framework? It was also evident from the 2081(b) application that CSAMP would be responsible for coordinating monitoring and research to assess efficacy of water-operations criteria, including: (1) operational criteria proposed to take effect at the time of commencement of north Delta operations; and, (2) alternative criteria that may provide equivalent or superior biological benefits while maximizing water supplies. Did this plan change, and if so, why?

The AM Framework describes the IICG and lists the composition of the team (ICF 2016, Section 5.1.1). The vision for the IICG seems to be heavily weighted toward water authorities such as Reclamation and DWR. The IICG will have a "senior manager/scientist" from each of the Five Agencies. "Additional agency staff or consultants" may be added as needed, but this has not yet been decided. As stated earlier, the Panel is concerned that the water users may have undue influence on scientific decision making. The Panel understands and supports the dominant paradigm in AM that calls for inclusion of stakeholder input in program implementation, but the Panel is concerned about stakeholders' (and especially water users') influence on the research prioritization.

The list of IICG duties are appropriate except for the last two (ICF 2016, Section 5.1.1). As the responsible agencies refine the list of duties for the IICG, the Panel suggests that #7 and #8, ("Establish mechanisms for developing and implementing AM changes [e.g., identifying performance measures/triggers to assess progress/outcomes, providing venues for synthesis and evaluation of available information, peer review, and developing recommendations in the face of new/refined understanding]"), might not be particularly appropriate for stakeholder input. As stated earlier, there does not appear to be a political body set up to make decisions if the monitoring information shows response outside the boundaries set for decision making. Again, the alternative is to set clear criteria and boundaries and have a process for political decision making if results fall outside of set bounds. The Five Agencies should be the entity that will decide when and how management should respond after reviewing results of research and monitoring, "Phase 4: Adapt" (ICF 2016, Figure 5-X). Biologists should not be involved in decision making and should just serve in advisory roles since it otherwise could be a conflict of interest.

The Panel suggests that decision-making processes regarding what research and monitoring gets funded and carried out in Phases 1 and 2 of the four-phase plan should be primarily based on input from personnel with scientific backgrounds.

The existing Long-term Operations Biological Opinion (LOBO) science panel review was specifically highlighted (ICF 2016, Figure 5-3) as one review panel for "Phase 2: Assess." The structure and charge of the LOBO panel should be re-evaluated to ensure that it can support this type of assessment role. In the last couple of years, this six-member panel has evaluated three or four "hot-topic issues" annually. Similar to the structure of the panel for the California WaterFix Aquatic Science review, the LOBOs panel is provided with material one month prior to a two-day meeting and then responds to charge questions in a written report. After participating agency and Delta Science Program review of the LOBOs review process last year, this annual review panel was changed to a biennial review. Therefore, this review, as currently structured, has limited capacity to evaluate multiple high-interest research findings with implications for "Phase 3: Integration" and "Phase 4: Adaptation."

The Five Agencies should have a team of scientists and engineers advising them. If water users are included in an advisory function and will be involved in decision making regarding research, then other stakeholders, including representatives from environmental groups, should be included as well (as in the CSAMP/CAMT process). Regarding Phases 3 and 4, Integration and Adaptation, the Panel would like more information about governance and decision making in these phases. How will a culture of risk and experimentation and learning be supported?

Question 1E: Do the commitments to new research, monitoring, and modeling appropriately support the management component of the Framework?

The AM Framework commits to new research, monitoring and modeling, but details are lacking regarding guarantees behind the commitments. What will guarantee that the Five Agencies address the need for additional resources, people, and capacity for research? The Panel notes the inclusion of a section on funding, which states that "[c]urrent and anticipated funding requirements and timelines will be determined through Five Agencies coordination and with the IICG", but details are missing. Will funding sources be contingent on stakeholder or water user access to decision making? If so that could create a conflict of interest. In the Panel's Phase 1 review (Simenstad et al. 2016), the Panel recognized the need for more explicit plans for monitoring species' status and the direct and indirect effects of (1) PA construction and operations (for determining whether these are jeopardizing species or adversely modifying habitat) and (2) restoration and mitigation activities. In the cover letter that accompanied the revised AM Framework, which was modified in response to the Panel's Phase 1 comments, the responsible agencies deferred these details to the forthcoming BiOps; therefore, the monitoring plans still need to be developed in sufficient detail for definitive review. The AM Framework (ICF 2016, Section 6.3) does identify positive steps for providing information needed to better manage and rebuild salmonid populations. These proposed efforts should be discussed and evaluated further in a detailed monitoring and research plan. Each effort should be linked to specific questions and AM triggers.

The AM Framework states that "much of our most valuable monitoring and analytical tool development suffers from a lack of long-term funding security and fragmented implementation, which together lead to inefficiencies in applied science to better inform management decisions." Since these details and assurances are still missing, it makes evaluation of adequacy and effectiveness difficult. Accordingly, the Panel has some concerns about capacity for carrying out the envisioned research and calls attention to the problem of attrition in Delta science experts due to retirement and a failure to replace those leaders, especially in state and federal agencies. This is resulting in a knowledge-base drain, and all agencies should proactively plan for recruiting the necessary lead researchers and research technicians. How will all agencies address the need for additional resources, people, and capacity for research?

Question 1F: Will the approaches to scientific research and monitoring allow robust and adequate documentation of effectiveness in reducing uncertainty associated with CWF and existing measures to minimize and mitigate impacts to species?

Regular (at least annual) review and report on the status of key indicators and an evaluation of results from actions and experiments is crucial. The Panel is optimistic about the ability to document and track the results of scientific research and monitoring if the research is guided continuously by the newly formed IICG group rather than in the patchwork manner of the past. The responsible agencies and IICG will need to articulate how they will determine effectiveness in reducing uncertainty and what criteria they will use to determine effectiveness. The larger issue, however, is whether and how the envisioned science program will be carried out.

From the perspective of AM, there are two inherent aspects to the WaterFix uncertainties: (1) how priorities will be assigned to the key scientific uncertainties that constrain realistic estimation of PA impacts on listed species; and, (2) uncertainty in the approach and commitment of the responsible agencies to new and expanded monitoring, research, modeling, and analysis that will be required to address (1). It is certain that the existing capacities under current monitoring and research (e.g., Interagency Ecological Program; IEP) are already strained and that both funding and science resources will need to be amplified to meet this additional need. For instance, the considerable uncertainties around the population dynamics of Delta Smelt and Longfin Smelt constraints on the interpretability and application of the Longfin Smelt-Delta outflow relationship will require additional science investigations of PA impacts across life history stages, regions of the Delta and Bay, and time periods that are not presently addressed.

Question 1G: Will the approaches to scientific research, monitoring, and associated decision making allow for tracking the effects of CWF on populations of the four listed species over time and the effectiveness of management actions?

Both this question and Question 1F are concerned with the ability to track results of research, monitoring and decision making. As stated earlier, the Panel would benefit from seeing a comprehensive research and monitoring plan before answering this question.

The CWF PA did not describe future studies and monitoring efforts, the designs of which have not been finalized. Detection of future changes in listed species' distribution and abundance will be dependent on these unknown details. Monitoring needs to be designed with the capability to assess the outcomes of AM and mitigation actions and their implications for the survival and recovery of ESA-listed species. The criteria for determining "effectiveness of management actions" needs to be explicitly described. While tracking the effects of CWF and associated management actions in an effective manner is certainly critical, the Panel's bigger concern around decision making concerns transparency and accountability regarding how decisions will be made in response to what is tracked.

4.2 CDWF 2081(b): general permit questions

The 2081(b) application only addresses species that are listed under the California ESA. Therefore, Panel responses to questions related to the 2081(b) application do not address PA effects on federal ESA-listed steelhead, sturgeon, and killer whales.

4.2.1 To what extent are the analyses used for the CDFW 2081(b) permit application scientifically sound and their conclusions scientifically supported?

The CDFW 2081(b) permit application recognized where uncertainty limits the type of analyses that can be defended. For those analyses that can be defended, the methods are generally sound and are scientifically supported. In general, the best available science has been used, but the Panel recognizes that new information and analyses are still required to effectively evaluate the impact of the Proposed Action (PA). Detailed answers to this question are discussed for each panel charge question below.

Question 2A: Do analyses of CWF operations and impacts to species through 2060 resolve panel comments raised in Phase 1 of this review? Is climate change adequately incorporated into the cumulative analysis?

Question 2A: Delta Smelt

Thermal effects described in the 2081(b) application depended on results published by Brown et al. (2016), but did not consider climate effects beyond 2039 due to uncertainty in future trends in greenhouse-gas emissions. Two, widely divergent emission scenarios were applied while creating the Brown et al. (2016) predictions, which extended to the year 2100. The panel assumes that the 2081(b) application did not consider climate effects beyond 2039 due to mid-century divergence in these two emission scenarios. Impacts related to future climate-related changes in X2 are based on 2025. It is acknowledged that entrainment at the NDD may increase due to increasing sea level. Given that Delta Smelt are already near the NDD (evidence follows below in Table 1), and that most Delta Smelt habitat is downstream of the NDD, sea-level rise would be expected to cause a larger proportion of the Delta Smelt population to be impacted by the NDD.

Higher water temperatures are expected to cause habitat compression and reduced reproductive potential under both the PP and NAA to comparable extents. Higher air temperatures are expected to shift precipitation away from snow and towards rainfall, changing seasonal and spatial snowmelt patterns and thus altering freshwater inflow patterns (2081(b) application, Section 5.A.A.2, Appendix 5.A-Attachment 2). These positions are incorporated into the cumulative effects. Ongoing beach-seine monitoring is maintained by the fish agencies at stations (n = 58) throughout the legal Delta as well as in upstream and downstream areas. Despite the broad geographic distribution of stations, two of the top five stations with the highest Delta Smelt catch were located near or upstream of the NDD. The top five beach-seine stations for Delta Smelt in recent years (highest sum of catch, Table 1) are:

1. SR012W – Sandy Beach, Seine Route North Delta, Region 2 – downstream of NDD
2. SJ001S – Antioch Dunes, Seine Region Central Delta, Region 3 – downstream of NDD
3. SR049E – Garcia Bend, Seine Route N. Delta & Sac, Region 2 – upstream of NDD at river mile 49
4. SR043W – Clarksburg, Seine Route North Delta, Region 2 – near upstream-most intake at river mile 43
5. SS011N – Steamboat Slough, Seine Route North Delta, Region 2 – downstream of NDD

Table 1. Comparison of recent (2012-2016) catches of Delta Smelt at different beach-seine stations, where *Count* is frequency of encounter (number of seine deployments with non-zero catch) and *Sum* is the total number of individuals collected. Stations are sorted by their sums, with the top five stations highlighted in yellow (data source: https://www.fws.gov/lodi/juvenile_fish_monitoring_program/jfmp_index.htm).

Station	*Count*	*Sum*
SR012W	31	140
SJ001S	5	88
SR049E	8	39
SR043W	3	20
SS011N	2	9
LI001E	4	8
LI003W	5	8
LI006E	5	7
SR014W	6	6
SR060E	3	5
LI010E	2	4
LI005W	2	3
LI006W	3	3
LI007E	3	3

MK004W	3	3
SR024E	1	3
SR062E	3	3
GS010E	1	2
LI007W	2	2
TM001N	1	2
LI001W	1	1
LI002E	1	1
LI008E	1	1
SJ026S	1	1
SR055E	1	1
Totals	98	363

Question 2A: Salmon

Quantitative analyses involving salmon only considered climate effects through 2039. The 2081(b) application should justify why it concluded that climate change will not differentially impact salmon via the PA versus NAA, especially considering anticipated acceleration of trends beyond 2030. An adverse effect of the PA on Chinook Salmon viability in the future when overall conditions are less favorable may have greater consequences than at present.

The 2081(b) application briefly mentions the predicted effects of climate change on salmon habitat, but the analysis is incomplete. The report states in Climate Change sections 4.3.8.2 and 4.4.8.2: "*Some global climate models (GCMs) predict that summer water temperatures in the Sacramento River and its tributaries may increase by 3°C to 6°C by the end of this century, which would result in a greater frequency in exceedance of lethal water temperature thresholds.*" "*Predicted reductions in reservoir cold water pool storage volume would diminish the capacity of managers to counter water temperature increases resulting in a greater frequency in exceedance of lethal water temperature thresholds.*" Climate effects on stream flow were briefly noted, but changes in flow by season should be discussed in more detail so that effects on each salmon species and life stage can be evaluated. Climate-related impacts on salmon habitat were projected to be much greater after year 2030, but the modeling effort to evaluate PA effects on salmon only considered climate-related effects through 2030. The 2081(b) application concludes: "*These impacts would occur regardless of the PP, for the effects are not evident when compared to the NAA.*"

The 2081(b) application should further justify its conclusion that climate change would not differentially impact salmon via the PA versus the NAA. For example, findings from the Delta Passage model (e.g., 2081(b) application, Section 4.3.4.1.2.2.1.6) indicate that the PA would lead to slightly lower survival of salmon through the Delta compared with the NAA, and the Interactive Object-oriented Salmon Simulation (IOS) life cycle model indicates a 25% reduction in median spawning escapement of winter Chinook under the PA compared with the NAA. The reduction in survival under the PA compared with the NAA is expected to be greater during dry versus wet years. The frequency of drier years is expected to be greater during future climate change, especially after 2030, which is the last year considered in the 2081(b) application modeling effort. Therefore, the frequency of lower survival conditions under the PA compared with the NAA may be greater during projected climate scenarios, especially as year 2100 is approached.

Survival of salmon during life stages outside the Delta (e.g., spawner to smolt, and ocean rearing) is likely to be lower during future climate change in response to less favorable temperature, stream flow, and perhaps ocean conditions. Therefore, a slight negative impact of the PA on salmon survival is likely to have greater consequences for the viability of salmon under future climate scenarios than scenarios that were modeled through 2030 when climate change effects will be relatively small. In other words, a reduction in survival while migrating through the Delta in response to the PA (2091(b) application, Section 4.3.4.1.2.2.1.7) would have greater consequences for salmon viability towards the end of the century when additional factors are adversely affecting viability compared with the contemporary period. This observation differs from that view of no differential impact presented in the 2081(b) application.

