BDCP1597.

From: Danyella Herrera <dherrera@norcalwater.org>
Sent: Monday, July 28, 2014 12:11 PM
To: bdcp.comments@noaa.gov
Cc: 'Ryan Wulff - NOAA Federal'; David Guy
Subject: NSWA BDCP Comments

Please use the link below to download the BDCP comments from the North State Water Alliance.

https://www.hightail.com/download/ZUcweFllZDVxRTBLSk1UQw

Please confirm NOAA has downloaded and received the comments.

Thank you,

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NORTH STATE WATER ALLIANCE
UNIFIED FUTURE

July 28, 2014

John Laird, Secretary for Natural Resources
California Natural Resources Agency
1416 Ninth Street, Suite 1311
Sacramento, CA 95814

Re: The Bay-Delta Conservation Plan (BDCP) and its Impacts on Regional Sustainability in the North State

Dear Secretary Laird:

The North State Water Alliance (*Alliance*) provides detailed comments today on the Bay-Delta Conservation Plan (BDCP) and the related environmental documents. With its comments, the *Alliance* provides detailed supporting technical analyses.

The *Alliance* has appreciated the efforts by the Governor this year to advance a comprehensive California Water Action Plan (Action Plan). We re-affirm the commitment we made to the Governor in our February 24, 2014 statement that we share the Action Plan's overarching goal to "meet three broad objectives: more reliable water supplies, the restoration of important species and habitat, and a more resilient, sustainably managed water resources system (water supply, water quality, flood protection, and environment) that can better withstand inevitable and unforeseen pressures in the coming decades." In partnership with state and federal agencies, the *Alliance* partners are expending their energy and resources advancing local and regional water management to advance regional sustainability for the Sacramento Valley and the watersheds upstream of the Bay-Delta. The *Alliance* partners' efforts support many beneficial purposes, including cities and communities, farms, fish, birds and recreation. ***Now is the time for progress to develop the infrastructure and the regulatory and operational certainty necessary to achieve the objectives in the Action Plan.***

Today, to advance our region's sustainability, we are providing detailed technical comments expressing our concerns with the current BDCP. The operations proposed by state and federal agencies in the BDCP pose a grave threat to our ability to serve water for various north state beneficial purposes—both now and into the future. As the *Alliance* has consistently stated, California needs to improve its water supplies, not just improve sharing across regions. The *Alliance* believes that the BDCP, as currently drafted and described, does not solve the state's water supply reliability problem, does not further the co-equal goals, and has the potential to cause significant impacts to the north state. Most vividly, the BDCP appears to be designed to require additional flows into the Delta that would directly reduce available water supplies, both surface and groundwater, for the north state's economy and environment. Unfortunately, the BDCP and its environmental document do not identify or sufficiently address these impacts.

On December 3, 2013, the *Alliance* presented our paper "BDCP and the Further Need for Statewide Solutions" that articulated a practical approach to measure the BDCP against four important policy pillars: regional sustainability, no redirected impacts, water rights protections and the co-equal goals. The *Alliance* has called upon technical experts of various disciplines to advise us and support our efforts for regional sustainability. Now, to assist us in reviewing the BDCP documents, several of these experts have prepared technical reports analyzing the BDCP documents, which are technical supplements with our detailed comments available at www.northstatewater.org. Our review indicates the following:

- The modeling supporting the BDCP is flawed, outdated and relies upon unrealistic assumptions regarding operations with climate change. The BDCP technical analysis does not support project approvals and needs to be updated to ensure that the best available scientific tools are used to evaluate the BDCP's impacts.

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- Problems and uncertainties in the BDCP project elements and technical analyses concerning salmonids and pelagic fish demonstrate that the BDCP will not meet the biological needs of covered salmonid and pelagic fish species and is more likely to harm these species than contribute to their recovery.

- The BDCP lacks an adequate and reliable source of funding.

To be clear, these comments are not academic. If these issues are not adequately and clearly addressed up front in this process, then the BDCP and related state and federal processes could and will likely redirect impacts--both water supply and financial--to the north state. The BDCP's proponents have repeatedly given various assurances that this will not happen, but the draft BDCP documents leave open the possibility that the BDCP and its operations will not reflect those assurances.

The Brown Administration should not advance or tolerate actions that redirect impacts from the Bay-Delta to upstream areas and thus impede upstream efforts to maintain or promote regional water sustainability. To avoid this conflict, the *Alliance* strongly urges the Brown Administration to re-focus its efforts towards a more coordinated approach to managing the Delta as called for in the Action Plan.

The *Alliance* was formed around a common passion that the region formed by the Sacramento Valley and the adjacent Sierra Nevada and Coast Ranges is a truly unique place tied together by its water resources. On the leading edge of balancing ecological, economic and social sustainability, the region is an *exceptional* place to live, work and raise a family. The region joins together a world-renowned mosaic of natural abundance: productive farmlands and forests, wildlife refuges and managed wetlands, the State Capital, other dynamic cities and vibrant rural communities, and meandering streams, creeks, canals, and rivers that support and feed fisheries and natural habitats knitted into the landscape. The north state is home to all of this, it is an *essential* part of the state's water resources and vital to our long-term economic and environmental future.

The *Alliance* looks forward to engaging with you, the Brown Administration, the BDCP proponents, and various other parties to craft strategies that improve water sustainability statewide.

Sincerely yours,

David Guy
President
Northern California Water Association

Mike McKeever
Chief Executive Officer
Sacramento Area Council of Governments

John Woodling
Executive Director
Regional Water Authority

John Kingsbury
Executive Director
Mountain County Water Resources Association

Roger Niello
President and CEO
Sacramento Metro Chamber

cc: Federal and State Officials
NSWA Participants

North State Water Alliance (NSWA) Comments on Draft Bay Delta Conservation Plan, EIR/EIS, and Implementing Agreement July 28, 2014

These comments are submitted on behalf of the North State Water Alliance (NSWA) and the parties listed on Exhibit A attached hereto. The NSWA appreciates this opportunity to provide these comments on the proposed draft Bay Delta Conservation Plan (BDCP or Plan), draft Implementing Agreement (IA) and draft environmental impact report/environmental impact statement (DEIR/EIS). We first summarize our major concerns with these documents. We then present our detailed comments on the BDCP, IA, and DEIR/EIS. Because the BDCP states that the Plan and supporting documents are incorporated in the DEIR/EIS, our comments on the BDCP should also be considered comments on the DEIR/EIS.

I. INTRODUCTION

The NSWA is a growing coalition of cities, counties, water providers, business, agriculture, and community groups in Northern California. Our common geography and interests have brought us together to work closely on water issues. Our mission is to promote responsible statewide water solutions that protect the economy, environment and quality of life for the North State and for all Californians. The North State region spans an extraordinary mix of cities and rural communities, forests, mountains, farmlands, wildlife refuges and wetlands.

The NSWA understands and appreciates the need to find a comprehensive solution to California's water supply reliability problems, and meet the coequal goals for the Delta. The NSWA supports comprehensive statewide water solutions in California that include: (i) increased investment in regional water storage projects and infrastructure; (ii) water conservation as a way of life; (iii) an operational plan for the state's water systems to fulfill obligations to the North State; and (iv) water rights and supply assurances. With these guiding principles in mind, the NSWA has reviewed and measured the BDCP against the following policies to determine whether it will affect our ability to assure sustainable water supplies for the economy and environment within the region, both now and for the next 50 years. Most of these policies were articulated in the Sacramento San Joaquin Delta Reform Act of 2009 (Delta Reform Act), which expressly recognized the unique nature of the North State upstream of the Bay-Delta. One reflects a commitment regarding areas upstream of the Delta by spokespersons for both the federal and state governments.

- **Regional sustainability**: The state policy on regional sustainability (Wat. Code, § 85021) mandates that "each region that depends on water from the Delta watershed shall improve its regional self-reliance for water through investment in water use efficiency, water recycling, advanced water technologies, local and regional water supply projects, and improved regional coordination of local and regional water supply efforts." Water resources managers continue to implement this state policy. The BDCP, State Water Resources Control Board (SWRCB) planning, and other Delta actions should not interfere with or stifle upstream efforts to maintain or promote regional water sustainability and self-sufficiency in the North State.

- **Water rights protections:** Water supplies for all beneficial purposes in the North State depend upon the exercise of water rights and contracts. As a result, the Legislature expressly recognized that water rights and area-of-origin provisions in the North State shall not be impaired or diminished as a result of any program or project in the Bay-Delta. (Wat. Code, § 85031.) Water rights, contracts and area-of-origin priorities must be recognized and fully implemented by state and federal agencies to ensure reliable supplies for all water uses and needs in our region. These water rights also provide a solid foundation for the operation of the state and federal water projects, thus helping to advance active water management throughout California.

- **No redirected impacts**: The Governor, Secretary of Interior and policy leaders in the BDCP process have emphasized that the BDCP will not redirect any impacts to areas upstream of the Delta. In their July 25, 2012 statement, the Governor and Secretary confirmed that "State and U.S. governments will make sure implementation of BDCP will not result in adverse effects on the water rights of those in the watershed of the Delta, nor will it impose any obligations on water users upstream of the Delta to supplement flows in and through the Delta." The North State is neither a party to nor a direct beneficiary of the BDCP; thus, there must be no resultant impacts to water supplies or the economy and environment in the North State.

- **Coequal goals**: The state's co-equal goals call for "providing a more reliable water supply for California." (Wat. Code, § 85054.) This includes areas in the North State upstream of the Bay-Delta, where water supply entities will provide reliable water supplies for the region. More specifically, this includes more reliable water supplies for all beneficial uses, including cities and rural communities, farm lands and forests, refuges and managed wetlands, recreation and the meandering streams, creeks, canals, and rivers that support fisheries and aquatic habitat.

NSWA believes that the BDCP as currently drafted does not solve the water supply reliability problem, does not further the coequal goals, and has the potential to cause impacts either not identified or not sufficiently addressed in the BDCP and its DEIR/EIS.

II. SUMMARY OF COMMENTS

Our review indicates that the BDCP documents contain at least three fundamental flaws that must be addressed immediately in order to allow for adequate review of the BDCP and DEIR/EIS. These defects include flawed project operations and modeling, inadequate provisions for financing, and likely harm to Sacramento Valley salmonids, pelagic fisheries, and waterfowl.

A. The BDCP Operational and Hydrologic Modeling Is Flawed

The modeling that supports the BDCP and its effects analysis is inadequate in several ways. First, the hydrologic model is outdated and has several major flaws in its assumptions and inputs. Only days after the BDCP documentation was released, the Department of Water Resources (DWR) released its State Water Project (SWP) Draft Delivery Reliability Report 2013, which uses the most currently available and corrected hydrologic model in its analysis. The BDCP fails to use this updated model. Second, while the BDCP anticipates changes in hydrologic patterns as a result of climate change, the BDCP modeling assumes there would be *no change* to SWP and Central Valley Project (CVP) operations to respond to those changes. This assumption is simply unrealistic. It is contradicted by the recent reaction by the SWP, CVP and regulators to the recent severe drought conditions throughout California, each of whom altered SWP and CVP operations and requirements to accommodate the drought conditions. Last, the BDCP's modeling simulation of the operation of existing south Delta pumps and the proposed north Delta tunnel diversions does not match the BDCP project description. Because the operations model fails to match the described project, the BDCP overestimates Delta outflow and underestimates exports from the Delta by several hundred thousand acre-feet per year, and underestimates the related impacts on North Delta water levels and salinity. In sum, the existing BDCP technical analysis cannot support state and federal agencies' project approvals. The technical analysis needs to be updated and corrected to ensure that the best available, accurate, scientific tools are used to evaluate the BDCP's impacts.

B. The BDCP Will Result in Significant Biological Impacts With No Guaranteed Benefit to Salmonids or Delta Pelagic Fisheries

Problems and uncertainties in the BDCP's project elements and technical analyses concerning salmonids and pelagic fish demonstrate that the BDCP will not meet the biological needs of covered salmonid and pelagic fish species and is more likely to harm those species than contribute to their recovery.

C. The BDCP Lacks an Adequate and Reliable Source of Funding

Under both state and federal law, a habitat conservation plan (HCP) must ensure that there is adequate funding to implement its conservation actions. The BDCP does not meet this standard. It depends not only on funding from the current proposed bond – which is subject to amendment and general election vote, and has already been delayed four years – but also a second, as yet undefined, bond and equally vague federal funding. (BDCP, pp. 8-84 to 8-85, 8-109 to 8-110.) Moreover, the BDCP does not contain adequate assurances that the water agencies that would receive incidental take coverage are the only agencies that would be asked to contribute funding to the project. Many of the funding sources identified in the BDCP are speculative and otherwise insufficient to support the issuance of "take" permits under Section 10 of the Endangered Species Act (ESA) or the Natural Communities Conservation Planning Act (NCCPA). Indeed, DWR's representatives acknowledged complete funding might not be available and have even discussed the possibility that the BDCP might need to be scaled back in the future in the event anticipated funding is not available.

As summarized above and discussed in more detail below, the BDCP would have significant adverse effects on the North State and its environment. In addition, the information provided to date in the BDCP documents fails to demonstrate that the BDCP would comply with the preceding four policies. As a result, the NSWA cannot and does not support the proposed BDCP.

The key issues – modeling, species impacts, and finance – must be addressed and resolved prior to any party being expected to conduct a detailed review of and comment on draft documents. The BDCP proponents should correct these key deficiencies and then recirculate the BDCP and DEIR/EIS to allow for meaningful public review and participation. Without the assurance of recirculation and even with significant defects on these key issues, however, NSWA has reviewed the BDCP and DEIR/EIS and has developed comments on the BDCP to the extent feasible based on what was provided to the public.

III. COMMENTS ON THE BDCP

Developing comprehensive and detailed comments on the BDCP and the DEIR/EIS is difficult because of the significant and numerous flaws contained in the BDCP documents and analysis underlying the documents. The lack of any well-defined operating plan for the proposed North Delta intakes, errors in hydrologic modeling, modeling used for an effects analysis that violates the very rules contained in the BDCP itself, and an effects analysis based on this flawed modeling leaves the public in the position of trying to correct the significant flaws in the document in order to assess the true impacts of the project. In addition, Conservation Measures 2 through 22 are discussed only at a programmatic level. One might presume that the true purpose of the Plan is simply to build the North Delta diversions and twin tunnels (inaptly named Conservation Measure 1 (CM1)). However, if the intent of the BDCP is to satisfy the requirements of the Delta Reform Act, fulfill the co-equal goals, and fulfill DWR's public message about the Plan, the BDCP should do a better job of articulating the specifics of *all* the conservation measures in the plan – not only the single conservation measure that provides DWR's contractors with their water supply reliability. Indeed, it is entirely unclear whether the approving agencies can provide any regulatory assurances when most conservation measures are discussed only at a programmatic level.

The burden of producing a comprehensible DEIR/EIS, HCP and natural communities conservation plan (NCCP) and supporting analyses should not fall on the public. Instead, a project proponent is required to provide an adequate and comprehensible public draft documents for public comment. Once the significant flaws in the BDCP are addressed and the BDCP is recirculated for public review and comment, the public will be in a better position to understand the true impacts of the BDCP and to provide detailed comments.

A. The BDCP Fails to Satisfy Federal ESA Requirements

The BDCP fails to meet the requirements of Section 10(a)(2)(B) of the federal ESA. In order to issue an incidental take permit (ITP) under Section 10, an HCP must demonstrate that the proposed taking "will not appreciably reduce the likelihood of the survival and recovery of the species in the wild." (16 U.S.C. § 1539(a)(2)(B)(iv).) In addition, the HCP must provide assurance that there is adequate funding available to implement its terms and conditions, as well as to address any unforeseen circumstances that may arise. The BDCP does not meet these requirements. The overwhelming evidence demonstrates the BDCP will not adequately protect listed and threatened species and may, in fact, reduce the likelihood of their survival and recovery in the wild. Further, the BDCP's "assurances" that funding is and will be available for its implementation are inadequate. Despite the myriad of financial sources discussed in the BDCP, it is clear that the "adequate funding" required by the ESA and its implementing regulations has yet to be secured.

1. The Plan Fails to Protect Listed Species

Both independent and State agency experts who have reviewed the BDCP have concluded the Plan will not help, and is likely to hurt, protected fish species.

a. The Fisheries Analysis Does Not Demonstrate the BDCP Will Meet the Biological Needs of Pelagic Fish and Does Not Adequately Address Uncertainties About the Plan's Effectiveness

Robert Latour, Ph.D., has reviewed the analysis by which BDCP seeks to demonstrate that it will meet the biological needs of the covered pelagic fish species. (Ex. B. Latour, R., Ph.D., *Technical Review of the Bay-Delta Conservation Plan (BDCP) and Related Environmental Impact Review (EIR)* (July 9, 2014) (Latour Report).) As discussed in more detail in Dr. Latour's technical memorandum, which is included as Exhibit B to these comments, the BDCP's analysis does not adequately demonstrate that its conservation measures will generate sufficient benefits for those species to meet their biological needs. The BDCP therefore cannot support the approval of an HCP under the ESA or an NCCP under the NCCPA.

As Dr. Latour's technical memorandum discusses in detail, the BDCP's analysis for pelagic fish contains the following important flaws:

- <u>Uncertain effects of habitat expansion</u> – The BDCP relies primarily on a habitat suitability analysis that assumes that an increase in habitat units through geographic expansion of habitat would result in increased numbers of those species. As explained by Dr. Latour, however, there is significant uncertainty concerning habitat usage by pelagic fish in the Delta. Thus it is not possible to conclude that the habitat expansion proposed by the BDCP, in fact, will generate higher numbers of the covered fish.

- Failure to use available ecosystem models – The BDCP relies only on qualitative analysis of habitat and food webs for the habitat expansions it proposes. The well-recognized Ecopath ecosystem modeling tool, however, has been used for habitat restoration projects in other areas and could have enabled quantitative analysis of those proposed habitat expansions' effects, but the BDCP did not use that tool.

- Failure to extend qualitative models into quantitative analysis – The BDCP's analysis for pelagic fish relies on a qualitative analysis of important environmental factors for lifestages of the relevant fish species and whether the proposed Plan would benefit those lifestages. However, the BDCP does not include a quantitative analysis of these relationships or the relationships between environmental effects on different lifestages. The BDCP therefore does not demonstrate how its proposed actions would benefit a covered species as a whole. Published quantitative analyses of at least some of the key relationships are available but are not considered in the BDCP.

- Failure to account for uncertainties in analysis and results and possible negative impacts – There are a number of similar habitat restoration projects across the country that could help define the uncertainty that the BDCP may not generate its projected benefits, and the possibility that the Plan might have negative impacts on the covered species. The BDCP, however, does not rely on studies of those other projects to define the uncertainty associated with its proposals. The BDCP therefore does not consider the best available science. Moreover, while fisheries management throughout the United States now incorporates analyses of uncertainty and risk consistent with the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006 (16 U.S.C. §§ 1801-1884), the BDCP contains no such analysis. Finally, the BDCP does not adequately account for the fact that its multi-stage analyses for pelagic fish rely on many estimates that probably propagate errors and therefore generate uncertain results. Without estimates of precision for those results, it is not possible to determine how likely it is that BDCP would meet the covered species' biological needs or by how far the Plan might miss its biological objectives. The BDCP's analyses for pelagic fish, therefore, do not demonstrate that the Plan is likely to generate the benefits necessary to support the desired regulatory approvals.

- Overly Conceptual Management and Monitoring Program – The BDCP's monitoring and adaptive management program does not adequately define what information it will measure, how it will measure that information, how its program will be integrated with existing monitoring efforts or how it will determine whether progress is being made. The BDCP's monitoring and adaptive management program is at best a plan to have a plan, which is inadequate.

For these reasons and the further reasons provided in Dr. Latour's expert report, the BDCP documents do not support the approval of conservation plans under the ESA and the NCCPA.

b. The BDCP Fails to Protect Sacramento River Basin Anadromous Salmonids

The California Advisory Committee on Salmon and Steelhead (Advisory Committee), an expert advisory committee to the California Department of Fish and Wildlife (DFW), has recommended that the DFW director deny any incidental take permit under State law because the BDCP will contribute to the further decline of two fish species protected under both the state and federal endangered Species Acts: the Sacramento River Winter Run and Spring Run Chinook Salmon. Notably the Advisory Committee found, "Because Sacramento River Winter Run and Spring Run Chinook Salmon are already significantly depleted and BDCP will further reduce smolt survival, DFW cannot make a finding that the BDCP will lead to recovery of the species." (Ex. C, February 26, 2014 letter from Vivian Helliwell, Chairman, to Charlton H. Bonham.)

The Advisory Committee's findings were seconded by expert fisheries biologist Dave Vogel, whose study of the BDCP concludes that the BDCP's potential adverse impacts to anadromous salmonids could be catastrophic. (Ex. D, Vogel, D., *Comments on the Public Draft Bay-Delta Conservation Plan (BDCP) and Draft BDCP Environmental Impact Report/Environmental Impact Statement* (June 6, 2014) (Vogel Report).) Mr. Vogel's detailed review of the BDCP documents indicates that they contain a deeply flawed analysis of the potential effects and impacts of the BDCP on anadromous fisheries including, but not limited to, the following key deficiencies:

1) Oversimplification of salmonid behavior and BDCP impacts on salmonids.
2) Extensive unresolved uncertainties concerning impacts on salmonids associated with the BDCP and its various elements.
3) Conclusive statements strongly suggesting positive effects for salmonids that have no legitimate foundation.
4) Consistent pattern of overstatement of potential benefits and understatement of potential adverse impacts to salmonids.
5) Frequent erroneous or invalid assumptions in the analyses of effects on salmonids.
6) Propagation of errors in BDCP fish models resulting from faulty BDCP CalSim II water supply and water operations modeling (BDCP Model).
7) Lack of essential details on key BDCP elements (e.g., design features of the north Delta intakes, Fremont Weir fish passage, and in-Delta habitat alterations).
8) Improper reliance on "adaptive management" without describing how future problems may be resolved through such management.
9) Misuse or lack of use of the best available science.

In particular, the BDCP used a variety of models to evaluate the project's potential effects on salmon. As described in detail in Mr. Vogel's report, those models used for the BDCP were particularly constrained because of a lack of empirical data, incorrect data, and very low reliability and confidence in the models' outputs. Some of the fish models related to salmon survival and behavior are based on faulty data, which render model run outputs invalid and incapable of comparing BDCP alternatives. In many instances, inputs to the models were based on inflated and biased fish survival estimates that would not provide valid comparisons of the BDCP scenarios. Although the BDCP claims "[t]he methods used reflect the best available tools and data regarding fish abundance, movement, and behavior" (BDCP, p. 5.B-i), Mr. Vogel's report demonstrates why that assertion is not correct.

As also noted by Mr. Vogel, when the models suggested unfavorable results (i.e., adverse impacts on salmonids), they were downplayed or not used. Conversely, when the models suggested favorable results (i.e., beneficial impacts on salmonids), they were overplayed and used. Because there was so much reliance on models for the BDCP analyses and impact determinations, it is critical to understand the very serious limitations of those models. The documentation for various models describes some of the limitations, but those discussions are fragmented and buried in the voluminous appendices, and commonly not carried forward into the main body of the BDCP document.

For these reasons and the further reasons provided in the Advisory Committee's letter and Mr. Vogel's expert report, the BDCP documents do not support the approval of conservation plans under the ESA and the NCCPA. They are also insufficient for purposes of compliance with CEQA and NEPA. The information provided is not accurate, and leads to mischaracterization of impacts to the environment.

2. The BDCP Lacks an Adequate and Reliable Source of Funding

Section 10 of the ESA requires the United States Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) find that the applicant for an incidental take permit (ITP) will ensure that sufficient funding be available to implement an HCP. (*Southwest Center for Biological Diversity v. Bartel* (S.D. Cal. 2006) 457 F.Supp.2d 1070, 1105.) While there is no requirement that an applicant have cash or a fully funded trust account available to implement an HCP, an applicant must demonstrate that there is adequate funding for the HCP and that funds are not speculative or dependent on the future actions of others. Indeed, an HCP cannot be approved without identification of secured funding sources for activities contemplated by the HCP. In particular, an HCP must ensure that there is adequate funding and specify the sources of funding available to implement the HCP's steps to minimize and mitigate impacts to its covered species. (16 U.S.C. §§ 1539(a)(2)(A), (B).) Thus, an HCP must detail the funding sources that will be available to implement any proposed mitigation program.

For large-scale HCPs like the BDCP, funding issues present a real concern because of the geographic scope of the area and because the number and scope of the activities contemplated require substantial budgets. Where perpetual funding is required to implement any mitigation measures, the HCP must establish programs or mechanisms to generate those funds. Importantly, an applicant for a permit cannot rely on the speculative future actions of others to fund activities related to an HCP. (*Southwest Center for Biological Diversity v.*

Bartel (S.D. Cal. 2006) 470 F.Supp.2d 1118, 1155, citing *National Wildlife Federation v. Babbitt* (E.D. Cal. 2000) 128 F.Supp.2d 1274, 1294-1295, and *Sierra Club v. Babbitt* (S.D. Ala. 1998) 15 F.Supp. 1274, 1280-1282.)

The lack of adequate funding to ensure implementation of mitigation and other conditions of an HCP can be a fatal flaw. In fact, the lack of adequate funding and appropriate funding assurances has resulted in the invalidation of HCPs. HCPs must include a funding plan that outlines mandatory funding measures and provides for potential future adjustments to account for increased costs. (*Southwest Center for Biological Diversity v. Bartel*, *supra*, 470 F.Supp.2d at p. 1156.)

At least two HCPs in California were invalidated due to the uncertain nature of funding to support the activities contemplated in the HCP. The City of Sacramento's HCP for the Natomas area was invalidated due, in part, to inadequate funding assurances. (*National Wildlife Federation v. Babbitt*, *supra*, 128 F.Supp.2d at p. 1274.) The City of San Diego's HCP also was invalidated for lack of adequate funding. (*Southwest Center for Biological Diversity v. Bartel*, *supra*, 470 F.Supp.2d at p. 1118.) There, the City of San Diego prepared an HCP that needed funding to acquire land for a "preserve" and to administer the plan for the life of the incidental take permit. San Diego's proposed source of funding relied on future actions, consisting of future regional plans with other local jurisdictions, raising the sales tax, or issuing bonds, which would require voter approval. While San Diego promised to use its "best efforts" to implement the financing and land acquisition components of the plan, San Diego's failure to ensure funding for the plan was fatal. The federal court found that the proposed funding source was unreliable and speculative, and that the USFWS could not rationally conclude that the City would "ensure adequate funding" as contemplated by the ESA.

Like the San Diego and Natomas HCPs, the BDCP fails to demonstrate that adequate funding will be available not only to provide funding for land acquisition and administration but also to carry out the conservation measures that are the foundation of the plan. The BDCP does not fulfill even the most basic requirement that there be adequate funding available for any of the conservation measures. Even the introductory paragraphs in the Funding Chapter (Chapter 8) qualify the entire funding discussion as being based on a "programmatic level" estimation of project costs. Identification of needed funding is deferred to an Implementation Office, which will, at some unspecified future time, develop annual capital and operating budgets. (BDCP, p. 8-1.)

The BDCP also is intended to serve as an NCCP under California law. In this regard, the BDCP also fails to meet the funding mandates of the NCCPA. The NCCPA demands an Implementing Agreement detailing, among other things: (1) provisions "specifying the actions [CDFW] shall take . . . if the plan participant fails to provide adequate funding"; and (2) "mechanisms to ensure adequate funding to carry out the conservation actions identified in the plan." (Fish & G. Code, § 2820(b)(3).) The BDCP fails to comply with this mandate.

A fatal defect in BDCP Chapter 8 is the assumption that funding responsibilities can simply be deferred to some future date. (BDCP, p. 8-2.) Without an understanding of who will pay and what funding is needed, there is no way to assess whether adequate funding exists sufficient to provide any regulatory assurances to the project proponents. Indeed, the BDCP itself admits that the BDCP is not intended to establish an allocation of costs or repayment responsibilities; instead, finance plans will be developed separately by "various funding agencies" through future discussions. (BDCP, p. 8-2.)

Moreover, the BDCP attempts to impose costs of certain conservation measures on the general public when those costs should be borne by the water contractors receiving the benefit of the Plan. For example, the BDCP suggests that the contractors should be responsible for 12.6 percent of the costs of CM4. (BDCP, Table 8-41.) The rationale is that a small portion of restoration occurring under CM4 currently is required by the USFWS Biological Opinion for the Long-term Operational and Criteria Plan (OCAP BiOp). However, the BDCP fails to disclose that tidal restoration will also serve to mitigate the adverse impacts of relocating the diversion facilities to the North Delta. In fact, the benefits of tidal restoration are assumed in the modeling of project effects in key areas such as water temperature. Without CM4 (and CM5), the relocation of pumping facilities to the North Delta would increase the frequency and severity of reverse flows in the Sacramento River. Restored tidal areas allow the incoming tide to dissipate and mask the effects of the new North Delta intakes. As such, the cost of CM4 is more appropriately imposed on the contractors because CM4 mitigates the operational impacts of the North Delta intake facilities.

The BDCP relies, in part, on various federal funding sources – sources that require action by Congress to authorize the ongoing expenditure of funds or new authorizations to provide funding for certain BDCP activities. The federal Antideficiency Act (31 U.S.C.A., § 1341 et seq.) prohibits, among other things, the creation of obligations in excess of amounts already appropriated and committing the federal government to pay funds not yet appropriated. To the extent the BDCP relies on any funding sources that exceed current federal authorizations or would require the appropriation of funds, that reliance likely runs afoul of the Antideficiency Act.

In addition to the above, nearly all of the identified funding sources are too speculative to support the issuance of take permits as requested by the project proponents. These funding sources are outlined in Section 8.3 of the BDCP. Below are some examples of speculative and uncertain funding for the BDCP:

- The BDCP contemplates that CVP contractors have "committed to fund construction, operation, and construction-related mitigation costs for implementation of CM1 . . . ." (BDCP, p. 8-73.) However, according to the BDCP, the United States Bureau of Reclamation (USBR) is not a permittee and there is no commitment to wheel federal water through the new facilities – and therefore no basis for assuming federal contractors will pay for facilities that will only wheel SWP water.

- To fund CM1, the BDCP indicates that the state and federal contractors "could issue either general obligation or revenue bonds." (BDCP, p. 8-78.) However, and as recognized by the BDCP, general obligation bonds require voter approval and are therefore speculative.

- For State funding sources, the BDCP relies upon a significant contribution from a "water bond" currently scheduled for the 2014 ballot. (BDCP, p. 8-84.) BDCP attempts to analyze prior bonds, concluding that passage of the current bond is likely and others likely would be passed during the Plan's implementation period. (BDCP, p. 8-85.) Yet bond passage is not assured and any funding relied upon from yet-to-be-passed bond measures is purely speculative, as the voters could reject the bonds. Indeed, and as the BDCP recognizes, the current bond proposal already has been delayed multiple years because the economic climate was not favorable for passage. In fact, the reality is that the bond may not have been passed by the voters. Given the history of *this* bond and the speculative nature generally of voter-approved financing, it is unreasonable for the BDCP to rely on this funding source.

- The BDCP then looks to existing bond source availability in California. (BDCP, § 8.3.5.2.) While not articulated, it appears that the BDCP anticipates that it will "corner the market" in existing bond funds – using all available bond funding for the BDCP. (BDCP, pp. 8-86 to 8-91.) If this is the intent, the BDCP needs to discuss (both in the BDCP and DEIR/EIS) the other projects throughout the State that will not be able to receive funding from these bond sources. Generally, it is speculative to conclude that *all* of the remaining bond funds under the cited programs will be made available *only* to the BDCP.

- The BDCP assumes continued funding for programs and studies under the Interagency Ecological Program (IEP). (BDCP p. 8-91.) The BDCP assumes an "overlap", without any factual support, of IEP work and the BDCP. Without any substantiation, the BDCP assumes that IEP funding will account for $55 million over the permit term. (BDCP, p. 8-91.) There is, of course, no requirement or guarantee that the State Legislature will continue to fund IEP efforts and those funds can therefore not be relied upon to provide stable and secure funding over the life of the permit term.

- The BDCP assumes that nearly $2 million per year will be available from the Delta Stewardship Council (DSC) to support the Plan. DSC funding is not certain because it is subject to the State's budget process. The DSC cannot provide assurances that any funding will be available to support BDCP and certainly cannot assure $2 million per year for the life of the permit term. This funding source is speculative and uncertain.

- The BDCP assumes a roughly $2 million annual financial contribution from the Delta Bay Enhanced Enforcement Program (DBEEP) program. (BDCP, p. 8-93.) The BDCP indicates that, through the DBEEP program, DWR funds roughly $2 million annually for DFW's enforcement efforts to reduce illegal take of fish species. (BDCP,

p. 8-93.) While it is not clear from the text, this is part of the SWP budget – and will be a funding requirement imposed on the SWP contractors. The document must discuss the underlying sources of this funding to provide an appropriate assurance that the funding will be available through the permit term. As revealed in the BDCP, the current agreement for the DBEEP is only three years. This funding is not certain for the 50-year term of the permit. Moreover, this funding is directed to existing efforts; if it is redirected to the BDCP, this money will not provide a net benefit over current conditions.

- The BDCP relies on funding provided through the 2010 Fish Restoration Program Agreement. (BDCP, p. 8-94.) The document, however, recognizes that subsequent agreements would need to be executed and that funding would need to be included. (BDCP, p. 8-94.) Funding is therefore not guaranteed from this program.

- The BDCP also relies on existing state grants for *possible* funding sources. (See BDCP, pp. 8-94 to 8-99 [Wildlife Conservation Board grants for work "relevant" to the Plan; Ecosystem Restoration Program funding "applicable" to the BDCP; Environmental Enhancement Fund availability is "intermittent" and "not guaranteed"; Fisheries Restoration Grant Program has funding "uncertainties"].) While certain of these programs may provide a possible source of funds, none provides the financial certainty sufficient to issue the requested permits.

- One federal funding source relied upon by the BDCP is the Central Valley Project Improvement Act (CVPIA) Restoration Fund. (BDCP, p. 8-99.) The CVPIA Restoration Fund is necessarily connected to the CVP – and 75 percent of funds paid into the Fund are either reimbursed as a feature of the CVP or are a non-reimbursable expenditure. The BDCP describes itself as a project that is State (SWP/DWR) owned and is not part of the CVP. USBR is not a project proponent nor is it a party to the draft IA. It is therefore not appropriate to assume CVPIA funding to support DWR's project. Moreover, reliance on the continuous appropriation of these funds likely violates the Antideficiency Act.

- The BDCP also relies on speculative California Bay-Delta appropriations to fund portions of the BDCP. (BDCP, p. 8-103.) There are a host of problems associated with reliance on these funds, the foremost of which is the assumption that *any* federal appropriation of funds will be made through the expected term of the permit. Additional problems include, as recognized by the BDCP, that funding and programs at best, are "relevant" to the BDCP. Many of the funds are directed to federal agencies that are not parties to the BDCP and are not parties to the IA. There is no basis to rely on this funding for the term of the permit, and it cannot provide assurances sufficient to authorize take of listed species. Moreover, reliance on the continuous appropriation of these funds likely violates the Antideficiency Act.

- The BDCP relies on Regional Ecosystem Conservation through the NMFS. (BDCP, p. 8-108.) However, and as the BDCP expressly admits, there are no current estimates for funding that might be available to NMFS for projects in the San Francisco Bay area. (BDCP, p. 8-109.) There is no basis for relying on any funding from this source in support of the BDCP. Reliance on the continuous appropriation of these funds likely violates the Antideficiency Act.

- The BDCP's reliance on existing federal grants is speculative. (BDCP, pp. 8-110 to 8-118.) While certain grant programs might provide the BDCP with opportunities to compete for available grant funding, there is no guarantee that the BDCP will be awarded any grants under any of the programs identified in the document.

- The BDCP's reliance on possible future federal authorizations is too speculative to rely upon, as the permittees "intent to collaborate and seek federal authorizations" provides no certainty in funding. (BDCP, p. 8-109.) Reliance on the appropriation of these funds likely violates the Antideficiency Act.

The speculative nature of the funding sources identified in the BDCP is fatal to the Plan, as take authorization cannot be issued without greater certainty in funding. Not surprisingly, testimony of a DWR representative after release of the draft Plan confirmed the speculative nature of the BDCP funding. At the February 12, 2014, California Assembly Committee on Accountability and Administrative Review oversight hearing on the BDCP, DWR's representative, Laura King Moon, testified about the nature and certainty of funding to support the BDCP. She testified that in the event funding is not available, the potential regulated entities will revisit the Plan, renegotiate ESA take permit scope of coverage and possibly scale back the project. (Laura King Moon Testimony, California Assembly Committee on Accountability and Administrative Review BDCP Oversight Hearing (Feb. 12, 2014) (Moon Feb. 2014 Testimony), time stamp 00:19:00-00:19:40.) Testimony at this hearing revealed that funding is uncertain and relies upon the assumption that funding will be provided because, generally, state and federal governments have funded other significant restoration projects. (*Id.*, 00:18:23-00:18:30.)

In addition to the speculative funding sources, at least certain categories of expenses grossly underestimate the funds needed to complete the conservation measures. Land cost is one example. The BDCP makes assumptions about land acquisition that will occur over the life of the project. Inherent in these assumptions (not only in costs, but also in the implementation schedule referred to in Chapter 8 (BDCP, p. 8-5)) is that there will be continued funding available for all conservation measures through the life of the permit. However, as DWR's representative testified to the California Legislature, funding might not be available for the entire project, which will necessitate scaling back the BDCP. (Moon Feb. 2014 Testimony, 00:19:00-00:19:40.) This creates the risk that the only element of the Plan to be implemented would be the diversion and twin tunnels, with insufficient funds to implement the conservation and mitigation measures required to mitigate their impacts.

Another major flaw in this section is the cost assumption associated with land acquisition. Cost estimates are based upon California Chapter of the American Society of Farm Managers and Rural Appraisers (CSFMRA) published in 2009. Data published by CSFMRA in 2009 indicated that land values were increasing through 2009 and the trend was for further increases. The BDCP ignores this fact. Moreover, land values assume simple real estate market values for various types of cropland. This assumes a stable real estate market with normal demand and willing sellers of the property sought to be acquired. Those assumptions are unreasonable for a number of reasons. First, to the extent the BDCP creates a demand for 153,114 acres of property needed for various conservation measures and mitigation in the project area, prices will likely increase substantially. Second, and more importantly, the assumptions fail to take into account the very real likelihood that the project proponents will need to acquire the vast majority of needed property through condemnation. Once that process is initiated, prices will not be based on current use of the property – but instead on highest and best use. Thus, real property values and funding needed to purchase land are grossly underestimated.

Even after land is purchased, the BDCP is unclear about long-term funding for lands purchased for the BDCP. For example, when discussing the long-term protection of Reserve lands, BDCP provides that this protection will be accomplished "using techniques identified in CM11, *Natural Communities Enhancement and Management*, commensurate with funding limitations." (BDCP, p. 6-10.) It is unclear what type of funding limitations could exist (this could be tied to the uncertainties of funding, discussed above) and what impact the lack of adequate funding would have on the Reserve lands. The BDCP's failure to clearly articulate how financing and long-term protection will be accomplished in a way that is accessible to the public is a significant flaw in the BDCP.

The discussion of Changed Circumstances, in Chapter 6, also reveals deficiencies in funding considerations. For example, when discussing Levee Failures as a changed circumstance under the BDCP, the Plan assumes that the costs associated with the failure of a "non-BDCP" levee will fall on "the appropriate responsible entity." (BDCP, p. 6-35.) What the BDCP fails to reveal, however, is that it is DWR (or some combination of permittees) that will likely be the "appropriate responsible entity." Local levees are maintained by local reclamation districts, which themselves are comprised of local landowners who are protected by those levees. With DWR becoming a significant Delta landowner under the BDCP, DWR, as a result of its land ownership, will be responsible like any other local landowner for the operation and maintenance – even of these "non-BDCP" levees. The BDCP's obfuscation of this issue misleads the public by suggesting the costs of remediation of a non-BDCP levee will not be part of the costs of the Plan. Moreover, while the BDCP suggests that local reclamation districts will be financially responsible for reconstructing restored areas in the event of levee failure, DWR failed to analyze whether any of these local reclamation districts have the resources or financial capacity to reconstruct restoration areas. The BDCP should include such an analysis if the BDCP is going to rely on these local agencies to act as a backdrop in the event of levee failure. Otherwise the BDPC permittees cannot assure adequate funding for the Plan.

In addition, the BDCP anticipates that in the event of a levee failure, one possible corrective action would be to purchase and restore *additional lands* as a "replacement" project. Neither the BDCP nor the DEIR/EIS discusses the additional costs of purchasing replacement lands, or discusses the additional impacts of taking *more* productive agricultural land out of production in the Delta in the event restored lands are lost to a levee failure. BDCP's failure to discuss these circumstances is quite troubling, particularly when DWR has been trumpeting the very likelihood of catastrophic Delta levee failure as creating the need for the proposed alternate conveyance. If catastrophic Delta levee failure is so likely, surely DWR needs to have a financial plan in place, as a local landowner, to fund local Delta levees and prepare for the likelihood of having to replace large restoration areas.

While the ESA and NCCPA demand that adequate funding be identified and available to implement the projects outlined in an HCP and NCCP, the BDCP fails to satisfy any funding requirement. Even the BDCP's reliance on funding from federal contractors based upon the delivery of federal CVP water is flawed, as USBR will not be a permittee and is not a party to the IA. The remaining sources of funding identified in the BDCP are too speculative to support the issuance of an ITP.

3. The BDCP Improperly Relies on Actions by Parties Not Subject to Its Permits or IA

The BDCP process involves issuance of permits to specific permittees, and the permittees therefore cannot rely on any third parties (non-permittees) to undertake measures to accomplish the Plan's goals. This is true even in the context of "adaptive management." If the BDCP relies on the actions of anyone not subject to the regulatory authority of the permittees or not a signatory to the IA, a legally flawed HCP and a flawed CEQA/NEPA document result. Indeed, the obligations of overseeing implementation of the BDCP fall on the permittees, which is precisely why federal agencies require that the permittees be capable of overseeing HCP implementation and have the authority to regulate the activities covered by the permit, including implementation of all restoration and mitigation measures. Here, none of the permittees has the authority to regulate many of the activities contemplated by the various conservation measures that make up the BDCP. Any reliance on voluntary efforts by third parties, or statements in the BDCP that required elements of the plan will simply happen in the future are insufficient to demonstrate that the various activities are reasonably certain to occur. HCPs have been invalidated for this precise reason. (*National Wildlife Federation v. National Marine Fisheries Service* (D. Or. 2003) 254 F.Supp.2d 1196, 1205.)

There are no binding commitments from state and local agencies either to fund or to implement the responsibilities delegated to them by DWR. Without those binding commitments, NMFS cannot make a finding that any of those actions are "reasonably certain to occur" – a finding necessary to make a no-jeopardy determination. For example, CM1 involves the construction and operation of conveyance facilities that will divert water from the Sacramento River and convey it through tunnels to the South Delta. (BDCP, pp. 3.4-12 to 3.4-13.) It is questionable whether the massive new diversion facilities are a true "conservation" measure. It is also clear that USBR must commit to utilize those new facilities in order for CM1 to be "effective" and for it to be financially viable. (BDCP, § 3.4.1.4)

The modeling undertaken as part of the BDCP includes changes in operation of federal CVP facilities, including Shasta and Folsom reservoirs, and Jones pumping plant in the South Delta. It is quite clear that, in order for CM1 to be both financially and operationally viable, USBR must wheel CVP water through the new facilities. Moreover, the funding chapter, Chapter 8, discusses the funding contribution from CVP contractors and how other "jointly developed facilities" are to be funded by both state and federal water contractors. (BDCP, p. 8-70.) Indeed, Chapter 8 assumes federal water supplies will be moved through the new conveyance facilities – and clearly states that "[t]he financial support of the state and federal contractors is *essential in order to implement the plan*." (BDCP, p. 8-82, emphasis added.) However, USBR is not a permittee nor is it a party to the draft IA. USBR will therefore not be bound under the ESA to undertake any actions to implement CM1. The BDCP and DEIR/EIS make an unwarranted assumption in this respect. The BDCP documents' lack of clarity on the role and commitment of the federal government and federal water contractors confuses the public about the real nature of the BDCP.

Similarly, CM17, *Illegal Harvest Reduction*, anticipates funding to support more game wardens to enforce fish and game regulations in the Delta to reduce illegal harvest of species. The BDCP, however, does not appear to guarantee that DFW will implement CM17 as envisioned by the BDCP. Likewise, implementation of CM21, *Nonproject Diversions*, requires the execution of interagency agreements. (BDCP, p. 6-4.) With lack of commitments and the inability of the permittees to regulate the conduct of these third parties, it is not clear that these conservation measures will be implemented at all. Without those assurances, incidental take permits cannot issue.

4. The BDCP Fails to Adequately Define the Role of the USBR and the Relationship to the ESA Section 7 Process

The BDCP describes itself as a project proposed by the State, through DWR, to be owned and operated by the State. Reading the Plan it is easy to get the impression that the only difference between existing conditions and the operation of CM1, once constructed, is a different location for diverting SWP water. This, perhaps, is one of the most misleading aspects of the BDCP. The purported benefits of CM1 include the reduction in entrainment of fish in the South Delta that currently result from pumping operations in the South Delta, along with certain reverse flow conditions that occasionally result from South Delta pumping operations. To reduce or eliminate those conditions, USBR must move CVP water through the new North Delta facilities. That is not the only change that will result. The BDCP modeling reveals that there will be significant operational changes at upstream reservoirs, including in CVP owned and operated reservoirs. The BDCP fails to adequately discuss the nature and purpose of those changes and fails to discuss the impacts associated with those changes.

The BDCP also fails to adequately describe how the ESA Section 7 process could impact the BDCP and the water supply expectations that form the water supply side of the BDCP. For example, the BDCP fails to adequately discuss the current Coordinated Operations Agreement (COA) between the state and federal government and what changes will be necessitated by the BDCP. For example, the COA allocates responsibility for Delta outflows between those agencies and their respective projects. That responsibility will inevitably be altered by the BDCP. How those responsibilities are allocated impacts operations of upstream reservoirs and those who receive water from them, including project water service contractors, settlement contractors, wildlife refuges, and fisheries.

The BDCP limits its geographic extent and analysis of impacts to the Delta region. Its failure to reveal changes in upstream CVP and SWP operations also prevents adequate consideration of environmental impacts in the DEIR/EIS, a fatal flaw in those documents as well. Delta operations cannot be segregated from upstream operations; the two are interrelated and interdependent.

The BDCP must be revised to discuss the nature of the relationship between the BDCP and the operation of various CVP facilities, including upstream reservoirs, federal pumping facilities, to provide an understanding of likely changes needed to the COA, and to discuss how future ESA Section 7 consultations could impact the underlying assumptions in the BDCP. A thorough discussion of these issues is necessary so the public can understand how the impacts might differ between the SWP and CVP and whether there will be any certainty in the operations of the CVP.

5. The BDCP Fails to Consider Future Water Supply Demands in Northern California

Generally, there are two types of circumstances relevant to the ESA's "No Surprises" rule: unforeseen circumstances and changed circumstances. Unforeseen circumstances, also called "extraordinary circumstances," are changes over the life of an HCP that were not or could not be anticipated by the applicants, USFWS or NMFS. Changed circumstances, on the other hand, are not uncommon and can reasonably be anticipated and planned for. (50 C.F.R. § 17.32 (b)(5).)

One such changed circumstance, as it relates to the BDCP, is that some of the water supplies currently being exported by the CVP and SWP will be needed in the counties or areas wherein the water currently being exported originates. California law expressly recognizes the prior right of communities in those areas to water currently being exported, to the extent that water will be needed to adequately supply the beneficial needs of those areas. (Wat. Code, §§ 10505, 10505.5, 11460, 11463 and 11128; also *id.*, §§ 12200-12220.) The State's own demographic data predicts significant population increase in counties north of the Delta during the proposed term of the BDCP, with counties such as Sacramento, San Joaquin, Nevada, Placer, Yolo and Yuba projected to grow by 50 percent or more. (See California Department of Finance, Demographic Research Unit, Report P-1 (County): State and County Population Projections, July 1, 2010-2060, available at http://www.dof.ca.gov/research/demographic/reports/projections/P-1/.) That demand for water will increase in and north of the Delta with this population growth, and thus the likelihood that less water will be available for export uses is reasonably foreseeable. The BDCP must account for this increased demand as a changed circumstance. Increased demands in the areas of origin have either been omitted entirely or are otherwise underestimated in the BDCP modeling. The BDCP must accurately describe future demands in the area of origin and disclose the impacts under the BDCP, of less water being available for BDCP permittees/participants. This is also a deficiency in the BDCP DEIR/EIS, mischaracterizing among other things cumulative impacts and the multiple future scenarios.

B. The BDCP Fails to Comply with NCCPA Requirements

As noted, the BDCP also is intended to serve as an NCCP under California law. The primary objective of an NCCP is to "identify and provide for those measures necessary to conserve and manage natural biological diversity within the plan area while allowing compatible and appropriate economic development, growth, and other human uses." (Fish & G. Code, § 2805(h).) As an NCCP, the BDCP must provide for the protection of habitat, natural communities, and species diversity, as well as contain specific conservation measures that are based on the best available science and that meet the biological needs covered species. Like an HCP, an NCCP must also provide assurances with regard to its implementation and the sources of funding to be used to carry out proposed conservation actions. As discussed above and throughout these comments, the BDCP does not ensure protection of species diversity, is not based on the best available science, and fails to meet the funding assurance requirements of both the ESA and the NCCPA. As such, the BDCP fails to meet the most basic standards to serve as an NCCP and cannot be relied on to support the taking of covered species under the NCCPA.

C. The Assurances Sought by the BDCP Violate California's No Injury Rule and Contravene the Priority of Water Rights

The BDCP describes the "assurances" the permittees will enjoy as a result of its implementation. The BDCP explains that the assurances provide "durability and reliability" to agreements reached with various agencies as part of the Plan's implementation. (BDCP, p. 6-28.) Generally speaking, "assurances" provided to a permittee are *guarantees* of sorts that, if a permittee lives up to its end of the bargain in implementing an HCP, it will not be required to undertake any additional measures for the benefit of the species covered by the HCP.

The BDCP casts these assurances in an interesting way. The BDCP suggests that, if the terms and conditions of the BDCP are being met, the federal government,

> will not require additional conservation or mitigation measures, including land, water (including quantity and timing of delivery), money, or restrictions on the use of those resources. (BDCP, p. 6-28.)

The BDCP recognizes that these "assurances" will not and cannot apply to USBR, so it is only DWR that will receive the assurance that it will not be required to commit any additional property – including land, water, or money – for the benefit of species covered by the BDCP. However, the assurances that the BDCP seeks contravene California water law, violating the "no injury" rule and disregarding the rule of priority of water rights.

As part of the construction of CM1, DWR will need to file with the SWRCB Petitions for Change in Point of Rediversion of water under the SWP water right permits to add the North Delta intakes as an additional point of diversion for SWP water. If the USBR participates in the BDCP, the same will be true for USBR's water right permits for the CVP, as CM1 will not be feasible without including CVP water as part of the operations of CM1. In order to approve the requested changes, the SWRCB will need to find, among other things, that the requested changes "will not injure any other legal user of water." (Wat. Code, § 1701.2.)

As defined in the current draft documents and their proposed assurances for project proponents, however, the BDCP cannot meet the requirements for the SWRCB to approve the necessary Petitions for Change. Water Code section 1702 sets the key requirements for such petitions, to wit:

> Before permission to make such a change is granted the petitioner shall establish, to the satisfaction of the board, and it shall find, that the change will not operate to the injury of any legal user of the water involved.

This requirement protects not only water users who hold their own water rights, but also those receiving water under contract. (*State Water Resources Control Board Cases* (2006) 136 Cal.App.4th 674.)

There are many reasons why the BDCP, as described in the draft documents, cannot satisfy Water Code section 1702's "no injury" requirement. If DWR is correct in the BDCP that constructing CM1 relieves it of any further obligation to forego any storage or diversion of water for species covered by the Plan, then any additional water required would have to be provided by other water right holders. As species may continue to decline in the foreseeable future, granting the water-right changes necessary to implement the BDCP, with the assurances that the Plan contemplates, could injure other legal users of water and could require other water users to forego diversions for the benefit of DWR's and USBR's diversions of water to BDCP proponents. In addition, as discussed elsewhere in these comments, the CVP/SWP operations incorporated in the No Action Alternative, as well as the "proposed project" Alternative 4, would involve drawing at least one upstream reservoir (Folsom Reservoir) down to dead pool in 10 percent of years as well as depleting other upstream reservoirs (e.g., Shasta), creating conditions that would prevent other water users from obtaining supplies to which they are entitled under contract rights and water rights, which supplies are critically needed in upstream communities. These impacts represent very serious injuries.

The BDCP also would fail to meet Water Code section 1702's "no injury" requirement because of its uncertain impacts on the CVP. As discussed elsewhere in these comments, while the BDCP states that releases from Oroville Reservoir would be used to meet Delta outflow requirements associated with Alternative 4, BDCP does not even attempt to determine how those Oroville releases would affect CVP operations under the COA. In addition, while the BDCP acknowledges that USBR cannot obtain the same sort of long-term ESA coverage as DWR, the BDCP does not attempt to determine how this disparate treatment would affect CVP operations. These omissions mean that it would not be possible for the BDCP to demonstrate how CVP/SWP operations under the Plan would affect the water supplies of CVP water service contractors who are not BDCP proponents.

The proposal that senior water right holders will be required to forego water diversions to make the BDCP a success is inconsistent with California law. The SWRCB recently attempted to impose a condition on senior water rights held by the El Dorado Irrigation District (EID) and the El Dorado County Water Agency (EDCWA) that would have required EID and EDCWA to forego diversions for the benefit of junior users. EID and EDCWA challenged the SWRCB's action, arguing that the imposition of the condition (which effectively required senior water right holders EID and EDCWA to forego diversions to help meet Delta water quality standards that the CVP and SWP were responsible for meeting, while allowing junior users to continue to divert water), violated the long-standing principle of water right priorities. Both the lower and appellate courts sided with EID and EDCWA. (*El Dorado Irrigation District v. State Water Resources Control Bd.* (2006) 142 Cal.App.4th 937 (*EID v. SWRCB*).)

Importantly, the Court of Appeal held that the SWRCB's attempt to impose this condition "contravened the rule of priority, which is one of the fundamental principles of California water law." (*EID v. SWRCB, supra*, 142 Cal.App.4th at p. 943.) Indeed, the court recognized prior pronouncements of the California Supreme Court explaining that a court's first concern when addressing water right controversies is to "recognize and protect the interests of those who have prior and paramount rights to the use of waters." (*EID v. SWRCB*, citing *Meridian, Ltd. v. San Francisco* (1939) 13 Cal.2d 424, 450.) While the Court recognized that the rule of priority is "not absolute," the Court was very clear in holding that the SWRCB is obligated to protect water right priorities unless doing so would result in the unreasonable use of water, violations of the public trust doctrine, or "other important principles" of California water law. (*EID v. SWRCB* at pp. 966-967.) When these circumstances present themselves, "every effort must be made to preserve water right priorities." (*Id.* at p. 966.) Thus, any attempt, through the BDCP, to undermine water right priorities, or to attempt to require upstream senior diverters to forego diversions to meet BDCP goals and objectives, thereby allowing the continued export of water by junior appropriators, will violate long-standing principles of California water law.

The California Supreme Court reached a similar conclusion in *City of Barstow v. Mojave Water Agency* (2000) 23 Cal.4th 1224 (*Barstow*). There, the Court rejected a "physical solution" as a method of settling a water right dispute where the physical solution relied on an "equitable apportionment" and did not consider prior rights. Importantly, the *Barstow* Court noted the need to protect and recognize prior rights when it opined: "In ordering a physical solution, therefore, a court may neither change priorities among the water rights holders nor eliminate vested rights in applying the solution without first considering them in relation to the reasonable use doctrine." (*Barstow* at p. 1250.) *Barstow* and *EID v. SWRCB* make clear that any suggestion that entities not parties to the BDCP must forego diversions to make BDCP a success violates California law.

In addition to the foregoing, as discussed above, area-of-origin statutes[1] mandate that water use within the area of origin – in this case Northern California – not be reduced due to the export of water for use outside the area of origin. In fact, the water rights granted by the State for the operation of the SWP and CVP are conditioned upon compliance with area-of-origin laws. Any attempt to subvert the area-of-origin statutes, whether through a private HCP process (via regulatory assurances) or through the CEQA/NEPA process, will result in clear violations of those statutes intended to protect areas of origin, including the protection of Northern California water supplies from injury by export projects.

D. The Governance Structure Is Overly Complicated and Uncertain

The BDCP proposes a complicated governance structure that (1) may subject other water users to the Plan's requirements and risks; (2) depends on undefined participation by USBR; and (3) leaves CVP contractors other than BDCP proponents open to undefined risks. This structure is inadequate to support approval under the NCCPA and the ESA. For the BDCP to be considered for approval under the NCCPA and the ESA, these problems must be corrected and all draft BDCP documents must be recirculated for public review and comment.

BDCP Chapter 7 describes the proposed implementation structure as involving the following, among other elements:

- USBR is one of the entities that will have "ultimate responsibility for compliance with the provisions of the BDCP and the associated regulatory authorizations" (BDCP, p. 7-1);

- The BDCP sets "out the parameters within which DWR and USBR will conduct SWP and CVP operations and infrastructure development" (BDCP, p. 7-7);

- Federal agencies, presumably including USBR, would continue to "seek regulatory coverage under ESA Section 7(a)(2) for federally listed species" (BDCP, p. 7-9);

- "For Delta operations, the BDCP will provide the basis for ESA Section 7 consultation on the coordinated long-term operation of the CVP" (BDCP, p. 7-10);

[1] The area-of-origin statutes include Water Code sections 10500 et seq. and 11460 et seq.

- USBR and DWR will prepare an "Annual Delta Water Operations Plan," which will be part of "coordinated operation plans for the federal and state projects" (BDCP, pp. 7-4, 7-12);

- An Implementation Office and Program Manager would be: (1) governed by an Authorized Entity Group (AEG) that includes only representatives of USBR, DWR, and the state and federal contractors who are BDCP proponents; (2) assigned "certain responsibilities concerning the implementation of the BDCP" and would be required to be "responsive" to the AEG (BDCP, pp. 7-1 to 7-2, 7-8, 7-10 to 7-11); and

- A Stakeholder Group of approximately 38 members, only one of which would be required to represent Sacramento Valley water agencies – which would be two fewer than the number of required representatives from "conservation groups with fish and wildlife management," equal to the number of representatives from "fishing organizations" and equal to the number of representatives from "hunting organizations." (BDCP, pp. 7-19 to 7-20.)

This implementation structure is inadequate under the NCCPA, the ESA, NEPA and CEQA because it fails to clearly define how USBR – and by extension, USBR's non-BDCP CVP contractors[2] – would be affected by the decisions made within the BDCP. USBR generally operates the CVP as an integrated system. In some places, the BDCP suggests that decisions made within the BDCP primarily by the AEG – whose only water-user representatives would be BDCP proponents – would control or at least substantially affect decisions that would affect non-BDCP CVP water service contractors. For example, as noted above, the BDCP indicates that the Plan could "set parameters" for CVP operations and control USBR's ESA consultations concerning the "coordinated long-term operation of the CVP." In other places, the BDCP acknowledges the legal reality that the CVP cannot be granted the same long-term ESA coverage as the SWP can be granted under the ESA's Section 10.

It is unclear how the proposed implementation structure would reconcile these incongruities. For example, the BDCP states that USBR and DWR will prepare an "Annual Delta Water Operations Plan," which will be part of "coordinated operation plans for the federal and state projects." These "coordinated" operations would include USBR's and DWR's operation of the proposed Delta tunnels (CM1) and the "water operations aspects" of the Yolo Bypass Fisheries Enhancement measures (CM2). Nowhere, however, does the BDCP explain how these project-specific actions could be disentangled from CVP and SWP operations that serve water users who are not BDCP proponents. USBR's and DWR's water rights and contracts with non-BDCP water users do not authorize them to adversely impact those water users by complying with BDCP's terms. Moreover, nowhere does the Plan

[2] These are the many CVP contractors who are not BDCP proponents and permittees, including many of the parties submitting this comment letter.

explain how USBR will be able to make the commitments required when its operations will continue to be subject to consultation and re-consultation under ESA Section 7.

Chapter 6, Plan Implementation, describes the timeline within which the various conservation measures will occur. Recognizing that certain public funds are not guaranteed, the BDCP recognizes that "the timing of funding available from public sources for actions that conserve species in the Plan Area [], may dictate the timing of some implementation actions." (BDCP, p. 6-2.) While the BDCP argues that the timing of implementation actions will nonetheless meet the "rough proportionality" requirement, there certainly is no assurance that this will be the case. The BDCP fails for this additional reason.

Moreover, key elements of the Plan will not even be developed until many years after the Plan has taken effect. For example, the first "version" of the Annual Water Operations Plan – which will contain information essential to the public's understanding of the Plan – will not be developed for nearly a decade after the BDCP is approved. (BDCP, p. 6-23.) According to the BDCP, DWR and USBR (non-permittee and non-signatory to the IA) retain final approval authority over the Annual Water Operations Plan. (*Ibid*.). Without an appropriate operations plan proposed as part of the BDCP itself, the public is deprived of understanding the actual and potential impacts associated with CM1. Moreover, it is not clear that the federal agencies can issue take authorization for a project when no one – not even the project proponents – knows how it will be operated.

These uncertainties, and the overall vagueness of the proposed implementation structure, prevent the BDCP from being adequate to support an NCCP under the NCCPA, an HCP under the ESA and a valid EIR/EIS under NEPA and CEQA. The NCCPA requires that, for DFW to approve a NCCP, DFW must be able to find that the "plan includes the estimated . . . process by which . . . conservation measures are to be implemented . . . ." (Fish & G. Code, § 2820(a)(10).) Similarly, for NMFS and USFWS to approve an HCP, the ESA requires the applicant to submit an HCP that specifies what steps the applicant will take to minimize and mitigate the impact of all takings. (16 U.S.C. § 1539(a)(2)(A)(ii).) The BDCP cannot meet these requirements because its implementation structure, and particularly USBR's role in it, is so uncertain. These uncertainties also prevent the BDCP from supporting a sufficiently stable project description to produce a valid EIR under CEQA or a valid EIS under NEPA. (See 40 C.F.R. § 1501.2(b); *Sierra Club v. Babbitt* (E.D. Cal. 1999) 69 F.Supp.2d 1202, 1217-1218 [project description with insufficient detail does not permit sufficient public comment and violates NEPA]; *Concerned Citizens of Costa Mesa v. 32nd District Agricultural Assn.* (1986) 42 Cal.3d 929, 938 (*Concerned Citizens of Costa Mesa*).)

E. BDCP Modeling Is Inadequate Because It Is Inconsistent With American River Settlement Contracts, the Terms of Folsom Reservoir's Water Right Permits, and Practical Experience in This Drought Year

As set forth in detail in the comments of the American River Water Agencies on the BDCP and BDCP DEIR/EIS,[3] the BDCP hydrologic modeling, and therefore much of its environmental analysis, is flawed because it assumes that Folsom Reservoir could be operated in a manner that would violate several settlement contracts, as well as water right permit terms, that apply to the reservoir. Specifically, the modeling assumes that it would be legally possible for USBR to allow Folsom Reservoir to be drained below its municipal and industrial water-supply intake to its dead pool and therefore to levels that would make it impossible to satisfy the settlement contracts and water right permit terms that protect local communities'[4] water supplies from the reservoir. It also improperly assumes that USBR would not comply with the City of Sacramento's settlement contract. The modeling probably underestimates the risks to water supplies from Folsom Reservoir that would occur with the BDCP's implementation because it apparently does not account for probable adjustments to CVP operations under the COA. Finally, contrary to experience in this severely dry year, that modeling assumes that USBR, the SWRCB, and other agencies would not adjust operations to protect water supplies for municipal purposes. Because those assumptions are incorrect, the BDCP modeling, and the DEIR/EIS's environmental analysis that relies on the modeling, are not supported by substantial evidence, and any impact analyses that rely on the modeling do not comply with CEQA and NEPA.

F. The BDCP Does Not Comply With Delta Reform Act Requirements

The Delta Reform Act contains a specific mandate for the BDCP. (Wat. Code, § 85320.) Unless the BDCP meets specified criteria, the BDCP will not be eligible for state funding. (*Id.*, § 85320(b).) Among those criteria are the requirements that the BDCP include a comprehensive review and analysis of all of the following:

- A reasonable range of flow criteria, rates of diversion, and other operational criteria required to satisfy the criteria for approval of a natural community conservation plan as provided in subdivision (a) of Section 2820 of the Fish and Game Code, and other operational requirements and flows necessary for recovering the Delta ecosystem and restoring fisheries under a reasonable range of hydrologic conditions, which will identify the remaining water available for export and other beneficial uses.

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[3] Their water rights and contracts, and American River region impacts, are identified in more detail in the American River Water Users' July 2014 Comments on Bay Delta Conservation Plan and Draft EIR/EIS.

[4] This includes without limitation the following water service providers and their retail and wholesale customers: the City of Sacramento, the City of Folsom, San Juan Water District, the City of Roseville, and Placer County Water Agency.

- A reasonable range of Delta conveyance alternatives, including through-Delta, dual conveyance, and isolated conveyance alternatives and including further capacity and design options of a lined canal, an unlined canal, and pipelines.

- The potential effects of climate change, possible sea level rise up to 55 inches, and possible changes in total precipitation and runoff patterns on the conveyance alternatives and habitat restoration activities considered in the environmental impact report.

- The potential effects on migratory fish and aquatic resources.

- The potential effects on Sacramento River and San Joaquin River flood management.

- The resilience and recovery of Delta conveyance alternatives in the event of catastrophic loss caused by earthquake or flood or other natural disaster.

While the BDCP appears to remain in development, it appears clear it will not include a comprehensive review and analysis of flows necessary for recovering the Delta ecosystem, one of the co-equal goals, and restoring fisheries. While the BDCP does mention alternatives that DWR considered, the BDCP does not include a comprehensive review and analysis of those alternatives, as required by the Delta Reform Act. The BDCP also fails to include an appropriate analysis of the impacts of climate change on the system. While the BDCP recognizes that climate change will occur, it fails to discuss the likely reaction (operational and regulatory) and fails to adequately discuss and analyze the impacts of climate change on restoration activities in the Delta. Assumptions about the adaptation to climate change instead are buried within the technical model and thus not accessible or apparent to the public or decisionmakers. And while effects on migratory fish and aquatic resources are addressed, they are not addressed adequately, as demonstrated by the comments of the Delta Independent Science Review Panel in its review of the BDCP Effects Analysis. (See Delta Science Program Independent Review Panel Report, BDCP Effects Analysis Review, Phase 3 (Mar. 2014) (Delta Science Program Report), Ex. E; see also Vogel Report, Ex. D; Latour Report, Ex. B.)

G. The BDCP Fails to Account for and Describe Impacts of Integrating the BDCP Into the DSC's Delta Plan

Water Code section 85320 provides that if DFW:

> . . . approves the BDCP as a natural community conservation plan pursuant to Chapter 10 (commencing with Section 2800) of Division 3 of the Fish and Game Code and determines that the BDCP meets the requirements of this section, and the BDCP has been approved as a habitat conservation plan pursuant to the federal Endangered Species Act (16 U.S.C. Section 1531 et seq.), the council shall incorporate the BDCP into the Delta Plan.

While the BDCP recognizes it will be incorporated into the Delta Plan if it meets the standards of an NCCP, the BDCP fails to discuss the consequences of that incorporation. (BDCP, pp. 1-27 to 1-28.) Later in the document, however, there is a recognition that the BDCP may stand in the way of future projects. Indeed, the BDCP goes so far as to suggest future regulations might be prohibited if they are inconsistent with the BDCP. (See BDCP, p. 6-46 [future projects and regulations must evaluate effects on BDCP and be evaluated for consistency with the BDCP].) The BDCP suggests it will constrain future USFWS and NMFS consultations as well. (BDCP, p. 6-47.)

To the extent the BDCP will be a future measure of consistency, whether through the Delta Plan or otherwise, the BDCP and its accompanying DEIR/EIS must consider and evaluate the impacts of the BDCP on foreseeable future projects. The BDCP must, for example, analyze whether it will impact existing general plans in the Delta region, whether it will impact future transportation projects, recreational opportunities, and similar projects. Local agencies, like Sacramento County, should have a full understanding of how the BDCP might impact the County and its residents – not just through the construction of physical facilities – but also by any proscriptions on County activities that may follow as the BDCP acts as a prohibition on future activities. The omission of information explaining the consequences of incorporating the BDCP into the Delta Plan has deprived the public of information necessary to understand the project's impacts on local governments.

IV. COMMENTS ON THE IA

The draft IA does not meet the requirements of the ESA and NCCPA. As a preliminary matter, the IA is incomplete and does not provide the public with a sufficiently complete picture of the obligations and assurances that will ultimately be included in a final implementing agreement. None of the exhibits to the IA were made available with the document on the BDCP website or elsewhere, to the NSWA's knowledge.

An implementing agreement provides the permitting agencies with the requisite assurances that the project for which incidental take coverage is proposed has adequate funding, and that all appropriate mitigation and conservation measures will be implemented. The current IA fails to provide those assurances and is otherwise inappropriate.

A. Lack of Participation by USBR

As explained in more detail above in comments on the BDCP, it does not appear that USFWS, NMFS, or DFW can make all of the required findings to approve the BDCP, particularly because there are no assurances that USBR will commit to any actions or provide any funding to support the BDCP. USBR is identified as an Authorized Entity in the IA, yet the IA specifically provides that the IA establishes no obligations on behalf of USBR. Given the integral nature of USBR's participation in the BDCP, and the absolute necessity of USBR's commitment to wheel water through the proposed facilities and to provide funding for the BDCP, the IA must describe the assurances that USBR will do its part under the BDCP.

Moreover, it is unclear how the IA can provide adequate funding assurances without commitments from USBR. For example, IA Section 13.1.1 obligates the Authorized Entities, which includes USBR, to provide funding to implement the BDCP. Yet, and as explained above, the IA specifically provides that (1) the IA creates no obligations for USBR, and (2) there is no commitment of federal funds for the BDCP. Except, USBR will not be a signatory to this "contract." If there is insufficient funding because USBR fails to provide its share of implementing costs, who will cover the shortfall? See also Section 13.2, wherein the IA represents that USBR has committed substantial resources to ensure implementation of the BDCP. Without being a party to the IA, it is unclear how the IA can make this representation as to USBR.

B. Inadequate Funding Assurances

As discussed in more detail, above, Section 10 of the ESA requires the USFWS and NMFS to find that the applicant for an ITP ensure that sufficient funding will be available to implement an HCP. The NCCPA requires the same of an NCCP. Not only does the IA fail to ensure sufficient funding to implement the BDCP, it expressly recognizes the current lack of federal funding commitments and the possibility that insufficient funds will be available to implement the BDCP. Notwithstanding the recognition that there could be a significant funding shortfall, the IA provides that the Authorized Entities will not be required to provide land, water, or monetary resources beyond their existing commitments. The IA lacks any semblance of funding commitments to implement the BDCP.

Moreover, the IA's continued inclusion of USBR as an Authorized Entity in the context of commitments and assurances is improper, as USBR cannot obtain regulatory assurances under Section 10 and, according to the IA, is not committing to the implementation of the BDCP in the means required by the ESA and NCCPA.

C. Improper Restraint on USFWS and NMFS Discretion

The IA repeatedly and improperly attempts to restrain future USFWS and NMFS discretion regarding enforcement of the IA and in future review under NEPA and the ESA. While Section 14.0 purports to recognize the ongoing authority of USFWS and NMFS, other language in the IA contradicts that recognition. For example, Section 13.2 provides that, even if sufficient funds are not available to implement the BDCP, the Authorized Entities will not be required to provide additional land, water, or monetary resources to support covered species. In addition, Section 20.1.9 eviscerates any subsequent NEPA review of Covered Activities by *requiring* USFWS and NMFS to assert that the BDCP conservation measures fully address any impacts to covered species, even if the science (and monitoring) proves to the contrary. This provision is inappropriate because it constrains the NEPA responsible agencies' judgment and discretion and compels a particular finding by them, even if there is substantial evidence to the contrary. This improper restraint on agency expertise and discretion deprives other federal agencies and the public who fund those agencies of the benefit of NMFS and USFWS expertise and guarantees that NEPA review will not be fully objective or lacking in bias. The consequence of this improper restraint on wildlife agency expertise means other agencies seeking objective input will have to go to outside experts to get an objective review and recommendations.

D. Insufficient Detail Regarding Decision Tree Process

The Delta Stewardship Council's Delta Science Program Scientific Review Panel was highly critical of the Decision Tree process set forth in IA Section 10.2.1. (See Delta Science Program Report, Ex. E.) The draft IA fails to adequately address the concerns raised by the Scientific Review Panel.

E. Improper Exclusion of Compensatory Mitigation Critical Habitat

Section 20.1.6 provides that critical habitat will be excluded from the Plan area only if the BDCP adequately protects such habitat. If critical habitat is included in the plan area, then necessarily the BDCP does not adequately protect the habitat and species that depend on it. Thus, in the event critical habitat *is* included, it is inconsistent with the ESA to say no compensatory mitigation or minimization measures will be required of the permittees. Due to the vast Plan area, this provision would allow the most significant factor affecting the success of listed species – water operations and diversions – to continue to harm them, in direct conflict with the ESA.

V. COMMENTS ON THE DEIR/EIS

A. The Project Description Is Too Vague, and Subject to Too Many Uncertainties, to Permit Meaningful Environmental Review

The BDCP and DEIR/EIS project description do not provide enough information about the project or its operations to permit the public to evaluate effects on the environment. The California Supreme Court has explained that, under CEQA "[a]n accurate, stable and finite project description is the *sine qua non* of an informative and legally sufficient EIR." (*Concerned Citizens of Costa Mesa*, *supra*, 42 Cal.3d at p. 938.) This same standard applies under NEPA. (See also 40 C.F.R. § 1501.2(b); *Sierra Club v. Babbitt*, *supra*, 69 F.Supp.2d at pp. 1217-1218 [project description with insufficient detail does not permit sufficient public comment and violates NEPA].) The project description in the DEIR/EIS fails to satisfy these requirements because it, as with the BDCP itself, contains a very large number of crucial uncertainties, vague descriptions and analytical gaps.

In order for incidental take coverage to be authorized under the federal ESA, USFWS, NMFS or both must find that a HCP will: (1) "to the maximum extent practicable, minimize and mitigate" the impacts of the taking; and (2) "not appreciably reduce the likelihood of the survival and recovery of the species in the wild." (16 U.S.C. §§ 1539(a)(2)(B)(ii), (a)(2)(B)(iv).) Similarly, for DFW to approve an NCCP, the NCCPA requires, among other things, that:

- "The plan contains specific conservation measures that meet the biological needs of covered species and that are based on the best available scientific information regarding the status of the covered species and the impacts of the permitted activities on those species." (Fish & G. Code, § 2820(a)(6).)

- "The plan provides for the protection of habitat, natural communities, and species diversity on a landscape or ecosystem level through the creation and long-term management of habitat reserves or other measures that provide equivalent conservation of covered species appropriate for land, aquatic, and marine habitats within the plan area." (Fish & G. Code, § 2820(a)(3).)

- "The development of reserve systems and conservation measures in the plan area provides, as needed for the conservation of species, all of the following: …
(B) Establishing one or more reserves or other measures that provide equivalent conservation of covered species within the plan area and linkages between them and adjacent habitat areas outside of the plan area." (Fish & G. Code, § 2820(a)(4).)

- "The plan includes the estimated timeframe and process by which the reserves or other conservation measures are to be implemented, including obligations of landowners and plan signatories and consequences of the failure to acquire lands in a timely manner." (Fish & G. Code, § 2820(a)(9).)

Just as NEPA and CEQA require that the project analyzed in an environmental document be sufficiently well defined to inform the public of what is proposed and of the projected environmental effects of implementing that project, these standards for an HCP and NCCP necessarily require that conservation actions be specific and well defined.

All elements of the BDCP – even the proposed new North Delta diversion and tunnels – are presented as conservation measures that would benefit at least some of the covered species. Yet, under the BDCP's terms discussed above, essentially all of those conservation measures are subject to being "modified, replaced, or supplemented" as a result of the adaptive management process. According to the BDCP, those conservation measures could be changed by the agreement of the BDCP's proponents and the resources agencies, without further public involvement.

There is no description of how SWP and CVP facilities upstream of the Delta actually would operate with the proposed tunnels. The "high outflow" scenario not only relies on speculative water transfers, but also assumes that the CVP would accrue undefined obligations to the SWP under the COA. (BDCP, p. 3.4-19.) The studies that would drive the decision tree's results "have not yet been determined." (BDCP, p. 3.4-32.) The structure and operation of the proposed Implementation Office and related groups, councils and teams is unclear. (BDCP, Ch. 7.) Uncertainties like these fail to convey to our agencies or the public an adequate understanding of the Plan or its possible effects. The BDCP and the DEIR/EIS therefore must be revised and recirculated for public review before any decisions can be made concerning permitting and implementation of the Plan.

1. The Decision Tree That Would Govern BDCP Operations Is Undefined, Contains Insufficient Detail to Understand How Water Operations Would Occur, and Will Generate Standards That Would Be Subject to Constant Modification

As proposed in the BDCP and described in the DEIR/EIS, the decision tree concerning spring and fall Delta outflows would allow for the completion of NEPA/CEQA review and permitting of the BDCP under the ESA and the NCCPA while the levels of those outflows are determined by regulatory agencies, DWR, USBR and the BDCP-proponent CVP and SWP contractors. (DEIR/EIS, p. 3-207.) The BDCP proposes that the decision tree process will conclude by the time that the proposed tunnels would begin operating. (BDCP, p. 3.4-25 [“Once CM1 operations begin, the decision-tree process will end”]; DEIR/EIS, pp. 3-207 to 3-208.) As described in the BDCP and DEIR/EIS, however, the decision tree process and the CVP/SWP operations that would be necessary to implement the H4/high outflow alternative are so uncertain that they cannot support any analysis that sufficiently informs the public of the possible impacts of implementing the BDCP. Moreover, the BDCP and DEIR/EIS state that, even after the decision tree process’s conclusion, CVP/SWP operations would be subject to constant change under the BDCP’s adaptive management rules.

Not even the studies that would underlie the decision tree process are defined. DEIR/EIS’s Table 3.4.1-5 is titled “Key Uncertainties and Potential Research Actions Relevant to CM1.” (DEIR/EIS, p. 3.4-32.) It identifies one key uncertainty as, “Are the initial spring outflow criteria . . . necessary, in conjunction with other conservation measures in the Plan, to achieve the biological objectives for the covered fish?” As a “Proposed Research Action” to resolve this question, however, the DEIR/EIS states only the following: “[Studies necessary to evaluate this uncertainty, which is the root of the spring outflow decision tree, have not yet been determined.]” Similarly, Table 3.4.1-5 identifies the following as the “key uncertainty” concerning fall Delta outflows: “Is the USFWS Reasonable and Prudent Alternative (RPA) action for Fall X2 . . . necessary, in conjunction with other conservation measures in the Plan, to achieve the delta smelt biological objectives?” In response, Table 3.4.1-5 states only the following: “[Studies necessary to evaluate this uncertainty, which is the root of the fall outflow decision tree, have not yet been determined.]” Similarly, the DEIR/EIS indicates that not even the hypotheses that would drive the decision tree studies have been determined; it describes the decision tree’s first step as: “Clearly articulate scientific hypotheses designed to reduce uncertainty about what outflow criteria are needed . . . .” (DEIR/EIS, p. 3-207.) Accordingly, on the critical issue of what stream flows will be required for the BDCP to be permitted, the BDCP and DEIR/EIS do not even identify the studies that will be necessary for decisions to be made.

This lack of information prevents the BDCP from being adequate to support the issuance of any permits under the ESA and the NCCPA. The available information about the decision tree would not support USFWS, NMFS, and DFW making the specific determinations concerning the effect of the BDCP on the covered species under Section 10 of the ESA and Fish and Game Code section 2820 that would be required for those agencies to issue the desired permits and plans. For example, given that even the studies to support the decision tree are not defined, DFW could not determine that the outcome of the decision tree would be a "specific conservation measure that meets the biological needs of the covered species and that is based on the best available scientific information," as required by Fish and Game Code section 2820(a)(6).

Similarly, the fact that the BDCP does not even identify the studies that will be necessary to resolve the decision tree causes the DEIR/EIS to be inadequate under NEPA and CEQA. The DEIR/EIS attempts to navigate the decision tree's uncertainties by including an analysis for each of the decision tree's four possible outcomes. This expansion of the possible proposed-project scenarios only creates confusion, however, because the DEIR/EIS also says that the four decision-tree/Scenario H outflow regimes could be combined with any of the project alternatives, not just the proposed-project Alternative 4, to create a "hybrid alternative." (DEIR/EIS, p. 3-202.) The DEIR/EIS therefore presents a range of what appear to be 36 different possible action alternatives, many of which are only addressed by the draft EIR/EIS as being within "the bookends created by the entire range of alternatives addressed in the EIR/EIS." (DEIR/EIS, p. 3-202.) This application of the decision tree to expand the DEIR/EIS's scope means that the document does not clearly identify for the public the project that may actually be implemented. Moreover, as discussed in more detail below, the BDCP's and DEIR/EIS's descriptions of how the decision tree's options would be implemented are inadequate.

Finally, even if it were possible for the decision tree to support adequate environmental analysis at this point, the BDCP suggests that the decision tree's results could be substantially revised as a result of periodic review. (BDCP, pp. 3.4-354 to 3.4-355.) "Every 5 years, water facility operating criteria will be comprehensively reevaluated as part of the program-level assessment conducted by the Implementation Office, as described in Chapter 6, Section 6.3.5, *Five-Year Comprehensive Review*." (BDCP, p. 3.4-354.) While this portion of the BDCP points to Section 6.3.5 as explaining how this comprehensive review of operating criteria would occur, Section 6.3.5 contains no detail on that subject. (BDCP, p. 6-27.)

2. The BDCP's and DEIR/EIS's Description of How the Decision Tree Would Be Implemented Renders the BDCP and DEIR/EIS Inadequate

The descriptions in the BDCP and DEIR/EIS of how the CVP and the SWP would operate are deficient for both the decision tree outcome that is likely to be permitted initially and for all possible decision tree outcomes. The BDCP proposes that its proponents be issued ITPs under the ESA and the NCCPA before analysis under the decision tree is complete. The BDCP, however, acknowledges that some decision must be made at the permitting stage about what decision tree variant will be the default project to be implemented:

> This decision tree and the BDCP must account for several important and distinct timing issues. First, in the near-term at the time of permitting, the fish

> and wildlife agencies must make decisions based on the best scientific and commercial data available at that time . . . . [¶] The parties understand and appreciate these timing issues. For permitting purposes, the applicants propose a project with operational and flow criteria intended to achieve the biological goals and objectives, which, among other things, include the range of operational and flow criteria for the high-outflow and low-outflow scenarios. *It is expected that USFWS, CDFW and NMFS will issue a permit for the proposed project, which may include as permit terms and conditions the operational and flow criteria related to the high-outflow scenario in the application.* (BDCP, p. 3.4-24, emphasis added.)

The BDCP and DEIR/EIS give no reason to believe that the ESA and NCCPA permits that the project proponents are seeking in the near term would do anything other than set the H4/high outflow standards as the default permit terms for BDCP operations, subject to possible change under the decision tree. Review of the BDCP, however, confirms that the proposed project provides no meaningful information about how the H4/high outflow scenario would be implemented. The BDCP's Table 3.4.1-1 is entitled "Water Operations Flow Criteria and Relationship to Assumptions in CAL-SIM Modeling." (BDCP, p. 3.4-18.) That table describes, for the "Parameter" entitled "Spring outflow," the Delta outflow criteria that would be implemented in the H4/high outflow scenario. (BDCP, p. 3.4-19.) Table 3.4.1-1 then states the following concerning how that scenario would be implemented:

> March-May outflow targets are achieved using flow supplementation provided through an approved water transfer, by limiting CVP and SWP Delta exports to a total of 1,500 cfs, and finally, if these two water sources have been utilized, through releases from Oroville, with subsequent appropriate accounting adjustments between the SWP and the CVP.

Other than the 1,500 cfs limitation that could be imposed on CVP/SWP Delta exports, none of these key means of implementing the H4/high outflow scenario appears to be defined anywhere in the BDCP documents. Those documents do not identify the source and amounts of any transfer water that would contribute to meeting the H4/high outflow requirements. It is impossible to determine what resources could be affected by the water transfers that apparently would be necessary to implement the decision-tree variant that is the most likely to be reflected in any ESA or NCCPA permits that would be issued in the near term. Thus, the DEIR/EIS's analysis is inadequate because it does not incorporate key components of the most likely proposed project.

Similarly, the lack of any "subsequent appropriate accounting" that reflects the obligations that would apply to the CVP if SWP water from Oroville Reservoir were used as the primary supply to meeting the H4/high outflow scenario renders the DEIR/EIS's environmental analysis inadequate. The BDCP documents do not appear to make any attempt to allocate to the CVP any effects that would result from the "subsequent appropriate accounting" between the CVP and the SWP that would occur as a result of releases from Oroville to meet the H4/high outflow requirements. Nonetheless, under the existing COA the release of substantial amounts of water from the SWP's Oroville Reservoir at least could result in upstream CVP reservoirs – primarily Shasta and Folsom Reservoirs – increasing releases at later times to meet some other Delta water quality standard or other regulatory requirement. The BDCP and DEIR/EIS apparently make no attempt to define or model any such impacts on CVP reservoirs, however. The lack of any such analysis appears to surface in odd BDCP hydrologic modeling results. For example, those modeling results show end-of-September storage in Folsom Reservoir *increasing* in the H4/high outflow scenario at many exceedance levels relative to the No Action Alternative (DEIR/EIS Appendix 5A, p. 5A-C113), even though the H4/high outflow scenario would place a large new demand for spring releases on the SWP, which presumably would have to be adjusted under the COA. COA adjustment would result in some of the increased spring demand being applied to Folsom Reservoir (as well as Shasta), reducing storage in that reservoir. This is contradicted by the BDCP modeling results. The failure to incorporate any rules to reflect "subsequent appropriate accounting" under the COA for the increased release requirements that the H4/high outflow scenario would impose on the SWP's Oroville Reservoir renders the BDCP and the DEIR/EIS inadequate.

3. The BDCP and DEIR/EIS Do Not Adequately Describe How the BDCP Would Affect CVP Operations

One of the BDCP's fundamental purposes is to provide DWR and the BDCP contractors with 50 years of coverage under the ESA and the NCCPA. The BDCP proponent contractors are a subset of the entire CVP/SWP project water service contractors and also do not include the settlement contractors. The BDCP explains that the DWR and BDCP proponent contractors' further obligations for maintaining the species covered by the BDCP would be limited under the No Surprises policy and other policies. (BDCP, pp. 6-28 to 6-30, 6-45 to 6-46.) The BDCP, however, acknowledges that USBR – and, implicitly through USBR, the CVP contractors who are not BDCP proponents – cannot receive that level of regulatory certainty because USBR's operation of the CVP generally would be subject to possible consultation under ESA Section 7(a)(2). (BDCP, pp. 7-9 to 7-10.) The BDCP and DEIR/EIS are inadequate because they assume that, but do not adequately explain how actions under the BDCP could be disentangled from USBR's operation of the CVP. They also do not adequately explain the potential effects on other water users and the environment of implementing the BDCP given the proposed significant limitations on BDCP proponents' responsibilities for the relevant listed species.

The DEIR/EIS describes USBR's action as follows:

> Reclamation's action in relation to the BDCP would be to adjust CVP operations specific to the Delta to accommodate new conveyance facility operations and/or flow requirements under the BDCP, in coordination with SWP operations. (DEIR/EIS, pp. 3-1, 3-5, 3-40.)

This is not a sufficient project description. How will USBR adjust CVP operations? Affected operations are not limited to the Delta – the effects extend upstream to the

Sacramento River and its tributaries, and the Folsom and Shasta reservoir operations. None of this is addressed in the DEIR/EIS, as discussed below. Moreover, the BDCP indicates that its terms will affect USBR's ESA consultations, stating, "[f]or Delta operations, the BDCP will provide the basis for the ESA Section 7 consultation on the coordinated long-term operation of the CVP." (BDCP, p. 7-10.)

The BDCP, however, contains no CVP operations plan that could explain how CVP "operations specific to the Delta" could be segregated from other CVP operations so that each set of operations would bear only its appropriate level of responsibility for listed species during BDCP's 50-year term. USBR generally operates the CVP as a coordinated system. For many years, USBR's operation of the CVP and DWR's operation of the SWP has been the subject of ESA biological opinions covering all project operations. As discussed above in relation to the H4/high outflow alternative, the BDCP obliquely acknowledges that SWP operations under that alternative – and presumably all other alternatives – may trigger obligations under the COA under which the CVP would need to contribute resources as part of "subsequent accounting" due to the SWP's operation to contribute water from Oroville Reservoir to meet the H4 Delta-flow requirements. (BDCP, p. 3.4-19.)

The BDCP creates a significant risk to water users who are not BDCP proponents that their water uses will be affected by events that would be within what the BDCP defines as "unforeseen circumstances." (See BDCP, pp. 6-45 to 6-46.) Under the Plan, BDCP proponents presumably would be immune from most consequences of such circumstances' occurrence, but the BDCP does not explain how those assurances could affect other water users, and especially CVP contractors who are not BDCP proponents. If the BDCP had contained an operations plan demonstrating how USBR would operate in conjunction with BDCP to address the needs of those non-BDCP CVP contractors, it might have been possible for the DEIR/EIS to explain how granting BDCP proponents' desired assurances might affect those other water users. No such operations plan exists. Instead, as discussed elsewhere in these comments, and in the above-referenced comments of the American River Water Agencies, the BDCP's hydrologic modeling assumes that, in the case of climate change, USBR generally would operate upstream reservoirs so that they would go dry in 10 precent of years, which would cut off supplies to many contractors and the communities they serve.

Without a well-described operations plan for at least the CVP that explains how BDCP's terms – especially, the regulatory assurances its proponents would receive – would be integrated with CVP operations outside the scope of the Plan, the BDCP and DEIR/EIS lack evidence necessary to support the required findings under the ESA and NCCPA or under NEPA and CEQA.

4. BDCP's Conservation Strategy Is Subject to So Much Uncertainty That It Does Not Permit Adequate Environmental Review

Both the BDCP's conservation strategy as a whole and many of its individual conservation measures are subject to so much potential variation in their definitions and implementation that they give the public little idea of what the proposed project actually is –

other than the proposed 9,000 cfs diversion and tunnels. The BDCP thus fails to provide sufficient information to support approval as an HCP, NCCP or adequate environmental review under NEPA and CEQA.

The inappropriate level of uncertainty embedded in the BDCP is demonstrated most clearly by the Plan's statements that even the problem statements and biological objectives that drive how the conservation strategy is defined are subject to substantial revision. The BDCP describes a nine-step overall adaptive management process that would culminate in "Step 9: Adapt." (BDCP, pp. 3.6-13 to 3.6-19.) The BDCP describes that step as the "primary decision-making step of the adaptive management process." (BDCP, p. 3.6-21.) It further makes clear that even aspects of the conservation strategy as fundamental as biological problem statements and objectives may be changed through this process, at any time:

> The Adaptive Management Team will reexamine elements of the conservation strategy in the context of the nine-step adaptive management process and recommend revised management approaches, as appropriate. For example, this may entail revisions to problem statements, biological objectives, conceptual models, implementation actions, or monitoring actions. The Adaptive Management Team will recommend changes to conservation measures or biological objectives consistent with the sequencing of tools and resources described in Section 3.4.23, *Resources to Support Adaptive Management*, to the Authorized Entity Group and Permit Oversight Group for decision. (BDCP, p. 3.6-19.)

Just how broadly adaptive management may alter the whole conservation strategy is revealed in statements such as: "The Adaptive Management Team will periodically reexamine all elements of the conservation strategy in the context of the adaptive management process and recommend revisions, as appropriate." (BDCP, p. 3.6-21.) The BDCP contains specific terms governing the process for changing biological objectives and conservation measures. (BDCP, pp. 3.6-22 to 3.6-25.) Under those terms, biological objectives and conservation measures could be modified by a consensus of the Authorized Entity Group – i.e., representatives of BDCP's proponents – and the Permit Oversight Group – i.e., the resource agencies:

> If the Authorized Entity Group and the Permit Oversight Group agree that the proposed changes are warranted, the relevant conservation measures or biological objectives will be modified and such changes implemented as directed. (BDCP, p. 3.6-23.)

The BDCP presents certain constraints on modifications of conservation measures, but those constraints are not particularly limiting:

> Changes to a conservation measure will be limited to those actions reasonably likely to ensure that (1) the impacts (or levels of impacts) of a covered activity on covered species that were not previously considered or known are

> adequately addressed or (2) a conservation measure or suite of conservation measures that is less than effective, particularly with regard to effectiveness at advancing the biological goals and objectives, is modified, replaced, or supplemented to produce the expected biological benefit. (BDCP, p. 3.6-24.)

All elements of the BDCP – even the proposed new North Delta diversion and tunnels – are presented as conservation measures that would benefit at least some of the covered species. Yet, under the BDCP's terms discussed above, essentially all of those conservation measures are subject to being "modified, replaced, or supplemented" as a result of the adaptive management process. According to the BDCP, those conservation measures could be changed by the agreement of the BDCP's proponents and the resources agencies, without further public involvement.

These fundamental problems are not excused by the fact that the BDCP is required to incorporate adaptive management. Under the NCCPA, the BDCP may be permitted as an NCCP only if it integrates adaptive management strategies and contains an adaptive management program. (Fish & G. Code, §§ 2820(a)(2), (a)(8).) However, the NCCPA also requires:

> The plan contains *specific conservation measures that meet the biological needs of covered species* and that are based upon best available scientific information regarding the status of covered species and the impacts of permitted activities on those species. (Fish & G. Code, § 2820(a)(6), emphasis added.)

The NCCPA therefore requires that an NCCP demonstrate scientifically how it will "meet the biological needs of covered species" and include an adaptive management program that shows how the permittee will account for uncertainties and changed circumstances in implementing that plan to meet those biological needs. The Delta Reform Act confirms that this is the sort of adaptive management the BDCP must reflect. If the BDCP were permitted, the Delta Reform Act would require that DWR and DFW report to the DSC at least annually on project implementation and adaptive management. (Wat. Code, § 85320(f).) The Act defines "adaptive management" as follows:

> "Adaptive management" means a framework and flexible decisionmaking process for ongoing knowledge acquisition, monitoring, and evaluation leading to continuous improvement in management planning and *implementation of a project* to achieve *specified objectives.* (Wat. Code, § 85052, emphasis added.)

Both the NCCPA and the Delta Reform Act therefore require that an adaptive management program be based on a defined project that is demonstrated to implement specified objectives that will meet covered species' needs.

For all these reasons the objectives and terms of the BDCP's proposed adaptive management program are so uncertain that they fail to satisfy the NCCPA's and Delta Reform

Act's standards for adaptive management and do not provide sufficient information to support adequate environmental review under CEQA and NEPA. As discussed below, the high level of uncertainty in BDCP's description of specific conservation projects independently supports this conclusion. Finally, as discussed in more detail in the enclosed technical memoranda by Dave Vogel and Robert Latour, Ph.D., the problems and uncertainties in BDCP's project elements and technical analyses concerning salmonids and pelagic fish indicate that BDCP is not a plan that can be demonstrated to meet the biological needs of covered salmonid and pelagic fish species. In short, BDCP is a concept, not a plan. The fact that, to be permitted, the BDCP would need to contain an adaptive management plan does not correct its fundamental flaw that it is too uncertain for environmental review and permitting. In fact, the BDCP's adaptive management program in itself supports this conclusion.

With the entire BDCP being subject to high levels of possible change and uncertainty, with project changes apparently possible at any time, there is no project description of the proposed Plan that is sufficient under the ESA, the NCCPA, NEPA, and CEQA. Contrary to CEQA's requirement that a project description be "accurate, stable and finite" (*Concerned Citizens of Costa Mesa, supra,* 42 Cal.3d at p. 938), the BDCP is intentionally defined to be unstable and indefinite. Because this problem is embedded at the core of BDCP's conservation strategy, the BDCP and DEIR/EIS's environmental analysis cannot be adequate.