Future climate change, especially after 2030, will likely lead to a longer series of years with stressful conditions for salmon. The carry-over effect of continuous adverse conditions is best evaluated using a life cycle model that incorporates previous-year effects on parent spawning abundances. The 2081(b) application used two life cycle models for winter-run Chinook Salmon: IOS and Oncorhynchus Bayesian Analysis (OBAN), but OBAN did not consider future climate scenarios. IOS considered climate change factors through 2030 (ICF, personal communication), but it did not specifically address periods of long-term drought beyond what was observed in the modeled years (1926-2002 and adjustments for climate through 2030; ICF, personal communication). IOS considered factors affecting salmon during several life stages in the Sacramento River and used the Delta Passage Model for PA effects in the Delta. A key prediction from IOS was that median adult spawning escapement of winter-run Chinook Salmon was 25% less under the PA than under NAA across the 81-year period (2081(b) application, Section 5.D.3.1.8.4). During dry and critical water years, median adult spawning escapement declined about 30-70% under the PA compared with the NAA (2081(b) application, Figure 5-D-150).

ICF consultants' noted in their Phase 2A Panel presentation that the effects of climate change on the ESA-listed species beyond 2030 need not be addressed in the final BA, but ICF consultants stated that updated models will need to be considered in the future and AM will be used to address future conditions (Wilcox et al. 2016). This comment by the consultants highlights the need for a robust AM program (see Section 3.1, above). Based on input from NMFS personnel at the public meeting (December 8 and 9), the Panel anticipates that the NMFS BiOp will further address the carry over effect of long-term drought on salmon viability under the PA versus NAA. The Panel also notes that climate change and associated rise in sea level might offer some mitigating effects if tidal and wetland restoration activities actively plan for and respond to opportunities for expansion of tidal wetlands with sea level rise.

Question 2A: Hydrodynamics

Climate change in the hydrodynamic models (CALSIM II and DSM2) incorporate projected climate (Q5) and sea level conditions at Year 2030. (2081(b) application, Appendix 5A). A significant amount of modeling effort is required to develop the Delta salinity-flow relationship required for the CALSIM II watershed model for modified sea level and climate change conditions. To create this relationship, the hydrodynamic models of the Delta (DSM2 and other multi-dimensional models) must be run for many different inflow, gate, and pump rate configurations. The resulting salinity-flow relationship, however, is only valid for the one bathymetric configuration of the Delta that is modeled. Therefore, as the system is modified by restoring habitat and climate conditions change, this salinity-flow relationship used in CALSIM II will need to be continuously modified. Development of the salinity-flow relationship for conditions beyond 2030 needs to be in development now.

Question 2B: The 2081(b) application currently utilized long-term averages to analyze near and far field effects of CWF operations on habitat conditions. Does this approach adequately describe year-to-year effects of CWF on covered fish species' population dynamics? Are there alternative analytical approaches available that are more appropriate?

Question 2B: Delta Smelt

Population dynamics were not modeled due to widely recognized uncertainties in model parameterization. Year-to-year variation in individual effects (entrainment, X2, abiotic habitat index) were considered by water-year type. However, water-year type cannot represent monthly conditions because it is based on differently weighted flows during particular seasons plus the weighted index for the previous year. Given that the Delta Smelt is an annual species (i.e., each year class must survive continuously and then successfully reproduce), additional analyses should have been based on months that were independent of water-year type. It appears that averaging months within water-year classes diminished the numerical difference between the PA and NAA.

Because wet months can occur during dry years and vice versa, classification by water-year type does not effectively segregate months along the wet-dry axis, and therefore differences among water-year average monthly values may falsely appear to be diminished. In addition, the water year index

Sacramento River Index = 0.4 * Current Apr - Jul Runoff + 0.3 * Current Oct - Mar Runoff + 0.3 * Previous Year's Index

is more heavily weighted towards April-July runoff, does not represent flows during August or September, and is biased by the previous year's index. As an annual species, Delta Smelt must successfully reproduce even during what are defined as "critical" water years by this index. That is, survival to reproduction requires survival during all months and all years by every year-class of fish. However, even with the diminishment of apparent differences caused by averaging, there appears to be a meaningful difference in X2 between the PA and NAA, particularly during August and September, when X2 has a large likelihood of extending into the river channels upstream of Chipps Island (2081(b) application, Figures 5.A.6-29-18, 5.A.6-29-19, Appendix 5.A). Even with this conservative (averaged) approach, there appears to be a difference of several km within important river reaches that separate the river channels from critical shallow-water habitats downstream that are used as rearing habitat by early juveniles during August and September. As noted in more detail in the FWS BiOp, the actual effect observed under the PA is likely to be much larger and more frequent than indicated in these plots.

Separation of X2 from critical shallow-water habitat near Suisun Marsh, Honker Bay, and Montezuma Slough is cause for concern.

Question 2B: Salmon

The 2081(b) application should consider effects of the PA versus NAA in response to prolonged drought conditions so that the propagative effect of low salmon productivity during each life stage and each generation can be evaluated. A life cycle model provides the framework for this type of analysis. Two life cycle models were described in the 2081(b) application, but these models only considered climate change effects through 2030 based on adjustments to base period observations (1926-2002). The Panel understands that NMFS Fisheries will present a comprehensive life cycle model in the BiOp that will be used for examining the effects of long-term drought conditions.

Question 2C—Part A: Is the approach used to characterize take and associated impacts to covered fish species populations scientifically valid given current understanding and the recognized limitations of available tools?

Question 2C-Part A: Salmon

The 2081(b) application uses a variety of approaches to estimate effects of the PA on salmon relative to the NAA. These approaches typically rely upon available data and models that have been developed in the watershed rather than attempting to develop new models and approaches specific to the CAWF project. The report attempts to highlights assumptions, limitations, and uncertainty of the analyses. More detailed documentation of assumptions and limitations of the modeling effort is typically found in the appendices.

The salmon models did not always incorporate the most recent information, which is continually evolving as new studies are published. For example, the IOS life cycle model used egg survival relationships based on a 1999 laboratory study that reportedly over-estimated egg survival in the Sacramento River in relation to water temperature (Martin et al. 2016). Other salmon egg mortality estimates in the report were likely based on the same or similar laboratory data and should be updated with these new findings. The Martin et al. (2016) study was published by NMFS scientists, so the Panel expects the BiOp to incorporate this new information.

The Delta Passage Model is a key tool to estimate survival of salmon through the Delta, and it should be updated and re-run with more recent survival data, if possible. Many survival studies have been conducted since the initial development of the model. The Delta Passage Model was developed from the tagging of large hatchery yearling fall Chinook Salmon smolts. A key uncertainty when using the Delta Passage Model is that the findings may not be representative of smaller wild winter- and spring-run Chinook Salmon. Salmon fry and parr rear in the estuary for longer periods and use different habitats compared with larger smolts, such that application of the smolt survival data as surrogates for smaller Chinook Salmon may lead to biased survival estimates. Since smaller juvenile Chinook Salmon rely on estuarine habitats for longer periods than larger yearling Chinook, the Panel suspects that removal of up to 40% of the Sacramento inflow (e.g., November of below normal years) may have a greater effect on these smaller life stages than indicated by the tagging of large hatchery late fall Chinook Salmon. Michel et al. (2015) noted that smaller Chinook Salmon passing through the Delta likely have lower survival compared with the large hatchery fall Chinook Salmon because they are smaller and more vulnerable to predators. Examination of mean size of juvenile Chinook sampled in the Delta during 2012-2016 (beach seines versus Chipps Island trawls; (https://www.fws.gov/lodi/juvenile_fish_monitoring_program/jfmp_index.htm) shows that sizes of winter- (73 mm in beach seines; 114 mm in trawls), spring- (58 mm in beach seines; 89 mm in trawls), late fall- (78 mm in beach seines; 134 mm in trawls), and fall-run (44 mm in beach seines; 82 mm in trawls) Chinook Salmon races are much smaller than the sizes of hatchery fall Chinook Salmon used in the Delta Passage Model (>140 mm). Salmon sampled by trawl were consistently larger than those in beach seines, as would be expected. Salmon sampled by trawl at Sacramento were 10-30 mm smaller than those at Chipps Island, suggesting considerable growth and residence in the Delta by Chinook Salmon. The smallest size of winter-run and spring-run Chinook Salmon sampled by beach seine in the Delta during 2012-2016 was 35 mm and 31 mm, respectively. These small salmon may be more vulnerable to water removal effects and associated changes in habitat than larger hatchery salmon used in the models.

Ultimately, a life cycle model approach is probably the best approach for evaluating cumulative effects of the project on salmon viability (see Rose et al. 2011). A life cycle model enables projected effects to be propagated from life stage to life stage and from generation to generation while also enabling the evaluation of long-term environmental change, e.g., droughts and changes in habitat. The IOS model is the most comprehensive life cycle model described in the report. It incorporates functional relationships for several life history stages that would be influenced by the PA, including survival through the Delta based on the Delta Passage Model. The OBAN life cycle model uses a statistical approach, but it uses a range of simple survival assumptions to characterize survival through the Delta rather than reliance on empirical data, such as the Delta Passage Model. The IOS model should be updated with new information on: (1) the relationship between egg survival and temperature in the Sacramento River (Martin et al. 2016); and (2) survival of Chinook Salmon passing though the Delta. The Panel was informed that NMFS fisheries is developing a more comprehensive life cycle model that will be used in the BiOp.

Question 2C—Part B: Are there improvements to the current methods that could be implemented, or are there available alternative analytical approaches that are more appropriate for analyzing the extent of take and associated impacts to the species?

Question 2C-Part B: Delta Smelt

Additional investigative approaches for Delta Smelt are outlined in Table 4.0-1 of the permit, but these are limited to specific, estimated impacts (entrainment, X2, flow relationships with fish, etc.) and did not include impacts that were avoided altogether due to uncertainty (e.g., food-web and population dynamics). More comprehensive life-cycle models are needed to integrate survival across life stages and water years while considering key factors. See recommendations by the Salmonid Life-Cycle Model Independent Panel (Rose et al. 2011) and the following discussion.

Question 2C-Part B: Salmon

As noted in our answer to Question 2C-Part A, the 2081(b) application analyses rely on data stemming primarily from relatively large Chinook Salmon (typically > 140 mm) even though sampling in the Delta show that winter-run and spring-run Chinook Salmon are typically much smaller than this. According to beach seine data, juvenile winter-run and spring-run Chinook Salmon as small as 35 mm and 31 mm, respectively, have been sampled. These data and the current reliance on much larger salmon for impact analyses highlights the need for a significant research effort on salmon fry and parr distribution, abundance, behavior and survival in the Delta (including predation impacts). This information is needed to: (1) inform life cycle models; (2) more accurately characterize potential effects of the PA versus NAA; and, (3) develop habitat restoration actions for juvenile salmon in the Delta.

Question 2D: Do the conclusions of the effects analyses for covered species adequately acknowledge and incorporate uncertainty as recommended in Phase 1 of this review?

Question 2D: Delta Smelt

Most uncertainty regarding Delta Smelt was adequately acknowledged. One Phase 1 recommendation that was not fully addressed is concern that the PA will frequently move X2 several km upstream into channel-type habitats (upstream of Chipps Island) and away from critical shallow-water habitat in the Suisun Marsh, Honker Bay, and Montezuma Slough area used as rearing habitat. As mentioned in the answer to Question 2B, the water-year-averaged X2 statistics presented in the CWF BA do not assuage this concern. Other highly relevant uncertainties that were not considered (or identified during Phase 1) include ongoing adjustments that will affect actual future inflows and ongoing adjustments to operations at the SDD (re-initiation of 2008 FWS BiOp, 2009 NMFS BiOp RPA Action Suite 1.2).

Regarding upstream displacement of X2 under the PA, please refer to the Panel's expanded answer to Question 2B. Regarding other uncertainties, a variety of adjustments are underway that will change flow rates and the way diversions are operated. Given the high probability of these changes occurring in the near future, the criteria and simulated data used in the CWF BA simulations may soon be superseded by new criteria and simulated data, causing the CWF BA to become unrepresentative of actual PA effects and the NAA.

Question 2D: Salmon

As mentioned previously, considerable uncertainty also stems from the use of surrogates to estimate survival of winter and spring-run Chinook Salmon migrating through the Delta. The Delta Passage Model, a key tool for evaluating the PA, was based on tagging of large yearling hatchery fall Chinook Salmon. Smaller juveniles rear in the estuary for longer periods and they typically use shallower habitats compared with larger Chinook Salmon smolts (Miller et al. 2010, Sturrock et al. 2015, Weitkamp et al. 2014). The 2081(b) application briefly mentions this limitation of the existing Delta Passage Model, but this limitation is not considered when developing conclusions regarding take and jeopardy. Given the greater reliance of smaller Chinook Salmon on shallow estuarine habitats and the proposal to remove up to 40% of Sacramento River discharge at the NDD (November of below average water year), the Panel suspects the reliance on large smolts as surrogates for smaller juveniles may underestimate potential adverse effects of water on winter and spring-run Chinook salmon. The 2081(b) application should discuss the potential direction of bias that the use of large smolts will have on the evaluation of take.

Question 2D: Statistical Uncertainty

The Panel is pleased to see a heightened emphasis on uncertainty in the 2081(b) application, relative to what the Panel saw in the draft BA. This greater emphasis is apparent in Section 4.0 of the Take Analysis (Chapter 4), especially in Table 4.0-1.

The Panel also appreciates that Chapter 4 now reports quantitative uncertainties more realistically in several ways, relative to the draft BA, along the lines suggested in our review of the draft BA (Simenstad et al. 2016). However, the Panel is still concerned about how Chapter 4 draws its conclusions about the predicted outcomes of PA and NAA scenarios, in the face of the uncertainties of predictions from its statistical models.