5. Specific Elements of BDCP's Conservation Strategy Are Subject to So Much Uncertainty That They Cannot Support an Adequate Project Description

The uncertainties associated with many of the BDCP's conservation measures emphasize the point that the overall project description is too amorphous to be adequate, but also themselves are sufficient reasons why the project description is inadequate.

a. Conservation Measure 2 (CM2) – Yolo Bypass Fisheries Enhancement

There are two key reasons why the DEIR/EIS's treatment of this key conservation measure, CM2, is inadequate. First, the BDCP explicitly states that this conservation measure is subject to a separate EIR/EIS that will "further refine" the measure and that is projected for completion by "year 4" of BDCP's implementation. (BDCP, p. 3.4-48; see also DEIR/EIS, p. 3-124.) The actual environmental analysis of this conservation measure therefore is effectively deferred to a later environmental document. Deferring analysis of a key element of the project is improper. (*Vineyard Area Citizens for Responsible Growth v. City of Rancho Cordova* (2007) 40 Cal.4th 412, 440-441.)

Second, CM2 includes numerous component parts, many of which would be subject to substantial development, possibly modification and even rejection during the BDCP's evolution. The DEIR/EIS states that CM2 includes "20 component projects that are to be implemented in four phases" and that, if the YBFEP [Yolo Bypass Fisheries Enhancement Plan] evaluation does not support implementation of one or more of the project components, they would not be implemented." (DEIR/EIS, pp. 3-45, 3-124.) The development of those projects will be subject to, among other things: (i) consideration of alternative actions; (ii) analyses of those projects' compatibility with the Yolo Bypass's core function as a flood control facility; and (iii) consultation with resource agencies, counties and reclamation districts, among others. (BDCP, pp. 3.4-48 to 3.4-51.) Moreover, the DEIR/EIS acknowledges that some of the components may be controversial and only proceed after another EIR/EIS. (DEIR/EIS, p. 3-124 [Category 3 actions].) Some of the component "projects" are actually only studies. (BDCP, pp. 3.4-51 to 3.4-54 [component projects 4, 5, 13]; DEIR/EIS, pp. 3-125 to 3-128.) Some of the component projects will only be implemented "if determined appropriate" or "if it is deemed necessary," presumably at some later date. (BDCP, pp. 3.4-51, 3.4-53.) Physical modifications to the Yolo Bypass to direct or restrain flow would be defined "through modeling and further concept development . . . ." (BDCP, p. 3.4-53.) The operations scenarios for modifying the Fremont Weir "are expected to be typical of, but not necessarily identical to, actual operational guidelines that will be developed in the course of subsequent project-specific design, planning, and environmental documentation." (BDCP, pp. 3.4-54 to 3.4-55.) In other words, the actual description of how that key component of the BDCP's conservation strategy would be implemented and operated is deferred for future development. These uncertainties concerning the many component parts of BDCP's CM2 prevent that measure from supporting an adequate project description and environmental review.

b. Conservation Measure 5 (CM5) – Seasonally Inundated Floodplain Restoration

Similar to the component parts of CM2, CM5 is so vaguely defined that it cannot support an adequate project description. CM5 would seek to "restore 10,000 acres of seasonally inundated floodplain along river channels throughout the Plan Area." (DEIR/EIS, p. 3-137.) However, there is no particular definition of what actions would be involved in implementing this conservation measure. Both the BDCP and the DEIR/EIS contain a list of possible actions, but preface that list by stating "[a]ctions to restore seasonally inundated floodplain habitats may include but are not limited to the following." (BDCP, p. 3.4-147; DEIR/EIS, p. 3-138.) In other words, there is no constraint on what habitats might be restored in the plan area, or where such restoration would occur. The most specific information defining this conservation measure is a "concept-level" plan that identifies four "south Delta" corridors where this conservation measure might be implemented and a list of factors that would be considered in siting and designing the restored habitat. (BDCP, p. 3.4-148.) CM5 is not defined well enough to support an adequate project description and environmental review.

c. Conservation Measure 6 (CM6) – Channel Margin Enhancement

Similar to CM5, CM6 contains significant uncertainties that prevent it from supporting an adequate project description and environmental review. The BDCP defines CM6 as involving the enhancement of 1,200 acres of habitat spread across three conservation zones without defining specific locations. (BDCP, p. 3.4-195.) Similar to CM5, CM6 contains a list of possible restoration actions, but prefaces that list by stating that actions that could be implemented would "include, but are not limited to, the following." (BDCP, p. 3.4-196.)

d. Conservation Measure 15 (CM15) – Localized Reduction of Predatory Fishes

The BDCP's problem statement for CM15 identifies several factors that it says must be considered in determining whether to implement predator reduction measures. (BDCP, p. 3.4-294.) Those factors include "[d]o biological benefits outweigh costs and social/political considerations?" (BDCP, p. 3.4-294.) The BDCP then states that, "[g]iven these uncertainties and constraints," CM15 "will initially be implemented as an experimental pilot program and a series of connected research actions." (BDCP, p. 3.4-295.) In other words, the entire conservation measure is subject to further definition that depends on studies to be completed after the BDCP is permitted. This lack of specificity regarding the project cannot support permitting under the ESA or the NCCPA or adequate environmental analysis under NEPA and CEQA.

e. Conservation Measure 16 (CM16) – Nonphysical Fish Barriers

CM16 would involve the installation of "nonphysical barriers to redirect juvenile fish away from channels and river reaches in which survival is lower than in alternate routes." (BDCP, p. 3.4-313.) The measure, however, is undefined at this time. The BDCP states:

> The Implementation Office *may* install nonphysical barriers at the sites described below . . . . The cost estimate for this conservation measure ... assumes that seven barriers would be constructed and operated during the permit term; *however, fewer than seven barriers may be constructed if they are found to be less effective biologically and more expensive per barrier than the cost estimates* . . . . [¶] The Implementation Office may consider other locations in the future, if, for example, future research demonstrates differential rates of survival in Sutter and Steamboat Sloughs or in the Yolo Bypass relative to the mainstem Sacramento River. (BDCP, p. 3.4-315, emphasis added.)

In other words, CM16 appears to be subject to complete reevaluation depending on at least the ultimate cost of the proposed barriers and relative effectiveness of barriers in different locations. This is not a stable and finite description of a project that can support permitting under the ESA and NCCPA or adequate environmental analysis under NEPA and CEQA.

f. Conclusion

With the entire BDCP being subject to high levels of possible change and uncertainty, with project changes apparently possible at any time and without full environmental review, there is no way the BDCP can satisfy CEQA's requirement that a project description be "accurate, stable and finite." (*Concerned Citizens of Costa Mesa, supra*, 42 Cal.3d at p. 938.) To satisfy CEQA and NEPA's informational requirements, both the BDCP and DEIR/EIS must be revised to provide meaningful detail about the project and an analysis of the potential impacts of each conservation measure upon which the Plan depends, supported by facts, and recirculated for public review before any decisions can be made concerning permitting and implementation of BDCP.

B. The Modeling of Bay-Delta Hydrology Is Fundamentally Flawed and Thus Fails to Comply With CEQA

It is well established that an EIR must be "prepared with a sufficient degree of analysis to provide decisionmakers with information which enables them to make a decision which intelligently takes account of environmental consequences." (CEQA Guidelines, § 15151.) As the California Supreme Court has said, an EIR must disclose to the public the "analytic route the agency travelled from evidence to action" and in doing so, the EIR "must contain facts and analysis, not just the agency's bare conclusions or opinions." (*Citizens of Goleta Valley v. Board of Supervisors*, (1990) 52 Cal.3d 553, 568.) CEQA Guidelines recognizes that the evaluation of the effects of a project "need not be exhaustive" and that the courts have "looked not for perfection but for adequacy, completeness, and a good faith effort at full disclosure." (CEQA Guidelines, § 15151.)

Two important decisions inform the way in which the courts have interpreted these standards. In *Berkeley Keep Jets Over the Bay Committee v. Board of Port Commissioners* (2001) 91 Cal.App.4th 1344 (*Berkeley Keep Jets Over the Bay*), the court considered the lead agency's use of an outdated air emissions profile. (*Id.* at pp. 1364-1365.) The state agency with relevant expertise, in that case the California Air Resources Board, commented that the Port Authority EIR's use of the outdated emissions information would "prevent a decisionmaker and the public from gaining a true understanding of one of the most important environmental consequences of increasing the number of flights." (*Id.* at pp. 1366-1367.) When reviewing the lead agency's use of the outdated emissions profile, the court found that the EIR did not meet the standard contained in Section 15151 requiring "a good faith effort at full disclosure." (*Id.* at p. 1367.)

More recently, in *Preserve Wild Santee v. City of Santee* (2012) 210 Cal.App.4th 260 (*Preserve Wild Santee*), the court considered a water supply assessment that estimated the demands of a proposed project at 881 acre-feet/year (AFY) in the context of an EIR that estimated the demands at 1,446 AFY. The court found that the EIR did not explain the discrepancy and that "such an unexplained discrepancy precludes the existence of substantial evidence to conclude sufficient water is likely to be available for the project." (*Id.* at p. 284.) Further, the court noted that where there is uncertainty of future water supplies, "the EIR must discuss possible replacement sources or alternatives to the use of the anticipated water, and of the environmental consequences of those contingencies. As the EIR in this case failed to include such a discussion in its analysis of the project's water supply impacts, it failed to meet CEQA's requirements." (*Id.* at p. 285.) Finally, in regard to the project's proposal to provide additional groundwater to maintain levels in a lake, the water supply assessment did "not account for any water demands associated with filling and recharging the lake." (*Id.* at p. 286.) In response, the court noted that "[a]n EIR may not ignore or assume a solution to the problem of supplying water to a proposed project. The EIR in this case has done exactly that by failing to analyze the impacts of obtaining potable water to fill and recharge the lake if there is insufficient groundwater for this purpose. Thus, it fails to satisfy CEQA's requirements." (*Ibid.*, internal citations omitted.)

For the reasons discussed below, the modeling used for the DEIR/EIS fails to comply with the above legal standards. As a consequence, the water supply modeling for the BDCP – which is the foundation for all of the other effects analysis – fails to satisfy CEQA and NEPA. Under these circumstances, the project proponents must: (i) fully revise the modeling used to analyze the BDCP, and (ii) recirculate the entire DEIR/EIS for public review.

1. The BDCP Used the Wrong Model Version

The most thorough technical analysis of the BDCP modeling has been performed by MBK Engineers, a recognized expert on CalSim II modeling of the operations of the CVP and the SWP. (MBK Engineers and Daniel B. Steiner, Consulting Engineer, *Review of Bay Delta Conservation Plan Modeling* (July 11, 2014), Ex. F (MBK Report).) The remainder of the comments in this section (IV.B.1) are based on the analysis and conclusions contained in the MBK Report and so constitute the opinion of an expert for purposes of CEQA.

The MBK Report found that the DEIR/EIS based its analysis on the 2010 version of CalSim II and notes that that version of CalSim II "has undergone significant revision to not only correct errors in the model, but also to reflect regulatory changes that adversely affect the accuracy and dependability of the 2010 CalSim II Model." (MBK Report, p. 3.) As described in more detail below, the errors inherent in the use of the 2010 CalSim II model mean that the BDCP modeling analysis fails to satisfy the demands of CEQA Guidelines section 15151. In that regard, the use of the 2010 CalSim II model is like the use of outdated emissions information in *Berkeley Keep Jets Over the Bay*. (91 Cal.App.4th at p. 1367.) Consequently, it is improper for the DEIR/EIS to rely on the modeling contained in that document; instead, the modeling must be redone and the DEIR/EIS revised to reflect the correct methodology and results, and recirculated for public review.

2. The Modeling Fails to Include an Operations Plan

As discussed above, CEQA requires that an EIR include a definite description of the project so that the public can understand what the lead agency is proposing. As the Court of Appeal has noted, "CEQA imposes requirements regarding (1) the time at which a project is defined and (2) the breadth of the definition. Because the EIR is intended to inform an agency's decision regarding the project, CEQA requires that an accurate, stable and finite description of the project be established early enough in the planning stages of the project to enable environmental concerns to influence the project's program and design, yet late enough to provide meaningful information for environmental assessment." (*Planning & Conservation League v. Castaic Lake Water Agency* (2009) 180 Cal.App.4th 210, 234-235, internal quotations and citations omitted.) Both for hydrologic and water quality issues, many of the operational aspects involve assumptions that are factored into the BDCP model. The model thus becomes the "project" for purposes of CEQA review. It is critical, then, that the model and its assumptions accurately and consistently reflect the proposed operation of the project. The MBK Report finds, however, that the modeling contains many flaws.

The MBK Report concludes, "[t]he BDCP Model contains erroneous assumptions, errors and outdated tools, which result in impractical or unrealistic Central Valley Project (CVP) and State Water Project (SWP) operations. The unrealistic operations, in turn, do not accurately depict the effects of the BDCP." (MBK Report, p. 1.) Also, "[i]n reviewing the BDCP Model it became apparent that coding errors and operating assumptions are inconsistent with the actual purposes of the projects, thus limiting the utility and accuracy of the [modeling] results." (*Id.* at p. 9.) The critical failings of the modeling undermine the accuracy and adequacy of the project description. Moreover, because the CalSim II modeling is the basis for all of the other effects analysis, these errors propagate throughout the entire document. As the MBK Report states, "[a]ny errors and inconsistencies identified in the underlying CalSim II model are therefore present in subsequent models and adversely affect the results of later analyses based on those subsequent models." (*Id.* at p. 10.)

3. The Modeling Fails to Accurately Describe the Project or Analyze Project Operations

After correcting for the many errors associated with the use of the 2010 CalSim II model, the MBK Report engages in an "apples to apples" comparison of the effects of the BDCP as compared to current operations of the CVP and SWP. In so doing, the MBK Report identifies a number of critical errors, which are detailed below. Each of these errors is sufficient to require that the DEIR/EIS be recirculated pursuant to CEQA.

a. The Modeling Understates Exports and Overstates Delta Outflow

The MBK Report finds that the BDCP modeling overstates Delta outflow and understates the export of water by the CVP and SWP by approximately 210,000 AFY. (MBK Report, p. 6.) The DEIR/EIS shows that there would be an increase in exports from the Delta of about 540,000 AFY, but according to MBK, when accounting for errors in the BDCP Model, the true increase would be about 750,000 AFY when the errors in the BDCP model are corrected. (*Ibid.*) In order to provide context for this error, 200,000 acre-feet is about one-fifth of the total capacity of Folsom Reservoir and about one-quarter of the total capacity of Diamond Valley Reservoir. According to the MBK Report, the reduced Delta outflow that would occur as a result of the much greater exports and that was not factored into the model DEIR/EIS "has the potential to cause greater water quality and supply impacts for in-Delta beneficial uses and additional adverse effects on species." (*Id.* at p. 7.) However, none of these effects was analyzed in the DEIR/EIS due to the errors in the CalSim II modeling.

b. The Modeling Misstates Diversions From the North Delta Diversion and the South Delta

The MBK Report also finds that the BDCP modeling does not correctly reflect the location of diversions that the CVP and SWP will make from the Delta. Specifically, the MBK Report indicates that, after the BDCP model errors are corrected, the BDCP would result in the diversion of approximately 680,000 more acre-feet at the North Delta diversion than is described in the DEIR/EIS. (MBK Report, p. 7.) Conversely, there would be approximately 460,000 AFY less water diverted at the South Delta facility than is described in the DEIR/EIS. (*Ibid.)* The project's change in the location of diversions thus has the potential to substantially change Delta hydrodynamics by significantly reducing Delta outflow. The reduction in outflow threatens significant effects to Delta water quality and aquatic biological resources in the area between the two points of diversion. Due to the errors in the BDCP modeling, though, none of these potentially significant effects has been analyzed in the DEIR/EIS.

c. The Modeling Relies on Unknown Water Sources to Balance Operations

The MBK Report focused its analysis of the BDCP on Alternative 4/H4, the High Outflow Scenario, because that is the proposed project alternative DWR is most likely to select for approval. The reason MBK decided to focus on Alternative 4/HR is that, ever since Water Right Decision 1485 in 1978, the chief way that the SWRCB as well as the NMFS, the USFWS and DFW have sought to protect aquatic species is through increasing what is known as Delta outflow, i.e., the quantity of water that leaves the Delta for San Francisco Bay and the Pacific Ocean. As a general rule, over time the regulatory agencies have demanded ever-increasing quantities of Delta outflow to protect threatened and endangered fish species. As a result, the MBK Report assumed that the alternative that would be most likely to be approved by those regulatory agencies would be the alternative with the greatest Delta outflow, which is Alternative 4/H4.

In order to provide water for increased Delta outflows and yet not deplete cold water supplies needed in the late summer and early fall, the BDCP anticipates that the needed water would be acquired through water transfers from upstream water users. (MBK Report, p. 18.) However, the MBK Report notes that this approach is "unrealistic." Specifically, the MBK Report states that, "[d]uring most of the spring, when BDCP proposes that Delta outflow be increased, agricultural water users are not irrigating. This means that there is not sufficient transfer water available to meet the increased Delta outflow requirements without releasing stored water from the reservoirs." (*Ibid.*) In other words, the BDCP calls for the acquisition of new water supplies from agriculture at times when such water is not available, or if it is available, would be inconsistent with other statements in the BDCP regarding project operation.

It is important to understand the reason that the MBK Report concluded that water would not be available from upstream water users. Those water users have contracts and/or water rights that allow them to divert water to meet their consumptive demands beginning with relatively small quantities of water in April, and then increasing quantities of water during the chief irrigation season during the summer. In this way, the use of water under these contracts tracks the demand for water for irrigated crops. However, if the goal is to provide water for fish, the timing of such demands is much earlier in the season, peaking in the March, April, or May time frame. Thus, meeting the needs of a fishery by means of transfers from agricultural contractors would require the diversion of water in quantities that far exceed the contractual quantities available during the spring outmigration. As a result, it is simply not plausible to provide water for fishery needs by transfer during the spring from agricultural contractors. This reliance on from unknown sources underscores and exemplifies the unrealistic nature of the BDCP modeling.

d. The BDCP Modeling Fails to Comply With the Coordinated Operations Agreement

The CVP and SWP coordinate their operations by means of the COA, which was initially approved by Congress almost thirty years ago. The BDCP modeling, however, assigns most of the responsibility for additional Delta outflow under the High Outflow Scenario to the SWP. This is inconsistent with the COA, which requires that if one project assumes a regulatory burden that applies to both projects, the other project will "pay-back" the first project in order to balance the various regulatory requirements.[5] In the case of the BDCP modeling, though, there is no provision to "pay-back" the SWP for shouldering the burden of increased Delta outflow. Thus, the MBK Report finds that the "BDCP Model overstates the impacts of increased Delta outflow on the SWP and understates the effects on the CVP." (MBK Report, p. 18.) In other words, the entire environmental analysis in the DEIR/EIS is flawed because it wrongly attributes certain flows from the CVP and others from the SWP. Here, the DEIR/EIS effectively overstates the effects of the BDCP on Lake Oroville and the Feather River system, while understating the effects on Shasta and Folsom Reservoirs and the Sacramento River system.

e. The Modeling of San Luis Reservoir and the Delta Cross Channel Gates Fails to Reflect Realistic Operations

Two other sets of errors in the BDCP modeling that are likely to create significant effects on the environment that were not analyzed in the DEIR/EIS occur in the modeling of San Luis Reservoir and the Delta Cross Channel Gates. The BDCP's modeling of storage at San Luis Reservoir uses an inappropriate target storage criterion that creates "problems in

[5] The COA can be found at https://archive.org/stream/agreementbetween00wash#page/n63/mode/1up.

upstream storage reservoirs and create[s] shortages for south of Delta water users that would not occur in the real world." (MBK Report, p. 17.) The MBK Report also identifies that the modeling does not account for closing the Delta Cross Channel Gates when, in a realistic operations scenario, those gates would be closed. (*Ibid*.) The CVP and SWP operate the projects in a manner that minimizes reservoir releases to the greatest extent possible, consistent with meeting the Delta outflow requirements, to preserve stored water for ultimate delivery to their respective contractors. However, the analysis in the DEIR/EIS did not reflect such project operations and so was not realistic. In this way, the BDCP modeling overestimates Delta outflow during October, which overestimates benefits of the BDCP to Delta smelt and reduces apparent effects of the BDCP to in-Delta diverters. Neither of these effects is analyzed in the DEIR/EIS.

4. The Modeling Fails to Accurately Depict Climate Change

The DEIR/EIS states that modeling of water quality and hydrologic impacts accounted for future changes in hydrology due to effects of climate change. However, the modeling does not reasonably represent future conditions with climate change because it failed to consider whether the CVP and/or SWP would seek to adapt their operations to respond to the challenges of climate change. As identified in the MBK Report, the CVP, SWP, and SWRCB already are implementing various adaptations to their operations to deal with the current and previous droughts. (MBK Report, p. 12.) All of these adaptations, which include updating flood control releases to reflect a changing climate, mandatory conservation, and modifying water allocation rules, reasonably can be expected to be continued in response to climate change. Each of these adaptations has a significant effect on the outcome of the model results. The failure to include consideration of these adaptations in the BDCP modeling undermines the validity of the results and the DEIR/EIS impact determinations on which they are based.

a. Modeling of Inflow to Millerton Is Incorrect

The DEIR/EIS attempted to analyze the effects of climate change at Millerton Lake (Friant Reservoir). However, that analysis did not adjust inflow into Millerton Lake to reflect the effects of climate change (decreased inflows). By overestimating inflows into Millerton, the modeling started a cascading series of errors that affected the output as it reflected the depiction of the entire CVP: overestimating flood control releases at Millerton and flows at the Mendota Pool, deliveries to the San Joaquin River Exchange Contractors of San Joaquin River water rather than water from the Sacramento Valley, underestimation of exports from the Delta and/or overestimates of Delta outflow. The MBK Report notes: "[t]his is a situation where one seemingly minor error cascades through the entire system . . . . In other words, all model results reported in the BDCP and associated Draft EIR/S contain this error, with the only exception of the Existing Biological Conditions baselines numbers 1 and 2 (EBC1 and EBC2), which are evaluated in the BDCP." (MBK Report, p. 11.)

Given these circumstances, both the decisions in *Berkeley Keep Jets Over the Bay* and *Preserve Wild Santee* indicate that the DEIR/EIS's analysis of climate change fails to satisfy

CEQA. The error in modeling will "prevent a decisionmaker and the public from gaining a true understanding of one of the most important environmental consequences" of the BDCP and so is comparable to the use of the outdated emissions data in *Berkeley Keep Jets Over the Bay*. (91 Cal.App.4th at pp. 1366-1367.) Moreover, the discrepancy between the estimates of Millerton inflow contained in the DEIR/EIS and the MBK Report is precisely the same type of discrepancy that the *Preserve Wild Santee* court found to preclude there being substantial evidence to support that EIR's conclusions. (*Preserve Wild Santee*, *supra*, 210 Cal.App.4th at p. 284.)

b. Modeling Fails to Account for Reasonable Existing and Future Climate Change Adaptations

The MBK Report did not attempt to evaluate whether the assumptions used in the BDCP modeling for climate change effects were accurate; instead, the MBK Report takes those assumptions as a given and then attempts to see whether those assumptions were properly modeled in evaluating the potential effects of the BDCP on the environment. The MBK Report concludes that the BDCP modeling is simply not realistic:

> [w]ith the predicted changes in precipitation and temperature implemented in the BDCP modeling, there is simply not enough water available to meet all regulatory objectives and water user demands. Yet the BDCP modeling continues its normal routine and thus fails to meet its objectives. In this aspect, the BDCP modeling simply does not simulate reality. (MBK Report, p. 12.)

The MBK Report notes that the experience of California during the current drought undermines the BDCP modeling simplistic assumption of "business as usual." The MBK Report states: "[t]he likelihood of an appropriate operational response to climate change is seen in the many modifications to CVP and SWP operations made during the past few months to respond to the current drought and supports the likelihood of future adaptations." (MBK Report, p. 12.) And, the "BDCP's simplistic approach of assuming a linear operation of the CVP and SWP produces results that are not useful for dealing with the complex problem of climate change because it does not reflect the way in which the CVP and SWP would actually operate whether or not the BDCP is implemented." (*Id.* at p. 13.) Ultimately, the MBK Report concludes: "the future condition [with climate change] will not be as depicted in the BDCP Model." (*Ibid.*)

As noted above, CEQA does not require perfection, but it does require that an EIR be adequate, complete and reflect "a good faith effort at full disclosure." By failing even to consider whether the CVP and/or SWP would seek to adapt their operations to respond to the challenges of climate change, the document is neither adequate nor complete and certainly does not reflect a good-faith effort at disclosure. (See *Preserve Wild Santee, supra*, 210 Cal.App.4th at p. 286 [lead agency may not ignore a problem or a potential solution].)

5. Conclusion

In each of these ways, the BDCP modeling fails to meet one of the essential standards for an EIR: to "demonstrate to an apprehensive citizenry that the agency has, in fact, analyzed and considered the ecological implications of its action." (CEQA Guidelines, § 15003(d).) Moreover, individually and collectively, these errors in the BDCP modeling fail to meet the standards established in *Berkeley Keep Jets Over the Bay* and *Preserve Wild Santee*. Specifically, the misstatements regarding the quantities of exports and Delta outflow, the allocation of BDCP diversions between the North Delta Diversion and the South Delta, the need for additional water to meet the outflow requirements of the High Outflow Scenario, the failure to consider the effects of the COA on the allocation of water between the CVP and the SWP, and the failure to realistically operate San Luis Reservoir and the Delta Cross Channel Gates all would "prevent a decisionmaker and the public from gaining a true understanding of one of the most important environmental consequences" of the BDCP and therefore fail to satisfy CEQA's standards. (*Berkeley Keep Jets Over the Bay*, *supra*, 91 Cal.App.4th at p. 1367.) Further, the discrepancies in the quantities of exports and the location of those exports represent substantial changes in the nature of the effects analyzed in the DEIR/EIS; those changes – by themselves – require that it be recirculated. (CEQA Guidelines, § 15088.5(a)(2) [substantial increase in the severity of an impact requires recirculation].)

Specifically, the BDCP modeling overestimates Delta outflow by 210,000 AFY, thereby understating a host of potentially significant environmental impacts (e.g., the effects of salinity intrusion on water quality as well as habitat for fish, etc.). The modeling also underestimates the quantity of water that would be diverted at the North Delta diversion by about a half million AFY, and so assumes that there will be far more fresh water in the Delta than would, in fact, be the case. Overestimating the fresh water of the Delta is likely to have significant impacts on a number of fish species, including listed salmonids and Delta smelt. Last, but certainly not least, the DEIR/EIS's failure to discuss the sources and availability of the additional water needed to satisfy the Delta outflow objectives for the High Outflow Scenario is not consistent with the standard contained in *Preserve Wild Santee*, which requires that the DEIR/EIS discuss the potential alternative sources for such water and states that an "EIR may not ignore or assume a solution to the problem of supplying water to a proposed project." (*Preserve Wild Santee*, *supra*, 210 Cal.App.4th at pp. 285-286.) Given the magnitude of these errors, and the substantial evidence of new and more severe significant impacts contained in the MBK Report, DWR must revise the DEIR/EIS and recirculate it for public review.

C. The DEIR/EIS Fails to Adequately Analyze BDCP Impacts to Sacramento River Basin Anadromous Salmonids or Pelagic Fish

The DEIR/EIS states that it incorporates the BDCP by reference. (DEIR/EIS, p. 1-2, fn. 3.) The problems with the BDCP's fisheries analysis therefore are problems with the DEIR/EIS. As discussed elsewhere in these comments and his enclosed report, Robert Latour, Ph.D., has reviewed the BDCP's analysis of pelagic fish issues and determined that the analysis is not supported by the best available science in many ways. Several of those deficiencies cause that analysis to be insufficient to support the DEIR/EIS as well. In particular:

- There is significant uncertainty in the analyses on which the BDCP relies to project increased pelagic fish populations, and the Plan does not adequately address that uncertainty;

- The BDCP does not use readily available quantitative ecosystem models like Ecopath to assess the proposed project's effects and instead relies on qualitative analyses of key ecosystem relationships; and

- The BDCP does not adequately account for potential errors at each stage of its multi-stage analyses.

These problems cause there to be a lack of substantial evidence to support the DEIR/EIS's pelagic-fish analysis.

Moreover, as detailed in the report and analysis prepared by expert fisheries biologist Dave Vogel (Ex. D), the BDCP's potential adverse impacts to anadromous salmonids could be catastrophic. In addition, Mr. Vogel's detailed review of the BDCP documents indicates that they contain a deeply flawed analysis of the potential effects and impacts of the BDCP on anadromous fisheries.

In particular, the BDCP used a variety of models to evaluate the Plan's potential effects on salmon. As described in detail in Mr. Vogel's report, those models used for the BDCP were particularly constrained because of a lack of empirical data, incorrect data, and very low reliability and confidence in the models' outputs, which render model run outputs invalid and incapable of comparing BDCP alternatives. In many instances, inputs to the models were based on inflated and biased fish survival estimates that would not provide valid comparisons of the BDCP scenarios. The BDCP and DEIR/EIS also did not use the best available data.

As also noted by Mr. Vogel, when the models suggested unfavorable results (i.e., adverse impacts on salmonids), they were downplayed or not used. Conversely, when the models suggested favorable results (i.e., beneficial impacts on salmonids), they were overplayed and used. Because there was so much reliance on models for the BDCP analyses and impact determinations, it is critical to understand the very serious limitations of those models. The documentation for various models describes some of the limitations, but those discussions are fragmented and buried in the voluminous appendices, and commonly not carried forward into the main body of the BDCP document. Nor are the limitations clearly disclosed in the DEIR/EIS.

Problems with the models themselves, the DEIR/EIS's failure to plainly disclose the limitations in the models, and the selective use of data and results favorable to the BDCP, deprived the public of meaningful information necessary to informed decisionmaking and cast serious doubt on the integrity and validity of the DEIR/EIS's determinations as to the BDCP's impacts on anadromous fish.

These fundamental analysis errors identified by Dr. Latour and Mr. Vogel must be corrected before the DEIR/EIRS can be used to accurately characterize the BDCP's effects on anadromous salmonids or pelagic fish.

D. The DEIR/EIS Fails to Adequately Analyze BDCP Impacts on Sacramento Valley Waterfowl and the Pacific Flyway

Many avian species use the Sacramento Valley's irrigated croplands as winter and breeding habitat. These croplands, especially small grains, provide crucial habitat in the Pacific Flyway, especially in areas such as the Central Valley where only a fraction of historic wetlands remain. The habitat values created by these croplands are described in detail in the Central Valley Joint Venture 2006 Implementation Plan (www.centralvalleyjointventure.org/science). As mentioned above, the BDCP and DEIR/EIS do not adequately analyze the impact on the Sacramento Valley's water supplies, including the potential reduction in the diversions of water that support avian habitat values on both irrigated cropland and natural wetlands. This includes both direct diversions of water to support these values, as well as tailwater from other agricultural uses and managed wetlands. Mark Petrie with Ducks Unlimited describes these impacts in detail in his comments for the November 14, 2012 SWRCB workshop on the Bay-Delta Plan (http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/docs/comments111312/mark_petrie.pdf). These Sacramento Valley impacts are described in more detail in comments on the DEIR/EIS by Ducks Unlimited, which are incorporated here by reference.

E. The DEIR/EIS Fails to Adequately Analyze BDCP Impacts on Sacramento Valley Groundwater Supplies

The DEIR/EIS discusses the potential for the BDCP to result in "minor decreases in water supply availability to CVP water users in the Sacramento Valley . . . ." (See *Analysis of Groundwater Conditions in Areas that Use SWP/CVP Water Supplies*, DEIR/EIS, p. 7-32, lines 30-40.) The estimated decrease in supply is 50,000 AFY. The section concludes, "[a] 2% increase in groundwater use in the Sacramento Valley to make up for any shortfalls in surface water supply is not anticipated to substantially impact the groundwater resources as long as the additional pumping is not concentrated in a particular area of the valley." This claim requires additional analysis. Who exactly are the Sacramento Valley CVP contractors that are being referenced? What is their distribution through the valley? What is the respective decrease in surface water for each? Overall the analysis of these impacts appears to focus on San Joaquin and Tulare Lake basins as well as on agricultural users, as opposed to municipal users.

The DEIR/EIS indicates the BDCP will have a negative impact on certain unidentified groundwater supplies. In considering the 2 percent proposal one must assume that the increase is not applied uniformly over the entire Sacramento Valley. No information is provided as to where additional pumping will take place, whether it will it interfere with existing conjunctive use programs, or whether it will exacerbate existing groundwater overdraft or cause groundwater overdraft in locations where that condition does not presently exist. As described in the American River Water Agencies' BDCP comment letter, municipal areas such as the Sacramento region – which is projected to be deprived of a huge component of its water supply due to the drawdown of Folsom Reservoir to dead pool 10 percent of the time[6] – will be required to find alternative water supplies, one of which is groundwater. This additional groundwater pumping would necessarily be geographically focused, as is municipal population. The impacts of such pumping are ignored in the BDCP and BDCP DEIR/EIS.

Furthermore, the DEIR/EIS states that additional pumping will not be concentrated in a particular area of the valley, but it does not describe the criteria that will be used to make that decision or how that decision may impact current and future users of the groundwater basin. How can individual purveyors and water users who participate in an existing or future groundwater management program be assured that they will not be negatively impacted by a proposal to increase groundwater pumping so that additional surface water can be redirected to the Delta or the south state?

F. The DEIR/EIS Does Not Adequately Address Socioeconomic Impacts

NEPA requires that an EIS address a project's socioeconomic effects. (40 C.F.R. §§ 1502.16, 1508.8; U.S. Bureau of Reclamation, *Reclamation's NEPA Handbook* (Feb. 2012), pp. 8-15, 8-17.) CEQA requires that an EIR address a project's socioeconomic effects that generate environmental consequences. (CEQA Guidelines, §§ 15064(e), 15131; *Bakersfield Citizens for Local Control v. City of Bakersfield* (2004) 124 Cal.App.4th 1184, 1204-1213.) As described below, the DEIR/EIS fulfills neither requirement.

1. The DEIR/EIS Does Not Fully Account for Socioeconomic Impacts in the Sacramento Region

The DEIR/EIS is based on operations of Folsom Reservoir that would have significant socioeconomic effects, but does not describe or analyze those effects or their environmental consequences. As discussed above, the hydrologic modeling on which the DEIR/EIS's environmental analysis is based assumes that USBR would, and would be allowed, to operate Folsom Reservoir so that it would be incapable of providing water supplies for communities located adjacent to the reservoir in approximately 10 percent of years. Hydrologic modeling of all of the DEIR/EIS's action alternatives then is based on that assumption. As also discussed above, the DEIR/EIS's hydrologic modeling probably underestimates the impacts of BDCP implementation on Folsom Reservoir storage because that modeling does not account for adjustments in responsibilities for Delta conditions under the COA and also does

[6] As elsewhere described, this projected reservoir operation is completely unrealistic and objectionable.

not depict scenarios drier than the 90 percent exceedance scenario. The current water year is drier than the 90 percent exceedance scenario.

Any scenario in which Folsom Reservoir would be unable to provide the primary water supply for the 500,000 people who currently rely on the reservoir would be highly likely to have significant socioeconomic impacts. Inadequate water supplies discourage economic growth and can lead to depopulation of areas that previously relied on the supplies that have become inadequate. These socioeconomic effects would be significant in themselves and also probably would generate significant resulting environmental effects. If the areas near Folsom Reservoir were to be demonstrated to have inadequate water supplies, then there probably would be resulting growth inducement in other parts of the Sacramento region with more reliable water supplies. In particular, such a shift probably would increase demands for development in parts of the Sacramento region with reliable groundwater, which also tend to be areas with agricultural and vernal pool resources and sensitive species like giant garter snake. In addition, adverse socioeconomic effects in the communities adjacent to Folsom Reservoir could affect the availability of recreational opportunities on the reservoir, which is one of the most heavily used resources in the State Parks system.

Given the CVP operations assumed by the DEIR/EIS's hydrologic modeling and continued through the DEIR/EIS's analysis of all alternatives' effects, NEPA and CEQA require that the DEIR/EIS analyze socioeconomic effects in the Sacramento region and indirect environmental effects on at least hydrological, terrestrial and agricultural resources. The DEIR/EIS's socioeconomic analysis, however, is limited to the statutory Delta. (DEIR/EIS, pp. 16-1 to 16-29.) The DEIR/EIS's growth inducement chapter indicates that no general plans in the Sacramento region were reviewed as part of that chapter's analysis. (DEIR/EIS, p. 30-101, Table 30-34.) The DEIR/EIS fails to analyze the socioeconomic effects within the Sacramento region of the Folsom Reservoir operations that it assumes USBR would implement under the BDCP or the indirect environmental impacts resulting from those socioeconomic effects, in violation of NEPA and CEQA.

2. The Socioeconomic Impact Analysis Should Be Expanded to the Entire Project Area

Without explanation, the DEIR/EIS limits the analysis of socioeconomic impacts to Delta counties (Sacramento, San Joaquin, Yolo, Solano, and Contra Costa Counties). However, as noted elsewhere in the DEIR/EIS, the BDCP impacts a much larger area. For example, Chapter 30 (Growth Inducement and Indirect Effects) describes the environmental setting/affected environment as including eight of the ten hydraulic regions of the state: San Francisco Bay, Central Coast, South Coast, Sacramento River, San Joaquin River, Tulare Lake, South Lahontan, and Colorado River. BDCP's growth inducing impacts are described for each of these eight regions. (See, e.g., DEIR/EIS, Table 30-26, p. 30-83.)

The socioeconomic impacts analysis is inadequate because it fails to analyze the entire environmental setting/affected environment of the proposed project and alternatives. In particular, analysis of the socioeconomic impacts to areas upstream of the Delta must be undertaken. The DEIR/EIS, discussing only Delta counties, concedes that "[p]otential social impacts and impacts on the community character may result from changes in employment, income, and changes in recreational uses and opportunities" resulting from BDCP. (DEIR/EIS, p. 16-42.) The DEIR/EIS, applying the broader environmental setting, also concludes that there will be recreational impacts in reservoir and lake elevations resulting in substantial reductions in recreational opportunities and experiences at North- and South-of-Delta Reservoirs. (DEIR/EIS, p. 15-274.) The DEIR/EIS recognizes that socioeconomic impacts can result from changes in recreational uses and opportunities in Delta counties, identifies potential recreational impacts to North-of-Delta reservoirs, but then fails to analyze the accompanying socioeconomic impacts to the communities around these reservoirs in violation of NEPA and CEQA.

Additionally, as described above and in the MBK Report, the BDCP's modeling errors underestimate and generally minimize the quantity of water diverted from North-of-Delta reservoirs. The socioeconomic impacts analysis should be expanded to include the entire project area and should incorporate accurate projections of North-of-Delta reservoir conditions under BDCP to fully assess and describe such impacts.

H. The DEIR/EIS Fails to Adequately Analyze Potential Growth Inducing Impacts

An EIR must discuss the ways in which a proposed project could foster growth. (CEQA Guidelines, § 15126.2(d).) The DEIR/EIS states that "[i]ndirect growth could occur if an alternative were to result in increased deliveries of reliable water supplies" (p. 30-38) and Table 30-26 sets forth the growth potential associated with deliveries of each of the Alternative 4 scenarios compared to existing conditions and the no action alternative. (DEIR/EIS, p. 30-83.) As discussed above and in the MBK Report, the BDCP's modeling errors underestimate the average amount of water exported from the Delta by approximately 214,000 AFY. This, in turn, inappropriately skews and minimizes the ways in which the BDCP fosters growth by increasing deliveries of reliable water supply. The DEIR/EIS must be revised to accurately evaluate the Plan's potential to induce growth using the correct volumes of water that would be exported from the Delta under the BDCP.

I. The DEIR/EIS Fails to Properly Analyze the BDCP's Cumulative Impacts

An EIR must discuss a project's cumulative impacts that are created as a result of the combination of the project evaluated in the EIR together with other past, present and probable future projects causing related or cumulative impacts. (CEQA Guidelines, §§ 15130(a)(1), (b).) Under CEQA, the "project" means the "the whole of an action, which has a potential for resulting in either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment, ..." (*Id.*, § 15378(a).) Similarly, under NEPA, cumulative effects must be analyzed for the whole of the "action" when added to other past, present, and reasonably foreseeable future actions. (40 C.F.R. § 1508.7.)

The DEIR/EIS fails to consider the cumulative impact that would result from the Bay-Delta Water Quality Control Plan update currently being developed by the SWRCB. The update, being addressed in phases, seeks to modify water quality requirements in the Bay-Delta, change water rights in the Bay-Delta and tributaries, and implement flow objectives for the Bay-Delta and tributaries. The SWRCB's ongoing efforts to modify the Bay-Delta Water Quality Control Plan are briefly described in the DEIR/EIS and are a probable future project for purposes of CEQA cumulative impact analysis. (See DEIR/EIS, p. 8-19). However, the potentially significant cumulative effects of the Plan update are not described in the cumulative effects analysis of Water Supply (see DEIR/EIS Ch. 5, § 5.3.4), Water Quality (see DEIR/EIS Ch. 8, Table 8-73), and are not described, analyzed, or even listed in Appendix 3D (see DEIR/EIS Appendix 3D-A, "Descriptions of . . . Cumulative Impact Analysis for the BDCP EIR/EIS"). The DEIR/EIS's failure to evaluate the potential for the BDCP, along with modifications to the Bay Delta Water Quality Control Plan, to result in significant cumulative impacts violates CEQA and NEPA.

J. The DEIR/EIS Fails to Properly Analyze Alternatives to the BDCP

CEQA requires that an EIR include a "reasonable range" of potential alternatives "to allow meaningful evaluation, analysis, and comparison with the proposed project." (CEQA Guidelines, §§ 15126.6(a), (c).) Under NEPA, an EIS "should present the environmental impacts of the proposal and alternatives in comparable form, thus sharply defining the issues and providing a clear basis for choice among options by the decisionmaker and the public." (40 C.F.R. § 1502.14.) The uncertainty surrounding critical aspects of the BDCP, such as the decision tree and adaptive management processes, make it impossible to know what the likely outcomes will be under each alternative and thus to meaningfully evaluate and consider alternatives, in violation of CEQA. Similarly, the inadequate project description violates NEPA by not "sharply defining" the issues to provide a clear basis for the choice among alternatives. The vagueness and uncertainty permeating the description of the BDCP in the DEIR/EIS precludes a meaningful consideration of alternatives because the public and decisionmakers are unable to assess the relative merits of the proposed project measured against alternatives. The lack of an accurate, stable and finite description of the preferred project also prevents the public and decisionmakers from determining if the alternatives set forth in the EIR/EIS are reasonable or if a new alternative could better satisfy project objectives with fewer or different environmental impacts.

VI. CONCLUSION

Both the BDCP and the DEIR/EIS fail in their fundamental purpose. As stated by its proponents, the purpose of the BDCP is to improve the reliability of water supplied through the Sacramento-San Joaquin Delta while improving ecosystem health and ensuring long-term protection of threatened and endangered fish species. The BDCP falls far short of these goals. Further, the DEIR/EIS is fundamentally deficient.

The current BDCP draft is based on flawed hydrologic modeling and erroneous and biased scientific analysis. Significant errors in the underlying model, from which all effects were analyzed, call into question the analyses and conclusions throughout the entire BDCP and the DEIR/EIS. Indeed, the BDCP hydrologic model reveals that much of the text of the BDCP and DEIR/EIS are contradicted by information in the model, that some effects are understated or ignored completely, and that operations in the model violate the operational rules contained in the BDCP as currently proposed.

The problems with the model, which underpins the Plan and environmental review, are especially concerning because the DEIR/EIS indicates that the BDCP will result in dozens of significant and unavoidable impacts. The residents and communities in the Sacramento Valley will bear a disproportionate burden of these impacts. Substantial questions have been raised about the BDCP's ability to meet any of the required standards for protecting listed species. And the BDCP depends on uncertain and speculative funding sources, which may result in those not benefiting from the BDCP's assurances having to shoulder a significant portion of its costs. As such, it does not meet any of the essential criteria for approval of an HCP or NCCP.

The DEIR/EIS also fails to summarize and convey information essential to the understanding of project impacts in a manner reasonably calculated to inform the readers and decisionmakers, in violation of NEPA's readability requirement and in violation of CEQA's requirement that documents adequately inform the public of the scope and potential impacts of a proposed project. The DEIR/EIS thus fails to provide sufficient, meaningful information about many of the Project's adverse effects, and it omits consideration of many impacts of concern to the residents of the Sacramento Valley.

Given these shortfalls, among others, the BDCP and DEIR/EIS fail to adequately provide the requisite accurate environmental documentation necessary for the local citizenry and public decisionmakers to reach an informed and thoughtful decision regarding the BDCP under NEPA, CEQA, and the state and federal Endangered Species Acts. The failure to provide sufficient information about the BDCP or credible evidence and objective analysis to support the DEIR/EIS's impact determinations has deprived the public of a meaningful opportunity to understand and comment on the project's substantial adverse impacts. Correcting these errors will require the addition of significant new information and, thus, the DEIR/EIS must be revised and recirculated for public review. (CEQA Guidelines, § 15088.5(a).)

Exhibits:

Exhibit A: List of Commenting Parties

Exhibit B: Latour, R., Ph.D., *Technical Review of the Bay-Delta Conservation Plan (BDCP) and Related Environmental Impact Review (EIR)*, July 9, 2014

Exhibit C: February 26, 2014 letter from Vivian Helliwell, Chairman, to Charlton H. Bonham

Exhibit D: Vogel, D., *Comments on the Public Draft Bay-Delta Conservation Plan (BDCP) and Draft BDCP Environmental Impact Report/Environmental Impact Statement*, June 6, 2014

Exhibit E: Delta Science Program Independent Review Panel, *Report, BDCP Effects Analysis Review*, *Phase 3*, March 2014

Exhibit F: MBK Engineers and Daniel B. Steiner, Consulting Engineer, *Review of Bay Delta Conservation Plan Modeling*, July 11, 2014

EXHIBIT A

List of Commenting Parties
Comments on Draft Bay Delta Conservation Plan, EIR/EIS,
and Implementing Agreement
July 29, 2014

Anderson-Cottonwood Irrigation District
Biggs-West Gridley Water District
Browns Valley Irrigation District
Butte Water District
Calaveras County Water District
El Dorado County Water Agency
El Dorado Water & Power Authority
City of Folsom
Glenn-Colusa Irrigation District
Meridian Farms Water Company
Natomas Central Mutual Water Company
Northern California Water Association
Paradise Irrigation District
Pelger Mutual Water Company
Placer County Water Agency
Princeton Codora Glenn Irrigation District
Provident Irrigation District
Reclamation District 108
Reclamation District 1004
Richvale Irrigation District
River Garden Farms
City of Roseville
City of Sacramento
Sacramento County Water Agency
Sacramento Municipal Utility District
Sacramento Suburban Water District
San Juan Water District
South Feather Water and Power
South Sutter Water District
Sutter Extension Water District
Sutter Mutual Water Company
Western Canal Water District
Yolo County Flood Control & Water Conservation District
Yuba County Water Agency

EXHIBIT B

Technical review of the Bay-Delta Conservation Plan (BDCP) and related Environmental Impact Review (EIR)

Prepared for:

The Sacramento Valley Water Users Group

By

Robert J. Latour, Ph.D.[1]
Consultant

9 July, 2014

Introduction

The Bay Delta Conservation Plan (BDCP) and associated Environmental Impact Report/Environmental Impact Statement (EIR/EIS[2]; referred to herein as the Plan) is intended to be a comprehensive conservation strategy to meet a series of broad biological goals and objectives for the Sacramento-San Joaquin Delta (Delta). Specific characteristics of the Plan were developed to restore and protect ecosystem health, water supply, and water quality within a stable regulatory framework. The core of the Plan is rooted in habitat conservation, and as result, it is intended to conserve the Delta ecosystem in a sustainable manner and contribute to the recovery of threatened and endangered fish species. The Plan is the result of a multiyear collaboration among public water agencies, state and federal fish and wildlife agencies, nongovernment organizations, agricultural interests, local governments, and the public. The conservation strategy inherent to the Plan was founded on an array of broad goals adopted and agreed to by stakeholders in 2006, and it is intended to be based on the best available science.

In December 2013, a draft of the Plan was released for public review/comment and I was asked to provide a technical review of several sections, most notably those relating to Delta fish species. The Plan is an extremely lengthy document that is structured as a series of chapters. The Executive Summary and beginning chapters provide overview information about the origin of the Plan, its geographic scope, and ecological conditions (past and present) of the Delta. Subsequent chapters contain specific details regarding the core conservation strategy, adaptive

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[1]Educational training: B.A. Mathematics, 1994; Master of Biomathematics, 1996; Ph.D. Biomathematics, 2000. Current position: Professor of Marine Science, Virginia Institute of Marine Science, College of William & Mary.

[2]The EIR/EIS states that it incorporates the BDCP by reference (EIR/EIS, p. 1-2 fn. 3).

management program, effects analyses, implementation strategy, and costs. In many respects, the Plan can be viewed as layers of technical material, where the initial chapters are layers devoted to discussing the Plan's conceptual approach, and later chapters are layers focused on specific details about how the Plan may or may not benefit the Delta ecosystem. Given this layered structure, I elected to break my review into two phases: (1) high level evaluation focused on the overarching conceptual approach used to assess impacts, and (2) more detailed evaluation of specific methods and conclusions about perceived benefits or negative effects on Delta ecosystem structure, functioning, and constituent biota. The leading theme of the entire review was whether or not the Plan is based on the best available scientific information and practices.

Following phase 1 of the review, it became clear that the Plan's overarching conceptual approach used to assess impacts, both positive and negative, lacks a number of requisite analytical elements. The Plan calls for a series of large-scale physical manipulations to the Delta, and several fundamental areas of consideration for assessing the impacts of those manipulations are either missing or insufficiently developed. Below I highlight five broad areas of consideration and provide supporting explanations as to why they are vital for either inclusion or further development within the Plan. Given the presence of significant weaknesses in the Plan's conceptual approach, phase 2 of the review was not exhaustively conducted. Evaluation of specific details and conclusions was limited to selected instances that provided supporting rationale for the five broad areas of consideration. Comments focused on the plausibility of specific ecosystem and fish species-specific benefits at this stage would, in effect, implicitly and incongruously provide support for the Plan's conceptual approach. Should the conceptual approach evolve over time to become more refined and based more directly on supporting quantitative analyses, then a full evaluation of the analytical details underpinning statements/conclusions pertaining to Delta ecosystem attributes and resident fish species would be appropriate. I welcome the opportunity to provide such an evaluation at a later date.

Areas for Consideration

1) Lessons Learned from Elsewhere: The Plan articulates lofty restoration goals and the plausibility of achieving those goals should naturally elicit some degree of skepticism. The scale of physical manipulations and restoration objectives appear to be nearly unprecedented (certainly for the Delta), and key unknowns about ecosystem processes and functioning are always present, even for the most studied aquatic ecosystems. Although I have not reviewed an exhaustive list of previous aquatic ecosystem restoration efforts across U.S., it suffices to say that many have been initiated over the past several decades. A few recent examples include: (i) the numerous dam removals along the east coast (e.g., Penobscot River , Mill River, Patapsco

River, Little River, Uwharrie River) and west coast (e.g., Columbia River, Carmel River) to provide native and anadromous fishes access to historically utilized habitats (see Stanley and Doyle 2003 for a review on tradeoffs of dam removal); (ii) tidal wetland restoration in Delaware Bay (i.e., the Estuary Enhancement Program, see Weinstein et al. 2001 for review), and (iii) the Everglades Restoration Plan (NRC 2012), which is a multifaceted effort to improve overall ecosystem health. Several of these restoration efforts are in various stages of completion, which presents what would seem like an ideal opportunity to conduct a meta-analysis of many restoration programs to understand the intended and unintended consequences. Have the desired positive benefits been realized in other places, and how/why? Were those benefits not realized, and how/why? What were (if any) the unintended positive or negative impacts resulting from restoration activities, and how/why were those realized?

The Plan, however, contains no review of previous restoration efforts nor does it reference past efforts elsewhere in its determinations about potential benefits or negative consequences of the proposed restoration activities to the Delta ecosystem and associated fish species. The Plan acknowledges that not everything is known about the Delta ecosystem, which implies there is uncertainty (perhaps notable in some instances) regarding its likelihood for successfully achieving stated goals and objectives. Therefore, from the perspective of maximizing the foundational information from which inferences about success/failure can be drawn, it would seem important and necessary to formulate the Plan within the context of 'lessons learned from elsewhere.' The Plan's failure to include a formal evaluation of the experiences of other major restoration efforts represents a glaring omission, which in turn, supports the conclusion that the Plan is not based on a complete analysis of available science.

2) Build it and They Will Come: The current Delta is a highly altered ecosystem. Most naturally occurring wetlands in the estuary have been lost due to morphological changes for agriculture, flood control, navigation, and water reclamation activities (Atwater et al. 1979). Other notable changes include modifications to the volume of freshwater entering the Delta and thus the natural delivery of land based sediment (Arthur et al. 1996), massive sediment loading resulting from large-scale hydraulic mining activities (Schoellhamer 2011), introduction and invasion of non-indigenous species (Cohen and Carlton 1998), input of contaminants (Connor et al. 2007), and reported decreases in chlorophyll-*a* (Alpine and Cloern 1992), zooplankton (Orsi and Mecum 1996), and fish abundance (Sommer et al. 2007). Monitoring data have indicated that relative abundances of several pelagic species declined dramatically in the early 2000s, giving rise to the phenomenon deemed the Pelagic Organism Decline (POD; Sommer et al. 2007). The best available science collectively indicates that various physical, biological, and chemical attributes of the Delta ecosystem are in need of restoration, which is consistent with the Plan's most basic and core objective.

The Plan outlines numerous conservation measures to restore a variety of habitat types, including tidal marshes, floodplains, channel margins, and riparian areas. The scale of habitat restoration in terms of proposed new acreage is ambitious and recognition that the quality, quantity, and availability of food in the Delta are limiting factors for fish species is generally consistent with prevailing scientific literature. Therefore, the focus to recreate and enhance the once abundant Delta habitat types that possess environmental (e.g., temperature, salinity, turbidity) and physical (e.g., depth, topography, vegetation, tidal influence) attributes for stimulating primary production and increasing fish growth and survival is conceptually appropriate. A key conclusion of the Plan, however, is that implementation of the proposed habitat restoration conservation measures will result in greater fish population abundances – 'the build it and they will come' phenomenon. The Plan's conclusion that more habitat will lead to more fish is largely based on a habitat suitability analysis, which takes into account habitat preferences by different life stages of fishes and the total number of habitat units (HUs) in the system (Section 5.E.4.4.1.1, Appendix 5E, Habitat Restoration). The Habitat Suitability Index (HSI) for life stage i of species j is given by:

$$HSI_{ij} = \sqrt[n]{F_1 \cdot F_2 \cdots F_n} \tag{1}$$

where F_i is the suitability factor for a life stage i that reflects conditions for an environmental attribute (e.g., temperature, salinity, turbidity) ranging from 0 (unsuitable) to 1 (ideal). Equation (1) is the geometric mean of the life-stage HSIs. Habitat units, which are indices of habitat potential, are then calculated for species' life stages:

$$HU_{ijk} = \sum_{h=1}^{n} HSI_{ij} \cdot P_{ijh} \cdot A_h \tag{2}$$

where for life stage i of species j, HSI_{ij} is the Habitat Suitability Index, P_{ijh} is the life stage preference for habitat type h, and A_h is the area of habitat type h.

Successfully increasing the number of viable HUs for fishes requires a detailed understanding of species-specific habitat suitability factors (F_i's in equation 1) and habitat preferences (P_{ijh}'s in equation 2). Specifying values for those parameters, which are the building blocks of equations (1) and (2), amounts to defining Essential Fish Habitat (EFH) for Delta fish species. Additionally, conditioned on there being more habitat area that is EFH, it would seem vital to conduct analyses that quantify potential gains in fish production in relation to the amount of newly proposed habitat area. These latter two points are now discussed in more detail.

Essential Fish Habitat[3] As defined by NOAA, EFH includes all types of aquatic habitat – wetlands, coral reefs, seagrasses, rivers – where fish spawn, breed, feed, and grow to maturity (http://www.habitat.noaa.gov/protection/efh/index.html). While there is published literature on aspects of habitat utilization of fishes in the Delta (e.g., Bennett 2005, Feyrer et al. 2007), the results do not appear to be unequivocal. For example, Kimmerer 2011 stated 'the distribution of delta smelt seems to have shifted northward in the last few years.' Fishes typically distribute in accordance to their own resource needs (e.g., requirements for food, habitat characteristics, etc.), and the notion that delta smelt may be recently more abundant in the northern Delta suggests one of two possibilities, (i) previously documented patterns in habitat use were incorrectly or incompletely described, or (ii) habitat preferences have shifted over time. Either case implies that the contemporary understanding of EFH for delta smelt (and other fishes in all likelihood) is not comprehensively documented. In light of this uncertainty, the question in relation to the Plan becomes, what will the exact characteristics of the newly proposed HUs be, and what level of assurance is there that those characteristics will match the needs of fishes in the Delta (i.e., qualify as EFH) and generate the Plan's projected benefits for those species? Limitations and uncertainties associated with the Habitat Suitability Analysis are listed in bullet form within the Plan (section 5.E.4.4.1.1, Appendix 5.E), and while these may represent important acknowledged issues, they are not directly incorporated into the Plan's analysis. The Plan does not include any analyses of the potential resulting effects (perhaps in the form of risk analyses) on the likelihood that it will succeed in producing the projected benefits for the relevant Delta fish species. Therefore, since the components of equations (1) and (2) are not formulated to include uncertainty in defining EFH, it is unlikely that the Plan's conclusions about beneficial effects of habitat restoration for fishes are known with acceptable levels of precision (more on the general topic of uncertainty below).

Food Web Modeling A primary purpose of the proposed restoration of the various tidal natural communities is to increase the food supply for fish species. The Plan's supporting rationale for this objective is because the POD is perceived to be related to an ecological regime shift in the Delta (Sommer et al. 2007, Baxter et al. 2010). Causes of the regime shift include introduced species (plants, invertebrates, and fishes) and a shift in nutrient dynamics supporting phytoplankton resulting in part from pollutant discharge (Sommer et al. 2007). The Plan describes how habitat restoration activities will quantitatively increase primary production (Section 5.E.4.4.2.5, Appendix 5E, Habitat Restoration). However, projected benefits of increased primary production realized by fish populations are based on a qualitative analysis of published literature rather than quantitative analyses such as food web modeling. The Plan cites the lack of a Delta food web model as the reason for its reliance on qualitative methods,

[3]Appendix 5.I. *Critical Habitat and Essential Fish Habitat Analysis* was not part of the public review draft and thus not reviewed.

yet an ecosystem food web model based on the Ecopath software (Christensen and Walters 2004) was recently developed for the Delta (Bauer 2010). Ecopath is a flexible and well-accepted ecosystem modeling tool designed to characterize the trophic linkages and community food web structure within aquatic ecosystems. Generally, the model requires inputs such as biomass, production, mortality, and diet composition for trophic groups ranging from detritus to plankton to fishes to marine mammals and birds. Although the model developed by Bauer (2010) is a mass balanced static snapshot of the Delta food web (Ecopath), with a modest amount of additional work, the time dynamic module (Ecosim) could be invoked to simulate food web interactions and to quantify potential gains in ecosystem production through increased HUs. Although hundreds of Ecopath with Ecosim (EwE) models have been developed for various ecosystems globally, two particularly relevant examples are highlighted here.

First, current approaches to restore Louisiana's estuaries include the reintroduction of Mississippi River water through freshwater diversions to wetlands that are hydrologically isolated from the main channel. To address questions surrounding how reduced salinities associated with freshwater input might impact estuarine organisms, de Mutsert et al. (2012) developed an EwE model to simulate the effects of diversion-induced salinity changes on species biomass distributions, food web dynamics, and community composition within the Breton Sound estuary. A key and unexpected conclusion of the de Mutsert et al. (2012) study was that the model demonstrated that the reintroduction of water diversion would not significantly change species distributions. In this instance, time dynamic food web modeling analysis provided evidence for an outcome that appeared to be unlikely when restoration activities were viewed within a strictly qualitative framework. The Plan contains no similar quantitative refinement of its qualitative analysis of projected food web benefits.

Second, the Delaware Bay ecosystem has been the focus of extensive habitat restoration efforts to offset finfish losses due to mortality associated with impingement. During the mid-1990s, the Public Service Enterprise Group increased the total marsh area of the bay by 3% (45 km^2), and while there was general consensus among experts that this restoration effort positively impacted the bay, exactly how and by what amount were unknown. To address these questions, Frisk et al. (2010) developed an EwE model of Delaware Bay to quantify effects of increased habitat on system productivity, and estimated that ecosystem biomass increased by approximately 47.7 t km^{-2} $year^{-1}$. The value of this study is that it provided a quantitative estimate of realized ecosystem benefits resulting from newly created habitat.

These highlighted studies are simply two of many published analyses that provided quantitative insights into restoration activities, and by analogy, the absence of similar analyses in the Plan lends support to the conclusion that the Plan has fallen short of utilizing the best available science.

3) Reliance on Qualitative Methods: The Plan's approach for determining net effects on covered fish species involves predicting expected benefits and/or adverse impacts by drawing on a general conceptual model (flow diagram) for each fish species and synthesizing available literature and analyses. The intent of the approach is to distinguish among four possible conclusions for the effects of the conservation measures:

- The Plan has a substantial impact on environmental attributes that have little importance to the covered fish species.
- The Plan has a small impact on attributes of major importance to the species.
- The Plan has a substantial impact on attributes of major importance to the species.
- The Plan has no effect on an attribute.

The first step of the effects analysis approach involves qualitatively ranking the relative importance of different attributes (stressors) to different life stages of covered fish populations. The next step involves formulating a qualitative conclusion regarding the magnitude of change to an attribute resulting from the Plan. The last step in the process involves considering the magnitude of change predicted to occur to an attribute because of the Plan in light of the importance of that attribute. Following these three steps, the Plan makes a judgment as to which of the four potential outcomes is likely for each life stage of each species. Scientific uncertainty of the underlying assumptions and conclusions regarding the effects analysis is also qualitatively scored from low to very high.

A benefit of the approach taken to determine net effects on fish species is its transparency and general ease of understanding, as noted in the Plan. In many respects, the qualitative ranking approach taken represents a fruitful first step to assessing impacts. It is, however, only a first step and the absence of subsequent quantitative analyses based on that first step is a significant omission. Expert judgment is important but its value does not compare to, and cannot replace information obtained environmental or ecosystem process-oriented analyses. As briefly noted above, absent from the Plan are mechanistic, quantitative, dynamic simulation analyses designed to evaluate and potentially validate the Plan's projected restoration outcomes. Conceptual, 'flow-chart' models of fish populations and associated exogenous stressors provide visualizations of linkages that (at most) support the formation of hypotheses regarding restoration impacts. They do not simulate ecosystem or individual fish population dynamics and thus cannot provide insight into how species abundances change over time. More quantitative-oriented methods exist, but the Plan fails to make use of them.

For example, Maunder and Deriso (2011) developed a multistage, state space population dynamics model for delta smelt, and although the results of this study are cited in the Plan, it does not utilize the model explicitly. The Maunder and Deriso (2011) model is an ideal tool for quantitatively projecting the population level effects of potential changes to vital rates (e.g., stage-specific survival terms) suggested to occur as a result of the Plan. The model assumes a one year life cycle for delta smelt, and it relates abundances of larval, juvenile, and adult stages through density dependent relationships. Stage-specific abundance projections are accomplished using the following general equations:

$$N_{t,s} = f(N_{t,s-1})e^{\sigma_{s-1}\cdot\varepsilon_{t,s-1} - 0.5\sigma_{s-1}^{2}} \qquad (3a)$$

$$N_{t,1} = f(N_{t-1,A})e^{\sigma_{A}\cdot\varepsilon_{t-1,A} - 0.5\sigma_{A}^{2}} \qquad (3b)$$

where $N_{t,s}$ is the abundance of stage s at time t, A denotes adults stage, σ_s is the standard deviation of the process variability for stage s, and *f* () denotes the functional form of the transition among stages.

Maunder and Deriso (2011) fitted the above model to various indices of delta smelt relative abundance and found that (i) larval (stage 1) abundance related to future juvenile (stage 2) abundance linearly, (ii) juvenile abundance related to future adult (stage 3) abundance nonlinearly through a traditional Ricker function, and (iii) adult abundance related to next year's larval abundance nonlinearly through a traditional Beverton-Holt function (Fig. 1). The nonlinearity of the transitions from stage 1 to 2 and stage 2 to 3 are the result of density-dependent effects on survival. For many fish species, density-dependent effects are quite common and there has been scientific support for this phenomenon for delta smelt (Bennett 2005). Important to note is the difference in the density-dependence among stages; the Ricker function (Fig. 1b) indicates

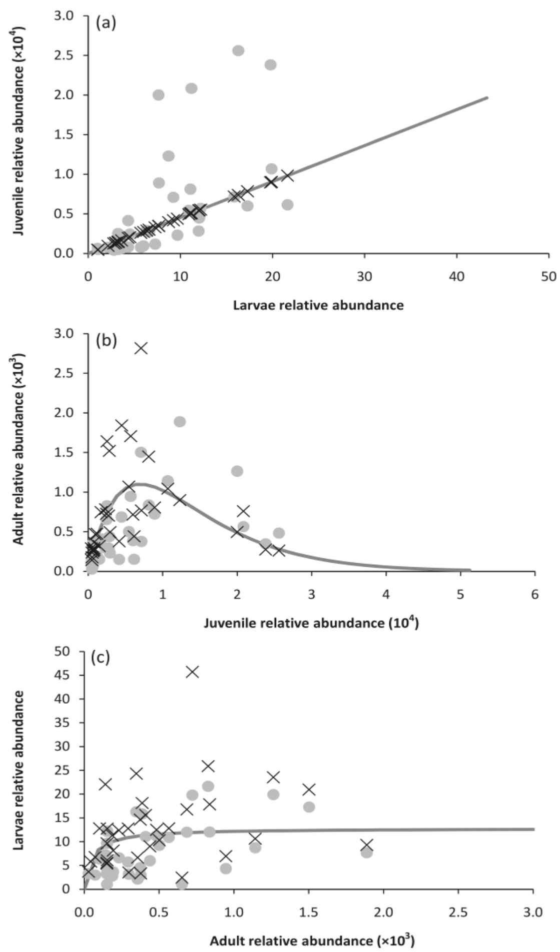

Fig. 1. Relationships among delta smelt stages: linear for larvae to juveniles, Ricker for juveniles to adults, and Beverton-Holt for adults to next year's larvae (Fig. 2 in Maunder and Deriso 2011).

there is a peak juvenile-adult relationship and that too many juveniles can negatively affect adult abundance (declining portion of the curve), and the Beverton-Holt function (Fig. 1c) indicates a plateau such that maximal future larval abundance can be achieved across a wide domain of adult abundances.

To illustrate how a quantitative model – even if not perfectly predictive – can expose possible uncertainties and variability in results projected by qualitative analyses, I applied the model from Maunder and Deriso (2011) in a hypothetical manner to generally evaluate possible benefits for delta smelt that the Plan projects. I used equations (3a, 3b) along with the estimated parameters provided by Maunder and Deriso (2011) to project delta smelt annual abundance forward in time (25 years) under base conditions (scenario 1) and where the slope of the line depicting the larval to juvenile transition (Fig. 1a) was increased by 20% (scenario 2). In other words, I assumed that environmental conditions improved so that the relative abundance of delta smelt larvae that successfully transition to juveniles increased 20%. The increased slope value was chosen arbitrarily, but is intended to loosely represent higher juvenile production, perhaps through increased food availability resulting from the Plan's habitat restoration efforts.

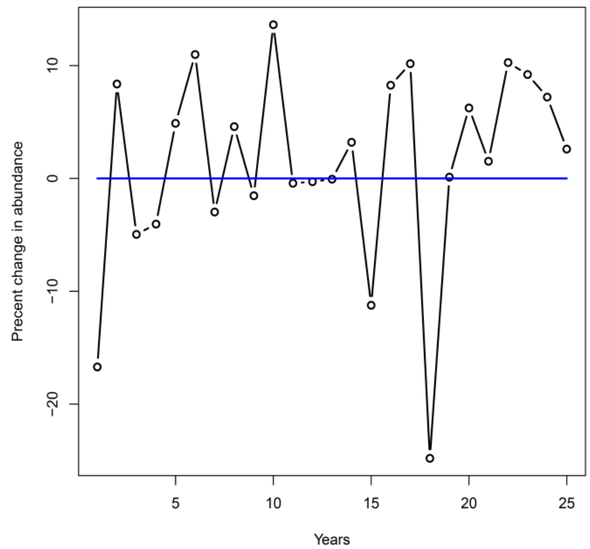

Fig. 2. Percent change in annual delta smelt abundance over a 25 year simulation when the slope of the line relating larval abundance to juvenile abundance was increased by 20%. Horizontal blue line represents no change in abundance between the two scenarios. Underlying population dynamics model and parameter estimates taken from Maunder and Deriso (2011).

The results of these projections were summarized as percent change in annual adult relative abundance for scenario 2 relative to scenario 1. Model output showed that scenario 2 yielded positive percent changes in annual adult delta smelt relative abundance for 15 out of 25 years, and the minimum, mean, and maximum percent changes were -24.8%, 1.4%, and 13.6%, respectively (Fig. 2). The lack of more frequent positive percent changes in annual delta smelt abundance is largely due to the nonlinear density-dependent effects governing the post-larval stage transitions. Sometimes there are negative feedbacks.

Caution should be exercised to not over interpret the results since the simulation was a bit simplistic and primarily designed to demonstrate the importance of mechanistic, dynamic fish population modeling activities when trying to infer the effects (both positive and negative) of habitat alterations such as those outlined in the Plan. Nonetheless, this exercise demonstrates the importance of using quantitative models to test hypotheses generated by qualitative models. This exercise shows that quantitative models identify possible uncertainty and variability in ecosystem results that may appear as smooth progress in qualitative analyses. The Plan's lack of quantitative modeling of its qualitative hypotheses concerning Delta fish species demonstrates that the Plan does not adequately account for factors that may affect the Plan's ability to generate the projected benefits for Delta fish species. Again, the Plan falls short of utilizing the best available scientific practices.

4) Absence of Uncertainty Analyses: The Plan does not explicitly build uncertainty into its effects analyses, which is inconsistent with state-of-the-art quantitative fisheries science methods. The Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (Act) of 2006 set forth very significant changes to how fisheries operating in federal U.S. waters are managed. Although there are many facets to the Act, core provisions relate to setting Annual Catch Limits (ACLs) that avoid overfishing while simultaneously accounting for scientific and management uncertainty. Even for the most heavily studies fish stocks, significant uncertainties exist in our understanding of life history, migration patterns, and fundamental population dynamics. Compliance with the Act requires the development of ACL buffers designed to minimize the risk of overfishing, and the risk is assessed via a formal treatment of uncertainty.

For many Delta fish species, the Act does not apply directly because home ranges are restricted to state waters and also because of no harvest. However, the spirit of the Act is important to note, particularly the formal acceptance that uncertainty is present even for the most extensively studied fish stocks. So, by analogy, if the fisheries management standard within the U.S. is to actively characterize and account for uncertainty, then it seems reasonable that the Plan should follow suit, at least to the extent possible.

Throughout the Plan, there is a lack of systematic, explicit quantitative analyses of uncertainty, particularly with respect to how scientific uncertainty may or may not affect the stated anticipated effects derived from restoration activities. Uncertainties are listed in numerous places within the Plan, which is an important first step, but identification of them does not facilitate understanding how they impact the likelihood of achieving desired restoration goals and objectives. Failure to include explicit analyses of error promulgation indicates that the Plan does not meet the standard used to federally manage fisheries (the Act) which further suggests that the Plan does not meet the best available science criterion.

<u>Example</u> Here I focus on a series of specific details regarding the Plan's approach to assessing potential increases in food supply to the Delta resulting from restoration activities. A primary objective of the Plan is to increase the quantity of habitat for fishes, which is thought to enhance the supply of food within the Delta ecosystem. Here the term food refers to phytoplankton, which are photosynthesizing microscopic organisms that create organic compounds from inorganic compounds such as carbon dioxide in water. Phytoplankton are agents for primary production, which is a process that supports aquatic food webs. The Plan's projected increases in food supply in the Delta resulting from newly created habitat are based on estimates of phytoplankton growth rate per day (G), as a function of depth (d):

$$G = -0.27\ln(d) + 0.86. \tag{4}$$

Equation (4) was originally published by Lopez et al. (2006) but differs from the equation on Fig. 3 taken from the Plan because the Plan converted the measurement of depth from meters to feet. Although the phytoplankton growth equation published by Lopez et al. (2006) was based on sound, peer-reviewed scientific practices, the Plan's use of it in the context of projecting food availability for fishes and other higher trophic level organisms is questionable for several reasons.

First, the Plan's projected increases in food supply to the Delta are based on the following equation:

$$\text{Prod-acres} = (\text{phytoplankton growth rate/day})_{\text{avg depth of stratum}} \times (\text{area of stratum}), \tag{5}$$

where Prod-acres is an index of food production and calculated as the product of the area of a newly proposed habitat stratum and the phytoplankton daily growth rate from equation (4) defined at the average depth of that habitat stratum. Thus, the Plan is assuming that more habitat acreage will produce more phytoplankton. However, strictly basing Prod-acres on phytoplankton growth rate

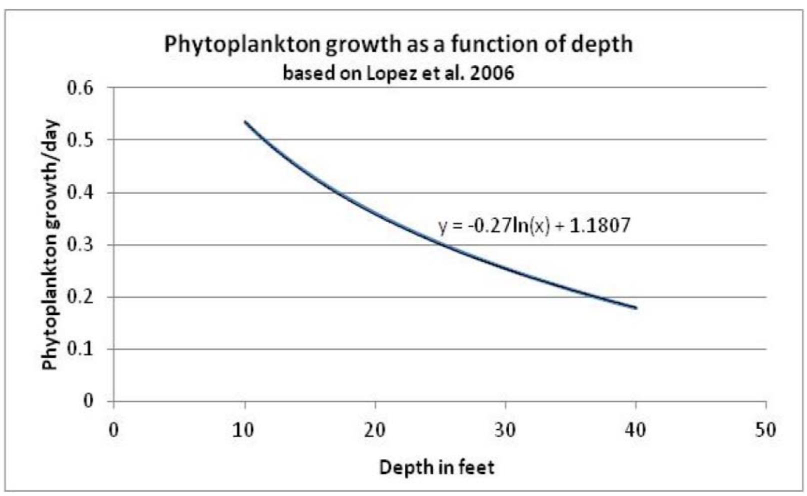

Fig. 3. Relationship between phytoplankton daily growth rate and depth published in the Plan.

does not necessarily provide information about the biomass of phytoplankton available to fishes and other higher trophic level organisms (more on this below). Since most contemporary ecosystem food web models (e.g., EwE, Christensen and Walters 2004) require inputs of both biomass and production (the product of growth rate and biomass) of modeled groups, the Plan's reliance on phytoplankton growth rate is highly questionable.

An additional weakness of the Prod-acres metric is that it implicitly assumes that all phytoplankton growth is available as food for the zooplankton consumed by Delta fish species. However, large portions of the phytoplankton community in the Delta and elsewhere are consumed by benthic organisms (e.g., clams) and microzooplankton (American Rivers review of the BDCP, Lopez et al. 2006). Thus, the projected increases in food availability and associated benefits for Delta fish species are very likely overly optimistic.

Not evident in Fig. 3 is the quality of the fit of the statistical model to the observed data, though review of Lopez et al. (2006) showed a reasonably good statistical fit of the original model (equation (3), $r^2 = 0.72$). The parameter r^2 is the coefficient of variation, which ranges between 0 and 1 and is a measure of the amount of variation in the raw data explained by a linear regression model. Therefore, a value of 0.72 indicates that 72% of the variation was explained, which is good. However, and following from above, further review of Lopez et al. (2006) revealed additional uncertainties in the phytoplankton/depth relationship not accounted for by the Plan. If phytoplankton biomass (PB) is regulated primarily by growth rate, then PB should vary with depth in a manner similar to that in Fig. 3. However, Lopez et al. (2006) indicated that discrete field sampling of PB throughout the Delta over several years showed that the variability of PB was irregular along the habitat depth gradient and uncorrelated to phytoplankton growth rate. Moreover, net phytoplankton production (gross primary production less losses due to respiration by phytoplankton) also weakly related to depth of the water column ($r^2 = 0.12$), and this result led Lopez et al. (2006) to reject the hypothesis 'that phytoplankton biomass varies systematically across gradients of habitat depth.' In other words, the biomass component of phytoplankton production does not vary with depth in a highly predictable manner. The Plan ignores these very important considerations, which further calls into serious question the accuracy of the Plan's projected increases in food supply available to Delta fish species.

Second, and building on the above comments about the inclusion of uncertainty, the Plan's evaluation of restoration benefits with respect to food production involves a combination of quantitative and qualitative analyses. By definition, qualitative metrics do not have associated estimates of precision, so error promulgation analyses cannot be conducted. Where qualitative metrics represent the only analytical option, uncertainty should be characterized as a range of plausible hypothesized outcomes, or by summarizing output resulting from a range of configurations of the qualitative metrics (e.g., low, medium, high).

However, in instances where the Plan makes use of quantitative metrics that have associated measures of precision, it does not carry those listed uncertainties into secondary analyses of the ecological mechanisms it relies on to support the projected benefits for Delta fish species. This omission implies that there are no error promulgation analyses within the Plan, and as a result, there is no way to assess the likelihood of realizing the Plan's projected outcomes. Formal uncertainty and error promulgation analyses can be conducted when quantitative methods are used, particularly statistical methods. Since equation (4) is based on regression techniques applied by Lopez et al. (2006), there is some uncertainty in the estimated slope, y-intercept values (standard errors), and the collective predictive relationship (prediction confidence intervals). Such standard error or confidence bounds, however, are not provided or incorporated into analyses of uncertainty regarding Prod-acres calculations within the Plan.

A hypothetical example demonstrates the importance of this omission. As means of illustrating the effects of modest uncertainty in the slope and y-intercept estimates of the phytoplankton growth rate function, 1000 simulated equations were generated by randomly selecting unique pairs of slope and y-intercept values each from separate normal distributions with means equal to the estimated values (-0.27 and 1.1807, respectively) and standard deviations equal to 10% of those means (0.027 and 0.11807, respectively). The results show that the daily phytoplankton growth rate as a function of depth can be quite variable when a small amount of uncertainty in the model parameters is simulated. That is, at a depth of 10 feet, daily phytoplankton growth ranges from 0.15 to 0.95 per day (Fig. 4). This raises the natural question, how does uncertainty in the phytoplankton growth function across depths affect estimated Prod-acres values and subsequent projected benefits of the proposed habitat restoration subregions?

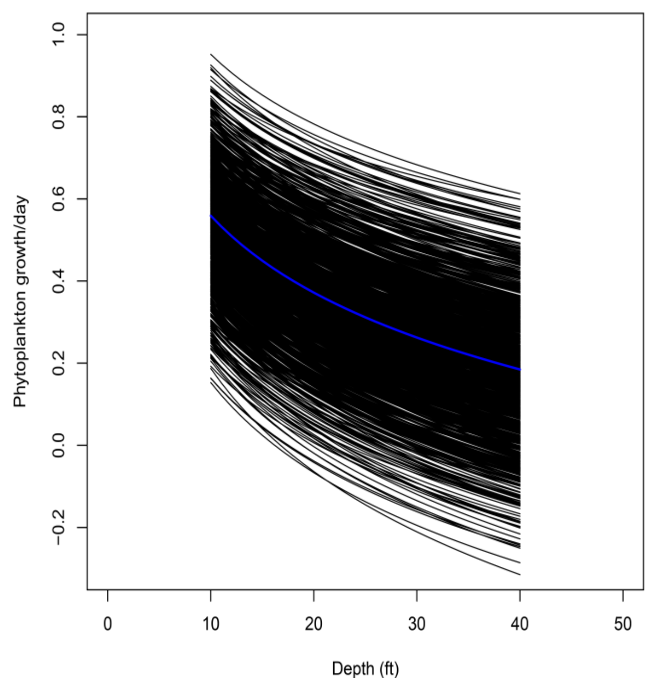

Fig. 4. Daily phytoplankton growth rates as a function of depth based on 1000 simulations of the equation on Fig. 3. The blue line is the base curve, and for each simulated curve, the slope and y-intercept values were chosen randomly assuming a modest amount of uncertainty (black lines).

Although this error simulation is simplistic, it serves to illustrate the importance of carrying forward uncertainty in predictive-type analyses. The absence of uncertainty analyses in the spirit of the hypothetical one here further supports the conclusion that the Plan does not make use of best available scientific practices.

5) Overly Conceptual Management and Monitoring Program: For any restoration effort, it is vital to enact a comprehensive management and monitoring program than will provide robust information in support of policies designed to achieve stated goals and objectives. To the degree possible, the management and monitoring program should specify a wide range of design elements, including but not limited to, the oversight manager or team, field approaches, sampling design characteristics, measured quantities and associated methods, approaches for data analysis and characterizing uncertainty, strategies for integration with existing monitoring programs, selection criteria for reference targets and thresholds, approaches for evaluating restoration progress, database management, tactics for disseminating results, and costs. In the case of the Plan, the global conservation strategy consists of 22 conservation measures and an adaptive management and monitoring approach is described for evaluating progress toward achieving those conservation measures (section 3.6, Chapter 3, Conservation Strategy). The adaptive management and monitoring program was designed in consultation with expert independent science advisors and several thoughtful principles are described. The essence of the program involves the following nine-step process:

1) Characterize the problem
2) Identify biological goals and objectives
3) Model linkages between objectives and proposed implementation actions
4) Plan and design implementation actions
5) Perform implementation actions
6) Design and implement performance
7) Analyze, synthesize, and evaluate
8) Communicate current understanding
9) Adapt.

Each of these steps is described in moderate detail within the Plan along with other process oriented attributes. Although having a well-defined administrative process is important to any management and monitoring program, the likelihood for successful implementation depends on having data collection and analysis protocols that will yield the types of information needed to measure performance. Unfortunately for the Plan, these elements have not been sufficiently developed. There is very little description of the science and monitoring program. The Plan only broadly discusses sampling strategies and it does not describe the measured quantities, methods for data analysis, specifics as to how the monitoring program will be integrated with the numerous existing data collection programs in the Delta, or reference points used to gauge restoration progress or the status of various biological components within the Delta ecosystem.

At most, the Plan provides a conceptual description of the characteristics of its monitoring program to be considered but it fails to define any of them in a tangible manner. Maintaining flexibility in a management and monitoring program is important so that necessary modifications can be made as the program matures; however, given the scale and specificity of many of the proposed restoration objectives and physical modifications to the Delta, it would seem necessary to articulate a far more developed and detailed approach. Simply delineating a plan to have a management and monitoring program is inadequate at this juncture especially since such a loosely defined approach provides no insight into whether or not the management and monitoring program will allow performance of the conservation measures to be successfully evaluated.

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Appendix

Sections of the Plan reviewed.

BDCP

- Executive Summary
- Chapter 2.3 – Existing Biological Conditions
- Chapter 3.2 – Methods and Approaches Used to Develop the Conservation Strategy
- Chapter 3.3 – Biological Goals and Objectives
- Chapter 5 - Effects Analysis: Effects on Covered Fish (sections 5.5.1 delta smelt, 5.5.2 longfin smelt)
- Appendix 2.A – Covered Species Accounts
- Appendix 3.G – Proposed Interim Delta Salmonid Survival Objectives
- Appendix 5.A.2 – Climate Change Approach and Implications for Aquatic Species
- Appendix 5.C - Flow, Passage, Salinity, and Turbidity
- Appendix 5.E - Habitat Restoration (section 5.E)
- Appendix 5.F – Biological Stressors on Covered Fish
- Appendix 5.G - Fish Life Cycle Models (delta smelt models only)
- Appendix 5.I Critical Habitat and Essential Fish Habitat Analysis

EIR

- Chapter 11 – Fish and Aquatic Resources: Reader's Guide (section 11.0)
- Chapter 11 – Fish and Aquatic Resources: Summary of Effects – Alternative 4 (section 11.0.2.8)
- Chapter 11 – Fish and Aquatic Resources: Stressors (section 11.1.5)
- Chapter 11 – Fish and Aquatic Resources: Methods for Analysis (section 11.3.2)
- Chapter 11 – Fish and Aquatic Resources: Determination of Effects (section 11.3.3)
- Chapter 11 – Fish and Aquatic Resources: No Action Alternative (section 11.3.4.1)
- Chapter 11 – Fish and Aquatic Resources: Alternative 1A (section 11.3.4.2)
- Chapter 11 – Fish and Aquatic Resources: Alternative 4 (section 11.3.4.9)
- Chapter 11 – Fish and Aquatic Resources: Cumulative Effects (sections 11.3.5, 11.3.5.1, 11.3.5.2)
- Chapter 11A – Covered Fish Species Descriptions (sections 11A.1, 11A.2 for delta smelt and longfin smelt)
- Chapter 11B - Non-Covered Fish and Aquatic Species Descriptions (sections 11.B.8, 11.B.9 for threadfin shad and bay shrimp)

EXHIBIT C

BDCP1597

California Advisory Committee On Salmon and Steelhead Trout

February 26, 2014

Charlton H. Bonham, Director
California Department of Fish and Wildlife
1416 Ninth St., 12th Floor
Sacramento, CA 95814

Subject: Recommendation to deny incidental take permit and Natural Communities Conservation Plan for Bay Delta Conservation Plan

Dear Director Bonham;

The California Advisory Committee on Salmon and Steelhead in our capacity to advise you, the director of the California Department of Fish and Wildlife, in preparing and maintaining "a comprehensive program for the protection and increase of salmon, steelhead trout, and anadromous fisheries" in California,[1] recommends that the you deny issuance of an incidental take permit for the Bay Delta Conservation Plan's Alternative 4 (BDCP) as a Natural Communities Conservation Plan (NCCP). The BDCP does not meet the requirements of Fish and Game Code 2820 for an NCCP and cannot legally be approved because it will contribute to the further decline of Sacramento River Winter Run and Spring Run Chinook salmon.

All races and runs of Central Valley salmon and steelhead populations have experienced over 90% declines since the State Water Project came on line in the 1960's. In particular, naturally produced Chinook populations have experienced severe declines resulting in the listing of Sacramento Winter Run as endangered and the Spring Run as threatened under the federal and state Endangered Species Acts. Adult returns of these two species are far below the fish doubling goals of the Anadromous Fish Restoration Program. Attachments 1 and 2 are figures from the Anadromous Fish Restoration Program showing the severe declines these two runs of Chinook salmon have experienced in the Sacramento River basin.[2]

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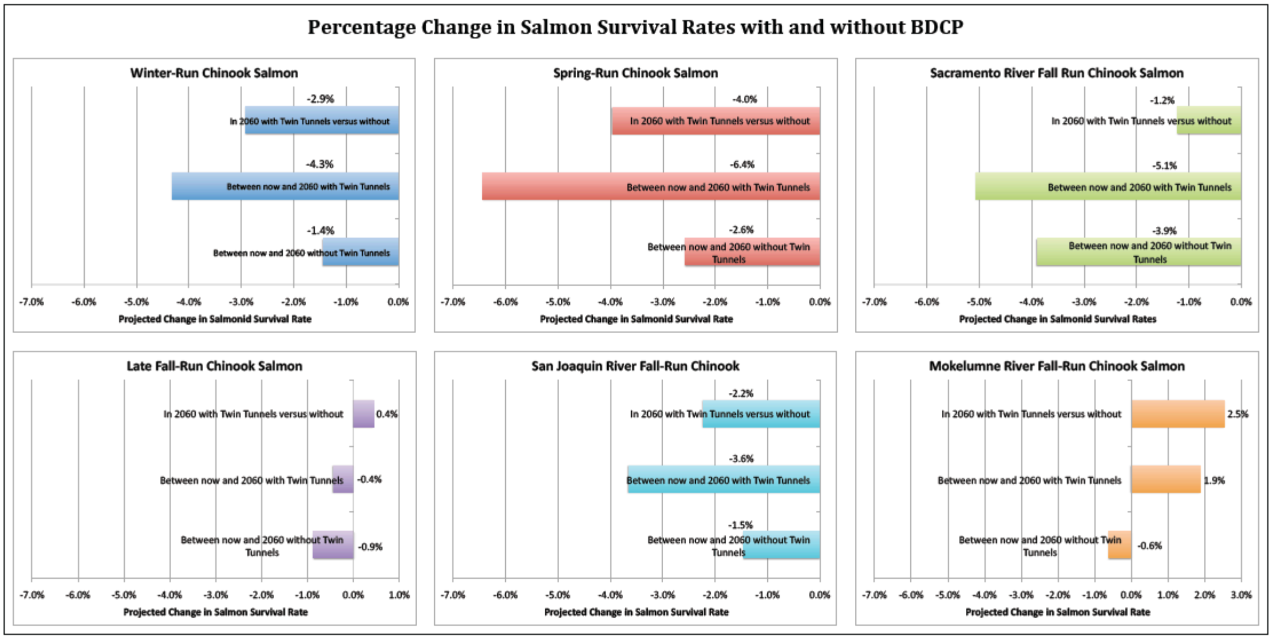
[1] California Fish and Game Code § 6920 (2008)
§ 6920. Preparation and maintenance of program; Consultation with public agencies
(a) The department shall, with the advice of the Advisory Committee on Salmon and Steelhead Trout and the Commercial Salmon Trollers Advisory Committee, prepare and maintain a detailed and comprehensive program for the protection and increase of salmon, steelhead trout, and anadromous fisheries.
[2] http://www.fws.gov/stockton/afrp/Documents/Doubling_goal_graphs_020113.pdf

Furthermore, according to data from Chapter 5, Effects Analysis of the November 2013 Draft BDCP, operation of the Twin Tunnels project will reduce winter run and spring Chinook salmon smolt survival by 2.9% and 4%, respectively. See Salmon Survival Rates Figure below taken from BDCP Chapter 5. Supporting data and source tables are shown in Attachment 3.[3]



BDCP promotes the unproven scientific hypothesis that habitat restoration can substitute for flow. However, the State Water Resources Control Board has already indicated that Delta inflows and outflows are presently insufficient to help listed species recover their former abundance.[4] BDCP would reduce Delta outflow, which contributes to the decreases to salmon smolt survival rates modeled by BDCP.

The concept of improving riparian and subtidal habitat to create an aquatic food supply for the Delta to make up for too much water diverted is an unproven theory that has been criticized extensively by federal agencies in their "red flag" comments on the BDCP.[5] Climate change will

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[3] Figure A taken from Draft Bay-Delta Conservation Plan, Chapter 5, Effects Analysis, Sections 5.5.3 through 5.5.6, Tables 5.5.3-10, 5.5.4-5, 5.5.5-8, 5.5.5-10, 5.5.5-18 and 5.5.5-20 See http://baydeltaconservationplan.com/Libraries/Dynamic_Document_Library/Public_Draft_BDCP_Chapter_5_-_Effects_Analysis.sflb.ashx

[4] "Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem
Prepared Pursuant to the Sacramento-San Joaquin Delta Reform Act of 2009." SWRCB, August 3, 2010. Page 4, second bullet. See
http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/docs/final_rpt080310.pdf

[5] See
http://baydeltaconservationplan.com/Libraries/Dynamic_Document_Library/Federal_Agency_Comments_on_Consultant_Administrative_Draft_EIR-EIS_7-18-13.sflb.ashx and
http://baydeltaconservationplan.com/Libraries/Dynamic_Document_Library_-_Archived/Effects_Analysis_-_Fish_Agency_Red_Flag_Comments_and_Responses_4-25-12.sflb.ashx and
http://baydeltaconservationplan.com/Libraries/Dynamic_Document_Library/NMFS_Progress_Assessment_Regarding_the_BDCP_Administrative_Draft_4-11-13.sflb.ashx and
http://baydeltaconservationplan.com/Libraries/Dynamic_Document_Library/NMFS_Evaluation_of_Flow_Effects_on_Survival_-_BDCP_Admin_Draft_-_4-11-13.sflb.ashx and

contribute to sea level rise directly in the Delta; this will help push X2 eastward into the Delta. BDCP analysis also shows that Sacramento River inflow will decrease directly from operation of the Twin Tunnels, and to some degree from lower upstream runoff (controlled by climate change and reservoir operation). The combined effect of continued high diversions from the Delta through BDCP (for the sake of "increased reliability") and the effects of climate change and X2 movement eastward will have a deleterious effect on Sacramento Winter Run and Spring Run Chinook salmon.

All of the conservation measures in BDCP with the exception of CM1 (Twin Tunnels) are programmatic in nature. Funding is far from assured, as identified in a recent Legislative Analyst's report. The LAO report identified that ecosystem restoration funding has not been secured and cost overruns are likely for land acquisition for habitat restoration. According to the report, [6]

"*If bond funds are not available in the near future and no additional funding sources are identified, some ecosystem restoration may not be funded, including the restoration actions needed before the tunnels begin operation. The BDCP states that the SWP and CVP will not pay additional costs or forgo water in the event of a funding shortfall*."

The funding plan at Table 8-37 of Chapter 8 in BDCP confirms the LAO's conclusion. The state and federal water contractors propose that they will only pay for 68.4 percent of BDCP's costs. Nearly 95 percent of their financing commitment is solely to the Twin Tunnels project in Conservation Measure 1, and the rest of BDCP's costs would be borne by taxpayers at large.

Because Sacramento River Winter Run and Spring Run Chinook salmon are already significantly depleted and BDCP will further reduce smolt survival, the Department of Fish and Wildlife cannot make a finding that the BDCP NCCP will lead to recovery of the species.

None of the alternatives considered in the BDCP Draft Environmental Impact Statement and Report would lead to the recovery of Sacramento River Winter Run and Spring Run Chinook salmon. None of the alternatives analyzed reduces the amount of water diverted upstream of or within the Delta. None of the alternatives analyzed considers meeting or moving toward meeting the State Water Resources' Control Board's Delta Outflow Criteria of 2010 that was specifically required by the legislature in 2009 "to inform planning decisions for the Delta Plan and the BDCP."[7]

Therefore, findings approving a NCCP for the Bay-Delta Conservation Plan cannot be made pursuant to Section 2820 of the Fish and Game Code for the following reasons:

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http://baydeltaconservationplan.com/Libraries/Dynamic_Document_Library/U_S_Fish_and_Wildlife_Service_Staff_BDCP_Progress_Assessment_4-11-13.sflb.ashx

[6] "Financing the Bay-Delta Conservation Plan", Legislative Analyst's Office, 2/12/14. p 8. See http://www.lao.ca.gov/handouts/resources/2014/Financing-the-BDCP-02-12-14.pdf

[7] Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem by the State Water Resources Control Board, August 3, 2010. See http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/docs/final_rpt080310.pdf

1. BDCP does not contribute to recovery and would jeopardize the continued existence of Sacramento River winter-run and spring-run Chinook salmon because smolt survival through the Delta is reduced by the project. (Fish & Game Code Section 2081(c))
2. The concept of habitat restoration measures to offset impacts from increased water withdrawals from the Delta (increased "reliability") is not supported by science, including but not limited to the 2010 SWRCB Delta Outflow Criteria. (Fish & Game Code Section 2081(b)(2))
3. The applicants do not assure funding and water supplies for habitat restoration measures. Habitat restoration measures will not be "shovel-ready" when the Twin Tunnels begin construction. (Fish & Game Code Section 2081(b)(4) and 2820(a)(10))
4. BDCP does not include analysis of an alternative or alternatives that would meet the recovery goals for Sacramento River Winter Run and Spring Run Chinook salmon. Such an analysis should at least take into consideration the State Water Resources Control Board's 2010 Delta Outflow decision. (Fish & Game Code Section and 2820(e))

In summary, the Bay-Delta Conservation Plan does not meet the requirements of the California Endangered Species Act or the Natural Communities Conservation Plan Act to recover Sacramento River winter-run and spring-run Chinook salmon. The BDCP NCCP is to be submitted to support issuance of an incidental take permit by the Department of Fish and Wildlife. For all of the above reasons, we urge you to reject approval of the BDCP as an NCCP.

We thank you for your consideration of these points and look forward to hearing back from you on this important matter.