In Chapter 4 and its appendices, the Panel found nine applications of regression models that compare PA to NAA outcomes over the 82-year projection scenario. We will use one such model as a working example: the simple linear regression that predicts the April-May salvage of juvenile Longfin Smelt as a function of April-May OMR flow (Appendix 4.A.1.6). This regression model takes the form:

$Y = a + bX + e$,

where Y= log10(juvenile salvage), X = (OMR flow), a and b are estimated regression coefficients, and e is the model's residual error (section 4.A.1.7).

In the Results (4.A.1.8) section, this model's predicted exceedance plot (Fig. 4.A-32) and time series plot (Fig. 4.A-33) display true 95% prediction intervals for predicted salvage under the NAA and PA scenarios, rather than confidence intervals used in the draft BA, as recommended by Simenstad et al. (2016). The use of prediction intervals gives a much more realistic picture of model uncertainty, and the Panel appreciates the additional effort exerted to develop such intervals for this and the other statistical models. In addition, as recommended by Simenstad et al. (2016), Figures 4.A-32 and 4.A-3 do not display the predicted mean values for PA and NAA, a practice that emphasizes the uncertainty that the predicted means would be the true outcomes of the scenarios.

However, Chapter 4 does not draw its conclusions about PA and NAA outcomes from its time series plots and exceedance plots that display prediction uncertainty. Rather, conclusions in the Chapter 4 text are consistently based on face-value interpretations of predicted mean values, as reported in tables (e.g., Table 4.A-11) and boxplots (e.g., Figure 4.A-31), neither of which indicate model uncertainty. For example, the first sentences of the Results section (4.A.1.8) summarize the regression results by stating "*Predicted salvage from the salvage-Old and Middle River flow regressions generally was less under the PP in wetter years and greater under the PP in drier years (Table 4.A-11 and Figure 4.A-31). The mean salvage in wet and above normal years was within 14-15% less under PP, similar (3% greater under PP) in dry years, and nearly 30% greater under PP in below normal years (Table 4.A-11).*" Similar wording is used throughout Chapter 4 when interpreting results from the other eight statistical models. (The panel does appreciate that the boxplots in Chapter 4 and its appendices now note their exclusion of model uncertainty, as recommended by Simenstad et al. (2016). However, the Panel notes that Chapter 4 did not attempt to propagate model uncertainty into the boxplot results, although Simenstad et al. (2016) suggested three ways that this could be done).

The Panel is especially concerned about using the face values of predicted means to summarize the *differences* between PA and NAA outcomes, without considering their uncertainties, as is illustrated in the preceding paragraph. Making a realistic interpretation of the predicted differences between NAA and PA is critical, because the overall message of the statistical models in Chapter 4 is that such differences are either quite small, or that they indicate less impact to ESA fishes under PA than under NAA. Thus, the Panel believes that it is important for the Chapter 4 authors, and their readers, to fully understand a hidden, but critical, assumption that underlies the use of predicted means to estimate differences between NAA and PA. To understand this assumption, consider the residual error term, *e*, in the above regression equation. For our example regression, the error term is not negligible, because $r^2 = 0.70$. Thus, the residual error accounts for $100(1-r^2)\% = 30\%$ of the variance in log10(salvage)). The residual error can be viewed as the sum of contributions from 2 sources: $e = F + M$. In this expression, *M* is “measurement error”, that is, the random error that occurs because Longfin Smelt salvage cannot be measured with perfect accuracy and precision. In the case of smelt salvage, the measurement error may be relatively small.

We focus instead on the other error component**,** *F,* which represents “other factors.” This is the model error that occurs because, among all the factors that probably impact Longfin Smelt salvage, river flow (*X* = OMR flow) is the only factor that is included in the regression model. Conceptually, several such other factors are known, such as smelt population size and population dynamics, predation effects, screening efficiencies at the South Delta salvage facility, and migration dynamics. These other factors are not included in the regression model because the current state of science cannot yet quantify their effects on smelt salvage, either empirically or theoretically. As a result, the individual and joint effects of all these other factors (including their interactive effects with flow) are implicitly bundled together and modeled as a single component, *F*, of the residual error. This situation is also true for the other eight model applications, with the possible exception of the Newman (2003) model. That is, the sole driving variable is some hydrodynamic measure (generally OMR flow or X2) that is assumed to differ under PA and NAA, and all other types of factors are excluded from the models.

For any year in the 82-year projection sequence, the regression model is used to predict Y_{NAA} = log10(salvage) for the NAA scenario, assuming the OMR flow level, X_{NAA} of that scenario:

$$Y_{NAA} = a + bX_{NAA} + F_{NAA} + M_{NAA} \quad (1)$$

In Equation 1, F_{NAA} and M_{NAA} are the “other factor” and “measurement” components of the residual error, *e*, that are assumed to occur under the NAA scenario for the modeled year. The regression model is then applied once more, to make corresponding predictions for the PA scenario:

$$Y_{PA} = a + Bx_{PA} + F_{PA} + M_{PA} \quad (2)$$

The difference between PA and NAA outcomes can then be estimated by subtracting Equation 1 from Equation 2:

$$Y_{PA} – Y_{NAA} = b(X_{PA} – X_{NAA}) + (F_{PA} - F_{NAA}) + (M_{PA} - M_{NAA}) \quad (3)$$

In Equation 3, the term $b(X_{PA} – X_{NAA})$ is the difference between the predicted mean values under the PA and NAA scenarios. Since Chapter 4 assumes that this difference accurately estimates the difference in log10 (salvage), which is ($Y_{PA} – Y_{NAA}$), then it also assumes that the second and third terms on the right-hand side must sum to zero, on average. There is no reason to expect that measurement error would differ, on average, between the PA and NAA scenarios, so one can assume that $(M_{PA} - M_{NAA}) = 0$. However, this implies that one must also assume that, on average, $(F_{PA} - F_{NAA}) = 0$.

This final assumption is of critical importance: it states that: "all salvage-associated factors, other than OMR flow, are assumed to have average, total effects on salvage that are identical under the PP and NAA scenarios (that is, $F_{PA} = F_{NAA}$)." Thus, even though Chapter 4 does not explicitly model any of these other factors, such as smelt population size and predation pressure, it is implicitly assuming that the PP would not alter their quantitative effects on smelt salvage, relative to NAA. This strong "excluded-factor" assumption, which has questionable realism, is applicable whenever the face-value differences between predicted mean values, without prediction intervals, are used to compare NAA and PP outcomes.

In contrast, the prediction intervals around the predicted means express a 95%-confidence range of possible nonzero values for the residual error, $(F_{PA} - F_{NAA}) + (M_{PA} - M_{NAA})$. If these intervals were incorporated into the comparisons between NAA and PA predictions, then such comparisons are more robust, in that they represent the more-realistic likelihood that factors excluded from the regression model have differing effects on salvage, under the PA versus NAA scenarios.

The preceding arguments apply to any regression model in which the residual error is defined as the difference between predicted and observed values, including the multiple linear regression, Poisson and logistic regression, local regression (LOWESS), and negative binomial formulations used in Chapter 4.

Although the Panel believes the excluded-factor assumption to be important, the Panel does not suggest a practical alternative to citing the predicted means from PA and NAA predictions, when summarizing regression results in the Chapter 4 text. Attempts to incorporate prediction-interval information into the textual summaries are likely to be cumbersome and unclear, although the Panel encourages the Chapter 4 authors to give it a try. However, the Panel does recommend that text be added, probably to Section 4.0, about "model uncertainty" and how it will be addressed throughout Chapter 4. This text could specify the types of models for which uncertainty can be estimated, and acknowledge that model uncertainty is still present in models (e.g., CalSim) where estimation is not possible. For regression models, the text could explain when and how prediction intervals would be reported and interpreted. Finally, the text could state how the predicted means would be reported (boxplots and means tables), and would explain the excluded-factor assumption that underlies interpretations of differences between the predicted means for PA and NAA.

4.3 CDWF 2081(b): Longfin Smelt Questions

Question 3A, 3B: (3A) Is the proposed approach to achieve the March through May spring outflow targets for Longfin Smelt likely to result in spring outflow equivalent to existing conditions? (3B) The relationship between outflow and Longfin Smelt abundance uses a six-month (January through June) averaging window (Kimmerer 2009). How well does the 2081 (b) application justify using a three month (March through May) averaging window to provide outflow targets and operational criteria during that period?

Question 3A, 3B: Mechanisms Underlying the Longfin Smelt abundance-Delta outflow relationships

Evidence and existing analyses, albeit limited, would appear to argue for a six-month (January-June) averaging window. Methods of assessing declines in Longfin Smelt used to evaluate potential effects of the PA are extensively based on correlative analyses, with more recent evaluations derived from population dynamics models. Jassby et al. (1995) and Kimmerer et al. (2013) compared that January-June time window to averaging X2 over a more restrictive March-May period. In their analysis of BDCP effects, Mount et al. (2013) considered the seasons of sensitivity of Longfin Smelt to changes in flow conditions to be February-March for juveniles and December-February for adults. Nobriga and Rosenfield (2016) used a February-May indexing period for age-2 Longfin Smelt to estimate age-0 larvae when their center of distribution is near X2. The 2081(b) application (Appendix 4.A) of adequacy of fit for the January-June X2 compared to the March-May averaging periods found that the January-June X2 averaging period was better supported in terms of explaining variability in the FWMT index (Table 4.A-1; Figure 4.A-1).

Yet, the Longfin Smelt abundance:Delta outflow relationships are adequacy-of-fit relationships rather than mechanistic relationships for abundance or survival. Thomson et al (2010) and Mac Nally et al. (2010) related Longfin Smelt abundance to X2 flow relationships, but also identified water clarity and prey as additional explanatory factors. The more recent Maunder et al. (2015) state-space population dynamics model applied to Longfin Smelt in the Bay-Delta was cited in the 2081(b) application and highlights the uncertainties about mechanisms underlying the vital rates of Longfin Smelt populations. Evaluating covariates that affect the vital rate of survival between two life stages, Maunder et al. (2015) found that two (Sacramento and Napa rivers runoff) flow variables were the strongest single covariate but that there was "definite evidence" for density dependence with prey density, e.g., *Eurytemora affinis* abundance, as well as ammonia and temperature as additionally relevant covariates.

Given the inadequacies of the current monitoring regime and protocols (e.g., often designed for other species, restricted habitat and time coverage), can these correlative analyses resolve the uncertainties about how flow modification (e.g., location of withdrawal) will actually affect Longfin Smelt population dynamics? The 2081(b) application acknowledges that the historical Longfin Smelt abundance:Delta outflow relationship "….*could change as a result of the PA (e.g., change in balance between north and south Delta flows for a given X2)*" (2081(b) application, Section 4.A.1). Uncertainties around the population dynamics of Longfin Smelt, that underlie the processes accounting for the Longfin Smelt abundance:Delta outflow relationship have been identified as substantial, including evidence for: occurrence and variation in population in critical time periods (e.g., winter versus spring); evidence for the importance of retention in the low salinity zone and its variation with outflow; smelt use of tidal wetlands and potential for benefit from food production exported from restoration sites; and the breadth of their distribution in the Delta, Bay and nearshore coastal ocean (2081(b) application, Section 5.3.2.3.2). As mentioned elsewhere, investigating these uncertainties will require additional empirical and modeling research of PA impacts across life history stages, regions of the Delta and Bay and time periods that are not presently addressed.

The available data and interpretations of emerging evidence acknowledge that the distribution of Longfin Smelt, particularly spawning adults and larvae, is much broader and involves more shallow water habitat than was previously appreciated (Grimaldo et al., in revision). Similarly, the lack of definitive information on stage-specific habitats occupied by Longfin Smelt for spawning, hatching and rearing is inhibiting population dynamics and life cycle modeling needed for CWF assessment. The AM Framework will need to expand/modify research and monitoring to resolve underlying mechanisms underlying the Longfin Smelt abundance:Delta outflow relationships, estimates of survival and utilization of shallow water habitat for spawning and rearing in the brackish zone. The responsible agencies need to recognize that our knowledge of Longfin Smelt distribution and ecology in the Bay-Delta is based on monitoring programs designed for other species and in regions or habitats (e.g., shallow waters or tidal marshes) that were not originally incorporated into a study design that would target Longfin Smelt. Assessment of the potential effects of the PA on Longfin Smelt population will depend on a much more mechanistic understanding of their somewhat impracticable response to spring outflow.

It should be noted here that export of Longfin Smelt juveniles/larvae <20 mm SL by the SWP, CVP, OMR flow, North Bay Aqueduct Barker Slough Pumping Plant and other small diversion systems is not considered here. Estimates of entrainment are highly uncertain because monitoring of entrainment of fish that size is limited and there are no related statistical models.

Question 3A, 3B: Hydrodynamics

Predictions of the Longfin smelt:Delta outflow relationship are based on modeled water operations by the CALSIM II watershed optimization model. The CALSIM II model is designed to optimize water transfers throughout the State Water Project (State) and the Central Valley Project (Federal) based on a long list of operational rules. These rules ultimately constrain the amount of water available for Delta Outflow and SWP/CVP exports.

Each one of the operational rules for the Delta needs to be re-evaluated and possibly modified under the PA because the major point of diversion will be shifted to the Sacramento watershed side of the Delta rather than the San Joaquin watershed side of the Delta. Changing operational rules will, in turn, change Delta Outflow and SWP/CVP exports in the CALSIM II watershed model. As a result, the predicted Longfin smelt:Delta outflow relationship will also change.

For example, the San Joaquin River import-export constraint is in place because the San Joaquin River is primary source of water exported from the South Delta facilities under the NAA configuration. The CALSIM II model appendix states:

> "[s]ince 2009 NMFS BiOp Action IV.2.1 San Joaquin River i-e ratio constraint is a primary driver for the Apr-May Delta outflows under the NAA, this criterion was used to constrain Apr-May total Delta

exports under the PA to evince desired NAA Mar-May average Delta outflows in the PA." (2081(b) application, Appendix 5.A).