Sincerely,

Vivian Helliwell, Chairman
P.O. Box 307
Eureka, CA 95502
vhelliwell@mcn.org

cc: Honorable Wesley Chesbro, Chairman Joint Committee on Fisheries and Aquaculture
Kevin Shaffer, CDFW Program Manager, Anadromous Fisheries Branch

Attachments:

1- Anadromous Fish Restoration Program Figure 4: Estimated yearly adult natural production, and in river adult escapements of Winter Run Chinook salmon
2- Anadromous Fish Restoration Program Figure 5: Estimated yearly adult natural production, and in river adult escapements of Spring Run Chinook salmon in the Central Valley rivers and streams.
3- Central Valley Salmon Smolt Survival With and Without BDCP

ATTACHMENT 1

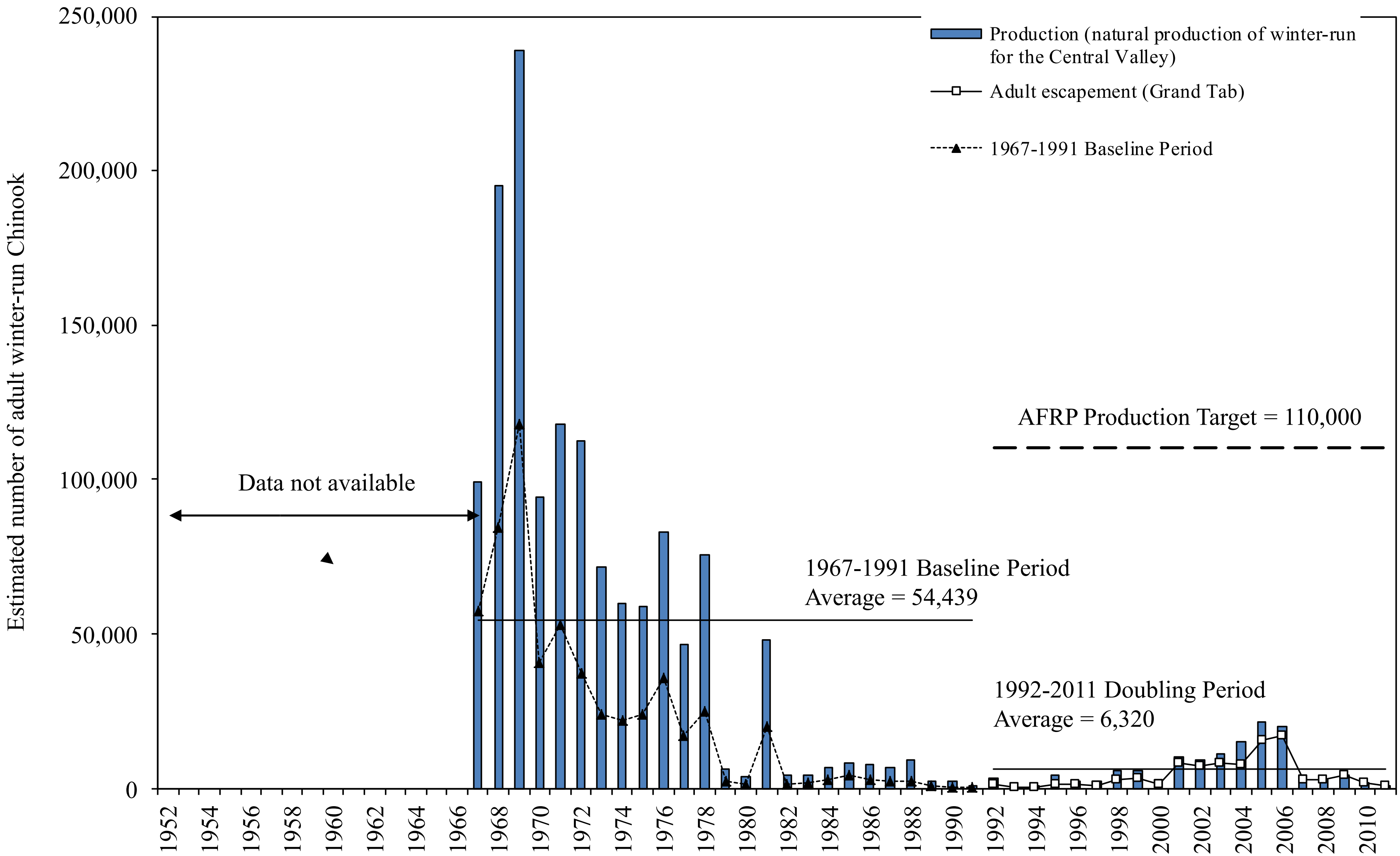

Figure 4. Estimated yearly adult natural production, and in river adult escapements of winter-run Chinook salmon in the Central Valley rivers and streams. 1992 - 2011 numbers are from CDFG Grand Tab (Apr 24, 2012). 1967-1991 Baseline Period numbers are from Mills and Fisher (CDFG, 1994).

ATTACHMENT 2

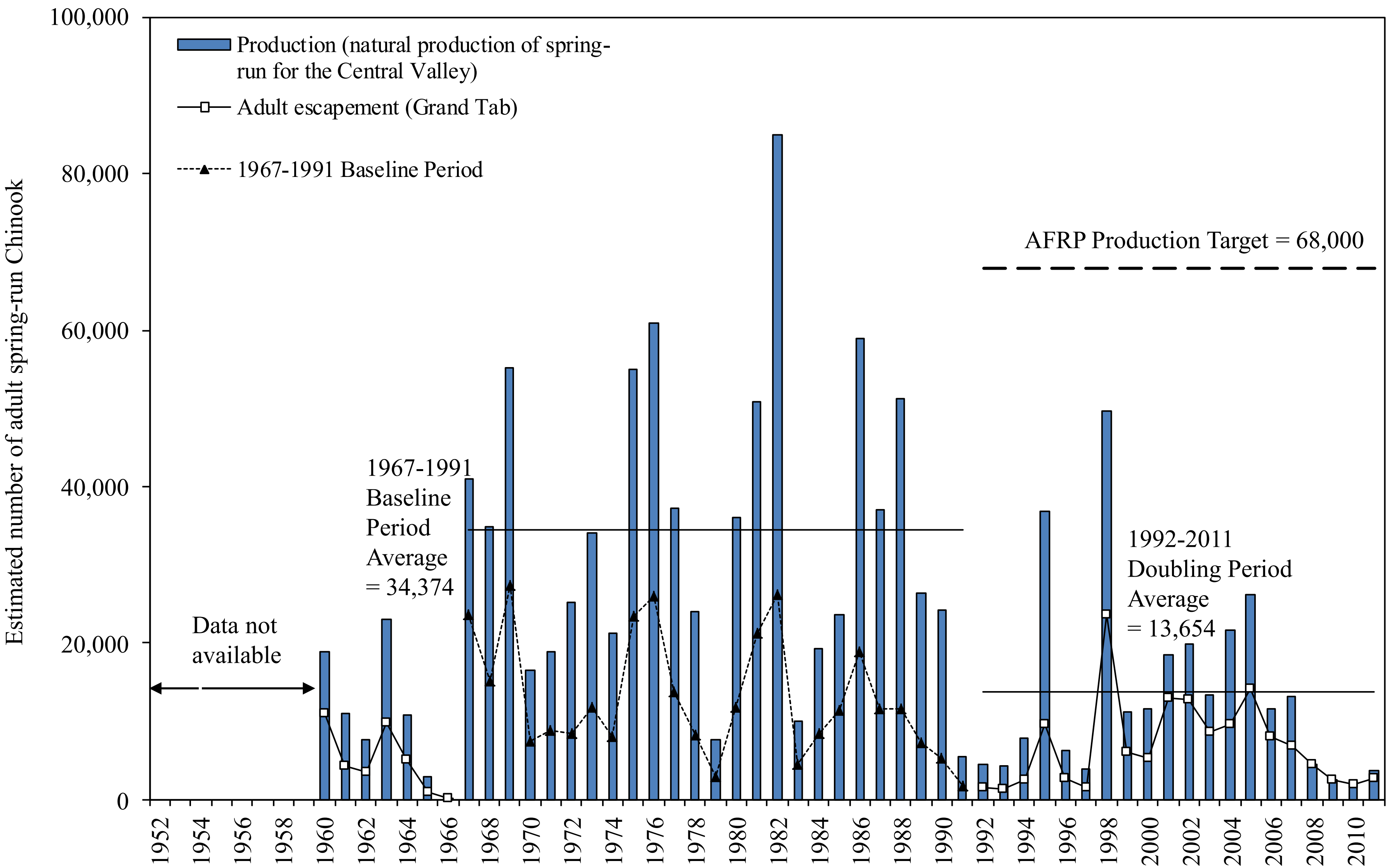

Figure 5. Estimated yearly adult natural production, and in-river adult escapements of spring-run Chinook salmon in the Central Valley rivers and streams. 1960 - 1966 and 1992 - 2011 numbers are from CDFG Grand Tab (Apr 24, 2012). 1967-1991 Baseline Period number are from Mills and Fisher (CDFG, 1994).

ATTACHMENT 3

BDCP1597

Percentage Change in Salmon Survival Rates with and without BDCP

Salmon Run/Statistic	BDCP Chapter 5 Source Table	Baseline Conditions Now (EBC1)	Baseline Conditions in 2060 Without BDCP (EBC2-LLT)	Twin Tunnels Operation in 2060 (ESO-LLT)	Between Now and Without Twin Tunnels by 2060	Between Now and With Twin Tunnels by 2060	In 2060 With Twin Tunnels versus Without
Winter-Run	5.5.3-10						
Average		34.7%	34.2%	33.2%	-1.4%	-4.3%	-2.9%
Median		32.4%	31.8%	28.7%	-1.9%	-11.4%	-9.7%
Spring-Run	5.5.4-5						
Average		31.1%	30.3%	29.1%	-2.6%	-6.4%	-4.0%
Median		27.0%	26.4%	25.1%	-2.2%	-7.0%	-4.9%
Sac River Fall Run	5.5.5-8						
Average		25.7%	24.7%	24.4%	-3.9%	-5.1%	-1.2%
Median		22.8%	21.6%	22.4%	-5.3%	-1.8%	3.7%
Late Fall-Run	5.5.5-10						
Average		23.1%	22.9%	23.0%	-0.9%	-0.4%	0.4%
Median		20.1%	20.6%	21.3%	2.5%	6.0%	3.4%
San Joaquin River Fall-Run	5.5.5-18						
Average		13.7%	13.5%	13.2%	-1.5%	-3.6%	-2.2%
Median		10.7%	10.3%	12.1%	-3.7%	13.1%	17.5%
Mokelumne River Fall-Run	5.5.5-20						
Average		16.0%	15.9%	16.3%	-0.6%	1.9%	2.5%
Median		15.2%	14.0%	14.1%	-7.9%	-7.2%	0.7%

Source: Chapter 5, Effects Analysis, Sections 5.5.3 through 5.5.6, Bay Delta Conservation Plan, 2013.

EXHIBIT D

June 6, 2014

Comments on the Public Draft Bay-Delta Conservation Plan (BDCP) and Draft BDCP Environmental Impact Report/Environmental Impact Statement

Dave Vogel
Senior Scientist[1]
Natural Resource Scientists, Inc.
P.O. Box 1210
Red Bluff, CA 96080
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GENERAL OVERVIEW

On an overall basis, the Public Draft Bay-Delta Conservation Plan (BDCP) and the Draft BDCP Environmental Impact Report/Environmental Impact Statement (EIR/EIS) (collectively, BDCP documents) are unreasonably voluminous, poorly structured, highly fragmented, extremely repetitive, nearly incomprehensible, and replete with contradictory statements and logic.

The BDCP is based on a premise that purports to provide an alternative or supplemental means to export northern California water past the Delta[2] to supposedly reduce impacts on fishery resources as compared to sole use of the existing federal and state south Delta water export facilities. The linchpin of this concept is to build three large water diversions on the lower Sacramento River. Many major design features and critical operational criteria have not been determined. As such, the proposed north Delta water diversions are an unprecedented, extremely high-risk experiment with a very high probability of failure for fish protection and an irreversible commitment of resources. Adverse impacts to anadromous fish could potentially be catastrophic.

These comments primarily focus on the potential effects of the BDCP on Sacramento River basin anadromous salmonids and the following key issues:

1) Oversimplification of salmonid behavior and BDCP impacts on salmonids. Salmonid fry, parr, and smolt behaviors are highly complex and variable but are not adequately incorporated into the BDCP analyses. For example, the BDCP used simplified, composite estimates in its analyses of juvenile salmon emigration into the Delta that does not account for very important inter-annual variability in outmigration timing caused by upstream precipitation events and hydrologic conditions. Due to the nature of how the north Delta intakes would operate, there is an unaccounted for variability in salmon exposure to the intakes, Fremont Weir, and downstream flow splits (e.g., Georgiana

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[1] A copy of my current resume is attached hereto as Exhibit 1.
[2] Conflicting statements on the topic of water supply are in the BDCP documents: "It is not intended to imply that increased quantities of water will be delivered under the BDCP." (EIR/EIS Page 2-5) "The BDCP is intended to minimize entrainment levels, while also *increasing water supply* and water supply reliability (emphasis added)." (BDCP Page 5.B-2)

Slough) that significantly compromises the ability to compare BDCP alternatives and assess potential effectiveness of its conservation measures.

2) Extensive unresolved uncertainties concerning impacts on salmonids associated with the BDCP and its various elements. The effects of every BDCP conservation measure associated with salmon are characterized as "uncertain" or "highly uncertain". In turn, the BDCP sequentially builds upon each uncertainty with the end product revealing the project's purported benefits for salmon to be untenable.
3) Conclusive statements strongly suggesting positive effects for salmonids that have no legitimate foundation. For example, the BDCP's proposed use of non-physical barriers throughout the Delta to guide fish, predator control at the north Delta intakes, and fish screen refugia lack reliable supporting basis and justification but are promoted as beneficial actions. Worse, some actions may actually cause more harm than good.
4) Consistent pattern of overstatement of potential benefits and understatement of potential adverse impacts to salmonids. Despite caveats primarily dispersed in BDCP appendices, the BDCP analyses and conclusions in the main body of the BDCP display a trend where favorable fish model outputs are overstated and unfavorable outputs are downplayed. For reasons described in these comments, the BDCP models, in reality, have a very low sensitivity for adequately providing the necessary comparative analyses to estimate benefits.
5) Frequent erroneous or invalid assumptions in the analyses of effects on salmonids. For example, the BDCP fish models' estimates of salmon survival and fish route selection used to evaluate various BDCP alternatives are unreliable for making management decisions among BDCP scenarios and conservation measures. Some of the salmon survival estimates used for BDCP models were undoubtedly inflated, but also possessed highly questionable and unknown variance in estimated salmon route selection at critical Delta flow splits, reach-specific survival, and overall survival through the Delta.
6) Propagation of errors in BDCP fish models resulting from faulty BDCP CalSim II water supply and water operations modeling (BDCP Model). Much of the BDCP fish modeling efforts relied on CalSim II model outputs but a recent independent review of the BDCP Model revealed numerous significant flaws (MBK 2014) that were, unfortunately, carried through to the BDCP fish models. The BDCP's inaccurate depiction of changes in water storage in upstream reservoirs, reservoir releases, and water exports in the north and south Delta would undoubtedly significantly alter analyses of the BDCP effects on salmonids and other fish species. The BDCP Model errors result in an adverse cascading affect on the reliability of the BDCP fish models and, therefore, the BDCP effects on salmonids were obviously mischaracterized by an unknown, but probably very severe, degree. Given the limitations and errors of the BDCP fish models described in these comments, the fish models' reliance on faulty BDCP Model outputs at the outset further adds to the undependably modeled and unknown BDCP effects.
7) Lack of essential details on key BDCP elements. For example, numerous critical design features and fish protective criteria of the north Delta intakes are not described or have not yet been developed, Fremont Weir fish passage options are unclear or undeveloped, and many conservation measures (e.g. in-Delta habitat alterations) lack any relevant supportive details as to their efficacy.
8) Improper complete reliance on ill-defined passive adaptive management without explicitly describing how future problems may be resolved. Recent, prominent examples

are provided in these comments to clearly demonstrate that there has been a strong, consistent legacy in the Central Valley and Delta of *not* implementing adaptive management for the protection of fishery resources, even for relatively simple actions. The BDCP is entirely dependent on so-called adaptive management to attempt correction of deficiencies in the plan after it is implemented. Recent experience indicates otherwise and statements in the BDCP documents lack reliability and do not inspire confidence that anticipated future problems for salmon caused by the BDCP would be resolved.

9) <u>Misuse or lack of use of the best available science.</u>[3] Among other examples, the BDCP failed to utilize the basic tenets of protective criteria for effective fish screen design (e.g., sweeping velocities and fish exposure time), misapplied data from juvenile salmon studies in the Delta, displayed a faulty understanding of juvenile salmon and predatory fish behavior and habitat preferences, misinterpreted past fish screen research projects, and omitted substantial relevant data for evaluative fish models.

The BDCP documents are severely biased in the ultimate conclusions because they are predicated on information that is highly tenuous, speculative, and substantially misleading. The documents frequently overlooked highly relevant scientific facts and instead chose to rely upon sparse information that was outdated or incorrect. The BDCP documents appear to selectively "pick and choose" reports and opinions that support its rationale while ignoring science that points to the opposite. The BDCP derived numerous conclusions from limited or erroneous information. For example, when modeling results suggested positive effects for fish, they were embellished and overemphasized, and when results indicated negative impacts on fish, they were downplayed and deemed insignificant. To summarize, the BDCP's effects analyses lack scientific objectivity.

As described in detail later in these comments, the BDCP has questionable benefits and feasibility, and is built upon invalid or extremely dubious assumptions. Major uncertainties are sequentially built upon major uncertainties throughout the BDCP documents, but the many caveats sprinkled throughout the EIR/EIS and BDCP do not carry through to the conclusions. A main concern is that the BDCP documents have relied extensively on assumptions about juvenile salmonids that are either incorrect or unfounded, and are full of highly speculative assertions and oversimplification regarding how BDCP actions may or may not affect these fish. Those assumptions are then used as a foundation for conclusions that are unsupported.

BDCP's So-Called "Best Available Science"

The BDCP claims to be based on the "best available science", directly implying to an uninformed reader that the document is "correct" in its analyses and interpretation. The BDCP provides the following statements in this regard:

> "The effects analysis is built on and reflects an extensive body of monitoring data, scientific investigation, and analysis of the Delta compiled over several decades, including the results and findings of numerous studies initiated under the California Bay-Delta Authority Bay-Delta Science Program, the long-term

[3] Due to the enormity and poor readability of the documents, comments not provided here on any particular statement or element in the BDCP do not imply agreement.

> monitoring programs conducted by the Interagency Ecological Program, research and monitoring conducted by state and federal resource agencies, and research contributions of academic investigators. It provides the fish and wildlife agencies with the information that they will need to make their regulatory findings and issue incidental take permits and authorizations for the BDCP." (BDCP Executive Summary Page 19)
>
> "The conservation strategy was informed by the collective experiences of professionals working in the Delta over the course of several decades, monitoring results and conceptual models developed over time through prior scientific efforts (e.g., those conducted by the California Bay-Delta Authority [CALFED] Science Program), and supplemented by data and analysis developed through the BDCP process. The conservation strategy is based on the best available science …" (BDCP Page 1-2)
>
> "The Bay Delta Conservation Plan (BDCP or the Plan) is built upon and reflects the extensive body of scientific investigation, study, and analysis of the Delta compiled over several decades, …" (BDCP Page 10-1)
>
> "Those conclusions are reached through a systematic, scientific evaluation of the Plan's potential adverse, beneficial, and net effects." (BDCP Page 5.1-1)

Such assertions (and a voluminous number of others throughout the BDCP documents containing similar wording), imply that the BDCP's foundation, models, findings, and conclusions are indisputable and beyond reproach. On the contrary, however, my review indicates that, in the BDCP much of the available scientific information was misused and/or misinterpreted and substantial quantities of some critically important scientific information were incorrect, outdated, overlooked, or perhaps purposefully not included. Many of the assumptions concerning anadromous salmonids are in error.

Overstatement of Potential Benefits

The BDCP has clearly overstated potential benefits to salmonids. For example:

> "Increasing the through-Delta survival of juvenile salmonids will be accomplished by maximizing survival rates at the new north Delta intakes, increasing survival rates at the south Delta export facilities, reducing mortality at predation hotspots, increasing habitat complexity through restoration actions along key migration corridors, guiding fish originating in the Sacramento River away from entry into the interior Delta, and ensuring pumping operations do not increase the occurrence of reverse flows in the Sacramento River at the Georgiana Slough junction." (BDCP Page 3.3-140)
>
> "Operation of the north and south Delta intakes provides the operational flexibility to achieve the following improvements." (BDCP Page 3.2-7)

- "Improve passage of fish within and through the Delta by improving hydrodynamic and water quality conditions that can create barriers to movement and high susceptibility to predators." (BDCP Page 3.2-7)

- "Reduce the risk of entrainment of covered fishes by conveying water from either the north or south Delta, depending on the seasonal distribution of their sensitive life stages." (BDCP Page 3.2-7)

> "The combination of moving water through a new isolated tunnel/pipeline facility in conjunction with the existing south Delta facilities—referred to as dual conveyance—is expected to provide flexibility sufficient to substantially reduce the entrainment of covered fish species while providing the desired average water supply." (BDCP Page 3.2-8)

> "DWR will construct new diversion and conveyance facilities that will be designed and operated to improve conditions for fish by conveying water from the Sacramento River in the north Delta to the existing water export pumping plants in the south Delta. This new tunnel/pipeline conveyance facility will allow for reductions in diversions at the existing SWP and CVP south Delta facilities, thereby minimizing reverse flows and reducing entrainment of covered fish species by the SWP and CVP in the south Delta." (BDCP Page 4-7)

Notably lacking in the BDCP documents are clearly articulated objective and impartial analyses and balanced statements concerning the project's potentially serious impacts (both positive and negative) to fish. This is discussed further below.

SPECIFIC COMMENTS

BDCP Conservation Measures

The BDCP proposes a suite of largely general, non-specific actions (conservation measures) to meet regulatory requirements for implementation of the plan.

> "The conservation strategy has been developed to meet the regulatory standards of Sections 7 and 10 of the federal Endangered Species Act (ESA), the Natural Community 7 Conservation Planning Act (NCCPA), and the California Endangered Species Act (CESA)." (BDCP Page 3.1-1)

Generalized statements are provided to suggest that the proposed conservation measures in the plan will result in a net improvement for conditions for fish and other species:

> "Landscape-scale conservation measures are designed to improve the overall condition of hydrological, physical, chemical, and biological processes in the Plan Area. These measures include improving the method, timing, and amount of flow and quality of water into and through the Delta for the benefit of covered species and natural communities." (BDCP Page 3.1-3)

However, as described below, some of the prominent proposed conservation measures and interrelated elements are non-specific, based on limited or no supporting data, have highly questionable benefits, and may actually create worse conditions for salmonids than the existing environmental baseline.

Conservation Measure 1 (CM1): Water Facilities and Operation

Fundamentally, it is not at all clear why CM1 is deemed a "conservation measure". The primary purpose of conservation measures is to offset adverse impacts *caused by* the water facilities and operations. There is no question that the proposed three massive north Delta water diversions, fish screens, and indirect effects of operations will have some degree of negative consequences to salmonids, possibly very severe. It is important to remember that the majority of Chinook salmon in the Sacramento Valley—the most important spawning and rearing habitat for salmon in California—would need to migrate past the proposed north Delta diversions. Indeed, some of the most prominent other conservation measures are specifically proposed to counterbalance the anticipated adverse impact of the north Delta diversions on salmon (e.g., CM2, CM6, CM15, and CM16).

The BDCP proposes to construct new fish screen facilities in front of each of three new, large (3,000 cfs) intake facilities with a 9,000-cfs-capacity pumping facility[4] on the Sacramento River upstream of Sutter Slough. The size of the proposed fish screen structures will be massive, greatly exceeding the size of existing fish protective facilities currently in use on the Sacramento River: "A number of potential intakes were investigated and those selected were numbers 2, 3, and 5, with screen lengths of 1,800 feet, 1,900 feet, and 1,950 feet, respectively."(BDCP Page 5.B-7) One of the most perplexing aspects of the BDCP is the proposal to add three or more extremely large diversions in the north Delta without any factual understanding of how those diversions and the corresponding structures would impact juvenile salmon. For example, the BDCP goes to considerable effort to downplay associated risks of predation associated with the intakes and promotes the ability to "control" predation in the future (e.g., BDCP Executive Summary, Page 60, BDCP Page 3.4-39, BDCP Page 4-75). With lack of that empirical knowledge, the BDCP relies on highly speculative opinions on the topic to derive definitive (but unsupported) conclusions. Worse, many of those convictions are one-sided and fail to adequately recognize alternative scientific views indicating that the water diversions and associated structures may have major adverse impacts to young salmon.

In terms of hydraulic and physical conditions for fish protection, the proposed north Delta intakes are sited in some of the worst locations. As stated by Fish Facilities Technical Team (FFTT) (2011), "There is *a high level of uncertainty as to the type and magnitude of impacts* that these diversions will have on covered fish species that occur within the proposed diversion reach

[4] On BDCP Page 5.B-7, the BDCP states "The 15,000 cfs-capacity tunnels would allow gravity-driven transport of water from the three new 3,000 cfs intakes on the left bank of the Sacramento River …". Presumably, this is an incorrect statement and was not altered since the BDCP was changed from a 15,000-cfs facility to a 9,000 cfs facility; this should be corrected.

(emphasis added).[5]" Based on decades of experience in the design and evaluation of fish screens and water diversions, I partially agree with this statement but would characterize the effects differently and as follows: There is _a high level of certainty the diversions will adversely impact salmonids, but the type and magnitude of those impacts are uncertain_. The following describes some of the primary limitations and problems associated with the proposed three north Delta diversions.

Fish Screen Sweeping Velocities

For fish screens of the nature described in the BDCP documents, high sweeping flows and velocities are critically necessary to protect juvenile salmon because it reduces exposure time to not only the screen face [lessening the likelihood of impingement against the screens (BDCP Page 5.B-5)] but to predatory fish that will certainly harbor around the facilities. Based on my prior work, the BDCP itself states that the new diversions "would be likely predator hotspots." (BDCP Page 3.4-300.) However, the BDCP provides numerous conflicting and confusing statements concerning how the three new fish screen intakes would be operated to meet the fishery resource agencies' [National Marine Fisheries Service (NMFS), California Department of Fish and Wildlife (CDFW), and the U.S. Fish and Wildlife Service (USFWS)] criteria for fish protection. For example:

> "The positive-barrier fish screens will be designed and operated in accordance with design criteria (e.g., screen mesh size, approach velocity) _currently used_ by the fish and wildlife agencies (emphasis added)." (BDCP Page 3.2-8)
>
> "CM1 calls for the North Delta intake structure to be constructed _to meet and exceed current NMFS criteria for approach and sweep velocities_, as discussed in more detail for winter-run Chinook salmon (emphasis added)." (BDCP Page 5.5.4-16)
>
> "The sweeping velocity of water passing the intakes should be greater than the approach velocity under the NMFS (1997) criteria, and _at least double the approach velocity_ per the CDFW (2000) criteria (emphasis added)." (BDCP Page 5.B-7)
>
> "These self-cleaning, positive- barrier fish screens will be designed to the established protection standards for salmonids and delta smelt, and _will comply with CDFW, NMFS, and USFWS fish screening criteria_ as discussed in Appendix 5.B, *Entrainment* (emphasis added)." (BDCP Page 4-9)
>
> "The intakes would be sized to provide screen area, in accordance with federal and state standards, sufficient to prevent entrainment and impingement of salmonids and delta smelt." (EIR/EIS Page 3-87)

[5] The FFTT (2011) report was written at the time when five diversion intakes were proposed for the BDCP; at the present time, three intakes are proposed.

It is important to note that the criteria currently used by NMFS and CDFW requires that the sweeping velocities be two times or greater than the approach velocities into the screens. With the mandated maximum through-screen approach velocities of 0.33 ft/s for juvenile salmon, the sweeping velocity criteria must be 0.67 ft/s or greater.

However, elsewhere in the BDCP, the documents perplexingly state that *fish screen criteria have not been finalized*. In the BDCP Appendix 5B, Entrainment, it reads: "… actual criteria for the fish screens have not been finalized" and that the BDCP analysis of the fish screens is simply "a general discussion because specific operational criteria and fish screen lengths have not been finalized". (BDCP Page 5.B-58) Other conflicting examples in the BDCP include:

> "Approach and sweeping velocity criteria for the north Delta intake screens have not been finalized, but approach velocity will be 0.33 foot per second (fps) (the criterion for salmonid fry) or less, …" (BDCP Page 5.5.1-31)

> "As noted for other species, approach and sweeping velocity criteria for the north Delta intake screens have not been finalized, but approach velocity will be less than or equal to 0.33 fps (the criterion for salmonid fry) and may at times be limited to 0.2 fps (the existing criterion for juvenile delta smelt)." (BDCP Page 5.5.3-23)

The BDCP acknowledges (in an appendix) that higher sweeping velocities are beneficial for young salmon but does not carry the critically important information forward in its analyses and conclusions:

> "Final specifications have not been established fully for the screens but laboratory studies show that salmonid screen passage time would be expected to be facilitated by greater sweeping velocity." (BDCP Page 5.B-387)

Adding more confusion to the topic, the BDCP indicates elsewhere that the sweeping velocities would be in the range of 0.4 ft/s, not 0.67 ft/s or greater (thereby violating existing criteria):

> "The detailed DSM2 tidal modeling of the intakes included a downstream sweeping velocity criteria of 0.4 foot per second; the intakes were not operated when the tidal velocity was less than 0.4 foot per second, as measured downstream of the intake." (BDCP Page 5.3-7)

> "DSM2 modeling of tidal velocities at the north Delta intakes indicated that these bypass rules would be compatible with a downstream sweeping velocity of 0.4 ft/sec that was assumed protective for reducing juvenile fish impingement on the screens." (BDCP Page 5C.A-114)

> "Compliance Monitoring Action: Confirm screen operation produces sweeping velocities greater than or equal to approach velocities." (BDCP Page 3.D-3)

The existing CDFW requirement[6] is that fish screen sweeping velocity should be at least two times the allowable approach velocity (or $\geq$ 0.67 ft/s) and that fish exposure time to the fish screen shall not exceed 15 minutes. The NMFS (1997) states that large stream-side installations may require intermediate bypasses along the screen face to prevent excessive exposure time to avoid fry impingement. A variance to that requirement was developed for the 1,000-ft long GCID screens, but only because of the very high sweeping flows at the facility. Some agencies outside California prefer that the sweeping velocities be at least 2 ft/s (USBR 2006). Emphasizing the importance and benefits of high sweeping velocities, Swanson et al. (2004b) state:

> "For young Chinook salmon subjected to prolonged exposure at a single large screened diversion or repeated exposures to multiple screens in their habitat or along their migratory route, the cumulative energetic costs could be substantial. … Collectively, the results indicate that, for juvenile Chinook salmon, optimal fish screen design should be guided by the objective of minimizing screen exposure duration, largely through balancing screen size (or length) with prevailing or engineered sweeping velocities."

The proposed BDCP intakes screens would possess insufficiently low sweeping velocities passing three extremely long screens positioned in close proximity causing very high, and therefore harmful, fish exposure time to the screens (discussed in more detail later in these comments).

The BDCP frequently cites a July 2011 Technical Memorandum by the FFTT to justify various components of the proposed new large fish screens. An examination of that document provides some revealing information relevant to the facilities' unsuitable locations. In reality, the FFTT was provided with poor options for fish protection due to the unique, unfavorable sites for water withdrawal from the north Delta. It is evident that the team had no choice but to recommend only general criteria that were severely constrained by the site-specific conditions of the various intakes, and not criteria necessary to protect fish. The FFTT (2011) stated that the proposed north Delta intake fish screens "… make it challenging to literally apply sweeping velocity criteria …". It is evident from the EIR/EIS that all of the numerous sites put forth for the intakes are poor for fish protection. The sites selected to carry forth from the EIR/EIS to the BDCP (Intakes 2, 3, and 5) were not chosen because those locations would provide good protection for fish but, instead, viewed as more favorable (but still bad) among the worst sites.

The BDCP modeling exercise for evaluating sweeping velocities at the proposed north Delta intakes utilized results of DSM2 modeling.

> "DSM2 modeling of tidal velocities at the north Delta intakes indicated that these bypass rules would be compatible with a downstream sweeping velocity of 0.4 ft/sec that was assumed protective for reducing juvenile fish impingement on the screens." (BDCP Page 5C.A-114)

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[6] http://www.dfg.ca.gov/fish/Resources/Projects/Engin/Engin_ScreenCriteria.asp

> "The salient point from these detailed modeling assumptions is that the north Delta intake operations largely were governed by cross-section-averaged sweeping velocity (unadjusted for the velocity at the screen face) downstream of each intake, as opposed to further downstream. There was no explicit consideration of tidal state (e.g., "do not pump during flood tides"), although tidal state would influence the criteria expressed in the modeling assumptions. Multi-dimensional modeling will be necessary to refine estimates of potential diversions." (BDCP Page 5C.4-92)

As an initial matter, an average channel velocity of 0.4 ft/s is not reflective of water velocities near the river banks where the fish screens would be located. The FFTT recognized this problem:

> "For an on-bank screen, there may be a significant difference between the average channel velocity and the sweeping velocity along the screen face due to the boundary effect of the river channel. This can be addressed to some degree by selecting screen sites on or just below the outside of river bends and modeling the flow past the screen to optimize the alignment of the screen." (FFTT 2011)

Additionally, in a BDCP appendix, the same problem is identified:

> "However, velocities in CALSIM/DSM2 are channel cross-section averages, and therefore would not represent the range of velocities that would occur across the channel, with lower velocities expected at the channel margins where the on-bank intakes would be (Pandey and Smith 2010)." (BDCP Page 5.B-88)

This issue is conceptually illustrated in cross-sectional profiles of a river (Figure 1). Scenario A depicts a relatively straight reach of river where the highest water velocities are near the center of the channel and the lowest near the channel margins thereby providing unfavorable locations to site long, flat-plate fish screens. However, in Scenario B, a bend in the river offers the highest water velocities on the outside of the river bend and, therefore, are preferred locations to position long, flat-plate fish screens and reduce fish exposure time.

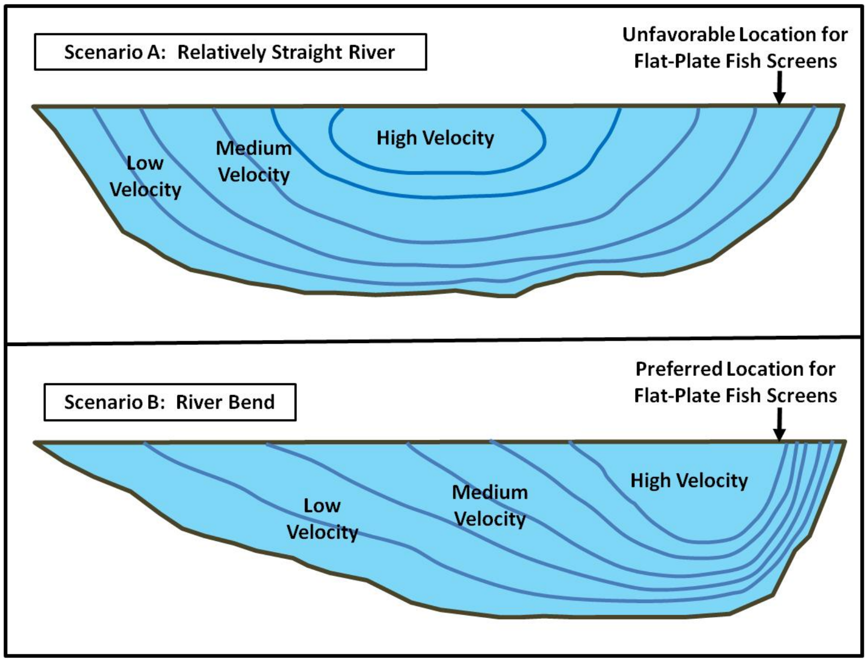

Figure 1. Conceptual diagrams of river cross sections showing locations of highest and lowest water velocities in a relatively straight river reach (Scenario A) and at a river bend (Scenario B).

These riverine hydraulic attributes are empirically demonstrated for cross-sectional profiles in Figures 2 and 3. Note that these examples are located in the Sacramento River upstream of the Delta where river gradient is much steeper, the channel is narrower, and overall water velocities are higher than the locations where the three north Delta intakes are proposed; however, the foregoing principles remain the same.

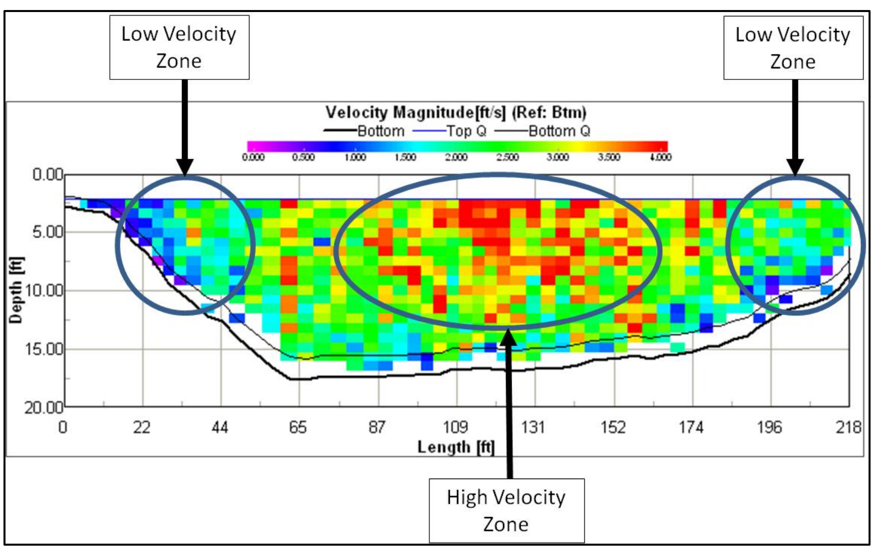

Figure 2. An Acoustic-Doppler Current Profiler (ADCP) cross-sectional transect of a relatively straight reach of the Sacramento River upstream of Knights Landing (from Vogel 2008a).

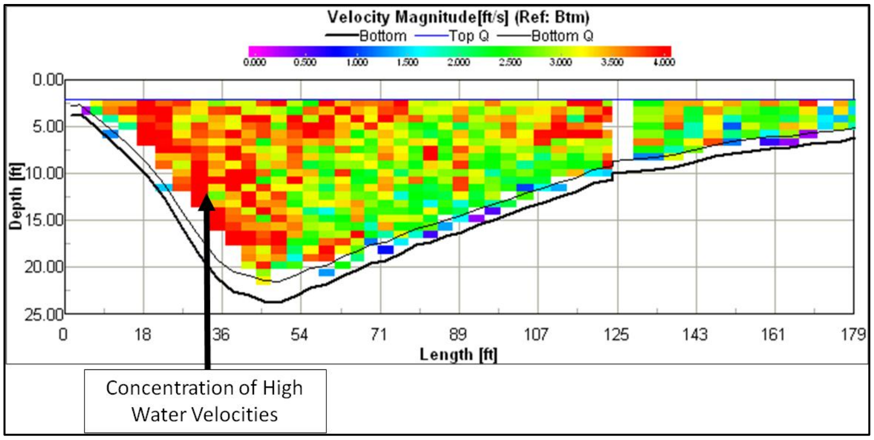

Figure 3. An Acoustic-Doppler Current Profiler (ADCP) cross-sectional transect of a river bend in the Sacramento River upstream of Knights Landing (from Vogel 2008a).

As pointed out by FFTT (2011), this problem for flat-plate fish screen siting to improve sweeping flows can be partially alleviated by locating the fish screens on the outside bends of the river channel. Existing examples of large Sacramento River flat-plate fish screens demonstrate how that measure has been successfully implemented (e.g., Figures 4 - 6).

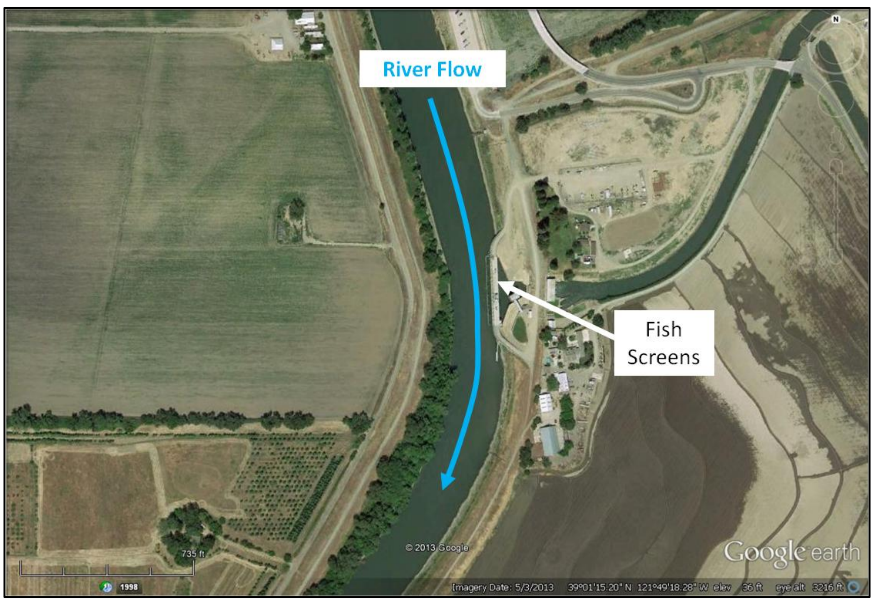

Figure 4. Aerial photograph of an example of an existing Sacramento River flat-plate fish screen located on an outside river bend to maintain high sweeping velocities.

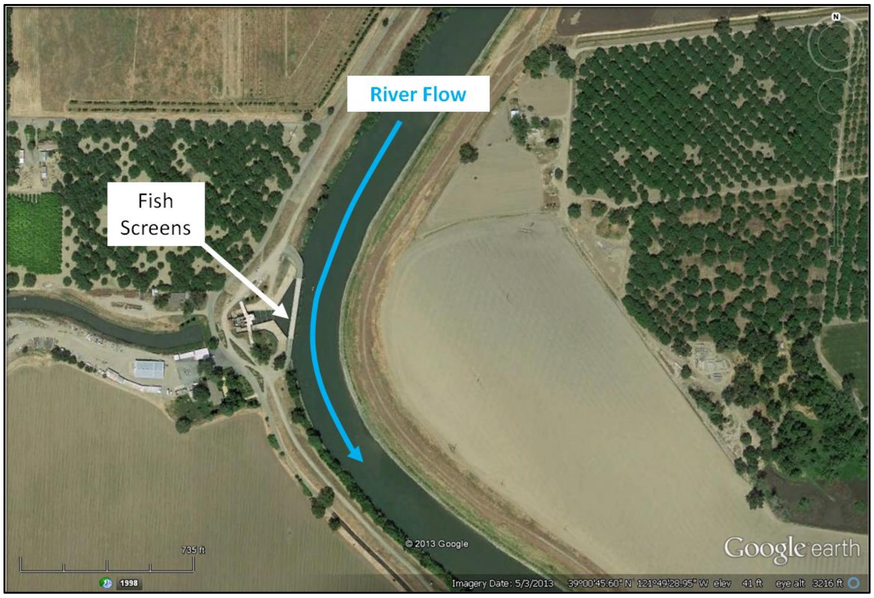

Figure 5. Aerial photograph of an example of an existing Sacramento River flat-plate fish screen located on an outside river bend to maintain high sweeping velocities. Water velocities passing the screen typically range between 2 to 4 feet/second (USBR 2006).

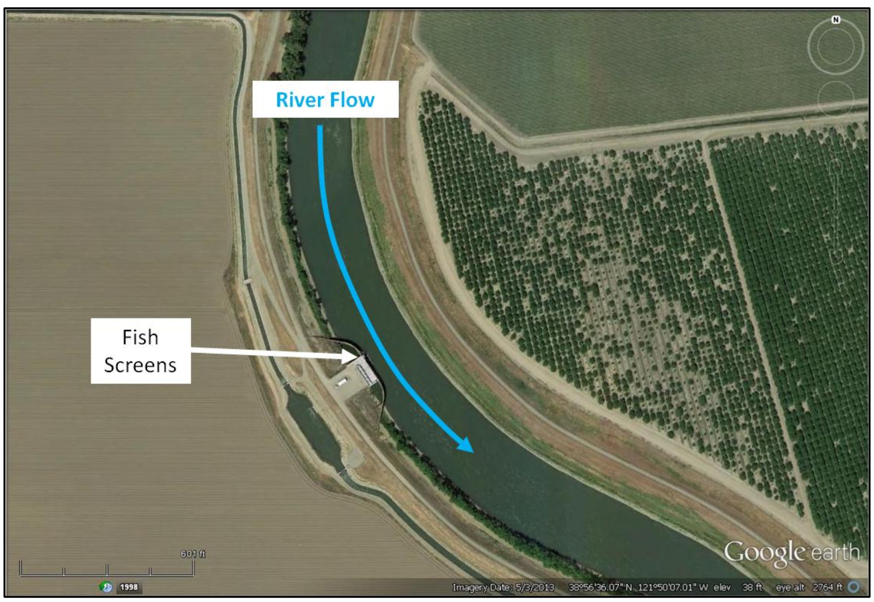

Figure 6. Aerial photograph of an example of an existing Sacramento River flat-plate fish screen located on an outside river bend to maintain high sweeping velocities.

In sharp contrast to these real-world examples, the three proposed north Delta intakes would be positioned in only *very slight* (or "gentle"[7]) river bends or relatively straight sections of the river channel (Figures 7 - 9) and lower gradient reaches of the river. (BDCP EIR/EIS, Page 3F-15, BDCP EIR/EIS Chapter 3, Appendix 3H)

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[7] Adjective used in the BDCP documents.

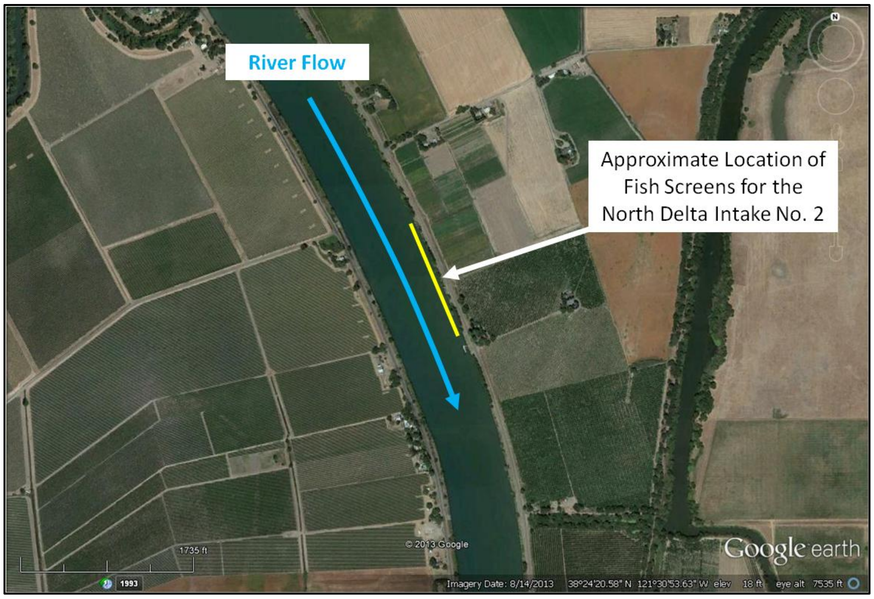

Figure 7. Aerial photograph of the approximate location of the proposed north Delta intake alternative no. 2.