However, under the PA, where the primary point of diversion is located on the Sacramento River, this San Joaquin River import:export (I:E) ratio criteria may not be a logical constraint on operations in some water-year types. Instead, a Sacramento I:E ratio criteria should be developed and evaluated.

4.4 CDWF 2081(b): Delta Smelt Questions

Question 4A: In the analysis of CWF construction and operational effects, how appropriate are beach seine surveys from the Delta Juvenile Fish Monitoring Program and Freeport diversion monitoring data (ICF 2015), in which Delta Smelt have been observed as by-catch, to characterize the proportion of the total Delta Smelt population in the vicinity of the north Delta diversions? Could these datasets be analyzed differently to better support the effects analysis?

The beach seine surveys do appear to be appropriate for assessing the relative distribution of Delta Smelt within the Sacramento River, although beach-seine deployment is largely limited to shorelines where there is minimal chance of snagging on subsurface obstructions, and thus the beach seine data are less representative of more typical shoreline types within the river. The style and specifications of the beach seine are appropriate for Delta Smelt; the net is a center-bag style that is 15.2 m long and 1.3 m high, with 0.3 cm square stretched mesh. Given its vertical height limitation, the beach seine is generally deployed in waters less than 1 m deep. Net deployment at the shoreline is appropriate for relevance to the NDD. The nets are deployed throughout the year. The geographic range of deployment extends long distances upstream and downstream of the NDD and includes a reasonable number of stations throughout the legal Delta as well as upstream reaches of the Sacramento and San Joaquin Rivers and downstream areas in Suisun, San Pablo, and San Francisco Bays. The September 9, 2014 metadata file (https://www.fws.gov/lodi/juvenile_fish_monitoring_program/jfmp_index.htm) states that 58 stations are currently in use. During the period 2012-2016, Delta Smelt were encountered in 231 beach-seine deployments, yielding 363 individuals (Table 2).

Table 2. Comparison of recent (2012-2016) beach-seine catches of Chinook and selected fish species that are associated with the Pelagic Organism Decline (*sensu* Mac Nally et al. 2010), where *Count* is frequency of encounter (number of seine deployments with non-zero catch) and *Sum* is the total number of individuals collected (data source: https://www.fws.gov/lodi/juvenile_fish_monitoring_program/jfmp_index.htm).

Species	*Count*	*Sum*
Chinook Salmon	1,723	59,423
Delta Smelt	98	363
Longfin Smelt	2	3
Rainbow Trout	59	88
Splittail	719	13,466

The analysis of the seine data in the 2081(b) application (Table 4.1-6) was straightforward, but could be improved. The proportion of Delta Smelt caught in the NDD area vs downstream was determined for individual years (1977 to 2011), and a mean of 18% of catch was calculated. Because total catches per year were often <5 individuals, the calculated proportions were often highly imprecise. This imprecision can be overcome by grouping years together. A multi-year bootstrapping approach could be used to estimate probabilities for use in the impingement estimate.

Another uncertainty that should perhaps be a high-priority research initiative under the AM Framework is the representation of the beach seine monitoring sites in assessing Delta Smelt distribution, life history patterns, and habitat utilization. The beach seine surveys are almost entirely positioned at locations were beach seines can be efficiently deployed, were there is minimal chance of snagging on subsurface obstructions. The result is that these monitoring data are likely representative of Delta Smelt occurrence and life history stage in clean beaches and boat ramps, but inadequately characterize the majority of habitat types across the Delta, and particularly where vegetation and natural (woody) debris and dense tidal wetlands inhibit deployment of a beach seine. Thus, while the beach seine data for Delta Smelt may correlate of the data from other aquatic ecosystems in the Delta, there is insufficient data to verify that assumption. The alternative concept—that Delta Smelt are distributed very heterogeneously in space and time according to the diversity of their aquatic habitats—is not testable with the beach seine monitoring. This may be more consequential given the high uncertainty about the habitats occupied by Delta Smelt during critical stages, e.g., spawning, that would be required for mitigation to effectively compensate for CWF effects with habitat restoration.

4.5 CDWF 2081(b): Chinook Salmon Questions

Question 5A: How well does the effects analysis evaluate new adverse effects on salmonid species due to north Delta operations and changes in south Delta operations?

The 2081(b) application presents findings from several available approaches for evaluating potential effects of PA operations on salmon survival. A tremendous amount of detail is presented and the findings are presented objectively. Although detail is appreciated, it also made it difficult to fully evaluate merits of the various analyses. While there is some commentary on the merits of various approaches, often the findings are simply presented without such assessment. Uncertainty in PA effects is frequently highlighted when presenting findings from the detailed analyses. However, uncertainty and potential bias from using surrogates (e.g., large hatchery yearling fall Chinook Salmon) in modeling intended to encompass diverse life histories is likely underestimated in the quantitative uncertainty estimates in the salmon analyses.

Comments on the Potential to Jeopardize Continued Existence of the Species

The concluding statements regarding levels of take and the potential of the PA to jeopardize the continued existence of the salmon species (2081(b) application, Sections 4.3.8.3, 4.4.8.3) do not describe the high uncertainty nor the level of potential adverse impacts to salmon that are presented in the main text. This summary section seems to be a significant departure from information presented in the detailed sections. The 2081(b) application concludes, *"it is generally not possible to quantify numbers of individuals that may be taken incidental to the many components of the proposed project. However, the overall potential for take is low. The covered activities, facilities, and changes in operations associated with the new facilities have a low likelihood of resulting in persistent changes in mortality of individuals. Habitat losses would be relatively small—~50 acres as a result of construction and 0.42 acres as a result of operational effects on channel margin benches (Table 5.4-1 in Chapter 5 Take Minimization and Mitigation Measures)—and are not expected to have a population-level effect." "Mitigation is expected to fully offset habitat loss and any loss of individuals because high-quality, larger-scale, intact habitat will be acquired, enhanced, and managed in perpetuity; see Section 5.4.3 Sacramento River Winter-Run Chinook Salmon of Chapter 5 Take Minimization and Mitigation Measures. Thus, the PP fully mitigates for the potential incidental take of winter-run Chinook salmon."* There are other examples in this section of the 2081(b) application that inappropriately minimize the potential effects of the PA on salmonids or concluding that large-scale habitat restoration will compensate for NDD impacts, particularly long-term operations.

The conclusion seems to stem from several significant assumptions. First, there seems to be an assumption that reduced exports from the south Delta under the PA would offset mortality of salmon associated with water diversion at the NDD. This key assumption seems to be based on the uncertain findings of the OBAN model, which is influenced by simple assumptions that the PA reduced survival through the Delta by 1%, 5%, 10% or 50%. In contrast to this apparent assumption in the Take conclusions, the reported incidental take of winter-run juvenile Chinook Salmon entrained at the south Delta pumps has averaged only 0.55% of the juvenile production entering the Delta (range 0.0-1.3%) (ICF International 2016, Appendix Section 5.D.1.1.2); similar estimates for spring-run Chinook Salmon are not available. The 95% probability intervals for the Export function in the OBAN model included both negative and positive values, indicating the uncertainty in the effect of this key variable, but this is not mentioned in the concluding statements.

The Take conclusions did not discuss or refute alternative findings that were presented in the main text. For example, the IOS life cycle model suggested significant adverse effects of the PA compared with the NAA. The IOS model indicated approximately 25% fewer winter-run Chinook Salmon spawners under the PA compared with NAA (median of all years; prediction intervals show consistently lower salmon escapement under the PA). During dry and critical water years, the cumulative effects of the PA were predicted to cause a 30-70% reduction in spawning Chinook Salmon (ICF International 2016, Fig. 5.D-150). The IOS and OBAN findings (and findings from other models) did not consider potential reductions in salmon mortality associated with real-time operation management and other measures, therefore it is difficult to quantitatively evaluate the effectiveness of these measures in reducing potential impacts of the PA. Nevertheless, the concluding statements assume these and other actions would fully mitigate adverse effects on salmon.

Secondly, the PA identified several take minimization measures (ICF 2016, Chapter 5) such as construction work windows, pulse flows during NDD operations, and real-time operations management. These actions should be help reduce potential adverse impacts, but there is uncertainty in how effective the measures will be. For example, as discussed below, pile driving will be limited to June 1 through October 31 in order to avoid most salmonids, but some winter- and spring-run Chinook Salmon will likely be present and, according to the analyses presented in the 2081(b) application, noise levels from impact hammering will be sufficient to injure salmon when present in the construction area. Less harmful methods will be used to install pilings when possible, but the tremendous number of pilings indicates considerable impact hammering will be needed to install pilings. These potential impacts did not appear to be mitigated.

The Take conclusions only addresses uncertainty associated with the amount of habitat restoration required to mitigate for 50 acres of habitat disruption during construction and 0.42 acres of habitat disrupted by project operations. Habitat is proposed to be mitigated using a 3:1 ratio of "restored" to disrupted habitat. The 2081(b) application estimates that only 0.42 acres of habitat would be disrupted by PA operations. This mitigation value is based on inundation of shallow wetland and artificial riparian bench habitats, which were influenced relatively little by the diversion of up to 40% of Sacramento River inflow in some months and water years (e.g., November, below normal year).

Thirdly, this analysis and the associated mitigation (3 x 0.42 acres of habitat) were apparently independent of the non-trivial effects resulting from the percentage of Sacramento River water and sediments that will be diverted, and the effect on salinity, sedimentation, and wetland vegetation across the Delta of NDD operations. Salinity, water depth, velocity, and vegetation are important factors contributing to salmon rearing habitat in the estuary. The quality and quantity of habitat available for Chinook Salmon and Steelhead in the Delta depend on inflows from the Sacramento River (del Rosario et al. 2013). Both short-term and long-term effects of water diversion on salmon habitat should be considered (see Hydrodynamics under Question 2A). The spatial distribution and density of rearing juvenile salmonids in the Delta was not described, so it is difficult to assess how water diversion will affect habitat that currently or with future restoration and climate change will likely support high rearing densities of juvenile salmon. The Panel anticipates that the NMFS BiOp will provide further details on how evaluation of NDD operations impacts on the availability and quality of juvenile salmon habitat in the Delta will inform mitigation goals. The present documentation states that "The primary instrument of minimization and avoidance of impact for listed fish species is compliance with the proposed operational constraints on the PP as detailed in Section 3.3.2 *Operational Criteria*, as further constrained in practice according to real-time operations as described in Section 3.3.3 *Real-Time Operational Decision-Making Process*." Furthermore, "A real-time operations procedure is adopted that will be used to manage and adjust bypass flows at the north Delta intakes, south Delta export operations, and Head of Old River Gate operations to optimize fish survival probabilities and habitat quality, consistent with overall operations criteria (see Section 3.3.3 Real-Time Operational Decision-Making Process). " How the estimated take of juvenile salmon from long-term operations will be mitigated by avoidance versus by compensation with additional high quality habitat is yet to be evident.

Therefore, the Panel finds that the concluding statement, "*Thus the PP fully mitigates for the potential incidental take of winter-run Chinook salmon."* underestimates potential adverse impacts on winter- and spring-run Chinook Salmon in response to PA construction and operations. Furthermore, as noted above, the conclusions simply assume that future climate change will have the same effect on salmon under the PA and the NAA even though some of the modeling results indicate greater negative impacts under the PA during dry versus wet years. The 2081(b) application should justify why it seemingly relies on some findings more than others.

Question 5B: Are the analyses of take by life stage and water year type scientifically sound? How useful are these analyses for determining annual population impacts?

An approach that examines potential impacts of the PA by life stage of salmon is appropriate because it helps to identify the mechanism of how the PA might affect salmon. These findings can then be used to rectify or mitigate for the adverse effect, if present. However, it is also critical to evaluate <u>cumulative effects</u> of the PA on salmon survival and viability. This is because effects during each life stage may be small and less apparent, whereas cumulative effects across all relevant life stages may identify impacts that are important to viability.

Question 5B: Construction Effects

The main text described the potential construction phase impacts to juvenile and adult salmon caused by impact pile driving in the Delta, but these potential adverse effects were not considered in the Take conclusions. Pile driving noise effects on juvenile and adult salmon is expected to be minimized by using vibration rather than impact hammer driving when soil conditions are suitable, and by restricting pile driving to June 1 to October 31, a period when fewer juvenile and adult Chinook Salmon are present. Clarification is needed to better document the migration timing of adult winter-run and spring-run Chinook Salmon as they migrate through Delta reaches where impact pile driving will occur. A tremendous number of piles will be installed and the report indicates ~30% of each pile may be installed by impact hammer. The report noted the potential use of other minimization measures such as dewatering and bubble curtains. However, the main text indicated noise produced by the impact hammer exceeded thresholds for injuring salmon up to 3,280 ft away (if no obstructions) or causing a behavioral response up to 32,800 ft (6.2 miles), assuming no obstructions such as bends in the river (2081(b) application, Table 4.3-2). At Clifton Court Forebay, *"Pile driving operations include the installation of an estimated 10,294 temporary sheet piles to construct the cofferdams for the embankments and divider wall, and 2,160 14-inch diameter concrete or steel pipe piles to construct the siphon at the NCCF outlet."* The Panel was not able to find the total number of piles by type and size for the entire effort, but these values indicate a substantial number of piles to be installed. Some winter- and spring-run Chinook Salmon are likely to be present in the Delta during pile driving, and some of these fish could encounter injurious decibels of sound during impact pile driving. Although the pile driving activity will avoid the period when most salmon are present, survival of salmon from the tail ends of the migration period is important for maintaining characteristics of viable salmon populations such as diversity and spatial structure.