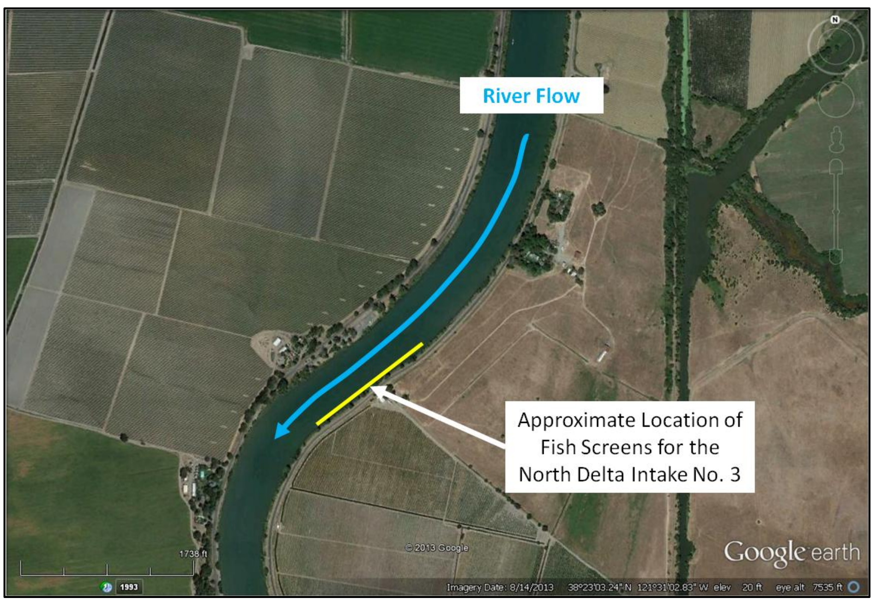

Figure 8. Aerial photograph of the approximate location of the proposed north Delta intake alternative no. 3.

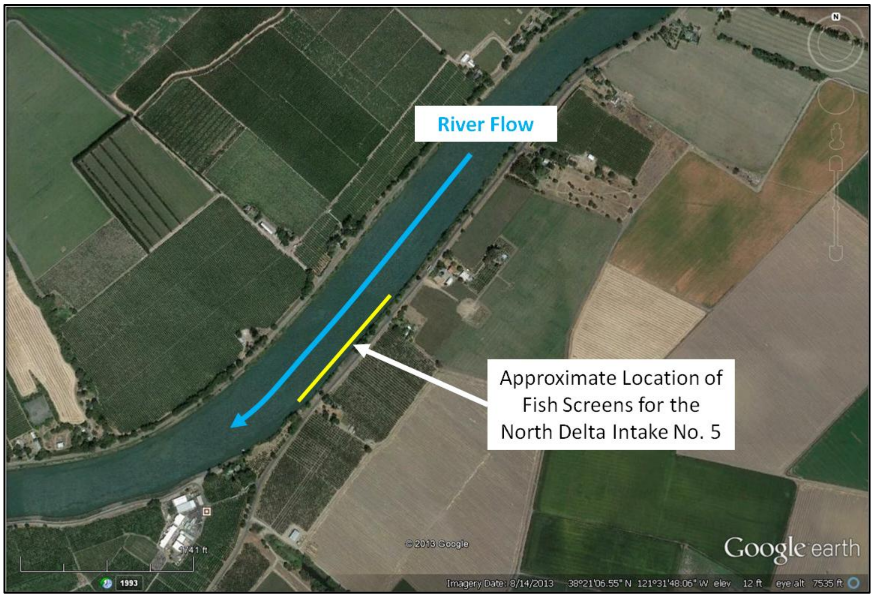

Figure 9. Aerial photograph of the approximate location of the proposed north Delta intake alternative no. 5.

These sites will not provide the near-screen sweeping velocities necessary to protect downstream-migrating salmon. The salient point is that past experience has clearly demonstrated that maintaining high sweeping velocities in front of large riverine flat-plate fish screens requires one of following to take place:

1) Alter river channel geometry and create channel constrictions to control the hydraulic conditions at the fish screens.
2) Position the fish screens on the outside sharp (not "gentle") bend of the river channel where high water velocities are naturally present (e.g., Figures 4 - 6).
3) Angle the fish screen out into the river channel in a downstream direction or jut the entire structure out into the channel in deeper, swifter water to maintain sweeping flows.

The locations of the north Delta intakes, as presently envisioned in the BDCP, do not possess any of those conditions. Of the options above, only number 3 could be implemented, in theory, to maintain high sweeping velocities on the face of the fish screens. However, doing so will create significant hydraulic controls in the river channel causing back-water effects and could produce unacceptable flood risks in the region. Additionally, this alternative would also create ideal predatory fish habitats. As shown in the schematic in Figure 10, ideal predator habitats are created by jutting the screen out into the river channel causing slack water and/or back eddies. Predatory areas are also generated adjacent to sheet pile walls upstream and downstream of the fish screens by eliminating laminar flow and causing hydraulic turbulence and eddies near the walls favoring predatory fish holding habitats and reducing predatory fish energy expenditure. As a result, juvenile salmon moving downstream past these locations are greatly subjected to predation. This problematic scenario is seen in Figure 10 at location "B" where fish become concentrated by reduced flow entrained through the fish screens. When migrating past the screens, the fish sequentially become more and more concentrated until reaching the lower-most portion of the structure where the small salmon can become easy prey for predators residing in the back eddies or slack water. Furthermore, even during periods when the north Delta intakes are not diverting water, young salmon would still be exposed to the predatory fish habitat in locations "A" and "B". Such problematic areas to avoid in fish screen designs have been described by others (e.g., Odenweller and Brown 1982, Vogel and Marine 1995, NMFS 1997, USBR 2006, CDFW 2010). These serious problems are not adequately described in the BDCP documents or are downplayed.

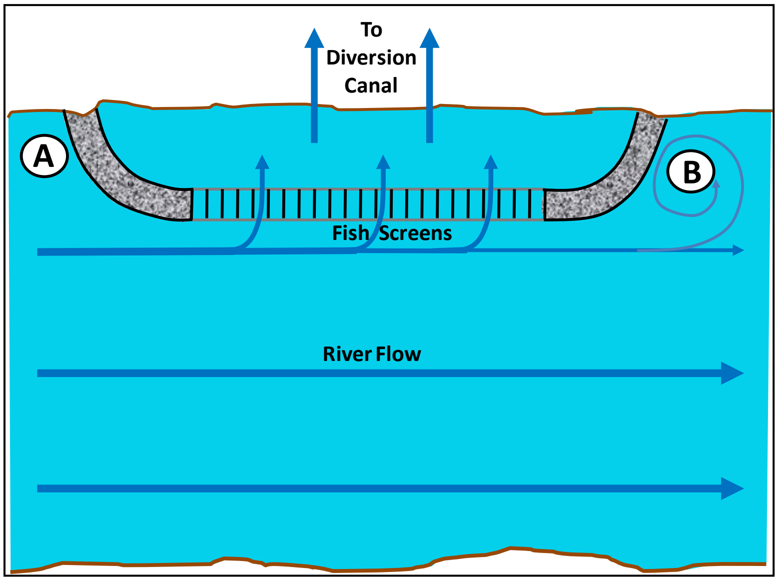

Figure 10. Top view schematic showing predatory fish habitats ("A" and "B") upstream and downstream of a hypothetical fish screen at a proposed north Delta water intake.

Notably, the BDCP portrays the positioning of the three large north Delta intakes as essentially flush with the riverbank (Figures 11 and 12). This is deceiving and makes the intake facilities look more benign than in reality. It would not be possible to construct and operate these types of facilities while subsequently providing protection for fish because of the previously- and later-described reasons. Among other problems, these configurations would not provide sufficient screen area and sweeping flows to protect salmon. The conceptual configurations displayed in Figures 11 and 12 would be unacceptable and not capable of meeting criteria for fish protection. It is not clear why the BDCP documents provide such misleading graphics when it is well known through technical details provided in NMFS (1997), USBR (2006), and CDFW (2010) such designs would fail to meet the fishery resource agencies' protection criteria for young salmonids. This is particularly disturbing because so much depends on the specific, yet undisclosed, design details of the intake facilities. The BDCP is extremely murky in regard to the critically important features of the facilities, and implies that many additional BDCP elements also lack transparency and have not used the best available scientific information. Additional fallacies in the facilities' basic designs are described elsewhere in these comments.

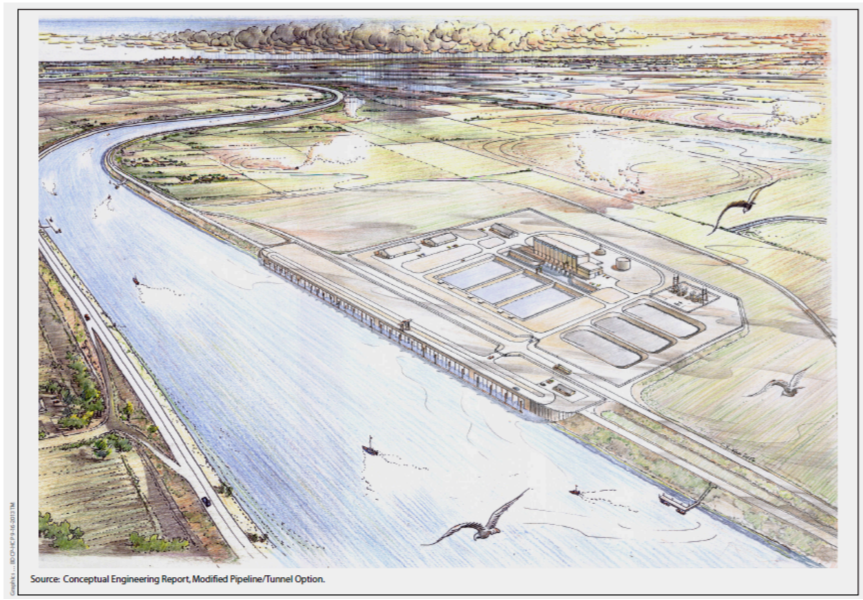

Figure 11. Conceptual rendering of a north Delta intake structure (BDCP Figure 4-7).

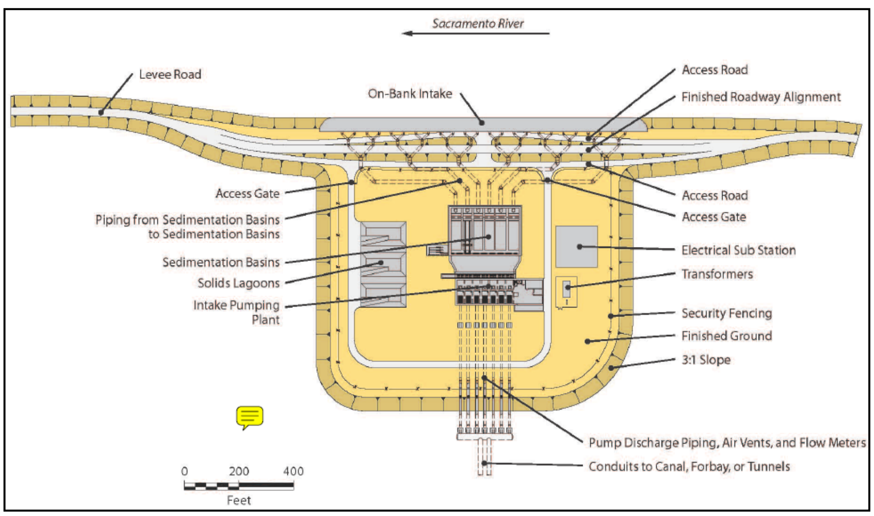

Figure 12. Conceptual intake structure for a 3,000 cfs proposed north Delta diversion (From BDCP figure 5.B.3-1 Source: Adapted from TM 20-2 Rev 0 Proposed North Intake Facilities for the Draft EIS, Figure O-5. Note that length differs from actual proposed intakes.)

The BDCP documents do not provide any information on how these serious limitations would be overcome and how negative results to fish can be avoided (other than “predator removal” and “adaptive management” discussed later in these comments). The puzzling part of the BDCP is that the river channel velocities near the proposed water intakes could have easily been empirically measured using an ADCP (e.g., Figures 2 - 3) during flow conditions when the diversions would operate in the future; theoretical modeling would not have been necessary. This deficiency is unexplained in the BDCP, and the information was not provided in the BDCP documents.

It must be emphasized that large, long fish screens of the type contemplated for the north Delta diversions using a criterion of such an exceptionally low sweeping velocity only equal to the approach velocities through the screens have never been constructed in the Central Valley. The proposed north Delta screen would be very long [up to 1,800 feet in length (BDCP Page 4-9)], greatly exceeding the length of existing screens. The estimated fish exposure times are extreme and vastly inferior to fish protection measures designed and implemented at other fish screens throughout the Central Valley (e.g., the 1,000-foot-long GCID facility described later in these comments), and would certainly result in adverse effects on salmon. No logical basis is provided in the BDCP to support viable protection resulting from such long fish exposure times and associated substandard conditions. To the contrary, the exposure times contemplated in the BDCP strongly suggest this will be a major problem for young salmon. Fish impingement and injury can result when exposure time to the screens is too long (USBR 2006). As cited by USBR (2006), a study by Smith and Carpenter (1987) evaluated duration of exposure for salmon fry and found that over 98 percent of the salmon fry tested were able to swim for at least 1 minute (and up to 3 minutes) before impinging on the screen with a screen operating at the NMFS approach velocity criterion of 0.33 ft/s. Those findings led to the NMFS criterion that salmon fry maximum exposure to fish screens should not exceed 60 seconds (USBR 2006). Because very large numbers of salmon fry will be exposed to the expansive north Delta intake screens and exposure times will be very long (discussed below), impingement will almost certainly occur and be high.

It is also important to note that fry impingement will likely be greater during periods of high water turbidity because of significantly reduced visual stimuli to avoid screen contact. For example, Swanson et al. (2004b) indicated that young salmon impingement rates on fish screens could increase with low water visibility, including high turbidity. Existing Sacramento River intakes utilizing long, flat-plate fish screens divert water during periods of relatively high water clarity in the spring, summer, and fall irrigation seasons. In sharp dissimilarity, the BDCP intakes will operate only when flows are very turbid following significant precipitation events in the upper watershed (generally during the winter months). To summarize, the expectation is that high rates of fry impingement will occur, not only because of low sweeping velocities (and associated very long transit times past the screens – discussed below), but also because of very low water clarity when the diversions would be in operation.

The BDCP discussion concerning the estimated enormous juvenile fish exposure times along the face of new fish screens positioned in front of the proposed large water diversion structures is particularly disturbing from a fish-protection standpoint. The BDCP provides extremely important, but very brief, illustrations of the severity of adverse conditions for young salmon at the proposed north Delta intakes. This information demonstrates the high degree of significance for adequate sweeping velocities past the extremely long proposed fish screens. Experimental trials at the University of California – Davis (UCD) Fish Treadmill facility suggest that juvenile salmon would experience very long passage times past the proposed north Delta intakes because of low sweeping velocities and long screen lengths (Figures 13 and 14). As described in the BDCP, the equations of Swanson et al. (2004a), upon which Figures 13 and 14 are based, estimate that with an approach velocity of 0.33 ft/sec <u>and sweeping velocity of at least twice this</u>[8], screen passage time would range from around 30 minutes (4.4-cm fish passing an 800-foot

[8] The BDCP actually proposes a much-less protective criterion.

screen[9] during the night) to nearly 5 hours (7.9-cm fish passing a 2,000-foot screen during the day) (BDCP Page 5.B-304). Compare those estimates to the 1,000-foot-long GCID fish screens possessing higher than 2 ft/s sweeping velocities (CH2M HILL 2002) and salmon passage times of only about 10 minutes. The 225-foot-long RD 108 Wilkins Slough screen has sweeping velocities ranging from 2 to 4 ft/s (USBR 2006). The estimated fish passage times for the north Delta intakes are excessive, far exceeding values for existing Sacramento River fish screens, and will likely result in impingement and predation. Importantly, many of the salmonids encountering the north Delta fish screens will be even smaller (i.e., weaker swimmers) than the size of salmon used in the UCD tests, further exacerbating the problem. This obvious adverse impact to salmon is remarkably downplayed in the BDCP documents. As discussed below, the BDCP has suggested a major relaxation of that criterion to sweeping velocities being only equal to or greater than the approach velocities, making passage times far longer (i.e., more severe) for juvenile salmon than depicted in Figures 13 - 14. Although empirical evidence indicates adverse impacts to salmon are probable, the BDCP states that the effects are "uncertain" and would be addressed *after the screens are constructed* by "monitoring and targeted studies" and, yet again, "adaptive management" (BDCP Pages 3.4-31, BDCP Appendix 3D). This proposed BDCP approach and poor, unreasoned analyses clearly did not use the best available science.

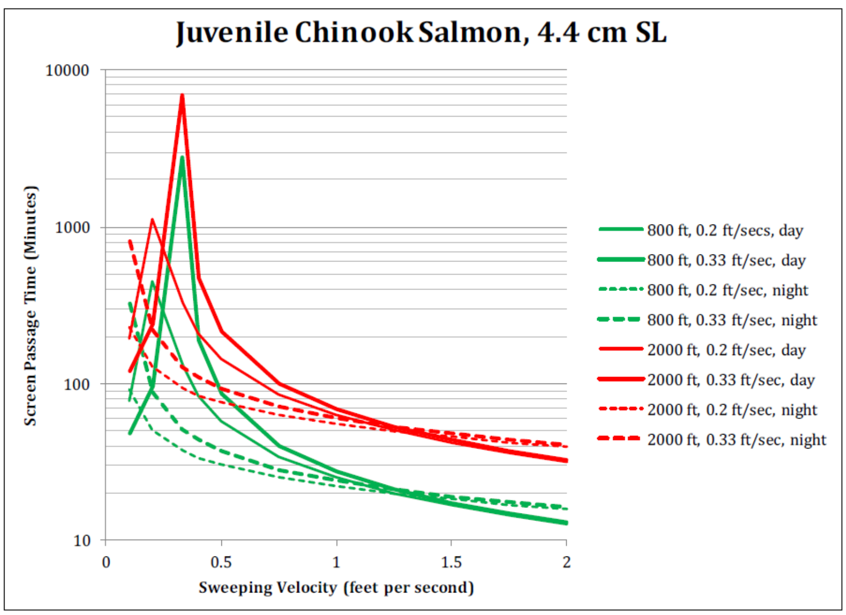

Figure 13. Estimate screen passage time for juvenile Chinook salmon (4.4 cm standard length) encountering an 800- or 2000-foot-long fish screen at approach velocities of 0.2 or 0.33 feet per second during the day and night. (from BDCP Figure 5.B.6-43)

[9] Note that the shortest proposed north Delta intake screen is 1,800 feet.

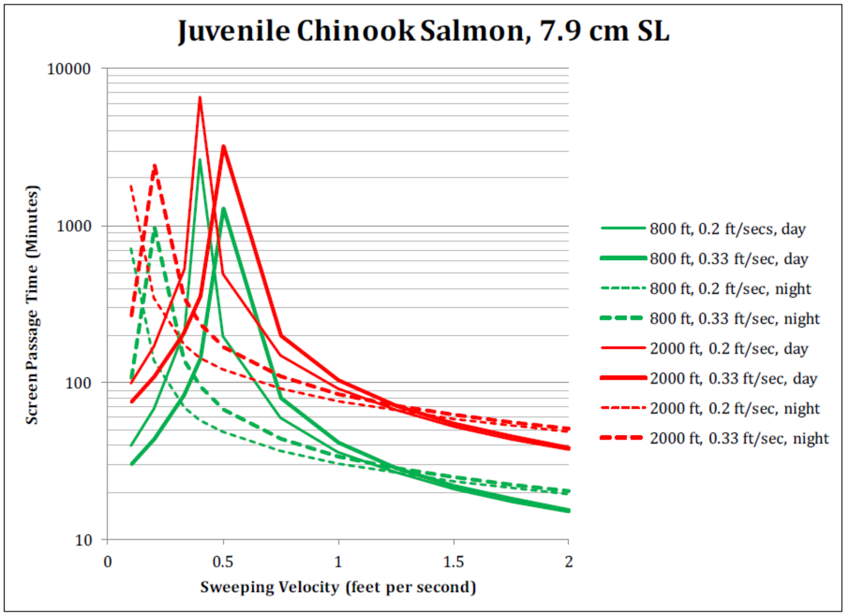

Figure 14. Estimate screen passage time for juvenile Chinook salmon (7.9 cm standard length) encountering an 800- or 2000-foot-long fish screen at approach velocities of 0.2 or 0.33 feet per second during the day and night. (from BDCP Figure 5.B.6-44)

The BDCP ignores these basic tenets of fish screen designs that have been formulated from years of extensive research and empirical studies and, instead, have used the following as a basis for the design of the fish screens:

> "North Delta intakes screening effectiveness analysis. Assessed potential for direct entrainment loss and impingement at screens for different sizes of fish based on literature and professional judgment." (BDCP Page 5.B-iii)

Although entrainment loss of salmon at the north Delta intakes would be expected to be very low, the literature and professional judgment should have indicated that impingement of salmon fry to likely be very high. The BDCP provides no scientific justification to support this serious discrepancy. It is not clear why the BDCP did not use the widely available best science concerning this critical element (e.g., Fisher 1981, NMFS 1997, Swanson et al. 2004a, Swanson et al. 2004b, USBR 2006, CDFW 2010).

It must be emphasized that all large fish screens constructed on the Sacramento River over the past 17 years were designed to meet the existing fishery resource agencies' criteria for high sweeping flows past the screens (NMFS 1997, CDFW 2010[10]). This measure was specifically implemented to protect juvenile anadromous salmonids, particularly fry (the weakest swimming life stage). Although the BDCP provides conflicting statements concerning exactly what the criteria would be for the proposed north Delta intakes, it appears that a major relaxation in that standard may be contemplated, primarily prompted by the serious physical constraints of the north Delta intake sites and ignoring protection for salmon. Based on questionable logic, the BDCP documents suggest that such a relaxation (if it does occur) is to protect small numbers of

[10] Note that CDFW updated the agency's criteria in 1997 (Petrovich 1997) to the present-day standards.

Delta smelt, not salmon (e.g., EIR/EIS Pages 3F-2, -3, -5, -7, -8, -13, -15 and BDCP Pages 5.B-311-313, 5-B-387). If the criteria are relaxed, it will likely have major adverse impacts on salmon fry originating *throughout* the Sacramento River basin. Except when the Yolo Bypass is flooding, the entire production of all runs and species of anadromous salmonids (unlike Delta smelt) must pass in front of each of the three proposed north Delta intakes (all positioned in close proximity). Impacts on salmonids could be disastrous.

Predation

The FFTT (2011) recommended that the new fish screens be designed to avoid creation of predatory fish habitat or increased vulnerability of prey. The BDCP claims that the three new fish screens at intakes on the Sacramento River will "minimize hydrodynamic conditions suitable for predatory fish". (BDCP Page 5.B-7) However, nowhere in the BDCP or EIR/EIS is it described how that near certainty will be avoided. The BDCP admittedly states:

> "… there is potential for an increase in predation risks at the north Delta intakes if they create holding habitat for piscivorous fish." (BDCP Page 5.B-303)
>
> "The north Delta export facilities on the banks of the Sacramento River likely will attract piscivorous fish around the intake structures." (BDCP Page 5.F-iii)
>
> … the proposed BDCP is expected to create new [predation] hotspots: North Delta water diversion facilities – Large intake structures have been associated with increased predation by creating predator ambush opportunities and flow fields that disorient juvenile fish." (EIR/EIS Page 3-157)

Unfortunately, the fish screen structures contemplated in the BDCP will create ideal conditions for predation on juvenile salmon and the documents provide no details on how that major problem can be avoided.

Furthermore, in the worst possible scenario for salmon, all three north Delta water intakes are to be located on the same side of the Sacramento River and in close proximity; water (and therefore fish) will be drawn toward the east riverbank. Apparently, this choice was not based on fish protection but, instead, for advantageous tunneling considerations (EIR/EIS Page 3F-15). Up to 3,000 cfs will be removed from the river at each of the three intakes but the fish will remain in the river channel. Downstream-migrating juvenile salmon will become more and more concentrated along the east bank of the river as the fish traverse the long length of each individual screen structure and arrive (if the fish do not perish from impingement or predation in transit) at the downstream end (Figure 15). This sequence of events will create a compounding concentration of fish. Predatory fish will undoubtedly become very accustomed to these ideal "feeding stations" at the lower end of each fish screen and the resultant impacts on juvenile salmon could be catastrophic. The BDCP does not describe how this serious dilemma can be avoided other than some undefined form of "predator removal" and "adaptive management" that are likely to fail (discussed later in these comments).

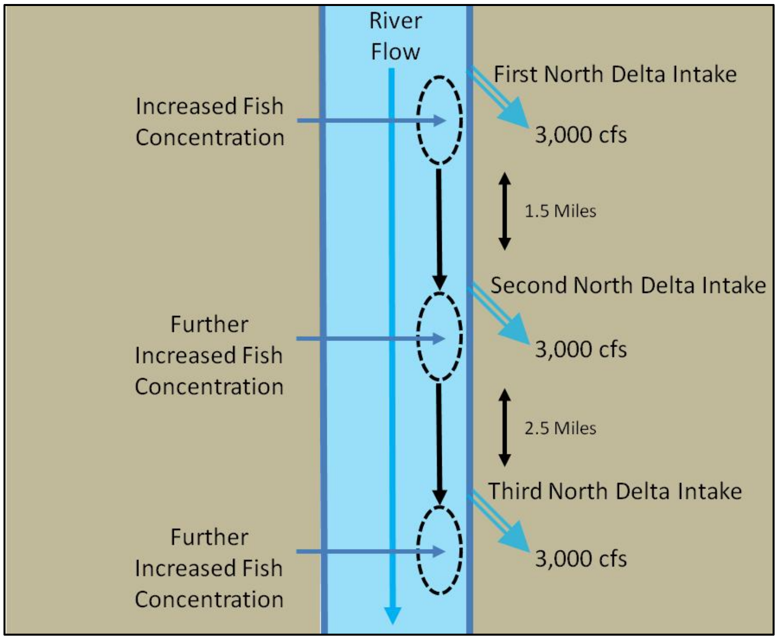

Figure 15. Conceptual plan-view schematic (not-to-scale) of the three proposed north Delta intakes on the Sacramento River and the concentrating effect on downstream migrating salmon toward the east or left bank (facing downstream).

Again, although the BDCP acknowledges this issue, no proven remedial measures are proposed to prevent it.

> "The vulnerability of covered fish to predation at the new north Delta intake structures is, to a large extent, dependent on the physical characteristic of each structure, whether fish would be concentrated or disoriented, and areas of turbulence and lower velocity refuge habitat that attract predatory fish." (BDCP Page 5.F-5)

It is important to note that the predation problem for salmon will not just exist at the lower end of the screens, but also across the entire length of the structures where salmon will experience an unquestionably long transit time and high exposure to predation. Predatory fish swimming in front of existing Sacramento River screens is already known to occur, even when sweeping velocities past the screens are very high (e.g., Figure 16). Predatory fish (e.g., striped bass) can easily swim in high velocity zones when prey (e.g., salmon) are abundant and vulnerable. This problem will be intensified with the very low sweeping velocities at the proposed north Delta fish screens where predatory fish can easily swim back and forth in front of the screens with minimal expenditure of energy. Indeed, the screen design, as presently contemplated, will provide additional "feeding grounds" for predatory fish such as striped bass and Sacramento pikeminnow that will "patrol" back and forth along the screen face. In that environment, salmonids have no protection from predation. In a very real sense, the three north Delta intakes will constitute three major gauntlets for salmon. In addition, the cumulative length of screens salmon may traverse will be nearly 1.1 miles of high vulnerability. The BDCP suggests that such structures should first be constructed, then monitored to determine if there are problems for fish. The BDCP appears to advocate the approach: "Build it and hope the fish survive."

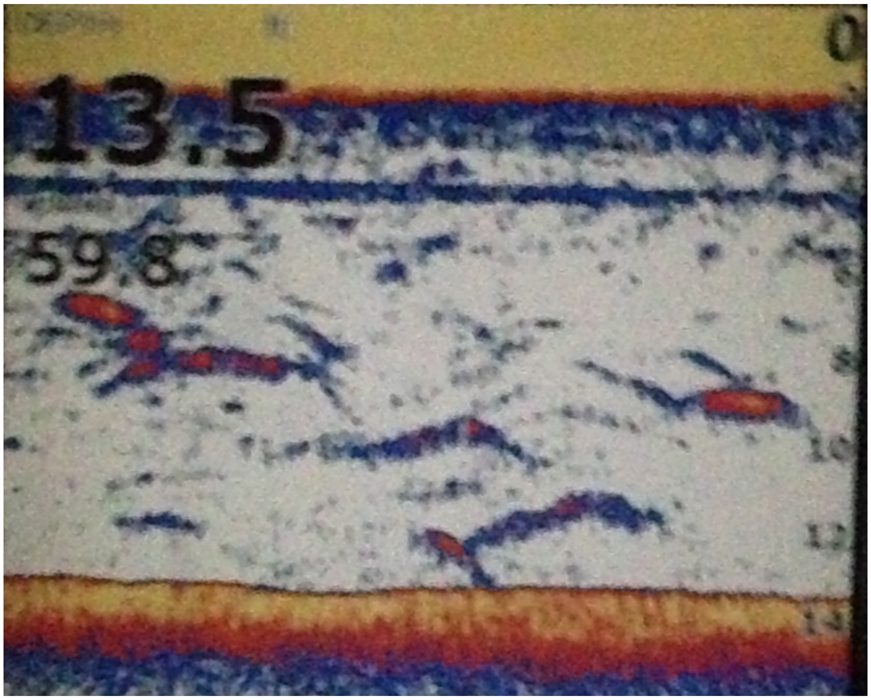

Figure 16. Depth sounder ("fish finder") image of numerous large striped bass swimming in front of a large Sacramento River fish screen. Species determined by hook and line angling. Photo by Dave Jacobs.

The BDCP states:

> "After intake structure construction is complete, the cofferdam will be flooded and the sheet pile walls in front of the intake structure removed. Sheet pile wall removal will be performed by underwater divers using torches or plasma cutters to trim the sheet piles at the finished intake structure slab grade. After removing the cofferdams, the riverbed in front of the intakes will be dredged to provide smooth hydrologic conditions along the face of the intake screens." (BDCP Page 4-10)

The last sentence of the preceding statement is very misleading and inaccurate. Dredging the riverbed in front of the cut off cofferdams will have minimal effect on hydraulic conditions along the face of the fish screens. Furthermore, the sheet pile areas described (upstream of the fish screens, along the cut off cofferdam near the base of the length of the screens, and downstream of the screens) are known areas where predatory fish may accumulate (e.g., Vogel and Marine 1995, USBR 2006). The BDCP does not explain remedial actions to avoid these problem areas for young salmon.

In addition to the convoluted sheet piles upstream, downstream, and along the base of the screens, each structure will possess additional complexities that create predatory fish holding habitat hazards for juvenile salmon. These include piles and floating booms in front of the screens and numerous large vertical wiper blades along the face of the screens. Based on an extensive literature review by Odenweller and Brown (1982), those hazards are described as follows:

> "The literature offers some assistance for minimizing and discouraging predation at the intakes and fish facilities. Piers, pilings, other supportive structures, and corners or other irregularities in a channel are referred to as structural complexities. Such structures may cause uneven flows and can create shadows and turbulent conditions. A structurally complex environment should be avoided. Corners, interstices, or other structural components that create boundary edges contribute to maximum foraging efficiency of large predatory fishes and the highest populations of predators will occur where structural boundary edges are present. Structural complexity can increase predation by providing locations for waiting predators (shadows, interstices, corners, etc.). The risk of prey to predation is a function of exposure, often directly related to the structural complexity of the system." (Odenweller and Brown 1982, at p. 48.)

Again, the BDCP does not address those known problems for salmon and, furthermore, why the readily available science on the topic was not utilized (e.g., NMFS 1997, USBR 2006, CDFW 2010).

Most importantly, the BDCP documents do not describe valid or proven remedial actions that would be undertaken to rectify predation problems when they would likely surface after the facilities are constructed. Instead, the BDCP states that it will use "adaptive management" to "inform" this predation uncertainty:

> "The uncertainty associated with predation at the north Delta intakes will be addressed with targeted research and adaptive management during implementation of the BDCP, and will also be informed by early implementation studies currently in the planning stage." (BDCP Pages 5.5.3-28 and -29)

Such ambiguous statements are inappropriate for such a potentially serious problem. The BDCP must provide descriptions of much more definitive measures for remedial actions.

Refugia Areas

In recognition of the probable adverse impacts to young salmon at the north Delta intakes from impingement and predation along the long face of the flat-plate fish screens, the BDCP recommends that fish "refugia" be incorporated into the design of the new screens (e.g., BDCP Pages 3.4-31-33, 3D-3, -10, - 28 and -29). The refugia are intended to be small resting areas along the fish screens behind racks that juvenile salmon could enter, yet would exclude predatory fish. This hypothetical concept evolved years ago from my personal underwater observations at a Sacramento River fish screen intake structure where large numbers of juvenile salmon were seen between the trash racks and fish screens: http://www.youtube.com/watch?v=kxzDCtTRiVo The FFTT (2011) report recommended that the refugia "panels" be the same length and height of a typical screen panel (15-ft wide) and be positioned approximately 100 feet apart along the entire length of each of the three new fish screens. If incorporated into the screen design, each screen would be considerably longer than without refugia. This concept is in its very early stages of experimental application and has been integrated into only one fish screen to date; it has yet to be field tested and it is entirely unknown if it will work. However, based on the one

Tehama-Colusa Canal (TCC) screen installation, the configuration (in this author's opinion) is unlikely to be favorable for salmon because of the sizing, spacing, and orientation of the racks in front of the refugia and shallow impression into the fish screen structure. The FFTT (2011) report recommended that the refugia concept be thoroughly evaluated prior to incorporation into the proposed north Delta fish screens. With such an untested theory that has enormous bearing and ramifications for fish protection, the BDCP should not be so reliant on this potential measure for salmon survival.

Because the designs of such refugia are unknown and untested, the BDCP proposes to:

> "Develop a physical hydraulic model to measure hydraulics and observe fish behavior in a controlled environment. Size/shape of refugia areas can be modified to optimize fish usage. Predators can be added to examine predation behavior near refugia (same as preconstruction study 3, *Refugia Lab Study* [Fish Facilities Technical Team 2013])." (BDCP Page 3.4-32)

and,

> "Perform field evaluation of one or more existing (or soon-to-be-completed) fish screening facilities using fish refugia. Use these data to develop understanding of expected effectiveness of fish refugia and to identify areas for improvement (same as preconstruction study 4, *Refugia Field Study* [Fish Facilities Technical Team 2013])." (BDCP Page 3.4-33)

Scale models are highly unlikely to provide useful information and data. It is this author's understanding that the one scale model of a refugia device used for the design of the new, untested TCC intake screens was conducted in clear water and artificially lighted conditions. Even when the TCC refugia are eventually evaluated, those screens are generally operated during clear-water conditions; applicability of those study results to the proposed BCDP intakes will be highly questionable. How salmon will respond to real-world conditions at the proposed BDCP north Delta intakes, with turbid water, poor (low) sweeping velocities, at night, and very long transit times along the screens are all unknown. For example, given that the BDCP intakes would be primarily operated during high Sacramento River flows when water clarity is very low, how would salmon have any visual stimuli to find and enter the so-called refugia?

Also, as mentioned previously, the BDCP failed to recognize that the north Delta intake screens will primarily operate during far different seasonal periods than when other large Sacramento River agricultural diversion flat-plate screens operate. Agricultural diversions operate in the spring, summer, and fall when water clarity is often high and the presence of anadromous fish is generally low. In contrast, the north Delta intakes would mainly be operated during the winter when water clarity is low and the presence of anadromous fish is very high. Debris loading on the fish screens and on the louvered fish refugia will be massive and unprecedented. My personal research and experience has demonstrated that Sacramento River flows during the winter possess enormous quantities of fine particulate material that could easily clog the screens and refugia. During such high river flow and debris-loading conditions, existing flat-plate screens either do not divert water or operate at only very low diversion rates. The north Delta intakes' operations will be just the opposite, and the maintenance problems could be insurmountable. The BDCP documents provide no specific insights, guidance, and analyses on this important issue.

With so much ambivalence in the BDCP documents due to a lack of empirical data to back up these decisions, how can one determine effects on fish? Because of all the unresolved uncertainties associated with the BDCP intakes, the FFTT (2011) report recommended that the effects of phasing construction of the north Delta intakes be analyzed in the EIR/EIS. The EIR/EIS subsequently did so (EIR/EIS Appendix 3F) and found that it would not be feasible to phase the construction as advocated in FFTT (2011). The inability to phase the construction greatly increases the risk to fishery resources because if the entire three-diversion facilities are completed and post-project evaluations determine critical design features have failed, impacts on salmonids could be ruinous. Building the massive facilities is an irretrievable commitment of physical and financial resources and, by their nature, significant structural modifications are implausible. It is improbable that the multi-billion dollar facilities would be removed if harmful effects on fish were discovered at a later date.

Sedimentation

The BDCP's description of the effects of the intake structures due to suspended sediment in the river and sedimentation within the facilities lacks supporting detail that will be integral to the efficacy of the project. The brief description of the facilities downplays the likely major problem that will be experienced with heavy sediment loading behind the screens. As mentioned previously, unlike most existing Sacramento River water diversions, the BDCP's three intakes will only be operated during high-flow conditions when suspended sediment in the water column will be very elevated. As a result, the three north Delta intakes will entrain enormous quantities of sediment. However, the description of the intake facilities provides an over-optimistic portrayal of how heavy sediment loads will be accommodated:

> "Water will travel in pipelines from each intake bay to a sedimentation basin and thence to intake pumping plants." (BDCP Page 4-8)
>
> "The planned operation of proposed intakes will help mitigate sediment deposition within the intake bays and conveyance conduits." (BDCP Page 4-19)

In this regard, based on my long experience and familiarity with evaluations of the 2,700 cfs Tehama-Colusa Canal (TCC) and 3,000 cfs GCID intakes, BDCP Figure 5.B.3-1 (Figure 17 below) is misleading and the portrayed design's feasibility is questionable. I participated in evaluations of sediment depositions at the TCC and GCID intakes and water velocity distributions at the GCID intake. Based on that experience, I believe that the "footprint" of the north Delta intake facilities would probably need to be much larger than illustrated in the BDCP documents. It is debatable that the extremely small sedimentation basins shown in the conceptual diagram and very briefly described in the EIR/EIS[11] could efficiently accommodate the large quantities of entrained sediment. With up to 3,000 cfs passing through the intakes, the

[11] "The sedimentation basin would be approximately 120 feet long by 40 feet wide by 55 feet deep, and would have interior concrete walls to create separate sedimentation channels." (EIR/EIS Page 3-87)

distribution of flow into the small basins would cause high water velocities that would not allow much of the sediments to settle out of the water column; the basins appear to be too short and narrow. Likewise, the spacing between the screens and the pump intakes is extremely short and may not provide sediment-settling effects. To achieve the salmon protection criteria of approach- or through-screen velocities of ≤ 0.33 ft/s, the piped intakes' design, as presented, could create numerous irregularities causing "hot spots" of high approach velocities and prevent uniformity regardless of use of flow-control baffling behind the screens. Additionally, I have conducted many dozens of underwater inspections of fish screens and have observed large sediment accumulations immediately behind the screens (upstream of forebays and sediment basins) that have proven to be problematic. To summarize, the actual footprint of the each of the three intake facilities would appear to require a larger area than implied by the BDCP.

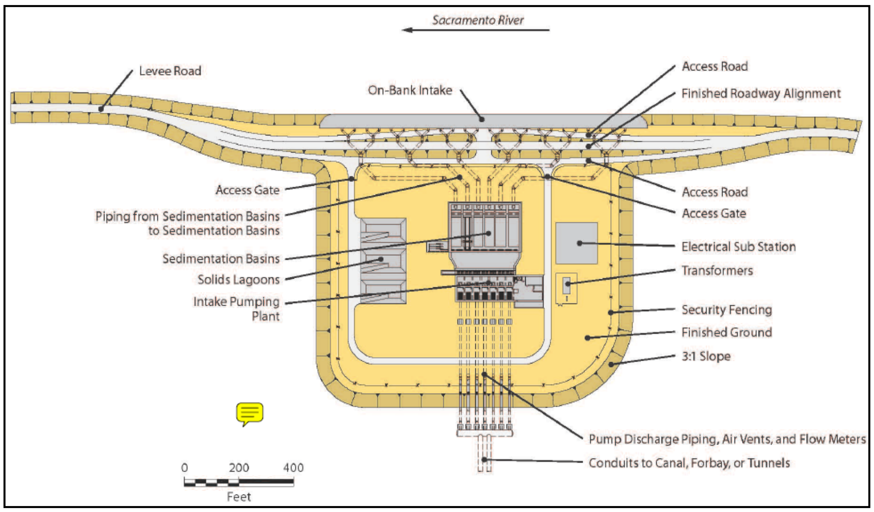

Figure 17. Conceptual intake structure for a 3,000 cfs proposed north Delta diversion (BDCP figure 5.B.3-1 Source: Adapted from TM 20-2 Rev 0 Proposed North Intake Facilities for the Draft EIS, Figure O-5. Note that length differs from actual proposed intakes.)

The following provides two empirical examples to demonstrate the foregoing concern. First, the design for the original TCC, a 2,700 cfs diversion on the Sacramento River located at the Red Bluff Diversion Dam, included a very large desilting basin at the headworks to prevent sediments from being deposited in the spawning channels of the Tehama-Colusa Fish Facilities located in the initial segments of the TCC downstream of the headworks (Figure 18). The upper portion of the TCC was designed to allow the conveyance of irrigation water and provide spawning habitats in a dual-purpose canal (which has since been abandoned) (Vogel 1983). This desilting basin was designed to settle out particles 50 microns and larger and is 0.45 miles long. Periodically, the TCC basin was dredged and the sediment was deposited into adjacent basins (Figure 18). Even with this enormous settling basin, large quantities of silt were nevertheless passed though the basin and deposited in the dual-purpose canal. The second example is a large forebay behind the GCID fish screens on the Sacramento River near Hamilton City. This design feature functions both as a settling basin to reduce silt entering the GCID main canal and provides sufficient area to accommodate uniform approach velocities through the 1,000-foot-long fish screens that include flow-control baffles (Figure 19). In both cases, the forebays are very large to accommodate less sediment loading than the north Delta intakes would experience. In sharp contrast, the design of the proposed three 3,000 cfs north Delta intakes does not accommodate any large forebays behind the fish screens to 1) contain the certain heavy silt loads or 2) have the ability to provide uniformity in screen approach velocities (Figure 17). These anticipated major problems with the north Delta intake facilities are not described in the BDCP documents nor do the documents describe how the problems would be rectified after the facilities are built. The design deficiencies and misleading information must be reconciled and corrected in the BDCP.

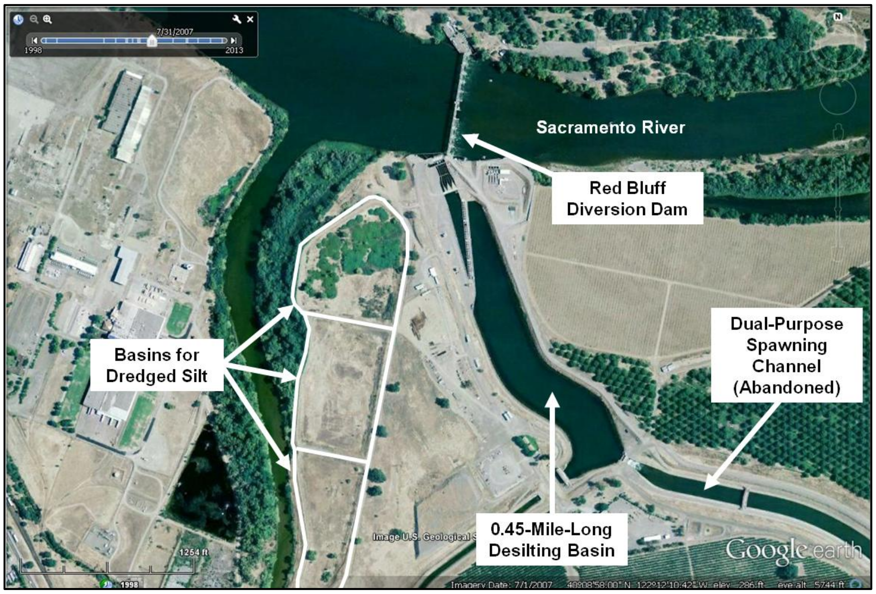

Figure 18. Aerial photograph of the Tehama-Colusa Canal headworks showing the 0.45-mile long desilting basin.

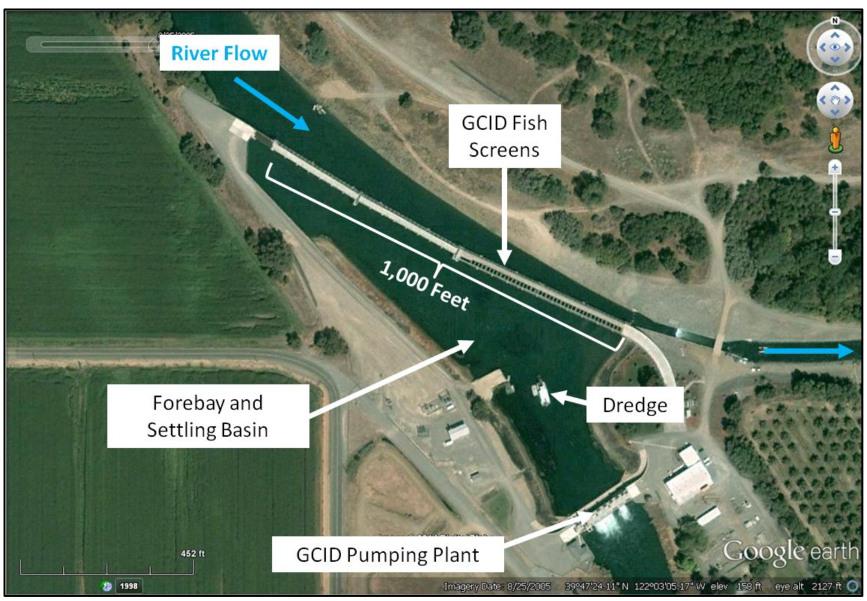

Figure 19. Aerial photograph of the GCID fish screens showing the large forebay behind the fish screens and upstream of the GCID pumping plant.

Also, there is insufficient spatial orientation for flow baffles behind the screens to perform the intended function of providing uniformity of flow distribution through the screens. This circumstance will undoubtedly produce hot spots of unacceptably high through-screen water velocities thereby creating additional hazards for young salmon by impingement. Clearly, if there is any promise of designing the north Delta intake facilities with some semblance of feasible operational capabilities, a much greater footprint for each intake may be required.

Furthermore, although the BDCP documents admit the north Delta intakes will remove large quantities of suspended sediment from the river, the documents do not adequately analyze and describe the resulting adverse impact on native fish in the Delta. Over the past three decades, there has been a reduction of turbidity (a surrogate of suspended sediment concentration) in the Delta (Hestir et al. 2010). A recent Delta Science Program workshop indicated that suspended sediment in the Delta provides significant benefits to fish. There appears to be consensus that even further reduction in turbidity and sediment in the Delta would have deleterious effects on native fish. Additionally, reduced sediment input to the Delta would also adversely impact planned fish habitat restoration projects (e.g., restoration of shallow-water habitats, wetlands restoration, etc.).

Bypass Flows

The BDCP has not adequately addressed the reduced flow in the Sacramento River downstream from the proposed multiple, large-scale water diversions positioned a short distance upstream of Sutter and Steamboat Sloughs, the Delta Cross Channel, and Georgiana Slough. When the diversions are in operation, flows in downstream areas will unquestionably be affected. And yet the BDCP provides the following incongruous statements:

> "Migration flows. Ensure that north Delta intake operations do not increase the incidence of reverse flows in the Sacramento River at the Georgiana Slough junction." (BDCP Page 3.3-139)
>
> "Operations will be managed at all times to avoid increasing the magnitude or frequency of flow reversals in Georgiana Slough." (BDCP Page 4-18)
>
> "At this point, implement Level III post-pulse bypass rule (BDCP Table 3.4.1-2) so that bypass flows are sufficient to prevent any increase in duration, magnitude, or frequency of reverse flows at two points of control: Sacramento River upstream of Sutter Slough and Sacramento River downstream of Georgiana Slough. These points of control are used to prevent upstream transport toward the proposed intakes and to prevent any more upstream transport into Georgiana Slough than under existing conditions." (BDCP Page 3.4-17)

These BDCP assertions are counter-intuitive and it is not at all clear how these measures will be accomplished.

Elsewhere in the BDCP, the documents acknowledge the physical reality of reduced flows:

> "Operation of the proposed north Delta diversions under the BDCP has the potential to adversely affect juvenile winter-run Chinook salmon through near-field (physical contact with the screens and aggregation of predators) and far-field

(reduced downstream flows leading to greater probability of predation) effects." (BDCP Executive Summary Page 48)

"Salmonids migrating down the Sacramento River generally will experience lower migration flows because of the north Delta diversions compared to existing conditions, which is a far-field effect of the north Delta diversions." (BDCP Page 5.5.3-24)

"The principal BDCP effects on the mainstem Sacramento River in the Plan Area will be associated with the reductions of flow caused by operation of the new north Delta diversions. The adverse effect of this flow reduction on covered species will be minimized by maintaining minimum instream flows past the intakes, called bypass flows."

"These results indicate that residence time will increase by 3 to 4 days (9 to 19%) as a result of the lower Sacramento River flow downstream of the north Delta intakes and the lower south Delta pumping under ESO for the hydrologic modeling scenarios used in the DSM2 analyses (WY 1976 through 1991)." (BDCP Page 5.3-36)

In more conflicting rationale, the BDCP suggests that reduced flow in reaches downstream of the north Delta intakes would supposedly result in more salmon entering Sutter and Steamboat Sloughs as favorable migration routes:

"Providing an alternative migration route for salmonids (Perry and Skalski 2008) and possibly splittail, sturgeon, and lamprey that circumvents the Delta Cross Channel and Georgiana Slough, thereby reducing the likelihood of covered fish species moving into the interior Delta where they may be exposed to higher predation pressure and entrainment into the south Delta pumps.

Providing high-value juvenile rearing habitat. Both slough channels support substantially more woody riparian vegetation and greater habitat diversity (e.g., water depths, velocities, in-channel habitat) than is present along the mainstem Sacramento River between Courtland and Rio Vista." … (BDCP Page 3.4-9)

Despite these purported benefits, the BDCP goes on elsewhere to provide even more conflicting statements:

"Despite these anticipated benefits, Perry and Skalski (2009) and Perry et al. (2010) indicate that survival rates of juvenile Chinook salmon in Sutter and Steamboat Sloughs are highly variable relative to the mainstem Sacramento River. They have found that survival has been higher than, lower than, and similar to survival rates in the mainstem Sacramento River rates." (BDCP Page 3.4-9)

Therefore, how can one conclude there are benefits to salmon resulting from increased entrainment into Sutter and Steamboat Sloughs?

Adding more confusion to the topic, the BDCP states that the timing and magnitude of bypass flows for the north Delta intakes are still under consideration:

> "The magnitude of bypass flows that may be required to limit adverse effects on juvenile salmonids remains under examination by the BDCP proponents and fish and wildlife agencies." (BDCP Page 5.5.3-25 and similar statement on BDCP Page 5.5.3-20)

> "The exact triggers and responses for [Real-Time Operations] RTO at the north Delta diversions are still under development." (BDCP Page 3.4-28)

Additional confusion is added by the following statement:

> "The CALSIM model assumed that there would be some south Delta exports in all months and the monthly pattern of north Delta diversions is not fully explained by the bypass rules; there were many months when the north Delta diversion could have been higher than CALSIM estimated." (BDCP Page 5C.A-114)

It is unclear what this statement means. It suggests that impacts are likely greater than that modeled by the CALSIM model.

Given the foregoing circumstances, the BDCP documents fail to provide for meaningful review a comment on impacts to fish. In this case and many others, it appears that release of the BDCP documents was premature.

BDCP Effects on Tidal Prisms in the Delta

On an overall basis, it appears that the BDCP documents acknowledge that the three north Delta intakes will adversely impact flows and salmon distributions in areas downstream from the intakes. However, the discussion of DSM2-HYDRO model analyses provides confusing information that appears to suggest that the north Delta diversions would not adversely affect flows, in relation to salmon migration, in the Sacramento River at Georgiana Slough (BDCP Appendix 5.C, Part 3). It is unclear how detrimental flow conditions for salmon would not occur with reduced flows resulting from the upstream north Delta intakes. Elsewhere in the documents, it appears that the BDCP is reliant on future habitat restoration in the Delta to offset potential flow distribution perturbations (including reverse flows) by altering tidal prisms which would subsequently result in no significant net change in flow characteristics at areas such as the Sacramento River/Georgiana Slough flow split[12] but would alter flows into Sutter and Steamboat Sloughs (e.g., BDCP Page 3.2-3). The underlying assumptions appear to be on shaky grounds. The entire discussion on this topic in Appendix 5.C, Part 3 is ambiguous, confusing, and full of uncertainties. Furthermore, the BDCP states that this topic is the subject of "ongoing research"

[12] E.g., "However, it is concluded, based on the currently available information presented above, that changes that may occur under the BDCP because of the North Delta Diversion and tidal restoration would result in neither a greater frequency of reverse flows nor a greater percentage of flow (and fish) entering the Interior Delta at this location, compared to EBC2_ELT and EBC2_LLT conditions." (BDCP Page 5C.5.3-331)

and stresses the need for improved model calibrations. Much of the existing discussion appears to be based on speculative information, considerable modeling uncertainties[13], and, perhaps, flawed model inputs and outputs. Much more specificity is necessary to adequately describe exactly where habitats would be changed, how much impact those habitat alterations would have on tidal prisms, and exactly how flow characteristics would change at Georgiana, Sutter, and Steamboat Sloughs.

The Proposed Three New North Delta Intake Fish Screens Compared to the GCID Fish Screens

The proposed north Delta intakes would have large, flat-plate screens (not facilities) similar to those used at GCID's intake farther north on the Sacramento River near Hamilton City. Notably, the physical nature of the actual screens would be similar, but the overall facilities' designs and operations would be radically different. Much of the justification for the design of the BDCP screens was ostensibly based on knowledge acquired from experience and research at the GCID screens. However, the BDCP erroneously applied and misrepresented the findings at GCID causing serious errors in the BDCP's analyses. Those fallacies were propagated throughout the BDCP resulting in fatal flaws in the BDCP's conclusions concerning effects on juvenile salmon. The following are examples.

First, the BDCP suggests that the proposed BDCP screens and the existing GCID screens would be similar:

> "The GCID fish screens are large, on-bank diversions comparable to the diversions proposed as part of the conservation strategy." (BDCP Page 5.F-20)

However, elsewhere, the BDCP states the structures are dissimilar:

> "…the north Delta diversion design and siting are considerably different [than the GCID screens]." (BDCP Page 5.F-iii)

Nevertheless, the BDCP frequently refers to the GCID screens for comparisons of features and salmon survival estimates as a basis for the north Delta intake facilities. For example:

> "The GCID screen is the closest correlate in size to the proposed north Delta intakes, and the Vogel (2008) study represents the only known observational study of Chinook salmon predation loss associated with large water diversion structures in a lotic system." (BDCP Page 5.F-22)

[13] E.g., "There are a number of uncertainties related to large-scale restoration of tidal natural communities and transitional uplands within the Plan Area. For example, it is unknown whether the presently limiting conveyance capacity of a number of Delta channels for tidal flows may become enlarged by scouring in response to Plan Area changes in geometry resulting from habitat restoration. These factors may have consequences for the hydrodynamics at the Sacramento River-Georgiana Slough divergence and other locations." (BDCP Page 5C.5.3-331)

> "Estimates of predator abundance and predation rates [at the three proposed BDCP intakes] were developed from fish screen studies conducted at GCID (Vogel 2008)." (BDCP Page 5.F-86)

Therefore, it is highly instructive and necessary to more-accurately describe the GCID fish protective facility in comparison to the proposed BDCP intakes to clarify serious misunderstandings and misconceptions within the BDCP documents. The following provides pertinent, clarifying information.

The GCID Sacramento River pumping station is located approximately 100 miles north of the city of Sacramento on the west side of the main stem Sacramento River and 206 river miles upstream from San Francisco Bay. It is located on a side channel off the main river channel with fish screens positioned upstream of the pumping plant (Figures 20 and 21). A Fish Screen Improvement Project (Project) was constructed at the site which included (among other features):

1) an extension of the existing flat-plate screens;
2) an upgrade to the existing facility;
3) an internal fish bypass system (which was closed in 2007) to route fish through pipes and back to an oxbow outlet channel a short distance downstream of the new screens;
4) a rock training wall on the river bank opposite the screens to enhance sweeping velocities past the screens,
5) a flow-control weir in the oxbow channel (which was removed in 2007); and
6) configuration of the oxbow outlet channel to route fish back to the Sacramento River.

Additionally, a large-scale, river gradient-control structure was constructed on the main stem Sacramento River near the diversion site to ensure long-term reliability of the fish protective facilities (Figure 20) (Vogel 2008b).

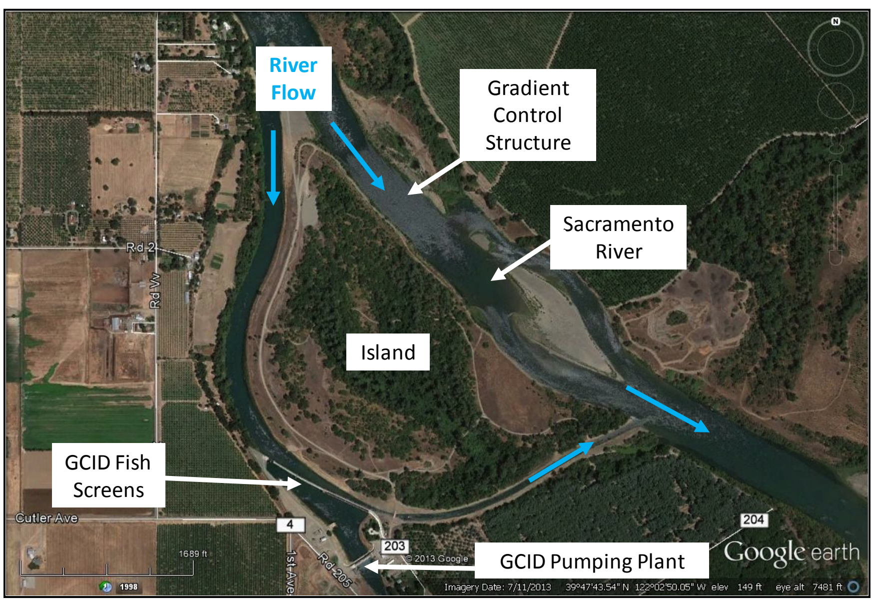

Figure 20. The GCID Hamilton City Pumping Plant and associated features of the Fish Screen Improvement Project.

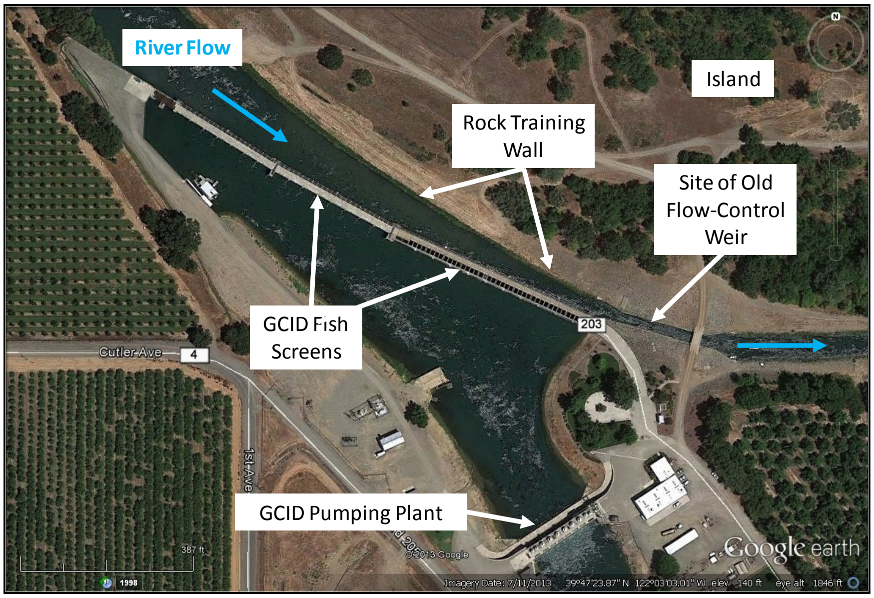

Figure 21. A close-up view of the GCID Hamilton City Pumping Plant and associated features of the Fish Screen Improvement Project.

A Fish Protection Evaluation and Monitoring Program (FPEMP) was established prior to completion of the GCID Project. A Guidance Manual was developed for the FPEMP to identify the experimental design, field methods, and equipment necessary to evaluate the biological performance of the new fish screen structure and gradient facility. The FPEMP was overseen and peer reviewed by a Technical Oversight Committee, including the California Department of Fish and Wildlife, National Marine Fisheries Service, U.S. Fish and Wildlife Service, U.S. Bureau of Reclamation, U.S. Army Corps of Engineers, GCID and other cooperating agencies. The Guidance Manual outlined extensive studies to evaluate overall fish survival at the screens, assess fish passage at the gradient facility, and determine relative abundance and distribution of predatory fish at the gradient site and nearby areas. Specifically, field tests were structured to provide empirical data in determining the effectiveness of the fish screen improvements. Biological field testing at the site (using live juvenile salmonids) was performed under a range of riverine and pumping conditions to ensure the Project provides sufficient protection for fish under future, naturally occurring conditions.

The BDCP provides misleading and inaccurate statements concerning the GCID studies:

> "The assumed 5% loss term is based on observations of acoustically tagged hatchery-raised juvenile salmon released at the GCID screens (Vogel 2008). Approximately 5% of acoustically tagged juvenile salmon migrating past the GCID fish screen were not detected downstream of the screen, presumably because they were consumed by predators. There is uncertainty in this estimate of predation loss because the lack of detections can also be due to malfunctioning of the acoustic tags or receivers, or by juvenile salmon swimming upstream out of detection of the acoustic-tag receiver." (BDCP Page 5.F-22)

> "In addition, a fixed estimate of 5% predation loss at each screened intakes was used, based on predation assumptions from the Glenn Colusa Irrigation District

> (GCID) facility on the upper Sacramento River (Vogel 2008)." (BDCP Page 5.F-14)

The origin of these statements is unknown but the assertions are incorrect. Vogel (2008b) used numerous salmonid mark/recapture studies as the primary method to estimate fish survival at the GCID screens, not acoustic-tagged salmon. Although acoustic telemetry was one of the many analytical methods to evaluate the fish screens, 237 fish mark/recapture experiments using several hundred thousand juvenile salmonids were conducted over a six-year period (2002 – 2007) by releasing experimental and control groups of marked salmonids; those tests were the principal basis for developing salmonid survival estimates at the GCID screen facility in Vogel (2008b). Additionally, the BDCP and its analyses failed to report the fact that the principal source of fish mortality at GCID discussed in Vogel (2008) was attributable to a flow-control weir that had been used to provide hydraulic head differential to operate the internal fish screen bypasses. In 2007, using true adaptive management resulting from the studies, the weir was removed, the bypasses were closed, and that source of fish mortality was eliminated (Vogel 2008b).

The BDCP provides additional misleading, inaccurate, and distorted statements concerning the GCID studies:

> "Uncertainties exist for striped bass densities associated with structures. Estimates of predator abundances are based on a few underwater pictures of predators observed holding around the GCID fish screens (Vogel 2008) and extrapolated to estimate predator abundances at north Delta intakes. These predators may be Sacramento pikeminnow, not striped bass, based on Vogel's (1995) review of GCID studies." (BDCP Pages 5.F-15 and -16)

The statement referencing a few underwater pictures by Vogel (2008b) is inaccurate and a mischaracterization. Additionally, the suggestion that striped bass observed at GCID were actually Sacramento pikeminnow is also erroneous and misleading. Unfortunately, the BDCP analyses used incorrect information in its attempts to model potential striped bass predation on salmon at the proposed new north Delta intakes (discussed later in these comments). To be clear, the extensive research at GCID was conducted over many years and high numbers of both striped bass and Sacramento pikeminnow were observed countless times by numerous individuals using multiple field methods including electrofishing, angling, fish traps, direct underwater SCUBA observations and underwater hand-held videography, surface-deployed underwater videography, surface observations, and extensive use of a dual-frequency identification sonar camera (DIDSON^{TM}).

The concentration of striped bass in the vicinity of the north Delta screens will undoubtedly be far greater and over longer seasonal durations than observed at GCID, the latter of which is much farther upstream of the Delta. Although striped bass seasonally migrate upstream of GCID, the vast majority of the population is in the Delta, the fish's principal freshwater habitat. High concentrations of striped bass are known to accumulate in the lower Sacramento River near structures such as a pipeline on the riverbed at Freeport just upstream of the proposed north Delta intakes (e.g., sonar camera footage showing striped bass at the pipeline:

http://www.youtube.com/watch?v=jOvjjx_10KM). Therefore, the BDCP assumptions and corresponding model results are invalid.

Although the BDCP gives confusing and conflicting information concerning how salmon survival/mortality were estimated for the proposed three north Delta intakes, those estimates were, nevertheless, based on the GCID studies (albeit, incorrectly):

> "The fixed 5% per intake loss assumption provides an upper bound of estimated losses at the north Delta diversion. Of the Sacramento Basin population of Chinook salmon smolts that reach the Delta, an estimated 3 to 10% (depending on the run) would migrate via the Yolo Bypass and would thus avoid exposure to the north Delta intakes. An estimated 12.0 to 12.8% of the migrating smolt population is assumed lost to predation, impingement, or injury as smolts emigrate past the three north Delta diversion intakes. This loss assumption, based on the Glenn Colusa Irrigation District (GCID) diversion, likely overestimates the mortality rates because the north Delta diversion design and siting are considerably different." (BDCP Page 5.F-iii)

Actually, mortality estimates at the north Delta intakes would be expected to be much higher than that observed at GCID, or just opposite of the BDCP's assumption. Because the GCID screens are located in a side channel of the Sacramento River, only a portion of the downstream migrating fish pass the screens. For example, if the side channel flow constitutes one third of the Sacramento River flow and fish are uniformly distributed with flow, only one third of the downstream migrating fish would pass the GCID fish screens. Also, downstream migrating fish originating from tributaries such as Butte Creek, Feather River, and American River are located downstream of GCID and those fish never encounter the GCID screens. Furthermore, for those salmonids passing GCID, most fish pass the site when pumping plant is not in operation or pumping is very low. Most naturally-produced salmon pass GCID's intake during the winter whereas GCID's primary diversion season is in the spring, summer, and fall.

Conversely, for the north Delta intakes, *all* of the downstream migrating fish in the entire Sacramento River basin would pass the north Delta intake screens, except during periods when the Yolo Bypass floods. Unlike GCID, most of the salmonids passing the north Delta intakes will likely do so when the diversions are in operation. Most importantly, in sharp disparity to the GCID fish screens, the north Delta intake fish screens do not possess the critically important features to control hydraulic conditions and many other features for safe salmon passage.

Because the BDCP analyses relied so heavily on the GCID studies and inaccurately portrayed that research, the entire discussion relative to the GCID screens must be rewritten to accurately represent the research findings. Furthermore, the BDCP analyses would be informed and benefit from much of the additional relevant research at GCID that was not used by the BDCP in analyzing potential effects of the north Delta intakes on salmon. Again, the BDCP has not used the readily available best available science on a topic critically essential for the BDCP analyses; this serious deficiency is not disclosed in the documents. Although the sites are significantly different, the research at GCID, spanning 14 years, provides valuable information on the topic of fish protection at large fish screens. The following technical reports, most of which have been peer reviewed, are examples:

- Vogel, D.A. and K.R. Marine. 1995. 1994 biological evaluation of the new fish screens at the Glenn-Colusa Irrigation District's Sacramento River pump station. Natural Resource Scientists, Inc. February 1995. 77 p. plus appendices.

- Vogel, D.A. and K.R. Marine. 1995. 1995 evaluation of juvenile Chinook salmon transport timing in the vicinity of the new fish screens at the Glenn-Colusa Irrigation District's Sacramento River pump station. Natural Resource Scientists, Inc. Prepared for Glenn-Colusa Irrigation District, Willows, California. November 1995. 34 p.

- Vogel, D.A. and K.R. Marine. 1995. A technical memorandum on 1995 predation evaluations near the GCID Sacramento River pump station. Natural Resource Scientists, Inc. Prepared for Glenn-Colusa Irrigation District, Willows, California. December 1995. 17 p.

- Vogel, D.A. and K.R. Marine. 1997. Fish passage and stress effects on juvenile Chinook salmon physiology and predator avoidance abilities. Technical report prepared as supporting research for the proposed Glenn-Colusa Irrigation District fish screens. Natural Resource Scientists, Inc. February 1997. 32 p. plus appendices.

- Vogel, D.A. 1998. Riverine habitat monitoring data in the Glenn-Colusa Irrigation District's oxbow bypass channel on the Sacramento River. Report prepared for the multi-agency Technical Oversight Committee. Natural Resource Scientists, Inc. 55 p.

- Vogel, D.A. 2000. Fish monitoring in the vicinity of the future Glenn-Colusa Irrigation District gradient facility on the Sacramento River, 1998 - 1999. Report prepared for the multi-agency Technical Oversight Committee. Natural Resource Scientists, Inc. September 2000. 29 p. plus appendices.

- Montgomery Watson, Natural Resource Scientists, Inc., and Jones and Stokes Associates. 2000. Guidance Manual for the Glenn-Colusa Irrigation District Fish Protection Evaluation and Monitoring Program. Prepared for the multi-agency Technical Oversight Committee. October 2000.

- Vogel, D.A. 2003. Fish monitoring in the vicinity of the Glenn-Colusa Irrigation District Sacramento River gradient facility, 1998 – 2001 (pre- and post-construction). Report prepared for the multi-agency Technical Oversight Committee. Natural Resource Scientists, Inc. February 2003. 45 p. plus appendices.

- Vogel, D.A. 2003. 2002 biological evaluation of the fish screens and gradient facility at the Glenn-Colusa Irrigation District's Sacramento River pump station. Report prepared for the multi-agency Technical Oversight Committee. Natural Resource Scientists, Inc. October 2003. 27 p.

- Vogel, D.A. 2005. 2003 biological evaluation of the fish screens at the Glenn-Colusa Irrigation District's Sacramento River pump station. Report prepared for the multi-agency Technical Oversight Committee. January 2005. Natural Resource Scientists, Inc. 37 p.

- Vogel, D.A. 2005. 2004 biological evaluation of the fish screens at the Glenn-Colusa Irrigation District's Sacramento River pump station. Report prepared for the multi-agency Technical Oversight Committee. May 2005. Natural Resource Scientists, Inc. 24 p.

- Vogel, D.A. 2006. 2005 biological evaluation of the fish screens at the Glenn-Colusa Irrigation District's Sacramento River pump station. Report prepared for the multi-agency Technical Oversight Committee. Natural Resource Scientists, Inc. May 2006. 40 p.

- Vogel, D.A. 2007. 2006 biological evaluation of the fish screens at the Glenn-Colusa Irrigation District's Sacramento River pump station. Report prepared for the multi-agency Technical Oversight Committee. Natural Resource Scientists, Inc. June 2007. 24 p.

- Vogel, D.A. 2008. Biological evaluations of the fish screens at the Glenn-Colusa Irrigation District's Sacramento River pump station, 2002 – 2007. Final Report prepared for the multi-agency Technical Oversight Committee. Natural Resource Scientists, Inc. April 2008. 48 p.

- Vogel, D.A. 2008. Technical memorandum prepared for the multi-agency Technical Oversight Committee for the GCID Fish Protection Evaluation and Monitoring Plan Biological Evaluations. Natural Resource Scientists, Inc. December 8, 2008. 5 p.

Additionally, the following peer-reviewed technical reports provide informative material for the BDCP concerning fish protection at Sacramento River diversions.

- Vogel, D.A. 1995. Losses of young anadromous salmonids at water diversions on the Sacramento and Mokelumne rivers. Report prepared for the U.S. Fish and Wildlife Service Anadromous Fish Restoration Program. January 1995. 34 p.

- Vogel, D.A. 2013. Evaluation of fish entrainment in 12 unscreened Sacramento River diversions, Final Report. Report prepared for the CVPIA Anadromous Fish Screen Program (U.S. Fish and Wildlife Service and U.S. Bureau of Reclamation) and Ecosystem Restoration Program (California Department of Fish and Wildlife, U.S. Fish and Wildlife Service, NOAA Fisheries). Natural Resource Scientists, Inc. July 2013. 153 p.

Fish Survival Rates at the North Delta Intakes

The estimates of juvenile salmon mortality at the three north Delta intakes have errors that likely underestimate impacts on salmon. The principal adverse effects to young salmon at the intake screens are described in the BDCP as likely attributable to predation:

> "The north Delta export facilities on the banks of the Sacramento River likely will attract piscivorous fish around the intake structures. Predation losses at the intakes were estimated using striped bass bioenergetics modeling of salmon and splittail predation, and a fixed 5% per intake assumed loss of Chinook salmon smolts migrating past the facilities. While bioenergetics modeling predicted high numbers of juvenile Chinook consumed (tens of thousands), the population level effect is minimal (less than 1% of the annual Sacramento Valley production). The bioenergetics model likely overestimates predation of juvenile salmon and splittail because of simplified model assumptions, further indicating potential predation losses at the north Delta would be low." (BDCP Page 5.F-iii)
>
> "Potential predation losses are estimated using two methods: bioenergetics modeling and estimates based on a presumed 5% loss per intake." (BDCP Page 5.F-75)

As an initial matter, the discussion of the percentage of juvenile salmon mortality at the north Delta intakes is very confusing and conflicting. On one hand, the predation mortality is assumed to be 5% for each intake based on assumptions buried in the appendices (e.g., BDCP Pages

5.5.3-28 and -29). This would be equal to an overall salmon mortality of 14.3% past all three intakes.[14] On the other hand, in the main body of the BDCP, overall salmon mortality in the river reach past all three intakes is assumed to be only 5% (or only 1.7% per intake) and is used as the final estimate in the modeling effort (e.g., BDCP Page 3.3-139, BDCP Page 3.3-151, BDCP Page 4-18). For reasons described in comments on CM1, such a low, optimistic mortality estimate is unlikely.

It appears that the BDCP chose the lowest estimate of salmon mortality because assumptions of higher salmon mortality would not allow BDCP fish benefits to "pencil out". This very large discrepancy is not explained or justified in the BDCP. In order to provide a more-balanced portrayal of estimated salmon mortality, it is recommended that the calculations be bracketed from a low to high[15] estimate per intake. For example, the BDCP could model the mortalities with estimates of 1%, 5%, and 10% per intake or overall mortality through river reach of intakes of 3%, 14.3%, and 27.1%, respectively.[16] Also, there is reason to believe that there may be considerable variability in salmon mortality among the three intakes. For example, the highest mortality would likely occur at the downstream-most screen because the fish would be more concentrated with river flow due to the upstream water withdrawals from the other two intakes (discussed previously).

Also, the BDCP must assume that predation mortality at the north Delta intakes would occur even when the diversions are not in operation. It does not appear that impact on salmon was taken into account. Although impingement and entrainment would not occur during non-diversion periods, predation mortality on salmon would still be evident for the previously-described reasons.

Unequal Transfer of Adverse Impacts to Sacramento River Basin salmonids from the south Delta to the North Delta

It seems that the premise of the purported BDCP benefits for Sacramento River salmonids resulting from the three north Delta diversions is to alleviate present-day adverse impacts caused by the south Delta diversions (e.g., EIR/EIS Page 31-5). The BDCP concept is to reduce south Delta diversions in wet years by diverting more water in the north Delta and then in dry years, rely on the south Delta diversions instead of the north Delta diversions (e.g., BDCP Page 5.B-11). Unfortunately, this is just opposite of favorable conditions for Sacramento River basin salmonids. In wet years, Sacramento River salmonids have a higher survival rate than in dry years. Reducing Delta inflow during wet years as a result of the north Delta diversions would be expected to reduce survival rates for Sacramento River basin salmonids, not increase them. Furthermore, under existing conditions, only a portion of the Sacramento River basin salmonids are adversely impacted by south Delta exports whereas the north Delta diversions will influence a far greater portion of the salmonids resulting in disproportionate impacts. Misleading statements in the BDCP suggest overall benefits to salmon resulting from reduced entrainment as

[14] The BDCP apparently mistakenly assumed the cumulative survival as 12% (BDCP Pages 5.5.3-28 and -29).
[15] "High" is used only as a relative comparison among three scenarios postulated here. For example, actual mortality could be higher than 10%.
[16] **Scenario 1:** $.99^3$ x 100% = 99% survival or 1% mortality. **Scenario 2:** $.95^3$ x 100% = 85.7% survival or 14.3% mortality. **Scenario 3:** $.90^3$ x 100% = 72.9% survival or 27.1% mortality.

a result of the BDCP. Entrainment reduction, as portrayed in the BDCP, is linked to the south Delta export facilities, not north Delta intakes. Entrainment reduction at the south Delta facilities does not offset the higher adverse impacts caused by impingement and predation anticipated at the north Delta intakes.

These problems are alluded to in the BDCP documents but they are not expanded upon at appropriate, more-prominent places. For example:

> "Improved flow management will be achieved primarily through relocation and operation of the primary point of diversion to the north Delta. This change in water operations is expected to reduce entrainment in the south Delta but may increase impingement and predation-related losses in the north Delta depending upon water- year type and model used to evaluate these elements (Appendix 5.B, *Entrainment*)." (BDCP Page 3.3-148)

New North Bay Aqueduct Diversion Impacts

The BDCP also proposes to provide a new, alternative intake for the North Bay Aqueduct:

> "Combined operations of a new intake on the Sacramento River and the existing intake at Barker Slough will be included under covered activities for future peak demand of up to 240 cfs." (BDCP Page 4-29)
>
> "Changes to the North Bay Aqueduct's Barker Slough Pumping Plant and its proposed alternative intake on the Sacramento River will represent no change to this attribute for salmonids because the intake is currently screened and will remain so in the future, at both locations." (BDCP Page 5.5.3-18)

It is not clear if the effects of this new intake on Sacramento River salmonids were evaluated. If not, there should be analyses of the effects of that intake resulting from potential impingement, predation, and reduced bypass flows downstream of the new diversion.

Conservation Measure 2 (CM2): Yolo Bypass Fisheries Enhancement

Conservation Measure 2 is described in the BDCP as a key element of the strategy to improve survival of covered fish species. However, as described in Appendix 3D, Monitoring and Research Actions, a primary incertitude with this measure is, "Do the modifications at Yolo Bypass function as expected, and if so, how effective are they?" (BDCP Page 3.D-30). To address this, the BDCP identifies 10 main "Potential Research Actions". Despite having no idea of the level of success, the BDCP advances this measure under the strong assumption it will bring about major benefits to fishery resources. Although inundation of the Yolo Bypass under certain conditions may generate favorable conditions for salmon, it is important for the BDCP to not overstate the currently unknown benefits and portray the potentially positive effects on salmon with a high degree of confidence.[17] For example, the BDCP states:

> "Growth and survival of larval and juvenile fish can be higher within the inundated floodplain compared to those rearing in the mainstem Sacramento River (Sommer et al. 2001b)." (BDCP Page 3.4-41, BDCP Page 3.4-42, EIR/EIS Page 3-122
>
> "However, an increase in the frequency, duration, and extent of inundation of the Yolo Bypass will be achieved and will contribute to an increase in the extent of suitable rearing habitat and the abundance of food available to juvenile salmonids, which is expected to contribute to an increase in survival." (BDCP Page 3.3-143)
>
> "Shallow-water habitat of floodplains provides for higher abundances of food and warmer temperatures which promote rapid growth. This results in larger out-migrants (Sommer et al. 2001a, 2001b), which presumably have higher survival rates in the ocean compared to mainstem Sacramento River out-migrants." (BDCP Page 5.5.3-1)
>
> "The Yolo Bypass provides a relatively high survival migration route through the lower Sacramento River." (BDCP Pages 5.5.4-3 and -4)
>
> "Sommer and coauthors (2001) examined the survival issue during 1998 and 1999 studies by conducting paired releases of tagged juvenile salmon into the Yolo Bypass and the Sacramento River. They found that the Yolo Bypass release groups had somewhat higher survival indices than the Sacramento River." (BDCP Page 5.F-80)
>
> "Other studies indicate that the relative survival of Chinook fall-run fry migrating through Yolo Bypass to Chipps Island was on average 50% higher than fish passing over the comparable section of the Sacramento River (Sommer, Harrell, et al. 2001)." (BDCP Page 3.3-143)

An examination of the original source document reveals the prior statements are incorrect in the level of conviction:

> "Sommer et al. (2001) examined the survival issue by doing paired releases of juvenile coded-wire-tagged salmon in Yolo Bypass and Sacramento River to obtain comparative data. They found that the Yolo Bypass release groups had somewhat higher survival indices than Sacramento River fish in both 1998 and 1999, but the sample size (n=2 paired releases) was too low to demonstrate statistical significance." (Sommer et al. 2001)

[17] This discussion is not intended to refute the assumption of potential importance of salmon rearing in the Yolo Bypass, but rather point out that the BDCP should be more cautious and scientifically objective in its discussion and analyses of the topic.

Also, the BDCP did not report the differing salmon survival information available in a more-recent report by Sommer et al. (2005). In a comparison of the survival of groups of coded-wire tagged salmon released into the Yolo Bypass with salmon released into the Sacramento River downstream of the Bypass, Sommer et al. (2005) found that estimated survival of fish released in the Yolo Bypass was higher in 1998, similar in 1999, and lower in 2000 (Table 1). This pattern of overstating positive results and downplaying negative results is prevalent in the BDCP documents and analyses.

Table 1. Number of coded-wire tags recovered in the ocean sport and commercial fisheries for Chinook salmon released in the Yolo Bypass and Sacramento River. The total number of tagged fish released in each location for each year is shown in parentheses. The survival ratio is calculated as the number of Yolo Bypass recoveries divided by the number of Sacramento River recoveries. (Table from Sommer et al. (2005)

Release Group	1998 (53,000)	1999 (105,000)	2000 (55,000)
Yolo Bypass	75	136	27
Sacramento River	35	138	47
Survival Ratio	2.14	0.99	0.57

In yet another example of the BDCP overemphasizing or mischaracterizing potential benefits of the BDCP, it states:

> "In the Yolo Bypass, Sommer et al. (2005) found the potential stranding losses are offset for juvenile Chinook salmon by the improvement in rearing conditions." (BDCP Page 5C.5.4-7)

In fact, the authors of that source document did not make that conclusive statement:

> "In the case of highly variable seasonal environments such as floodplains, stranding losses might cause excessive mortality in some years, but the risks ***may be*** offset by increased rearing habitat and food resources in other years (Sommer et al. 2001b, Brown 2002) (emphasis added)."

This is another example of the BDCP overstating potential fish benefits and understating possible detriments.

Although the BDCP CM2 is portrayed as one of the largest benefits to juvenile salmon that may result from the BDCP, obscure, contrary information buried throughout the BDCP documents indicates the benefits may be unsubstantial or could be offset by negative impacts at the north Delta intakes. For example, BDCP Table 5.F.6-5 (below) suggests overall negative outcomes for salmon, but downplays those impacts elsewhere in the BDCP.

Table 5.F.6-5. Average Proportion of Chinook Salmon Smolts Reaching the North Delta that Enter Yolo Bypass or Survive to the North Delta Diversion Reach, and the Average Proportion Smolts Lost at the North Delta Intakes

	ESO_ELT			ESO_LLT		
Race	% Enter Yolo Bypass[1]	% Survival to NDD[2]	% Loss at NDD Complex[3]	% Enter Yolo Bypass[1]	% Survival to NDD[2]	% Loss at NDD Complex[3]
Winter-run	12%	93.07%	11.69%	12%	93.07%	11.67%
Spring-run	9%	93.12%	12.10%	9%	93.12%	12.09%
Fall-run	4%	93.17%	12.80%	4%	93.17%	12.82%
Late fall–run	4%	93.08%	12.80%	4%	93.08%	12.81%

Notes:

1 Proportion of emigrating Sacramento River Basin smolt population entering Yolo Bypass.

2 Proportion of migrating smolts surviving to north Delta intakes (survival between Fremont Weir to north Delta Intake reach) estimated by the Delta Passage Model (DPM).

3 Proportion lost at the north Delta intakes based on NMFS assumption of 5% loss per intake (3 intakes total) for the group that passes the north Delta diversion complex.

> "In summary, the DPM results for winter-run Chinook salmon demonstrate that survival under the ESO scenarios generally was similar to, or slightly lower than, that of the EBC scenarios because there was a balance between elements contributing to higher survival (greater use of the Yolo Bypass and lower south Delta exports under ESO scenarios) and elements contributing to lower survival (lower survival in the Sacramento River mainstem and Sutter-Steamboat Sloughs because of the north Delta diversions under ESO scenarios)." (BDCP Page 5C.5.3-66)

The BDCP documents suggest that a primary benefit of CM2 is to "route" more salmon through the Yolo Bypass to avoid potentially negative effects resulting from exposure to the three north Delta intakes. For example:

> "The proportion of the population that may use the Yolo Bypass as an alternate migration corridor, as opposed to the mainstem Sacramento River, may be relatively small, but those fish that do migrate through the Yolo Bypass will not be exposed to the north Delta intakes." (BDCP Page 3.3-141)

> *"CM2 Yolo Bypass Fisheries Enhancement* intends to improve passage at the Fremont Weir and increase Yolo Bypass inundation, which may reduce predation risk on migrating covered fish by providing a migration route with potentially lower predation and entrainment risk (i.e., avoiding the north and south Delta diversions)." (BDCP Page 5.F-6)

These assumptions may ultimately be true if the Fremont Weir facilities are built. However, it is not clear if the BDCP analyses and modeling efforts accounted for the fact that, because of reduced flows in the Sacramento River downstream of Fremont Weir, the salmon remaining in the river will be more concentrated and may suffer higher mortality rates compared to the existing environmental baseline. If this circumstance was not analyzed, it should be addressed. If the scenario was addressed, the description of the analyses should be made clearer.

The BDCP documents should re-examine the specific spatial-temporal distribution of fry and juvenile salmon (all runs) and steelhead that may enter the Yolo Bypass under different water-year types. There appear to be discrepancies at different locations in the documents. This is important because those errors would carry through to subsequent analyses of potential benefits or detriments to the different runs and species. In this regard, an excellent database on the emigration of juvenile salmon has been developed by CDFW in the lower Sacramento River. CDFW operates two eight-foot-diameter rotary screw traps a half mile downstream of Knights Landing at Sacramento River mile 89.5. Among other purposes, the CDFW fish monitoring program is conducted to determine the timing and relative abundance of juvenile anadromous salmonids emigrating from the upper Sacramento River system (Vincik and Bajjaliya 2008). While the BDCP documents mention this sampling program and used some of the data in part, it is not clear if the BDCP fully utilized the appropriate data for the CM2 analyses and fish models (discussed later in comments on the BDCP fish models).

Juvenile salmon downstream migrations tend to occur in groups and pulses; these pulses may correspond to increased flow events and turbidity (Vogel 2011a, 2012b). For example, USFWS salmon research by Kjelson *et al.* (1982) and Vogel (1982, 1989) reported increased downstream movements of Chinook fry corresponding to increased river flows and turbidity, respectively. Young Chinook salmon may migrate downstream from the mainstem Sacramento River and its tributaries into the Sacramento-San Joaquin Delta as pre-smolts (fry and parr) or as smolts. The majority of the salmon emigration during wet winter conditions occurs during January through March (Vogel and Marine 1991). Storm events increase river flow and turbidity which causes many salmon to either volitionally or non-volitionally move from the upper river to the Delta. A later emigration of juvenile salmon occurs during spring as smolts, if the fish have not already left the primary rearing grounds in the upper river (Vogel 2013). Those characteristics are clearly demonstrated in detail by the CDFW fish sampling program. It appears that the BDCP documents used a more-generalized, composite type of analysis (including the sections on fish modeling) instead of a more-detailed scrutiny of salmon run emigration variability (using the CDFW database) in relation to specific hydrologic and riverine conditions (e.g., BDCP Pages 5C.4-46-47). Again, this should be clarified in the BDCP documents and checked for consistency.

Fremont Weir Fish Passage

CM2 is not possible without remedial fish passage measures at Fremont Weir in the northern Yolo Bypass. There are two primary issues with Fremont Weir fish passage:

1) The blockage of upstream migrating adult anadromous fish (salmon and sturgeon) at the weir when flows over the weir cease.
2) The passage of juvenile salmon over the weir into the Yolo Bypass.

The BDCP has largely tied these two issues together, making it difficult to evaluate the topics independently. For example, it is unclear what specific measure or suite of measures would be implemented at Fremont Weir to improve fish passage. At different locations in the BDCP documents, there are discussions of “notching” the weir, lowering a portion of the weir, modifying the weir, installing an operable gate facility, installing new weir gates, installation of a gated seasonal floodplain inundation channel, adding new adult salmon ladders, adding new adult sturgeon ladders, evaluating experimental sturgeon ramps, adding “auxiliary” fish ladders, etc. The BDCP appears to throw a hodgepodge of fish passage concepts at this issue, confusingly juxtaposing different jargon, with little regard as to the feasibility or practicality of the potential measures and how the different concepts would be integrated or used independently. Making the topic even more difficult to assess is that the BDCP provides no details on the designs, operations, or effectiveness of the various measures:

> "The efficacy of the passage improvements at the Fremont Weir and other locations in the Yolo Bypass (e.g., Lisbon Weir) cannot be estimated but will be monitored, and adjustments will be made through adaptive management." (BDCP Page 3.3-145)
>
> . .. should improve [sturgeon] passage over Fremont Weir, although there is low certainty that this will occur because those attributes have not yet been identified." (BDCP Page 5C.5.3-343)
>
> "Evaluations of the impacts of improvements to the Fremont Weir to increase inundation of the Yolo Bypass and reduce passage delays at the Fremont Weir have shown positive and negative effects." (BDCP Page 3.3-153)

The entire discussion of Fremont Weir fish passage should be reorganized to clarify (in a logical, sequential format), exactly what is being proposed with details on each separate proposal, including the pros and cons, and how the different measures would work independently or in concert.

Importantly, rectifying the problem of adult salmon blockage at Fremont Weir should (and likely will) occur independent of the BDCP. There is no reason why this dilemma for fish cannot be pursued absent the BDCP. This predominant problem for salmon has been known for many decades. The existing so-called Fremont Weir fish ladder is really nothing more than a solitary, very small, rectangular notch in the weir (Figure 22). A variety of non-controversial measures could be implemented to significantly reduce this problem, but no progress has been made. The 2009 NMFS Biological Opinion requires DWR and USBR to improve salmon passage at the site[18]. Progress has languished and ongoing destructive impacts to salmon continue. Other fish restoration programs (e.g., CVPIA) could employ actions to improve fish passage at the weir separate from the BDCP implementation.

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[18] Reasonable and Prudent Alternative Action I.7 (Reduce Migratory Delays and Loss of Salmon, Steelhead, and Sturgeon at Fremont Weir and Other Structures in the Yolo Bypass).

Figure 22. The Fremont Weir "fish ladder". Photo by Dave Vogel.

Additionally, adult fish stranding has been known to occur in a deep pool just downstream of the weir for many years (Figures 23 and 24). This site is on California State land and could easily be filled in to eliminate stranding, but no progress has been made.

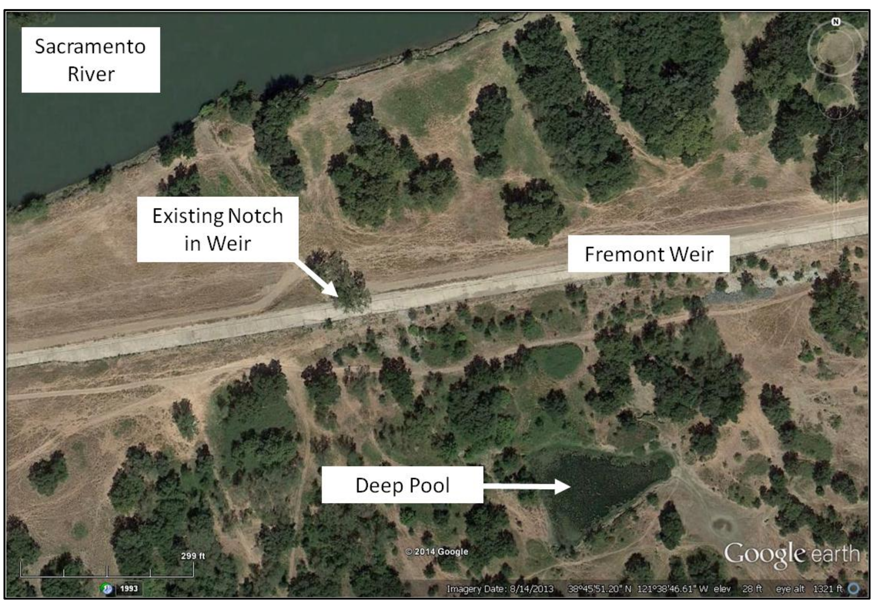

Figure 23. Aerial photograph of the deep pool just downstream of Fremont Weir where adult fish have been stranded.

Figure 24. Deep pool just downstream of Fremont Weir where adult fish have been stranded (see Figure 23). Photo by Dave Vogel.

Furthermore, there are culverts or unimproved road crossings on the northeast side of the Yolo Bypass in the Tule Canal that can trap juvenile salmon when flood flows recede in the Bypass (Figure 25 and 26). When entrapped upstream of these culverts or crossings, salmon perish from eventual warm water temperatures or predation, unless subsequent flooding of the Bypass occurs the same season. Timing of the flooding events cannot be controlled but physical features in the Tule Canal can be altered. These areas can be easily fixed at relatively low cost and are non-controversial. For example, operable gates combined with new road crossings would allow salmon to emigrate and still maintain the integrity of the crossings.

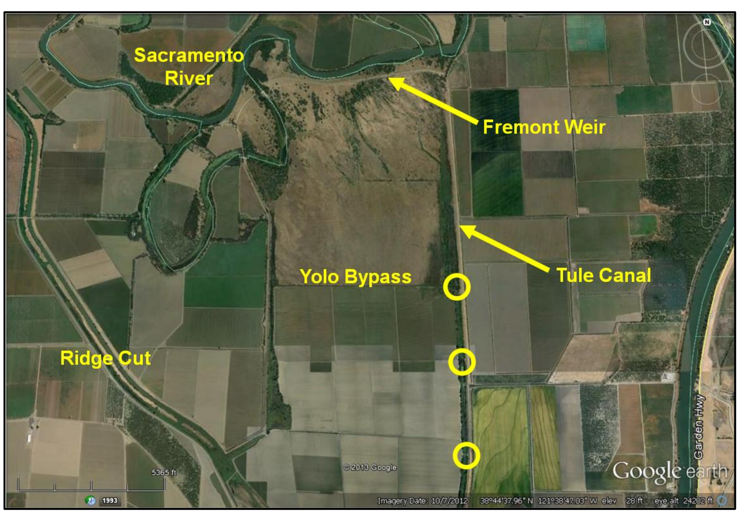

Figure 25. The northern portion of the Yolo Bypass showing the locations (circles) where new structures would be installed in the Tule Canal to improve juvenile salmon survival.

Figure 26. A culvert and unimproved road crossing in the Tule Canal. Photo by Dave Vogel.

Despite the 2009 NMFS Biological Opinion, there does not appear to be sufficient incentive by appropriate agencies to rectify these significant problems at this time. Remedial actions do not have to wait for the BDCP and could begin now in an incremental fashion. This false dichotomy presents CM2 as an all-or-none package which delays significant fishery restoration actions. If these problems, and others discussed in these comments, are fixed in advance of the BDCP, the potential fish benefits of the BDCP become less positive.

Adult Salmon Straying into the Colusa Basin Drain (CBD)

An important issue that continues to be unresolved in the BDCP is the serious problem with straying of adult salmon into the CBD. For those salmon that are attracted to flows exiting the southern portion of the Yolo Bypass in northern Cache Slough, some apparently enter the Ridge Cut and end up stranded in the CBD and perish. With increased flows into the Yolo Bypass resulting from the "notch" in Fremont Weir, more adult salmon may end up straying into the CBD without corrective measures. First, with increased flow entering Cache Slough, more adult fish would be expected to be attracted into the Bypass and if those fish are attracted to flows exiting the Ridge Cut and not the Fremont notch, those fish cannot re-enter the Sacramento River. Second, even with a notch in the weir, when flows subsequently recede to elevations lower than the notch, there still will be a threshold when fish passage has to be accommodated to prevent fish stranding. The BDCP does not provide any specific recommended solution for this problem even though increased frequency of Yolo Bypass inundation may exacerbate the problem. Instead, the documents recommend constructing and testing un-described, flood-neutral fish barriers "to prevent fish from straying into Knights Landing Ridge Cut and the Colusa Basin Drain." (EIR/EIS Page 3-127). Here again, much like the remedial actions described above, this action could be undertaken currently, and need not be delayed for the BDCP.