Question 5B: Near-field Effects

The 2081(b) application recognized uncertainty about whether predators might aggregate at the NDD and consume juvenile salmonids. The potential effect of increased predation at the NDD will be evaluated through compliance with a performance standard: *"maintain listed juvenile salmonid survival rates through the reach containing the NDD [0.25 miles upstream of the upstream-most intake to 0.25 miles downstream of the downstream-most intake] of 95% or more of the existing survival rate in this reach."* A <u>quantitative</u> performance standard such as this is a good approach for ensuring that predators do not have a greater impact than anticipated at the NDD. Actions to offset unexpectedly high mortality in this reach should be developed in the AM Framework.

A fundamental assumption is that less mortality of salmon is expected via exports at the South Delta facilities, especially in wet years when a higher percentage of water is diverted via the NDD. It is critical to consider the population level effect of exports on salmon through the South Delta pumps when evaluating water diversion from the South Delta versus the NDD. The 2081(b) application noted that the reported incidental take of winter-run juvenile Chinook Salmon entrained at the South Delta pumps has averaged 0.55% of the juvenile production entering the Delta (range 0.0-1.3%) (ICF International 2016, Appendix Section 5.D.1.1.2); however, similar estimates for spring-run Chinook Salmon are not available. Population level effects under current conditions identifies the limit to which reduced exports through the South Delta might benefit winter-run Chinook Salmon.

Quesiton 5B: Water Facility Operation Effects

A life cycle model is a key tool for incorporating and assessing cumulative effects, including future climate change effects. Life cycle models incorporate survival functions at key life stages in a framework that allows impacts to be accumulated across the life cycle and then passed on to the next generation. Two life cycle models were described in the 2081(b) application: IOS and OBAN. A comprehensive review of these models is beyond the scope of this review and further detailed documentation of the models and data would be needed. The IOS life cycle model is an example where PA effects by life stage were relatively small. However, significant adverse effects were detected when cumulative effects were examined by looking at spawning abundances, i.e., the life stage that reflects all previous mortality. For example, the PA was predicted to produce 25% fewer spawning salmon across all years (median) compared with the NAA. Spawning abundance declined to 30-70% in dry and critical water years. In contrast, the OBAN model predicted less adverse effects of the PA. The 2081(b) application should evaluate the strengths and weaknesses of these two models, which indicate very different PA effects. For survival through the Delta, the IOS model relied upon the Delta Passage Model. In contrast, the OBAN model assumed the NDD caused a reduction in Delta survival from 0.1 to 0.5. As noted above, conclusions about salmon take seemed to rely upon the OBAN model while not mentioning the findings from the IOS model.

Some analyses in the 2081(b) application seem to be based on outdated information. For example, some 2081(b) application analyses relied upon laboratory studies to evaluate the effect of water temperature in the Sacramento River on eggs survival, but Martin et al. (2016) reported that these laboratory studies underestimated egg mortality in the river. Also, the Delta Passage Model is a key tool for evaluating the effects of the PA on salmon survival in the Delta, but the underlying data may not be as complete as it could be. The Delta Passage Model is based on the tagging of large hatchery yearling late-fall Chinook Salmon and the 2081(b) application notes that these data may not reflect survival of much smaller winter- and spring-run Chinook Salmon that use the estuary differently from larger smolts (this observation was not considered in the conclusions) (see size information presented in answer to Question 2C-Part A & B). Michel et al. (2015) noted that mortality of other Chinook Salmon races are likely greater than that of the tagged hatchery salmon because they are smaller and more vulnerable to predators. A number of new survival studies have been completed in recent years and those data should be incorporated into the Delta Passage Model and IOS model. As discussed above (Question 2C-Part B), additional research on the use of the Delta by smaller Chinook Salmon is needed.

None of the modeling results considered the long-term effect that water diversion at the NDD would have on salmon habitat quantity and quality in the Delta. A considerable volume of water will be diverted from the NDD during some months and water years. This diversion will influence the distribution of salinity and sedimentation, distribution of wetland vegetation, and the distribution of rearing salmonids. Short-term effects of water diversion on dewatering of wetland and riparian habitats were estimated at select benches, but the 2081(b) application analysis did not consider all mechanisms of how water diversion may impact rearing salmon, as noted above in Question 5A. Juvenile salmon rear and grow in the Delta for extended times, and habitat quality and quantity are important to their survival.

Predation is a key source of mortality for ESA-listed fishes in the Delta. For example, non-native Striped Bass, a popular sport fish, is a significant predator on juvenile Chinook Salmon in the Delta (Lindley and Mohr 2003) and reduced flow may increase predation on salmon (Cavallo et al. 2013). Lindley and Mohr (2003) reported that entrainment at the South Delta water diversion facilities and ecosystem changes have reduced the carrying capacity for subyearling Striped Bass, and have contributed to their decline from the 1960s to 1996. However, this trend could be reversed if the PA does indeed reduce entrainment at the South Delta facilities. The 2081(b) application did not address this issue, but ICF consultants noted that some earlier information (Impact AQUA-201, Impact Aqua-203) may contain relevant information to be considered in the BiOp (Wilcox et al. 2016). These documents were not readily available to the Panel.

4.6 Panel Comments on Cumulative System Effects

The Panel recognizes that this 2081 (b) application is designed as species-level and life-stage-specific analyses, appropriate for maximal protection of CESA listed species. However, by taking this narrow approach, the analysis ignores that many of these species directly or indirectly interact over common Delta and Bay ecosystems and that their vulnerability to PA effects may be a function of cumulative effects of the project on Delta processes. That many of the 2081 (b) analyses identify the potential responses of individual species to PA alterations to the Delta are contingent on changes in hydrology, salinity, turbidity and other Delta-scale processes implies that there will be trade-offs in planning and managing for minimal incidental take among the three fish species, if not some of the other listed species as well. The Panel suggests that cumulative, Delta-scale ecosystem effects of the PA need to be evaluated in the context of at-risk species that overlap to various degrees of space and time in the Delta. Examples of cumulative or collateral, large-scale effects would include, but not be limited to, PA effects on: (1) tidal hydrology; (2) mitigation responses; and, (3) suspended sediment diversion.

Tidal Hydrology

The complicated interactions among river flow, tides, shifts in salinity and shallow habitats with proposed North Delta diversions were not effectively modeled or interpreted at the scale of the interconnected Delta. Smaller life history stages of the listed fish, their prey and predators utilize shallow, brackish water in the Delta but it is unclear to the Panel based on the 2081(b) application how they would collectively differ in their responses to the proposed NDD scenarios. CALSIM II hydrodynamic modeling is effectively used to evaluate likely environmental responses to the PA such as the X2 position. However, the Panel cannot determine whether or how the effects of the seasonally-dependent PA diversion scenarios consider the frequency and flooding of spawning, rearing and foraging habitats of the different species in different regions of the Delta. For example, how does the removal of up to 40% of the river water (hydrograph provided to the panel) in some months under the 2081(b) permit likely affect vegetation (high marsh, riparian) and associated habitat, secondary productivity, and turbidity in different down-estuary segments?

Mitigation Responses

Mitigation of long-term incidental take associated with project operations is not specifically addressed on a Delta-wide scale, yet the responses to large mitigation actions (e.g., breaching/removing levees for tidal wetland restoration) will vary appreciably depending on the region of the Delta that the mitigation action is occurring and where the response is manifested. As evidenced by hydrodynamic modeling of Suisun Bay and the Delta, the location and volume of increases in tidal prism that are likely to be represented by tidal wetland restoration will dictate changes in the tidal range—and thus elevation, frequency and duration of tidal flooding—of other segments of the Delta. At the November 2009 Ecosystem Restoration at the Landscape Scale: North Delta and Suisun Marsh Workshop sponsored by the Science Program, Chris Enright (DWR) and Jon Burau (USGS/Sacramento) both illustrated that restoration tidal marsh in Suisun Bay will dissipate tidal energy. As a result, the distance the tidal signal propagates into the interior Delta is reduced. Jon Burau recommended in that workshop, and again at the 2016 Bay Delta Science conference, that restoration efforts should be developed starting from the west (Suisun Bay) to the Northeast because there is a limited amount of tidal energy that can be distributed to these restoration efforts. (Science Program Workshop 2009)(http://www.science.calwater.ca.gov/events/workshops/workshop_eco.html) For instance, breaching of levees to restore historic tidal wetlands in the lower portion of the system (e.g., Suisun Marsh) as mitigation for post-larval and juvenile Longfin Smelt rearing habitat would likely result in depressed tidal flood regime in the northern Delta, potentially impacting the existing access of juvenile salmon to their tidal wetland rearing habitats, or the potential for similar tidal restoration actions in that region. Because the existing mitigation planning is unspecific about the design and location of these mitigation actions, there is no feasible way to assess the potential large-scale, site-specific impact of the PA.

Sediment Starvation

It has been estimated that the Bay-Delta's tidal wetlands will require a total sediment input of over 10 $Mm^3\ yr^{-1}$ (2.6 cm yr^{-1}) to keep pace with the higher projections of sea level rise, over twice as much as is currently being deposited (Barnard et al. 2013; DredgeFest 2016 report). It appears that the applicants have failed to analyze the effect of the 10% suspended-sediment (fines) loss due to NDD operations. It is encouraging to note that "*Sacramento River sediment removed from the water column by the NDDs will be reused as described above. However, to the maximum extent practicable, the first and preferred disposition of this material will be to reintroduce it to the water column in order to maintain Delta water quality*." (3.2.10.6). However, based on the NDD sedimentation basins design to "*capture sand-sized sediment and drying lagoons for sediment drying and consolidation*" (ICF International 2016, Section 3.2.2.1), the Panel would interpret that only the coarse (sand and larger particle sizes) will be retained, and that suspended fines (silt and clay particles) will be lost to the NDD to the south Delta.

Furthermore, there has not been a response to the Panel's Phase 1 report (Simenstad 2016, Appendix 7) concern about the uncertainty around potential sediment starvation by the NDD diversion of 7-16% of the Sacramento River load at Freeport. The primary response is: "*DWR will collaborate with USFWS and CDFW to develop and implement a sediment reintroduction plan that provides the desired beneficial habitat effects of maintained turbidity while addressing related permitting concerns (the proposed sediment reintroduction is expected to require permits from the Water Control Board and USACE). This would minimize the effects of sediment removal by the NDD.* " (2081(b) application, Section 5.3.2.3.1] There is an expressed uncertainty about where they would introduce the 'recycled' sediment but no information on the volume and sediment structure, that might be recovered from the sediment removed at the NDD intakes.

5 Acknowledgments

This Phase 2A and Phase 2B panel review occurred under an abbreviated timeline. The two reviews were spaced only a month apart, which meant that the panel was reading one set of documents, preparing for meetings in Sacramento, and asking the Delta Science Program and the agencies clarifying questions while the agencies were still developing the documents and charge questions for the second phase of the review. The Panel truly appreciates the assistance of Yumiko Henneberry and Lindsay Correa from the Delta Science Program for their efforts to keep the processes going. In multiple ways, Yumiko, Lindsay, and other select staff of the Delta Science Program staff went far beyond the call of duty for both the Panel and the agencies.

We would also like to thank the agencies and ICF International consultants for assembly of documents and their responses to our inquiries. Despite the challenging timelines, they were willing to do their best to keep the process rolling on their end as well.

6 References

[2081(b) Application] CDFW. 2016. California Incidental Take Permit Application for the California WaterFix and its operation as part of the State Water Project. Version: October 2016.

Armitage, D., de Loë, R.C., Morris, M., Edwards, T.W.D, Gerlak, A.K., Hall, R.I., Huitema, D., Ison, R., Livingstone, D., MacDonald, G., Mirumachi, N., Plummer, R., and Wolfe, B.B. 2015. Science–policy processes for transboundary water governance. Ambio 44:353-366.

Barnard, P.L., D. H. Schoellhamer, B.E. Jaffe, and L.J. McKee. 2013. Sediment transport in the San Francisco Bay coastal system: An overview. *Mar. Geol.* 345:3-17.

Benson, M.H., D. Llewellyn, R. Morrison, M. Stone. 2014. Water governance challenges in New Mexico's Middle Rio Grande Valley: a resilience assessment. *University of Idaho Law Review* 51: 196-228.

Benson, M.H. and C. Schulz. 2015. Adaptive management and law. In C.R. Allen and A.S. Garmestani (eds.) *Adaptive Management of Social-Ecological Systems*, pp. 39-59. New York: Springer. Birge, H.E., C.R. Allen, R.K. Craig, A.S. Garmestani, J.A. Hamm, C. Babbitt, K. Nemec, E. Schlager. 2014. Social-ecological resilience and law in the Platte River Basin. *University of Idaho Law Review* 51: 229-256.

Brown, L.R., L.M. Komoroske, R.W. Wagner, T. Morgan-King, J.T. May, R.E. Connon, and N.A. Fangue. 2016. Coupled downscaled climate models and ecophysiological metrics forecast habitat compression for an endangered estuarine fish: *PlosONE* 11(1):e0146724. doi: 10.1371/journal.pone.01467240146724Cavallo, B., J. Merz, and J. Setka. 2013. Effects of predator and flow manipulation on Chinook salmon (*Oncorhynchus tshawytscha*) survival in an imperiled estuary. *Environmental Biology of Fishes* 96:393–403.

Center for Biological Diversity v. Rumsfeld 2002

CDFW. 2017. E-mail dated 13FEB2017 from California Depart of Fish and Wildlife to the California WaterFix Aquatic Science Peer Review Panel (via Yumiko Henneberry, Delta Science Program). (Appendix 7)

Delta Stewardship Council Workshop. November 2009. Ecosystem Restoration at the Landscape Scale: North Delta and Suisun Marsh Workshop. (http://www.science.calwater.ca.gov/events/workshops/workshop_eco.html)

Del Rosario, R. B., Y. J. Redler, K. Newman, P. Brandes, T. Sommer, K, Reece, and R. Vincik. 2013. Migration patterns of juvenile winter-run-sized Chinook Salmon (*Oncorhynchus tshawytscha*) through the Sacramento–San Joaquin Delta. *San Francisco Estuary and* Watershed *Science* 11. :1-22. (http://escholarship.org/uc/item/36d88128

Grimaldo, L., Feyrer, F., Burns, J., and Maniscalco, D. In revision. Sampling uncharted waters: Examining rearing habitat of larval longfin smelt (*Spirinchus thaleichthys*) in the Upper San Francisco estuary. *Estuaries and Coasts*

Haskell, W.L. 1959. Diet of the Mississippi threadfin shad, *Dorosoma petenense* atchafalayae, in Arizona. *Copeia* 1959:298-302.

ICF. 2016. Adaptive Management Framework for the California Water Fix and Current Biological Opinions on the coordinated operations of the Central Valley and State Water Projects. 75 pp. (http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/CAWaterFix/Peer%20Review%202A/am_framework_161108.pdf)

ICF. 2017. Adaptive Management Framework for the California Water Fix and Current Biological Opinions on the coordinated operations of the Central Valley and State Water Projects. 75 pp. (file provided to Panel: AM Framework_161108_new revisions based on MOA2bPanelF2.pdf)

ICF International. 2016. Biological Assessment for the California WaterFix.

Independent Scientific Advisory Board (ISAB). 2015. Density dependence and its implications for fish management and restoration programs in the Columbia River Basin. ISAB Document 2015-1. Prepared for the Northwest Power and Conservation Council. http://www.nwcouncil.org/fw/isab/

Kimmerer, W. J. 2002. Effects of freshwater flow on abundance of estuarine organisms: physical effects or trophic linkages? *Marine Ecology Progress Series* 243: 39-55.

Kimmerer, W. J., E. S. Gross, and M. L. MacWilliams. 2009. Is the response of estuarine nekton to freshwater flow in the San Francisco estuary explained by variation in habitat volume? *Estuaries and Coasts* 32:375-389.

Kimmerer, W.J., M.L. MacWilliams, and E.S. Gross. 2013. Variation of fish habitat and extent of the low-salinity zone with freshwater flow in the San Francisco Estuary. *San Francisco Estuary and Watershed Science* 11(4). http://escholarship.org/uc/item/3pz7x1x8

Lindley, S. and M. Mohr. 2003. Modeling the effect of striped bass **(***Morone saxatilis***)** on the population viability of Sacramento River winter-run Chinook Salmon **(***Oncorhynchus tshawytscha***)**. Fishery Bulletin 101:321**–**331.

Mac Nally, R., J. R. Thomson, W. J. Kimmerer, F. Feyrer, K. Newman, A. Sih, W. A. Bennett, L. Brown, E. Fleishman, S. D. Culberson, and G. Castillo. 2010. Analysis of pelagic species decline in the upper San Francisco Estuary using multivariate autoregressive modeling (MAR). *Ecological Applications* 20:1417-1430.

Martin, B.T., A. Pike, S.N. John, N. Hamda, J. Roberts, S.T. Lindley, and E.M. Danner. 2016. Phenomenological vs. biophysical models for thermal stress in aquatic eggs. *Ecology Letters* doi: 10.1111/ele.12705

MAST (Management, Analysis, and Synthesis Team). 2015. An updated conceptual model of Delta Smelt biology: Our evolving understanding of an estuarine fish. Interagency Ecological Program for the San Francisco Bay/Delta Estuary, Technical Report 90.

Maunder, M. N., R. B. Deriso, and C. H. Hanson. 2015. Use of state-space population dynamics models in hypothesis testing: advantages over simple log-linear regressions for modeling survival, illustrated with application to Longfin Smelt (*Spirinchus thaleichthys*). *Fisheries Research* 164:102-111.

Michel, C. J., A. J. Ammann, S. T. Lindley, P. T. Sandstrom, E. D. Chapman, M. J. Thomas, G. P. Singer, A. P. Klimley, and R. B. MacFarlane. 2015. Chinook salmon outmigration survival in wet and dry years in California's Sacramento River. *Canadian Journal of Fisheries and Aquatic Sciences* 72(11):1749–1759.

Miller JA, Gray A, Merz J. 2010. Quantifying the contribution of juvenile migratory phenotypes in a population of Chinook Salmon *Oncorhynchus tshawytscha*. Marine Ecology Progress Series 408: 227–240.

Mount J., Fleenor, B. Gray, B. Herbold, and W. Kimmerer. 2013. Panel Review of the draft Bay-Delta Conservation Plan. Prepared for the Nature Conservancy and American Rivers. September. Saracino & Mount, LLC, Sacramento, CA. https://watershed.ucdavis.edu/library/panel-review-draft-bay-delta-conservation-plan

Nobriga, M. L., and J. A. Rosenfield. 2016. Population dynamics of an estuarine forage fish: disaggregating forces driving long-term decline of Longfin Smelt in California's San Francisco Estuary. Transactions American Fisheries Society 145:44-58.

Rose, K., J. Anderson, M. McClure, and G. Ruggerone. 2011. Salmonid integrated life cycle models workshop. Report of the Independent Science Panel prepared for the Delta Science Program, CA. http://deltacouncil.ca.gov/sites/default/files/documents/files/Salmonid_ILCM_workshop_final_report.pdf

Runge, M.C. 2011. An Introduction to adaptive management for threatened and endangered species. *Journal of Fish and Wildlife Management* 2:220-233.

Ruhl, J.B. and R.L. Fischman. 2010. Adaptive management in the courts. Minnesota Law Review 95: 424-484.

Schoellhamer, D.H., S.A. Wright, and J.Z. Drexler. 2013. Adjustment of the San Francisco estuary and watershed to decreasing sediment supply in the 20th century. *Marine Geology* 345:63–71. http://dx.doi.org/10.1016/j.margeo.2013.04.007.

Schultz, C. and M. Nie. 2012. Decision making triggers, adaptive management, and natural resources policy and planning. *Natural Resources Journal* 52:443-521.

Simenstad, C., J. Van Sickle, N. Monsen, E. Peebles, G. Roggerone, and H. Gosnell. 2016. Independent Review Panel Report for the 2016 California Waterfix Aquatic Science Peer Review. Independent scientific review prepared for the Delta Science Program, CA. http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/BDCP/ca_waterfix_aq_sci_review_report_final_may12.pdf

Stern, C.V., P.A. Sheikh, and C.T. Brass. 2011. *Adaptive Management for Ecosystem Restoration: Analysis and Issues for Congress*. Congressional Research Service, Washington D.C.Sturrock, A.M., J.D. Wikert, T., Heyne C., Mesick A.E., Hubbard T.M., Hinkelman et al. 2015. Reconstructing the migratory behavior and long-term survivorship of juvenile Chinook salmon under contrasting hydrologic regimes. *PLoS ONE* 10(5): e0122380. doi:10.1371/journal.pone.0122380

Swanson, K. M., J. Z. Drexler, C. C. Fuller, and D. H. Schoellhamer. 2015. Modeling tidal freshwater marsh sustainability in the Sacramento-San Joaquin Delta under a broad suite of potential future scenarios. *San Francisco Estuary and* Watershed *Science* 13 *doi:* http://dx.doi.org/10.15447/sfews.2015v13iss1art3

Thomson, J. R., W. J. Kimmerer, L. R. Brown, K. B. Newman, R. Mac Nally, W. A. Bennett, F. Feyrer, and E. Fleishman. 2010. Bayesian change point analysis of abundance trends for pelagic fishes in the upper San Francisco Estuary. *Ecological Applications* 20:1431-1448.

USFWS (United States Fish and Wildlife Service). 2008. Formal Endangered Species Act consultation on the proposed coordinated operations of the Central Valley Project (CVP) and State Water Project (SWP). U.S. Fish and Wildlife Service, Sacramento, CA. https://www.fws.gov/sfbaydelta/documents/SWP-CVP_OPs_BO_12-15_final_OCR.pdf

USFWS and NMFS. 1998. Endangered Species Act Consultation Handbook: Procedures for Conducting Section 7 Consultations and Conferences https://www.fws.gov/ENDANGERED/esa-library/pdf/esa_section7_handbook.pdf

Weitkamp, L. A., G. Goulette, J. Hawkes, M. O'Malley, and C. Lipsky. 2014. Juvenile salmon in estuaries: comparisons between North American Atlantic and Pacific salmon populations. *Reviews in Fish Biology and Fisheries* 24:713–736.

Wilcox, C., Greenwood, M., and C. Marcinkevage. 2016. Reponses to Panel's Phase 1 Comments. Presentation to Panel: Phase 2A.

Wright, S. A., and D. H. Schoellhamer. 2005. Estimating sediment budgets at the interface between rivers and estuaries with application to the Sacramento–San Joaquin River Delta. *Water Resource Research* 41(W09428). doi: http://dx.doi.org/10.1029/2004WR003753

Appendix 1 Biographies of California WaterFix Aquatic Science Peer Review Panel Members

Charles "Si" Simenstad (Chair) Charles ("Si") Simenstad is a Research Professor in the University of Washington's School of Aquatic and Fishery Science, where he coordinates the Wetland Ecosystem Team. Prof. Simenstad is an estuarine and coastal marine ecologist who has studied the organization and function of estuarine and coastal marine ecosystems throughout Puget Sound, Washington, Oregon and California coasts, and Alaska for over forty years. Much of this research has focused on the functional role of estuarine and coastal habitats to support juvenile Pacific salmon and other fish and wildlife, the associated ecological processes and community dynamics that are responsible for enhancing their production and life history diversity, and whether restoration of estuarine ecosystems can contribute to the recovery of depressed salmon populations. Si's most recent research focus is on developing and testing an estuarine ecosystem classification system for the Columbia River estuary, and employing it to delineate juvenile Pacific salmon habitat through the estuary gradient.

Prof. Simenstad is a Fellow of the American Association for the Advancement of Science, Co-Editor-in-Chief for Estuaries and Coasts, and Associate Editor for San Francisco Estuary & Watershed Science, Revue Paralia and the Encyclopedia of Puget Sound. He also serves on the Chief of the US Army Corps of Engineers Environmental Advisory Board and Washington Department of Natural Resources, Commissioner of Public Lands' Expert Council on Climate & Environmental Change. He has authored or co-authored 85 peer-reviewed scientific papers, 22 book and proceedings chapters, 34 miscellaneous publications and >125 workshop proceedings and technical reports. He has served as academic advisor for 32 M.S./Ph.D. graduate students, and served on an additional ~47 graduate student committees. Si holds a B.S. (1969) and M.S. (1971) from the School of Fisheries at the University of Washington.

John Van Sickle, Ph.D. (Lead Author, Phase 1) Dr. Van Sickle is a consulting environmental statistician, recently retired from the U.S. Environmental Protection Agency's Office of Research and Development. Since 1998, his research has focused on the monitoring and assessment of freshwater ecosystems, with an emphasis on indicators of health for multispecies biological assemblages, and on estimating the risks of aquatic stressors to biota. Prior to 1998 Dr. Van Sickle taught and did research in systems modeling, mathematics, statistics and ecology at Oregon State University and the University of Zimbabwe. Dr. Van Sickle earned his B.S. and M.S. in mathematics, and his Ph.D. in systems science, from Michigan State University, and also received an M.S. in statistics from Oregon State University.

Nancy Monsen, Ph.D. (Lead Author, Phase 2) Dr. Monsen's research has focused on multi-dimensional hydrodynamic modeling of the SacramentoSan Joaquin Delta and Suisun Bay for the last twenty years. Her Ph.D. research was based on the TRIM3D hydrodynamic model and recently she has been working on Stanford's SUNTANS hydrodynamic model. She also has consulting experience with the DELFT3d hydrodynamic model. Nancy Monsen joined Stanford University in August 2011, having worked previously with Philip Williams & Associates, Ltd. (now ESA PWA) and the U.S. Geological Survey (USGS). Funding for her Stanford research ended in August 2014 but she continued part-time as a visiting scholar at Stanford until August 2015, writing papers and assisting current PhD candidates and Post-Doctoral researchers in the Environmental Fluid Mechanics Laboratory. She has recently been on several science review panels including the Independent Review of the Draft Bay Delta Conservation Plan Effects

Analysis (2014), the State of the Science Workshop on Fish Predation on Central Valley Salmonids in the Bay-Delta Watershed (2013), and the Independent Review Expert Science Panel of the Collaborative Adaptive Management Team (CAMT) Proposed Investigations on Understanding Population Effects and Factors that Affect Entrainment of Delta Smelt at the State Water Project and Central Valley Project (2014). Dr. Monsen earned her doctorate in Civil and Environmental Engineering at Stanford University.

Hannah Gossnell, Ph.D. Dr. Hannah Gosnell is an Associate Professor of Geography in the College of Earth, Ocean, and Atmospheric Sciences at Oregon State University. Her research focuses on agricultural landscape change, water resource management, climate change and environmental governance in the context of rural working landscapes; and how laws and institutions might evolve to better reflect changing geographies and facilitate social-ecological transformation when necessary. Her PhD research focused on implementation of Section 7 of the Endangered Species Act and the development of a Reasonable and Prudent Alternative for the Animas-La Plata Project in the Colorado River Basin. Previous research also includes an examination of social and institutional processes leading to the development of the Klamath Basin Restoration Agreement and the Klamath Hydroelectric Settlement Agreement in 2010. A member of the Resilience Task Force of the IUCN Commission on Ecosystem Management, Dr. Gosnell has authored or co-authored over 40 peer-reviewed scientific articles and was Associate Editor for Rangeland Ecology & Management. She has served as a social scientist on several scientific review panels for the National Science Foundation's Long Term Ecological Research (LTER) program and is the Lead Social Scientist at the H.J. Andrews Experimental Forest LTER Program. She is currently a member of the Adaptive Water Governance Project funded by NSF's Socio-Environmental Synthesis Center and a Fellow at Colorado State University's Center for Collaborative Conservation. She was the 2015 recipient of the Quivira Coalition's Radical Center Research Award for "remarkable and enduring leadership in the difficult job of working in the radical center - the place where people are coming together to explore their common interests rather than argue their differences." Dr. Gosnell earned MA and PhD degrees in Geography from the University of Colorado, and a BA in American Civilization from Brown University.

Ernst Peebles, Ph.D. Dr. Ernst Peebles is a professor of Marine Science at the University of South Florida. He received his Bachelor's degree from Tulane University in his native New Orleans, and his Master's and doctoral degrees from USF in Tampa. After receiving his doctoral degree, Dr. Peebles worked as summer faculty at the Gulf Coast Research Laboratory in Ocean Springs, Mississippi, and also served as adjunct graduate faculty at Florida Gulf Coast University in Ft. Myers, Florida. His 82 publications reflect more than thirty years of experience working with dynamic coastal fish and shellfish habitat, with an emphasis on freshwater inflow effects, life history, and biomass pathways. Dr. Peebles and his students are currently developing a new method for reconstructing the geographic and food-web histories of individual fish using stable-isotope records that are stored within fish eye lenses.

Gregory Ruggerone, Ph.D. Dr. Greg Ruggerone has investigated population dynamics, ecology, and management of Pacific salmon in Alaska and the Pacific Northwest since 1979. He was Project Leader of the Alaska Salmon Program, University of Washington, from 1985-1993, and he continues to supervise graduate student research in Alaska. Most of his research involves factors that affect growth, age at maturation, and survival of salmon in freshwater and marine habitats (http://www.researchgate.net/profile/Gregory_Ruggerone/contributions). For the past 10 years, he has evaluated management of salmon fisheries in Russia, Alaska, British Columbia and California for sustainability using Marine Stewardship Council criteria. He recently served as the fish ecologist on the Secretary of Interior review of dam removal on the Klamath River. He is past-Chair of the Columbia River Independent Scientific Advisory Board (after serving the maximum 6 year term) and member of the Independent Scientific Advisory Board.

Appendix 2 Phase 2A Charge to Panel

The panel will review 1) the draft adaptive management framework for CWF and Current Biological Opinions on coordinated operations of the CVP and SWP and 2) the 2081(b) application analyses of the CWF impacts of take for Winter-run Chinook, Spring-run Chinook, Delta Smelt, and Longfin Smelt. Since these items will provide the basis of the 2081(b) permit, the reviewers should evaluate whether the items are sufficiently robust and at a level of scientific quality to serve their intended purposes. The Panel members will have at least 30 days to familiarize themselves with the materials.

The Panel will also be given relevant background information to consider and will receive presentations from the relevant agencies at the public meeting.

Specific questions for review of the CWF Adaptive Management Framework (Framework) and analyses of Winter and Spring- run Chinook, Delta Smelt, and Longfin Smelt presented in the 2081(b) permit application:

1. *Are the compliance monitoring, collaborative science, and adaptive management approaches outlined in the Adaptive Management Framework appropriate for addressing the uncertainties associated with the implementation of CWF, specifically related to CWF operations in conjunction with the SWP and CVP facilities? In answering this question, consider the following:*

    - Does the Framework adequately reflect comments and issues raised in Phase 1 of this review?
    - Is the Framework sufficient to address the uncertainties associated with the current analyses and provide a timely mechanism for addressing future changes in operations based on new understanding of listed species distribution and abundance?
    - How well does the Framework build off and incorporate existing adaptive management or related efforts?
    - Does the Framework adequately address areas or gaps not currently covered by existing efforts?
    - How thoroughly do the steps and decision-making processes outlined in the Framework support its intent and objectives? Do the commitments to new research, monitoring, and modeling appropriately support the management component of the Framework?
    - Will the approaches to scientific research and monitoring allow robust and adequate documentation of effectiveness in reducing uncertainty associated with CWF and existing measures to minimize and mitigate impacts to species?
    - Will the approaches to scientific research, monitoring, and associated decision making allow for tracking the effects of CWF on populations of the four listed species over time and the effectiveness of management actions?

2. *To what extent are the analyses used for the CDFW 2081(b) permit application scientifically sound and their conclusions scientifically supported? In answering this question, consider the following:*

General

- Do analyses of CWF operations and impacts to species through 2060 resolve panel comments raised in Phase 1 of this review? Is climate change adequately incorporated into the cumulative analysis?

- The 2081(b) application currently utilizes long-term averages to analyze near and far field effects of CWF operations on habitat conditions. Does this approach adequately describe year-to-year effects of CWF on covered fish species' population dynamics? Are there alternative analytical approaches available that are more appropriate?
- Is the approach used to characterize take and associated impacts to covered fish species populations scientifically valid given current understanding and the recognized limitations of available analytical tools? Are there improvements to the current methods that could be implemented, or are there available alternative analytical approaches that are more appropriate for analyzing the extent of take and associated impacts to the species?
- Do the conclusions of the effects analyses for covered species adequately acknowledge and incorporate uncertainty as recommended in Phase 1 of this review?

Longfin Smelt

- Is the proposed approach to achieve the March through May spring outflow targets for Longfin Smelt likely to result in spring outflow equivalent to existing conditions?
- The relationship between outflow and Longfin Smelt abundance uses a six-month (January through June) averaging window (Kimmerer 2009). How well does the 2081 (b) application justify using a three month (March through May) averaging window to provide outflow targets and operational criteria during that period?

Delta Smelt

- In the analysis of CWF construction and operational effects, how appropriate are beach seine surveys from the Delta Juvenile Fish Monitoring Program and Freeport diversion monitoring data (ICF 2015), in which Delta Smelt have been observed as by-catch, to characterize the proportion of the total Delta Smelt population in the vicinity of the north Delta diversions? Could these datasets be analyzed differently to better support the effects analysis?

Winter- and Spring-run Chinook Salmon

- How well does the effects analysis evaluate new adverse effects on salmonid species due to north Delta operations and changes in south Delta operations?
- Are the analyses of take by life stage and water year type scientifically sound? How useful are these analyses for determining annual population impacts?

Appendix 3 Materials for California WaterFix Aquatic Science Peer Review – Phase 2A

Review Materials:

1. California WaterFix Adaptive Management Framework
   a. Cover Letter: Response to Panel Comments on California WaterFix Adaptive Management
   b. Adaptive Management Framework for the California Water Fix and Current Biological Opinions on the coordinated operations of the Central Valley and State Water Projects
      - Example of Process for Effecting and Adaptive Management Change under the Framework (In Appendix 7 of the Adaptive Management Framework)
2. Selected sections from the 2081(b) application:
   - Chapter 4
   - Introduction and 4.1: Take of Delta Smelt
   - 4.2: Take of Longfin Smelt
   - 4.3: Take of Sacramento River Winter-run Chinook Salmon
   - 4.4: Take of Central Valley Spring-run Chinook Salmon
   - 4.5: Take of the California Tiger Salamander
   - Chapter 5
   - Appendices
   - 2.A
   - 4.A
   - 4.D
   - 6.A (Adaptive Management Framework for the California Water Fix and Current Biological Opinions on the coordinated operations of the Central Valley and State Water Projects)
   - Example of Process for Effecting and Adaptive Management Change under the Framework (In Appendix 7 of the Adaptive Management Framework)

Supplemental Materials:

1. Relevant publications
   - Mount, J., W. Fleenor, B. Gray, B. Herbold, W. Kimmerer (2013) Panel review of the draft Bay Delta Conservation Plan. Prepared for The Nature Conservancy and American Rivers. Saracino and Mount, LLC, Sacramento, California, pp 66-69.
   - Kimmerer, W.J., E.S. Gross and M. MacWilliams (2009) Is the response of estuarine nekton to freshwater flow in the San Francisco Estuary explained by variation in habitat volume? Estuaries and Coasts 32: 375-389.
   - DFG (2009) Report to the Fish and Game Commission: A status review of the longfin smelt (*Spirinchus thaleichthys*) in California. Department of Fish and Game (DFG), Sacramento, CA.
   - 77 FR 19756 (2012) Endangered and threatened wildlife and plants; 12-month finding on a petition to list the San Francisco Bay-Delta population of the longfin smelt as endangered or threatened, Federal register 77:19756.

2. California Water Fix Biological Assessment Appendices:
   a. 5A
   b. 5B
      i. Attachment 1
      ii. Attachment 2
      iii. Attachment 3
      iv. Attachment 4
      v. Attachment 5
   c. 5C

d. 5D
i. Attachment 1
ii. Attachment 2
3. California Water Fix Biological Assessment Chapter 5

Supplemental Materials Requested by the Panel:

- Table of contents for the 2081(b) permit application
- Response to Independent Review Panel Question 3
- Responses to Independent Review Panel Request for Information Regarding Longfin Smelt Analysis Changes

Supplemental Materials Provided at the Review:

- Project Description from DWR's incidental take application for California WaterFix

Appendix 4 Agenda of Phase 2A Public Meeting

AGENDA Order of agenda items and listed times are subject to change

Day 1 (December 8, 2016)

I. Introduction

9:00 – 9:10 Welcome Remarks

9:10 – 9:40 Opening Remarks – NMFS, USFWS, CDFW

9:40 – 10:10 Responses to Panel's Phase 1 Comments – CDFW, ICF, and NMFS

10:10 – 11:00 California WaterFix Adaptive Management Framework – CDFW, NMFS, and DWR

11:00 – 11:45 Review Panel/ Presenter Q&A

11:45 – 1:00 Lunch

II. Analyses of Winter- and Spring-run Chinook, Delta Smelt, and Longfin Smelt presented in the California Department of Fish and Wildlife 2081(b) Permit Application

1:00 – 1:30 Modeling approach to providing spring outflow – CH2M

1:30 – 2:00 Longfin Smelt Analyses – ICF

2:00 – 2:30 Delta Smelt Analyses – ICF

2:30 – 3:00 Winter- and Spring-run Chinook Analyses – ICF

3:00 – 3:15 Break

III. General Presenter/ Review Panel Discussion

3:15 – 4:00 Review Panel/ Presenter Q&A

IV. Public Comment

4:00 – 4:15 Public Comment Period

4:15 Adjourn

Appendix 5 Section on Sediment Starvation from Phase 1 Report (pp. 16-17)

"The Panel is concerned that NDD operations will increase the sediment starvation that is already occurring in the Delta (Schoellhamer et al. 2013), where approximately two-thirds of the sediment that enters the Delta is deposited in and sustains its marshes, sloughs, and mudflats. More than 80% of this sediment load originates from the Sacramento River, with the remainder from the San Joaquin River (Wright and Schoellhamer 2005). Therefore, it is important to consider not only how much sediment is exported from the Delta as a whole, but also consider whether there are critical habitats in the region of influence of that export site. Based on current water circulation patterns, the suspended sediment in the southern Delta has a low potential of being transported to the Cache Slough complex in the northern Delta, where large wetland restoration projects are being constructed. However, suspended sediment in the Sacramento River, where the proposed north Delta facilities will export water and sediment, is highly likely to be transported to the Cache Slough complex.

BA Appendix 3.B, Conceptual 1 Engineering Report, Volume 1, Section 6.1.2 describes the NDD sedimentation system that is designed to reduce sediment delivery through the dual conveyance system. It cites "normal settling depth and the design WSE depth that will enable sands and coarse silt materials (particle size between 1.75 mm and 0.075 mm) to settle in the basins". However, note that particle sizes 0.075-1.75 mm are usually considered to be all sand, not "coarse silt". Table 6.5 in that document provides estimates of sediment loading to each intake and Table 6.6, showing the river's actual sediment particle distribution, suggests that more than 61% will not settle in the basins. Thus, only about 40% of the sediment load captured by the NDD will be available for "recycling" back into the system, given the caveat that contaminant levels of the retained coarse materials would allow such reuse. Furthermore, the material that will be exported to the southern Delta through the PA's dual conveyance system will be the fine suspended sediments that provide the greatest benefits through accretion in tidal wetlands, to sustain elevation increases commensurate with sea level rise (Swanson et al. 2015), further starving the northern Delta tidal marsh habitat of juvenile Sacramento winter-run Chinook Salmon, as well as turbidity, a key abiotic habitat characteristic for Delta Smelt."

Appendix 6 Panel Comments on the Revised (2/13/2017) Adaptive Management (AM) Framework

In this Appendix, the Panel has reviewed a revised version of the Adaptive Management Framework (AM Framework) for the California Water Fix and Current Biological Opinions on the coordinated operations of the Central Valley and State Water Projects (BiOps), dated February 13, 2017 (ICF 2017), along with an associated e-mail from the California Department of Fish and Wildlife (CDFW 2017; Appendix 7). These documents respond to Panel comments in the draft Phase 2a Report (submitted to the Delta Science Program on January 20, 2017). The Agencies have revised the AM Framework since the Panel reviewed the November 8, 2016 version (ICF 2016) to: (1) include more information about the approach to collaborative science; (2) describe the process for research prioritization to address management relevant uncertainties; and, (3) clarify the makeup, role and responsibilities of the Interagency Implementation Coordination Group (IICG) in collaborative science, AM implementation, and decision-making. In the e-mail accompanying the revised AM Framework, the Agencies also: (1) provide five examples of "Priority Science"; (2) clarify the relationship between monitoring and real-time operation in AM; (3) describe the approach to experimentation; and, (4) discuss the need for funding.

Process for Research Prioritization

The e-mail (CDFW 2017) accompanying the revised AM Framework explains that research prioritization will take place primarily through the Collaborative Science and Adaptive Management Process (CSAMP), beginning with the Collaborative Adaptive Management Team (CAMT) and supported by topic specific technical teams. Recommendations for science priorities will typically be transmitted from the CAMT to the CSAMP Policy Group and subsequently to the Five Agencies for implementation with the support of the IICG. The AM Framework also notes that some priorities may be identified by the IICG itself. The Panel suggests that the process for research prioritization should begin with identification of specific goals and associated <u>quantitative</u> objectives that reflect desirable and reasonable outcomes for the overall WaterFix Project.

Clarification Regarding Collaborative Science: AM Framework Section 3.1

The agencies added a new section to the AM Framework on Collaborative Science (ICF 2017, Section 3.1). Overall, this section is a good addition and provides more information about how research and monitoring priorities will be established through collaboration between CSAP/CAMT, IEP and the new IICG. It highlights the need for "significant new investments" (funding) to support the necessary additional and ongoing science. However, the assurances for and sources of this additional funding still appear to be missing.

Clarified Role, Membership, and Responsibilities of the IICG (Section 5.1.1)

There is a discrepancy between the paragraph describing the IICG in the Executive Summary (ICF 2017, Executive Summary), which is identical to the previous draft, and new text describing the IICG (ICF 2017 Section 5.1.1) in the revised draft. This should be rectified.

The revised draft changes the composition of the IICG Membership. In the previous draft, "Members of the IICG would include a senior manager/scientist from each of the Five Agencies, as well as from San Luis and Delta Mendota Water Authority (SLDMWA), and the State Water Contractors (SWC)" (ICF 2016, Section 5.1.1). In the revised draft, "Members of the IICG would include representatives of DWR, Reclamation, two participating State and federal water contractors (one each representing the SWP and CVP), CDFW, USFWS, and NMFS" (ICF 2017, Section 5.1.1).

There has been a slight change in verbiage above, but the reasons are not clear. First, there will still be "representatives" from each of the Five Agencies and from the State Water Contractors, but they will not necessarily be "senior managers" or "scientists." The Panel is curious about the future role of scientists in the IICG and in AM implementation in a broader sense.

The IICG will have "representatives" from two participating State and Federal Water Contractors to represent the State Water Project (SWP) and the Central Valley Project (CVP). But it is now unclear whether it will be representatives from San Luis and Delta Mendota Water Authority (SLDMWA) and the State Water Contractors (SWC), or some other entities. Some water management organizations can have conflicts of interest with ESA implementation. Therefore, we urge the Five Agencies to think carefully about the appropriate role of state and federal water contractors in decisions regarding implementation of AM to reduce uncertainty, and ensure protection and support for recovery of listed species. A possible solution to this conflict of interest issues would be to have an independent panel of external experts familiar with both biological and water supply issues, such as the Delta Independent Science Board, serve in a reconciliation or advisory role over the IICG.

Specific responsibilities of IICG

The revised AM Framework (ICF 2017) includes two new responsibilities for the IICG: (1) "*identify priority science needs not addressed by CSAMP or IEP, and route requests for those science needs with appropriate funding to the appropriate entity with the capacity to complete them*"; and (2) "*promote and fund scientific activities/monitoring.*" The Panel appreciates the added transparency regarding the role of the IICG in the "collaborative science" endeavor and in promoting and funding scientific activities and monitoring. However, the Panel reiterates its concern about potential conflict of interest. If the funding for the AM program is coming from the state and federal water contractors, and they are part of the decision-making entity doing the routing of requests for science needs and funding to appropriate entities, then it is likely that their biases will be reflected in those aspects of AM decision making.

IICG Role in AM Implementation

A new section was added to Section 5.1 after the list of IICG responsibilities: "*The IICG will determine its own meeting schedule and administrative matters and its actions will be posted to a website or other appropriate electronic medium to ensure public access. The record would typically include a list of meeting attendees, meeting agenda, decisions and/or recommendations made, assignments to conduct additional work on a matter, audiovisual presentations or other materials distributed, and other documents relevant to the deliberations of the IICG. Members of the IICG will be able to propose adaptive management measures, for consideration by the Five Agencies, with regard to implementation of the current BiOps and CESA authorizations and those for the CWF as part of the Adaptive Management Program. This process does not apply to real time decision making within the criteria established within the existing and future ESA and CESA authorizations for the CVP and SWP.*" The new text enables some transparency in IICG activities presumably to foster public trust. It is uncertain whether the IICG governance arrangement will be acceptable to the public and stakeholders representing environmental interests. The new text clarifies that the IICG can propose AM measures for consideration by the Five Agencies and clarifies that they will not be able to influence real-time decision making.

Alterations to AM Phases

The revised AM Framework (ICF 2017) modifies the description of the "Phase 2: Assess" and "Phase 3: Integrate" phases of the Four-phase AM process.

For "Phase 2: Assess," a new paragraph ("Annual Review") has been added to Section 5.4.2.1: "*In the event that there are different hypotheses, lines of evidence or interpretations of science and/or data related to the adaptive management process, any member of CSAMP or the IICG can present their views to the LOBO biennial review or to a separate three member panel set up through the Delta Science Program. In such a case, to facilitate dispute resolution, the Five Agencies will receive the presentation prior to the panel presentation to see if further collaborative work can be undertaken or relevant information moved forward to Phase 3.*" The Panel appreciates the effort to provide a mechanism for resolving potential conflict around interpretation of scientific findings, establishment of research priorities, and other aspects of AM implementation. It is not clear whether that mechanism will be through the LOBO biennial review or through a new "three member panel set up through the Delta Science Program." Although the LOBO review is external and independent, the number of topics that the LOBO review can evaluate in its biennial meeting is limited, and this panel is not set up to be a rapid-response mechanism for science evaluation. The Panel recommends that the three-member panel become more formalized. In addition, looking ahead at developing a long-term knowledge base, the Panel recommends that science resulting from the "Phase 2: Assess" stage and other relevant stages be peer-reviewed as one way to reduce potential conflict. With regard to conservation and restoration of ESA-listed species, the Panel highlights the need to take a precautionary approach when findings remain uncertain.

The description of "Phase 3: Integrate" has changed to include an additional sentence: "*this includes different hypotheses, lines of evidence or interpretations of science and/or data put forward by any member of CSAMP or the IICG for peer review.*" The Panel appreciates the explicit recognition that findings from the "Phase 2: Assess" stage may not always be clear, and that there may be conflicting interpretations with important implications for how "Phase 3: Integrate" happens.

Priority Science

The email accompanying the AM Framework (CDFW 2017; Appendix 7) includes examples of current priorities. The Panel acknowledges that these investigations should intend to identify mechanistic/causal roles (i.e., relationships that are process-based), not simply statistical associations, and they should be framed within the context of current conceptual models. Likewise, the perspective on conceptual models should include ecosystem-level effects (e.g., changing trophic or water-quality baselines, inclusive of any mitigation effects), and not just single-species effects (e.g., entrainment mortality). Empirical or theoretical linkages to vital rates should be used to justify the research; for example, studying prey-abundance effects would be justified if prey abundance is suspected of affecting growth rate.

Clarification of Relationship between Monitoring and Real-Time Operations in AM

The e-mail (CDFW 2017; Appendix 7) responds to Panel's comments about lack of clarity regarding the relationship between monitoring and real-time operations in the AM Framework. We are assured that *"real-time actions informed by monitoring are intended to achieve key fish performance metrics, such as limiting the effect of entrainment at the facilities to avoid jeopardy. The monitoring to inform real-time operations is also used along with other monitoring and research within the system to assess the efficacy of the real-time operational criteria in meeting that objective. In the event that the real-time operational criteria are not achieving the objective or other criteria are more relevant, they may be changed through the AM process. The same applies to the monitoring methods employed to inform real-time decision making."* Ideally, any future monitoring developed for use in implementing AM should facilitate responsiveness capabilities at the shortest time frames possible or practical. The concept of "real-time" should reflect this ideal, and should not be limited to the "real-time" data types that have historically been used to modify operations (e.g., salvage or detection of migrating salmonids). The Panel appreciates CDFW's recognition that the efficacy of real-time operations will be evaluated in relation to objectives. The Panel emphasizes that quantitative and measureable objectives be developed that reflect success.

In earlier reviews, the Panel recommended a more robust commitment to "active management" involving the identification of "triggers" that would initiate change in management. The previous draft of the AM Framework sought to include triggers in Appendix 1 – Initial Objectives Derived from Current BiOps/CESA and CWF (ICF 2017, p. 51), but the Panel noted that these were really not triggers. The column header in the revised AM Framework still includes reference to "Triggers for Adaptive Management" (p. 52), but as stated in our previous review, we do not see these as triggers—they are instead management goals. Use of the term "trigger" here is confusing and we suggest removing that language since it does not describe what is in that table.

The Panel also recommends that all objectives in the AM Framework Appendix 1 (ICF 2017) include quantitative targets, so that these targets can be evaluated through monitoring as a means to describe progress. Many objectives are now quantitative so that progress can be measured, but some are still not quantitative, e.g., *"Manage the distribution and abundance of nonnative predators in the Delta and tributaries to reduce predation on listed fishes."* What is the desirable distribution and abundances of nonnative predators?

Clarification Regarding Opportunities for Experimentation

The Agencies clearly describe the steps that would need to be taken to conduct active AM in the form of operational experiments such as pulse flows. They provide an example of how the AM Framework process would be applied to the formulation of changed Shasta Reservoir temperature management as part of a process of reinitiating consultation.

Clarification Regarding Funding Assurances

With regard to the Panel's comment on the need for more information and assurances regarding the funding mechanisms for both monitoring and research to support AM, the Agencies responded that they agree that this is a priority, but do not provide any additional assurances or descriptions of the implementation process. This is a topic for future review panels to revisit, since without funding, best laid plans are moot.

Appendix 7 E-mail dated February 13, 2017 from California Department of Fish and Wildlife to the California WaterFix Aquatic Science Peer Review Panel

Memo for additional CWF materials

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Mon, Feb 13, 2017 at 5:42 PM
To: Panel Review Committee [addresses removed]

Dear Review Committee,

Please find below an explanation from CDFW regarding the two additional items I sent to you on their behalf earlier today:

Attached is the most current version of the Adaptive Management Framework (Framework) for the California Water Fix and Current Biological Opinions on the coordinated operations of the Central Valley and State Water Projects (BiOps). The Framework includes existing and future ESA and CESA authorizations and future operations with the California Water Fix. The Fishery Agencies and the Project Operators have modified the Framework since the Panel reviewed it in December to clarify the role of the Interagency Implementation Coordination Group (IICG) in the collaborative science and adaptive management implementation and decision-making. We continue to review the Panel's comments provided in the 1/20/17 Draft Phase 2a Report and work to incorporate recommendations and address concerns. As part of continued refinement of the adaptive management process we will be working to more clearly identify priority science to address management relevant uncertainties, see current examples below, and describe the process for prioritization which we expect would be primarily through the Collaborative Science and Adaptive Management Process (CSAMP), beginning with the Collaborative Adaptive Management Team (CAMT) and supported by topic specific technical teams. Recommendations for science priorities would typically be transmitted from the CAMT to the CSAMP Policy Group and subsequently to the five agencies for implementation with the support of the IICG. There may also be priorities identified by the IICG itself.

Examples of current priorities are: 1) Role of entrainment in limiting abundance of Delta Smelt, Longfin Smelt, and Winter and Spring-run Salmon: CSAMP process is evaluating this topic for Delta Smelt and Salmon; 2) Role of Fall Outflow in supporting Delta Smelt abundance and avoiding jeopardy: currently being addressed through CSAMP and associated Interagency Ecological Program (IEP) Project Work Team (PWT); 3) Role of winter and spring outflow in supporting Longfin Smelt abundance and avoiding jeopardy: IEP PWT has identified research actions and is developing a Longfin conceptual model to guide future research and analysis to inform development of a life cycle model; 4) Effectiveness of tidal habitat mitigation required by BiOps and CESA authorizations in the Delta and Suisun Bay in improving foodweb support and providing habitat for Delta Smelt, Longfin Smelt, and salmon. IEP PWT has developed conceptual model and monitoring protocols are currently being implemented; and 5) Assessment of alternative Delta migration pathways (e.g. Yolo Bypass) and the influence on juvenile survival and fitness.

We appreciate the Panel's comments regarding the need for clarity on how monitoring for real-time operations integrates with the AM Framework. The Panel has pointed out contradictions between the agencies characterization of the relationship. As the Draft Phase 2a Report points out real-time actions informed by monitoring are intended to achieve key fish performance metrics, such as limiting the effect of entrainment at the facilities to avoid jeopardy. The monitoring to inform real-time operations is also used along with other monitoring and research within the system to assess the efficacy of the real-time operational criteria in meeting that objective. In the event that the real-time operational criteria are not achieving the objective or other criteria are more relevant, they may be changed through the AM process. The same applies to the monitoring methods employed to inform real-time decision making.

Real-time operations occur within the operational criteria authorized under the endangered species authorizations and those established through the Bay-Delta Water Quality Control Plan. The ability to conduct operational experiments, such as pulse flows, would require an experimental operations plan coupled with an experimental design to test the underlying rational for conducting those operations, developed collaboratively by CSAMP with the support of the IICG. These experiments and their results, would be subject to independent review. The appropriate approvals under the existing authorizations would be required, which if outside the operational flexibility of the authorized criteria ("adaptive limits of operations"), could require re-initiation of consultation and permit amendment. Once approved the experimental operations would be implemented along with the associated science program for the length of time needed to address the scientific questions being addressed. Synthesis of the results would be conducted through a project work team assembled through the CSAMP. The synthesis would subsequently be independently reviewed. The final synthesis results would be used to inform development of an adaptive management action if appropriate to meet the objective of avoiding jeopardy and adverse modification to critical habitat. We have developed an example of how the AM Framework process would be applied to the formulation of changed Shasta Reservoir temperature management as part of the reinitiation process, see attached.

The Panel has pointed out the need for more information and assurances regarding the funding mechanisms for both monitoring and research to support adaptive management. Since the ESA and CESA authorizations for the existing operations of the SWP and CVP and those with CWF rely on an effective adaptive management program, clearly described funding needs and funding mechanisms is a priority for the Five Agencies for inclusion as part of the CWF BiOp and CESA permit.
We hope this additional information will aid the Panel in their review as part of Phase 2b. We appreciate Panels interest in assisting the agencies through their review and constructive input in developing the Adaptive Management Framework.

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