Relationship to the NMFS (2009) Biological Opinion (BiOp)

It is unclear why the BDCP apparently believes that DWR and USBR need not pursue the reasonable and prudent alternatives (RPAs) in the 2009 NMFS Biological Opinion related to upstream and downstream fish passage in the Yolo Bypass separately from the BDCP. The BDCP in fact argues that the Yolo Bypass RPAs will only be done through the BDCP and not taken up independently as indicated by the actuality that those RPAs were not included in the BDCP environmental baseline and other statements in the BDCP documents (e.g., EIR/EIS Pages 3-44 and 3-45). The BDCP largely claims the CM2 measures will provide bigger and better benefits for fish and, therefore, it makes more sense to only follow those measures collectively through the BDCP and not the 2009 NMFS RPAs. Additionally, with the advent of an EIR/EIS specific to Yolo Bypass fisheries enhancements, the BDCP suggests that process will take many years and cannot be accommodated through the 2009 NMFS RPAs. A progress report on the Yolo Bypass Salmonid Habitat and Fish Passage EIR/EIS at a March 20, 2014 meeting of the Yolo Bypass Fishery Enhancement Planning Team indicated that process is still in its infancy and substantial delays are expected even beyond that indicated in the BDCP. The BDCP also asserts that regulatory permits for the Yolo Bypass RPAs and the BDCP will take many years, and therefore, the agencies may as well pursue those permits under just one time frame: the BDCP's.

The BDCP evidently has inextricably linked BDCP CM2 to the 2009 NMFS BiOp Yolo Bypass RPAs such that DWR and USBR have no intention of pursuing those actions independently of the BDCP. It begs the question: What if the BDCP is not implemented? Many years will (and already) have passed without pursuit of beneficial actions for anadromous fish (particularly threatened and endangered fish) (e.g., reduced blockage of salmon at Fremont Weir and fish stranding discussed previously). There is nothing to prevent DWR and USBR from pursuing incremental beneficial actions on the NMFS RPAs such as those described above. The prominent step of "notching" the Fremont Weir to provide up to 6,000 cfs into the Yolo Bypass is the one measure that appears to be holding up progress toward implementation of all the other beneficial actions that are lower in cost, could be implemented in a more-rapid time frame, are much less controversial, and have unquestionable, immediate benefits to salmon. There is no need to link all of the associated actions within CM2 into a single package. The BDCP appears to be claiming credit for many Fremont Weir/Yolo Bypass improvements that are supposed to occur under the NMFS BiOp.

Conservation Measure 6 (CM6): Channel Margin Enhancement

BDCP CM6, channel margin habitat improvements, show promise for juvenile salmon rearing in the Delta, but it is not presently known exactly how to accomplish that objective. The BDCP touts admirable advocacy for providing benefits for salmon, but also acknowledges the lack of confidence on exactly how to do so:

> "There is uncertainty, however, about the effectiveness of channel margin restoration to increase the survival of juvenile salmonids passing through the Delta. Enhancement of 20 linear miles of channel margin was deemed to be

> sufficient to determine the effectiveness of enhancing channel margin habitats to increase survival." (BDCP Page 3.A-37)

The BDCP suggests adding woody debris at channel margins in the Delta as a means to increase rearing habitat quantity and quality for salmonids:

> "Install large woody debris (e.g., tree trunks, logs, and stumps) into constructed benches to provide physical complexity. Use finely branched material to minimize refuge for aquatic predators. Large woody debris will be installed to replace debris lost during enhancement; woody debris also is expected to increase or be replaced over time through recruitment from adjacent riparian vegetation." (BDCP Page 4-40)

Although such measures have demonstrated to work well for juvenile salmon in upstream riverine habitats, those practices have yet to prove success in the Delta. Such measures may actually create ideal conditions for predatory fish and worsen conditions for salmon in the Delta. The BDCP acknowledges this concern:

> "Because actions under CM6 have the potential to provide habitat for nonnative predatory fish, monitoring will evaluate the use of enhanced channel margin sites and associated woody debris by predators." (BDCP Page 4-40)

It is recommended that pilot projects on this measure be implemented and evaluated soon in the Delta; it should not wait for the BDCP.

Alternatively, the BDCP ought to provide more emphasis on the measure to increase the quantity and quality of salmon rearing habitats in the Delta channel margins through set-back levees and shallow-water habitats that are presently severely lacking in the region. As mentioned by Lindley et al. (2009): "One of the most obvious alterations to fall Chinook habitat has been the loss of shallow-water rearing habitat in the Delta." In Delta studies where fish sampling to compare shallow beaches with rip-rapped zones was achieved, salmon fry densities were higher in shallow beach areas (McLain and Castillo 2009). An obvious restoration measure which should be pursued to a larger degree because of its high probability of success is the re-creation of shallow, near-shore water habitats that juvenile salmon favor in the Delta (as contrasted to flooded islands). Importantly, these sites must be designed to avoid creation of predatory fish habitats and established in locations likely to be utilized within the principal fish migration corridors (Vogel 2011a, 2012a).

Creation of new shallow-water rearing habitats would likely have considerable merit toward salmon restoration. The Golden State Salmon Association has proposed such projects that could be incorporated into the BDCP process or other fishery restoration programs (Figure 27).

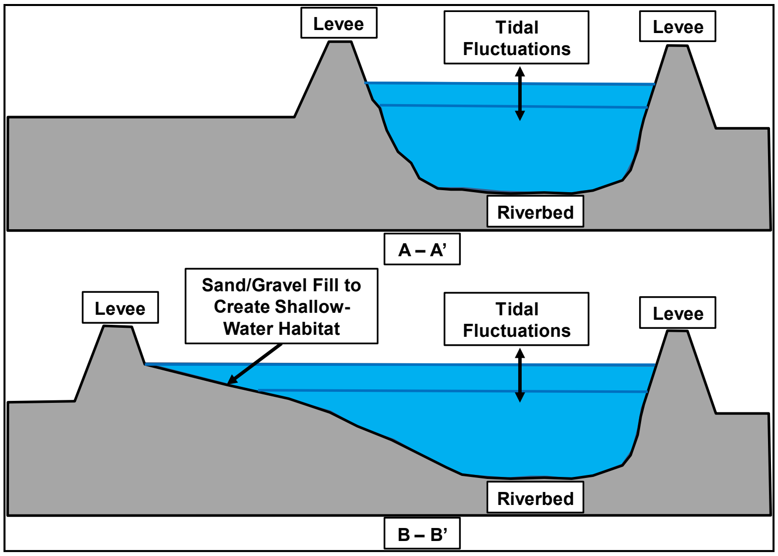

Figure 27. Conceptual before and after cross-sectional channel profiles of a shallow-water habitat restoration site with a set-back levee. Figure from Golden State Salmon Association Project Proposal D.15: Re-create shallow-water rearing habitats for salmon in the primary Delta migration routes while minimizing predatory fish habitat.

By its own admission, the BDCP states that salmon fry and smolts need safe habitats on the edge of the river channel to reduce exposure to predators.

> "However, enhanced channel margins are expected to facilitate safe downstream migration by increasing the habitat complexity that is needed for both smolts and fry to escape predators." (BDCP Page 3.3-45)

That admission in the BDCP is a counter-argument against the supposed benefit of the three new, large fish screen facilities (CM1). The above BDCP statement could be re-worded for CM1 to state: "However, worse channel margins caused by CM1 are expected to impede safe downstream migration by decreasing the habitat complexity that is needed for both smolts and fry to escape predators". CM1 will eliminate long reaches of upstream edge habitats important for salmon but CM6 is promoted to create edge habitats in downstream areas. Again, this points to the question why CM1 is proposed as a conservation measure because it appears that CM6 is proposed, in part, to offset the adverse impacts caused by CM1.

Conservation Measure 15 (CM15): Localized Reduction of Predatory Fishes

The BDCP CM15 is an unorthodox approach to a so-called conservation measure. By first implementing the plan, then exploring ways to control predator problems afterwards is highly unusual and not credible. The fact remains that there are numerous areas in the Delta where localized predation "hot spots" have long been known to occur, yet no actions have been taken to fix those problem areas. From a practical, logical standpoint, CM15's proposed effectiveness must first be demonstrated by: 1) initially working on alleviating predation problems at existing areas and 2) learning from those actions prior to building massive new structures. For example, the severe predation problem areas in front of the Tracy Fish Facilities and immediately behind the Clifton Court Forebay gates have been known for decades. It should be proven that those areas can be fixed prior to building the north Delta intakes. The lack of progress in addressing known predation problems at existing export facilities does not inspire confidence that predation problems at the proposed north Delta diversions would be handled effectively. The credibility of the BDCP could only be enhanced by showing in-place success of such actions instead of simply proposing untested, unspecified actions that would be attempted at some future date after the north Delta intakes become operational.

In the consistent pattern presented throughout the BDCP documents of overstating fish benefits, CM15 is also postulated as an action that will provide positive results. For example:

> "CM15 Localized Suppression of Predatory Fishes *will reduce* the local effects of predators on covered fish species by removing structures that host predatory nonnative fishes, conducting predator control at hotspot locations, conducting an extensive research program to evaluate alternative predatory fish control strategies, and implementing those strategies in an adaptive management context (emphasis added)." (BDCP Executive Summary, page 12)

> "In particular, CM15 Localized Reduction of Predatory Fishes *will reduce* local abundance of predatory fish and eliminate or modify holding habitat for predators at selected locations of high predation risk ("predation hotspots") (emphasis added)." (BDCP Page 5.F-3)

> "*It is concluded* that lowered predation under the BDCP through CM15 Localized Reduction of Predatory Fishes, in addition to other factors discussed above, has the potential to increase productivity and offset the potential for greater predation at some locations such as the north Delta intakes (emphasis added)." (BDCP Page 5.5.3-37)

> "Localized Reduction of Predatory Fishes (Predator Control) (CM15) – Actions implemented under this conservation measure *would reduce populations* of predatory fishes at specific locations and eliminate or modify holding habitat for predators at selected locations of high predation risk (emphasis added)." (EIR/EIS Pages 3-68 and 3-157

Also, in the recurring pattern of providing inconsistent and contradictory logic of the BDCP effects on fish, the documents elsewhere state:

> "The BDCP *could reduce* losses of juvenile winter-run Chinook salmon at existing localized areas where predation is intense (emphasis added)." (BDCP Executive Summary Page 48)

> "The primary purpose of CM15 is to contribute to biological goals and objectives related to abundance and passage of covered salmonids by locally reducing nonnative predatory fishes, which *it is hoped* will increase the survival of migrating salmonids (emphasis added)." (BDCP Page 4-74)

> "At the local scale, the benefits of targeted predator removal are likely to be localized spatially and of short duration unless efforts are maintained over a long period of time. *These benefits are highly uncertain, as the long-term feasibility and effectiveness of localized predator reduction measures are not known* (emphasis added)." (BDCP Page 5.F-iv)
>
> "*Because of the high degree of uncertainty* regarding predation/competition dynamics for covered fish species and the feasibility and effectiveness of safely removing large fractions of existing predator populations, the proposed predator reduction program is envisioned as an experimental pilot program within an adaptive management framework (emphasis added)." (BDCP Page 4-75)
>
> "Additionally, these restored areas may be targeted for predator removal during key occurrence of covered species in these areas, which may also reduce this effect, although *outcomes of localized predator removal are uncertain* (emphasis added)." (BDCP Page 5.F-iv)
>
> "*These benefits are highly uncertain, as the long-term feasibility and effectiveness of localized predator reduction measures are not known* (emphasis added)." (BDCP Page 5.F-iv)
>
> "*Predator removal treatments would likely have only have a short-term effect*, as the Delta is an open aquatic system and recolonization of treated areas by new fish predators may be rapid (emphasis added)." (BDCP Page 5.F-83)
>
> "*The effectiveness of a predator removal program is uncertain, as illustrated by the mixed results achieved by other programs* (emphasis added)." (BDCP Page 5.F-84)
>
> "*Actions to remove predators have a high degree of uncertainty* (emphasis added)." (BDCP Page 5.F-101)

CM15 is described in the BDCP as having major ambiguities as to its effectiveness and recommends an enormous amount of potential future unspecified research in an attempt to address that deficiency (BDCP Pages 3.D-33 and 3.D-34). However, most of the identified research in the BDCP should be more narrowly defined and conducted prior to embarking on a highly tenuous plan. Even simple actions such as performing literature reviews and interviews on the topic of predator control are identified as future activities (e.g., BDCP Pages 3.4-311, 3.D-34), but could have been performed and details included prior to the release of the BDCP. Indeed, many decades have passed since predator problems in the Delta were known, but no effective actions to address the topic have been implemented in those decades. After 50+ years of no progress, all of a sudden the BDCP now states that it will greatly reduce the predation problems at areas such as Clifton Court Forebay and other known, suspected, or future areas (i.e., north Delta intakes) in the Delta. It is incongruous to believe that suddenly the BDCP would now effectively address and resolve this complex issue.

The Delta Science Program sponsored a "State of the Science Workshop on Fish Predation on Central Valley Salmonids in the Bay-Delta Watershed" which convened a panel of six experts in July 2013 to examine the problem with predation on juvenile salmon in the Delta. Notably, the panel's final report lacked pragmatic advice on how to address the predation issue and provided no new or useful ideas for executable actions to alleviate predation. To a large degree, the panel simply threw up their hands and concluded that the predation dilemma in the Delta is an extremely complex problem and that much more research on the topic is needed. In fact, the primary emphasis of the panel's report focused on recommendations to conduct much more extensive standardized research and monitoring throughout the Delta. Based on my experience as a Principal Scientific Investigator for more than 100 fishery resource field research studies, most of the suggested studies would be extremely difficult to implement, exorbitantly expensive, highly questionable to achieve significant or valid results, logistically impractical, and very unlikely to lead to meaningful management actions. While the panel did not estimate the cost of implementing such studies, it would likely be in the neighborhood of several hundred million dollars. Given these conclusions, how and why would predator control and removal aspects of CM15 be deemed an effective conservation measure? Without known benefits for salmon, a highly debatable feasibility, past record of ineffective and non-actions, and the need to conduct many years of research, the predator control component of CM15 should be removed from the BDCP. Instead, the measure should focus on altering Delta habitats to favor juvenile salmon and reduce those areas where salmon are highly vulnerable to non-native predatory fish.

Conservation Measure 16 (CM16): Nonphysical Fish Barriers (NPB)

A key conservation measure proposed for the BDCP is the installation of NPBs (CM16) under the highly questionable ability to divert juvenile salmon from selecting unfavorable outmigration routes through the Delta. This conservation measure is confounding because of the BDCP's apparent faith in the success of future, yet-to-be-designed NPBs as a proposed measure to benefit salmonids. The specific type of NPBs proposed is the combination of a bubble curtain, sound, and lights in an attempt to deter juvenile salmon away from poor-survival migration pathways and toward higher-survival migration pathways. The most-prominent location proposed by the BDCP for NPBs is in the north Delta at Georgiana Slough in Walnut Grove, California, although numerous other sites are recommended (i.e., the Sacramento River at Fremont Weir, the Delta Cross Channel, the San Joaquin River at the head of Old River, Turner Cut, Columbia Cut, channels leading to Clifton Court Forebay and the Tracy Fish Facilities). The basic concept portrayed in the BDCP is as follows: If one assumes that juvenile salmon die at the three proposed intakes in the north Delta, installation of NPBs at fish migration route flow splits farther downstream and in the Delta will potentially help offset those fish losses. This conclusion, however, is at best speculative because of:

1) the highly experimental nature of NPBs,
2) the mixed results from studies of the NPBs (including failures),
3) the exorbitant costs for the type and locations of NPBs in the BDCP,
4) the very questionable practicality and feasibility of such a massive, infrastructure program throughout the Delta,
5) the potentially detrimental impacts on salmon and other native fish, and
6) NPBs have recently been abandoned in the Delta.

The BDCP nevertheless (and astonishingly) concludes:

> **"**Nonphysical Fish Barriers *will improve* the survival of outmigrating juvenile salmon and steelhead by using nonphysical barriers (underwater lights, sound, and bubbles) to encourage juvenile fish to avoid channels and river reaches in which survival is lower than in alternate routes (emphasis added)." (BDCP Executive Summary Page 12)
>
> "CM16 Nonphysical Fish Barriers *will be employed* to discourage juvenile salmonids from entering channels/migration routes that are known to have high predator abundance and/or predation rates, *further reducing predation rates within the Plan Area and contributing to an increase in survival* (emphasis added)." (BDCP Page 3.3-142)
>
> "Salmon, steelhead, and splittail *are expected to be effectively deterred* (emphasis added)." (BDCP Page 5.F-v)

Such barriers remain unproven for overall fish protection and should not be proposed as a positive remedial action for salmon to offset deleterious BDCP effects on salmon.[19] If and when testing of such behavioral barriers are shown to be effective at the sites proposed, then the BDCP could recommend those measures, but not before.

Because the BDCP relied so heavily on the potential benefits of NPBs and the BDCP fish models utilized some aspects of preliminary results of NPBs, the topic warrants closer scrutiny. Recently, a concept for a NPB in the lower San Joaquin River was introduced by Vogel (2009). The concept was to install a bubble curtain at the head of Old River in the San Joaquin River to determine if outmigrating juvenile salmon would behaviorally avoid entry into Old River. The goal was to increase the proportion of salmon migrating down the lower San Joaquin River where fish survival was assumed to be higher than the Old River migration route through the Delta. The California Department of Water Resources (DWR) decided to test the concept at the head of Old River in the spring of 2009, but with the use of not only bubbles, but sound and strobe lights. The BDCP cites the following results of those experiments:

> "Preliminary evidence suggests that a three-component barrier was effective in deterring, or discouraging acoustically tagged Chinook salmon juveniles from entering the head of Old River during a 2009 pilot study (Bowen et al. 2009)." (BDCP Page 3.4-314)
>
> "The three-component Nonphysical Barrier Test Project at the divergence of Old River from the San Joaquin River (head of Old River) in the Delta successfully deterred 81% of acoustically tagged Chinook salmon smolts from entering Old River (Bowen et al. 2009)." (BDCP Page 3.4-314)

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[19] "The effectiveness of nonphysical barriers and their interaction with predators is based on limited testing; thus, outcomes for salmonids remain uncertain." (BDCP Page 5.F-102)

Notably, the BDCP mentions (but does not adequately discuss) the significant fact that the head of Old River NPB was evaluated again in 2010 with mixed results and poor deterrence efficiency (SJRGA 2011). More importantly, on an overall basis, the predation impacts on juvenile salmon presumably caused by the physical presence of the NPB were believed to be so severe that the barrier is no longer considered a viable deterrent device at that location. For example:

> "A 2009 study found the deterrence rate to be as high as 81% (Bowen et al. 2009) while a follow-up study in 2010 found the deterrence rate to be 23%. … In fact, while the nonphysical barrier deterrence rate was 81% in 2009, the predation rate was so high that the juvenile salmon survival rate was not statistically different whether the barrier was on or off (Bowen et al. 2009)." (BDCP Page 5.F-85)

Yet the BDCP promotes installation of the same type of NPB at the head of Old River despite the fact that the best available scientific information indicates harmful effects on salmon; the illogical rationale is not disclosed in the BDCP. Confusingly, the BDCP also states that an operable gate (physical barrier) would be installed at the head of Old River to protect migrating fish (BDCP Page 5.3-11 and EIR/EIS Page 3-101). Then elsewhere, it is suggested that a traditional rock barrier may be installed at the site (EIR/EIS Page 3-119). What is the prevailing BDCP recommendation: a NPB, operable gates, or a rock barrier?

By far, the BDCP's greatest reliance on data used to support the concept of installation of NPBs, not only at Georgiana Slough, but throughout the Delta, is based on the results of a DWR pilot study at Georgiana Slough in 2011. However, the BDCP did not adequately describe the limitations and caveats of the study and, furthermore, did not disclose the fact that the use of a NPB at the site has since been abandoned. This is extremely important because the BDCP analyses, fish models, and resultant conclusions relied so heavily on that single study. The extrapolation of results from that study into BDCP fish models highly skewed model outputs and resultant conclusions of the BDCP effects on salmon.

DWR installed and evaluated a Bio-Acoustic Fish Fence (BAFF) (a form of a NPB advocated for use in the BDCP) at the entrance to Georgiana Slough in the winter and spring of 2011 and reported those results in 2012. A study was repeated in 2012 but those results are not yet available. Given the strong emphasis in the BDCP, closer examination of DWR's pilot study report (DWR 2012) is warranted to determine how accurately the BDCP portrays those results and how applicable they are to the BDCP's promotion for installation of NPBs throughout the Delta. The fish sizes used for the NPB experiment at Georgiana Slough ranged from 110 to 140 mm fork lengths (DWR 2012) which are larger than fall-, winter- and spring-run Chinook typically migrating past Georgiana Slough. The first fish releases occurred on March 16 and the last on May 15, 2011 (DWR 2012). Unfortunately, the 2011 experiments were conducted during abnormally high flow conditions (Figure 28) that complicated execution of the study.

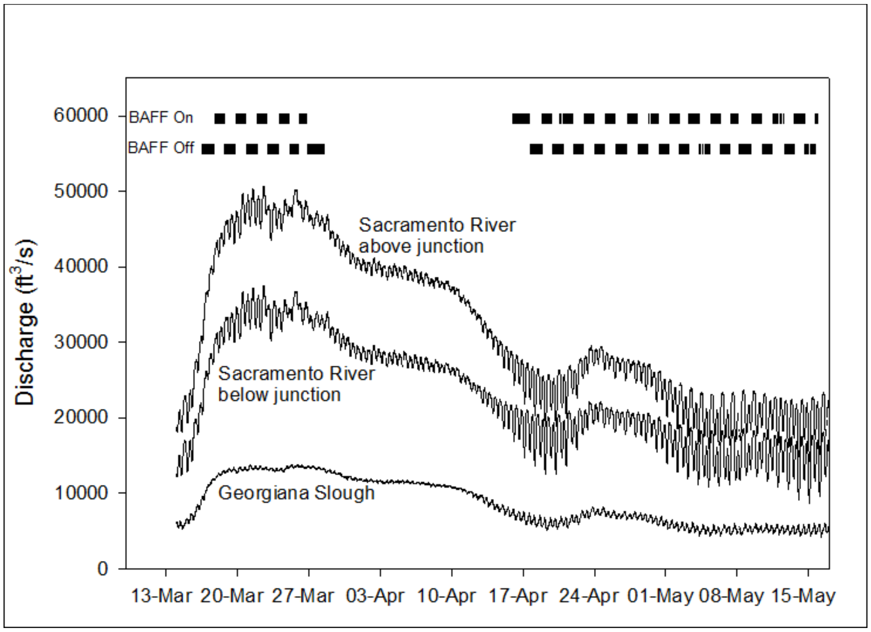

Figure 28. "River discharge and BAFF treatment at time of detection within the array" (from DWR 2012).

The BDCP failed to disclose that the 2011 Georgiana Slough experiment results varied depending on flow conditions at the time of the study. During higher flows, the NPB was not as effective in deterring salmon away from the entrance into Georgiana Slough compared to lower flows during the study. Importantly, the 2011 experiments were all conducted during abnormally high and strong unidirectional flows in the region and no experiments could be conducted during flood tides when Sacramento River flows are reversed and water can enter Georgiana Slough from both upstream and downstream of the Slough. Radio-telemetry studies at Georgiana Slough have demonstrated that juvenile salmon can initially safely pass the Slough and remain in the Sacramento River only to be subsequently advected back upstream during flood tide conditions and into Georgiana Slough (Vogel 2001a, 2002a, 2003a, 2011b). A NPB is unlikely to provide any significant protection for salmon under those conditions. This suggests that diversions through the upstream north Delta intakes would make salmon survival even worse by reducing Sacramento River outflows in this region of the Delta. The BDCP failed to adequately disclose or account for those foregoing circumstances.

Although the 2011 DWR study appeared to be well done, there nevertheless remains significant ambiguity in interpretation of study results. Some of the conclusions as to the effectiveness of the NPB in deterring salmon away from Georgiana Slough appeared subjective, allowing different interpretations. An example is shown in the following Figure 29 from the DWR (2012) report.

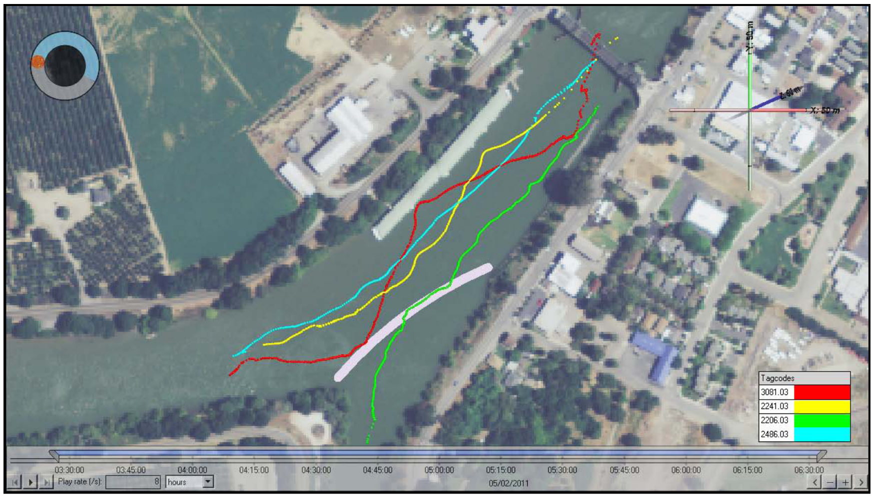

Figure 29. "Two-dimensional tracks of Chinook salmon smolts in the Sacramento River. Notes: All four smolts were released May 2, 2011 at 00:00 hours. All four tracks passed by the divergence of the Sacramento River and Georgiana Slough on May 2, 2011 between 03:17 and 03:44 hours. 2206.03 was undeterred and entered Georgiana Slough. 3081.03 and 2241.03 were deterred into the Sacramento River. 2486.03 was determined to be undeterred because it made no movement away from the BAFF." (from DWR 2012) Note that the curved white line is the location of the BAFF (NPB) and the entrance to Georgiana Slough is at the bottom of the figure." (from DWR 2012)

In this example, DWR (2012) assumed that fish no. 2241.03 (yellow line) was deterred from entry into Georgiana Slough. However, an alternative interpretation is that the fish was simply following the main flow of the Sacramento River and the NPB had no meaningful effect. In fact, this salmon behaved similarly to radio-tagged salmon observed during prior research at Georgiana Slough when no NPB was in place (Vogel 2002a, 2011b). Fish 3081.03 (red line) was also assumed by DWR (2012) to have been deterred from entry into Georgiana Slough; it may have been. However, the migration pattern for this fish was very unusual and uncharacteristic of smolt behavior seen in other telemetry studies. Note that this fish traversed diagonally (zigzagged) across the Sacramento River several times in a very short linear distance under exceedingly high flow conditions (>20,000 cfs). There are two alternative scenarios for this fish which are different than that postulated in DWR (2012). First, with the very high flows present at the time, when originally reaching the BAFF, the fish may have been simply following the main flow of the Sacramento River past Georgiana Slough. Second, based on prior research I conducted on the behavior and movements of radio-tagged salmon past Georgiana Slough, the behavior was not reflective of normal smolt migration. This unusual migration pattern may have actually been a result of the acoustic-tagged salmon being inside a predatory fish, not a live salmon (discussed later in these comments). In fact, the study could not determine if any of the fish approaching the barrier were live acoustic-tagged salmon or dead acoustic tagged salmon inside predatory fish. If these data interpretations are indicative of the study, significant differences of opinion on the study results are probable. The BDCP's discussion on NPBs did not disclose this considerable uncertainty.

Notably, the BDCP downplayed or largely dismissed the potential for the Georgiana Slough NPB to attract predatory fish over time even though it admits there is "considerable uncertainty" about potential predation (BDCP Page 5.B-57). As mentioned previously, the predator "magnet" problem caused by the NPB at the head of Old River was deemed to be too severe and risky for salmon so the barrier has not been pursed at that location. For Georgiana Slough, DWR (2012) states:

> "It is important to note that if the BAFF is used as a long-term management tool, predators could become conditioned to the BAFF On mode and may prey on salmon to a greater extent than under experimental operational conditions (BAFF On/BAFF Off). In addition, the habitat selected by and movement patterns of predators in the Sacramento River adjacent to the BAFF may vary within and among years in response to factors such as river flow and velocities, water temperatures, and recreational harvest. These factors, in combination with possible conditioning to BAFF operations, could result in different predation rates than those observed during the 2011 study." (DWR 2012)

Importantly (as it relates to the BDCP), since the 2011 and 2012 experiments at Georgiana Slough, DWR has abandoned plans to continue experimentation of the NPB at that location. That decision was made, in part, because of local landowners' complaints concerning the noise created by the generators used at the site to operate the NPB (notes from a March 4, 2014 meeting concerning USBR experiments on an electrical barrier in Deadhorse Cut). Instead, DWR has installed and is evaluating a floating shallow-draft metal-plate boom in front of Georgiana Slough to determine its efficacy in diverting juvenile salmon away from the Slough (Figures 30 and 31). This surface deflector wall currently under evaluation at Georgiana Slough may pose significant predation hazards for juvenile salmon. It could actually increase overall salmon mortality by providing ideal predator holding habitats and prey ambush sites. Although this predation topic was discussed previously in comments on CM2, it warrants repeating here:

> "The literature offers some assistance for minimizing and discouraging predation at the intakes and fish facilities. Piers, pilings, other supportive structures, and corners or other irregularities in a channel are referred to as structural complexities. Such structures may cause uneven flows and can create shadows and turbulent conditions. A structurally complex environment should be avoided. Corners, interstices, or other structural components that create boundary edges contribute to maximum foraging efficiency of large predatory fishes and the highest populations of predators will occur where structural boundary edges are present. Structural complexity can increase predation by providing locations for waiting predators (shadows, interstices, corners, etc.). The risk of prey to predation is a function of exposure, often directly related to the structural complexity of the system." (Odenweller and Brown 1982)

Again, the BDCP does not address those known problems for salmon and, again, overlooked the readily available science on the topic.

Additionally, the BDCP has not integrated the fact that salmon will be more concentrated in a lesser volume of water at the Sacramento River – Georgiana Slough flow split when the north Delta diversions are in operation (up to 9,000 cfs diverted from the river) and if the Fremont Weir "notch" is being utilized (up to 6,000 cfs diverted from the river). The result will be a higher proportion of salmon (and therefore numbers of fish) entering Georgiana Slough. Those adverse impacts do not appear to be described in the BDCP documents. If the detrimental effects were addressed, the accompanying description should be prominent and explicit. If those impacts were not accounted for in the analyses, this is an enormous shortcoming.

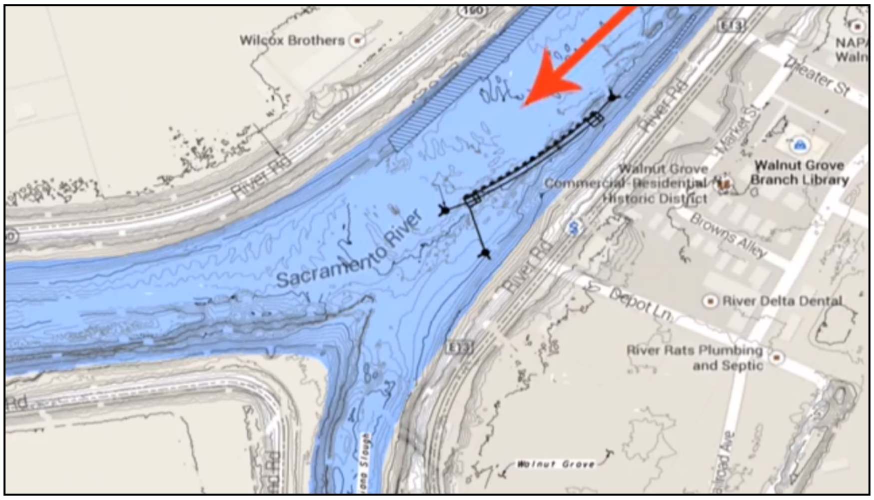

Figure 30. Plan-view diagram of the location of a floating defector wall installed near the entrance to Georgiana Slough on the Sacramento River. Georgiana Slough is at the bottom of the figure. Screen capture from: http://www.youtube.com/watch?v=937bXx9QMn8&feature=youtu.be

Figure 31. Floating wall being installed near the entrance to Georgiana Slough in 2014 (screen capture from: http://www.youtube.com/watch?v=937bXx9QMn8&feature=youtu.be

Despite the fact that the effectiveness of NPBs remains unproven for fish protection, and that experimentation of the device has been abandoned at Georgiana Slough and failed at the head of Old River, the BDCP nevertheless has proposed installing these devices at a total of <u>seven sites</u> in the Delta[20]: Delta Cross Channel, the Sacramento River at Fremont Weir, Turner Cut, Columbia Cut, head of Old River, Georgiana Slough, and the entrances to the south Delta export facilities (Clifton Court Forebay and the Delta-Mendota Canal intake). It is noteworthy that the BDCP provides no information on the efficacy of installing NPBs at these additional sites. Information is readily available to clearly demonstrate that some of those areas are not feasible

[20] BDCP Page 4-80.

and would provide no protection for salmon. In yet another example of promoting benefits to salmon without supporting information and not using the best available science, the BDCP states: "Barriers at these locations have a high potential to deter juvenile salmonids from using specific channels/migration routes that may contribute to decreased survival …" (BDCP Page 4-80). Some of the proposed sites are absurd. For example, the BDCP suggests installation of bubble curtains or log booms in the Sacramento River to shunt downstream migrating salmon into the Yolo Bypass at Fremont Weir:

> "If deemed necessary to enhance the attraction of juveniles into Yolo Bypass through the gated seasonal floodplain inundation channel (described above), construct and operate nonphysical or physical barriers in the Sacramento River. Examples of such barriers include bubble curtains or log booms (Phase 2 or 3, Category 3 Action)." (BDCP Page 3.4-53, BDCP Page 4-32, and EIR/EIS Page 3-127)

Figure 32 shows a hypothetical location for such a barrier north of Fremont Weir. Although the BDCP provides no details on this concept, it does not require an engineering analysis to determine it is infeasible and has no merit. During the period when salmon are emigrating past the weir and Sutter and Yolo Bypasses are flooding, the Sacramento River is a hostile environment for static in-river structures. Large trees and debris would destroy a structure positioned in this location. Furthermore, with extremely high channel velocities and low water clarity, there is no reason to believe that young salmon would behaviorally respond to such a barrier. The best available science indicates the fish would not respond favorably.

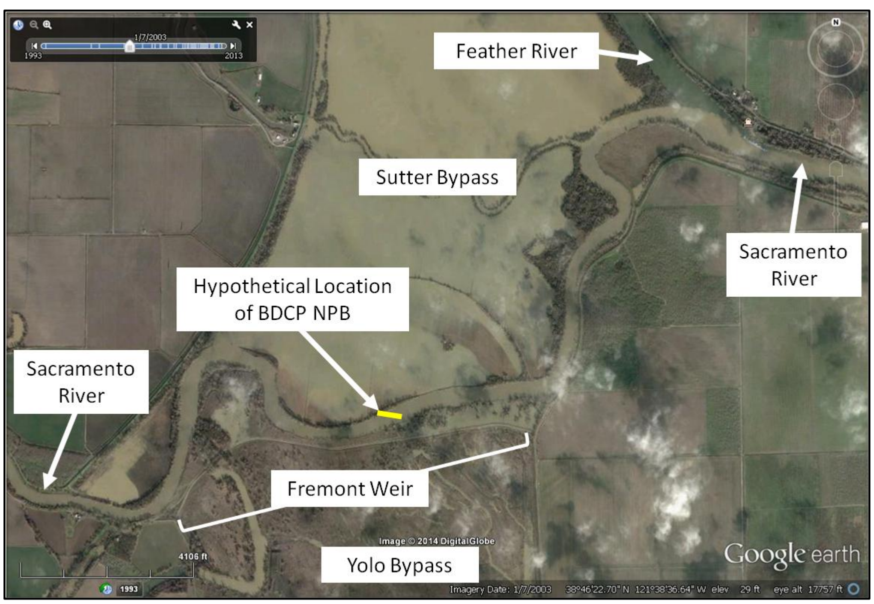

Figure 32. Aerial photo of the northern Yolo Bypass, Fremont Weir, and southern Sutter Bypass showing a hypothetical location of a bubble curtain or log boom suggested in the BDCP.

If the NPB at Georgiana Slough is deemed unacceptable (which apparently it already has), the BDCP, astoundingly, proposes construction of a flat-plate fish screen in front of the Slough:

> "Because about 25% of the Sacramento River water is diverted into the central Delta, additional consideration for screening Georgiana Slough may be warranted. If the non-physical barrier (bubble, light and sound) being investigated by DWR and Reclamation for the 2009 NMFS BiOp does not prove effective, <u>a flat wedge-wire fish screen, similar to what is proposed for the north Delta intakes could be designed and constructed</u>. The likely fish benefits and possible fish impacts could be investigated under the BDCP adaptive management process. (emphasis added)" (BDCP Pages 5C.A-121 and -122

This measure is also illogical and doesn't require an engineering analysis to know it is not feasible and would violate existing fishery resource agencies' criteria for fish protection. Clearly, the BDCP has not used the best available science that demonstrates negative impacts on fish would certainly occur. A positive barrier at that location would be disastrous for salmon. The sheer magnitude of flow entering the Slough would create extremely high through-screen velocities that would certainly impinge and kill young salmon and other species such as Delta smelt. Also, flow reversals under certain conditions occur in that vicinity (as described previously) and there is no bypass flow to route fish past the screens; enormous numbers of fish would be impinged. Furthermore, it is readily apparent from discussions in the EIR/EIS that some of the primary reasons for selecting the north Delta intake locations farther upstream was to avoid adverse impacts on Delta smelt and the lower sweeping flows present at locations farther downstream. The unreasoned and inconsistent logic is not described in the BDCP documents.

Other locations where the BDCP recommends installing NPBs are in the channels leading to Clifton Court Forebay (CCF) and the Delta-Mendota Canal:

> "Nonphysical barriers would be installed at the south Delta entrance canals leading to CCF and the Delta-Mendota Canal." (BDCP Page 5.B-57)

> "Nonphysical barriers at the entrances to Clifton Court Forebay (CCF) and the Delta-Mendota Canal (DMC) have the best potential to reduce entrainment of juvenile Chinook salmon and steelhead … The effectiveness of nonphysical barriers will depend on the water velocity characteristics in the vicinity of the barrier and on the extent to which predatory fish occur along the barrier. There is also uncertainty as to whether preventing entrainment into CCF and the DMC will enhance survival given the prevailing hydrodynamics in the area, i.e., if net reverse flows are present that may not allow fish to move away from the area and make them more susceptible to entrainment. Such uncertainties necessitate study to assess the effectiveness of nonphysical barriers at these locations." (BDCP Page 5.B-387)

As with the previously described sites, NPBs in the south Delta recommended in the BDCP are already known to be infeasible. The BDCP states that there is "considerable uncertainty" about velocities in the vicinity of proposed NPB locations (BDCP Page 5.B-57). Large amounts of existing data are readily available to demonstrate this is not true. Flow and channel velocities leading to the south Delta water export facilities are commonly high and there is no biological reason to expect juvenile salmon to behaviorally respond in the manner suggested in the BDCP. All the best available data and science demonstrates otherwise. For example, extensive historical ADCP channel velocity data available through the California Data Exchange Center for Old River leading to the export facilities clearly demonstrate that southerly water velocities can commonly be as high as 3 to 5 ft/s. Young salmon cannot swim against such high velocities for extended periods (Fisher 1981, Swanson et al. (2004a, 2004b). During an evaluation of radio-tagged Chinook salmon movements in the south Delta during December 2000 (Vogel 2002b), it was determined that salmon moved rapidly with direction of flow toward the export facilities, not against it (Figure 33). With south Delta exports, flow in northern Old River is often negative, very high, and salmon are forced to move southerly with the flow (Vogel 2005, telemetry data from Vogel 2010). Under those conditions, there is no bypass flow and salmon would move rapidly and unidirectionally into and through the NPBs. Note that even with high bypass flows during experiments with a NPB at the head of Old River, high flow through the NPB reduced its effectiveness.[21] With no bypass flow, why would NPBs be expected to work at the canals leading to CCF and the Delta-Mendota Canal? Again, the BDCP assumptions are not well reasoned and the documents do not explain such illogical conclusions.

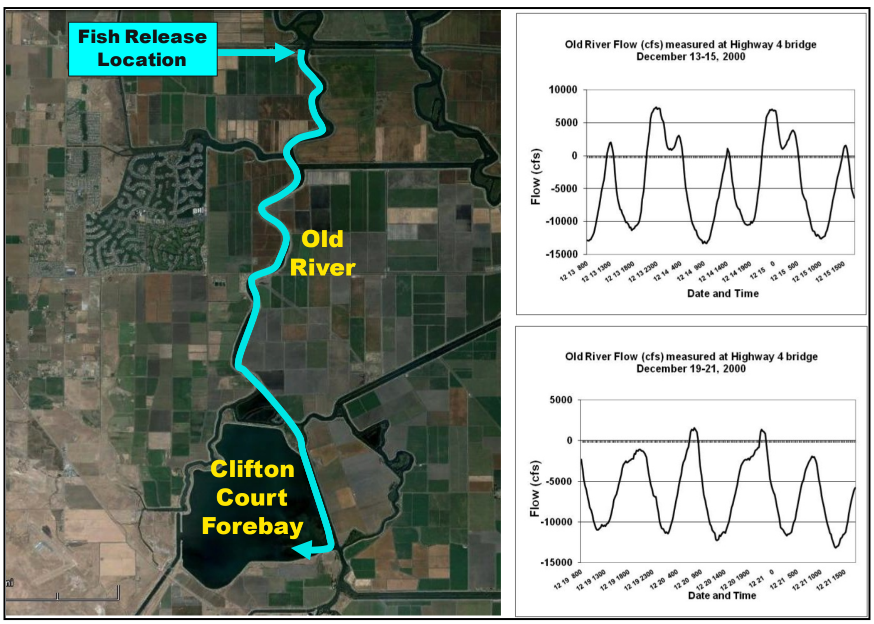

Figure 33. Migration route for some radio-tagged juvenile Chinook salmon released in northern Old River and flow measured at the Highway 4 bridge in northern Old River in December 2000 (adapted from Vogel 2002b, 2011b).

Recommendations for the installation of NPBs at sites already known to be infeasible should be removed from the BDCP. As pointed out later in the comments on the use of the BDCP fish models, the speculative assumptions on very high benefits for salmon resulting from NPBs should be changed to reflect more-realistic assumptions and balanced analyses.

[21] "Higher flows in 2010 resulted in reduced effectiveness [of the nonphysical barrier] in deterring juvenile salmonids, as juveniles may have lacked the swimming ability to avoid the barrier and be effectively deterred from entering the Old River (Bowen et al. 2009; Bowen and Bark 2010)." (BDCP Page 5.B-83)

The BDCP also provides no evidence that the installation of NPBs would not adversely impact the upstream migration of anadromous fish (not only adult salmon, but adult sturgeon). The BDCP gives short shrift to this important topic by indicating it was only qualitatively evaluated:

> "In addition, a qualitative analysis of the potential impeding effects of such barriers [on upstream migrating anadromous fish] was conducted that evaluated the relative position of the barriers in relation to species' position in the water column and the hearing and escape abilities of the species in relation to the acoustic deterrent provided by the barriers." (BDCP Page 5C.4-36)

This potentially serious problem must be investigated prior to reliance on NPBs. Even if NPBs are eventually found to provide benefits for salmon, those measures could be pursued independently of the BDCP. Here again, it appears that the BDCP is attempting to demonstrate fish benefits for actions that could be implemented separately from construction and operation of the north Delta water diversions.

In summary, CM16, like CM15, is yet another proposed action within the BDCP with highly tenuous outcomes in which purported fish benefits are assumed, but the BDCP identifies numerous uncertainties as to the potential effectiveness of this measure. The BDCP also recommends installation of NPBs at locations where it is already known the barriers would not be feasible. Additionally, it is unknown why the BDCP did not disclose highly relevant information that was contrary to the documents' assumed benefits to fish. Clearly, the BDCP has not used the best available science. Here again, answers to the numerous key uncertainties, such as those identified in BDCP Appendix D, should be pursued prior to implementation of the BDCP, not after; the risk of failure and severe impacts to salmon are too great.

Use of Fish Models for the BDCP Analyses

The BDCP used a variety of models to evaluate potential effects on salmon resulting from measures proposed for the BDCP. Although models are never perfect in predicting effects on salmon, those used for the BDCP were particularly constrained because of a lack of empirical data, incorrect data, and very low reliability and confidence in the models' outputs. Unfortunately, some of the fish models related to salmon survival and behavior are based on faulty data rendering model run outputs invalid and incapable of comparing BDCP alternatives. Some of the models' documentation aptly point out that the intent of the modeling exercises was not to estimate absolute fish survival, but instead to provide relative comparisons among BDCP scenarios (e.g., EIR/EIS Page 4-13). However, in many instances, inputs to the models were based on inflated and biased fish survival estimates (described below) that would not provide valid comparisons of the BDCP scenarios. Although the BDCP claims, "The methods used reflect the best available tools and data regarding fish abundance, movement, and behavior." (BDCP Page 5.B-i), that premise is simply not correct. It is also readily apparent that when the models suggested unfavorable results (i.e., adverse impacts on salmonids), they were downplayed or not used. Conversely, when the models suggested favorable results (i.e., beneficial impacts on salmonids), they were overplayed and used. Because there was so much reliance on models for the BDCP analyses, it is important to understand the limitations of those models. The documentation for various models describes some of the limitations, but those discussions are fragmented and buried in the voluminous appendices and commonly not carried forward into the main body of the BDCP document. In many instances, the models' documentation overlooked some serious limitations. The following discussion provides several example details on why many of the fish models are very limited or invalid for application to the BDCP.

Although large numbers of salmon fry enter the Delta each year, none of the fish models were capable of modeling the BDCP effects on this smaller-sized life stage salmon. This critical deficiency is an enormous shortcoming of the BDCP and leaves a tremendous amount of uncertainty in estimating the impacts of the BDCP on salmon. Some of the models attempted to evaluate BDCP effects only on the larger-sized, smolt life stage. For example, in use of the Delta Passage Model (DPM):

> "Many of the model assumptions are based on results from large, hatchery-reared fall-run Chinook salmon that may not be representative of smaller, wild-origin fish. Model is applicable only to migrating fish and not to those rearing in the Delta. Equations for estimating salvage have relatively low explanatory power for the data upon which they were derived." (BDCP Page 5.B-57)

> "Many of the model assumptions are based on results from large, hatchery-reared fall-run Chinook salmon that may not be representative of smaller, wild-origin fish. Model is applicable only to migrating fish and not to those rearing in the Delta. Model is mostly limited to operations-related effects on flow. Model only accounts for smolts and not other migrating juvenile life stages." (BDCP Page 5C.4-6)

> "Unfortunately, survival data are lacking for small (fry-sized) juvenile emigrants because of the difficulty of tagging such small individuals. Therefore, the DPM should be viewed as a smolt survival model only, with its survival relationships generally having been derived from larger smolts (>140 mm), with the fate of pre-smolt emigrants not incorporated into model results." (BDCP Page 5C.4-40)

Furthermore, the fish models were not capable of predicting BDCP effects on salmon because empirical data used for the input were based on existing (or more aptly, past) Delta conditions. Implementation of the BDCP would fundamentally change large-scale hydrodynamic, bathymetric, and fish habitat conditions in the Delta. These circumstances present an enormous dilemma for the BDCP analyses. Flow patterns (e.g., tidal and circulation) and physical habitats for salmonids would be substantially altered and the ultimate response of salmon to those conditions would change, probably significantly. The models used were based on data collected during conditions that would not be representative of future, altered conditions in the Delta. This major limitation is pointed out in BDCP Appendix 5.G:

> "The [life cycle] models are fundamentally constrained in that they are based on species–habitat relationships that have been established for the existing configuration of the San Francisco Bay/Sacramento–San Joaquin River Delta (Bay-Delta) and therefore do not incorporate the substantial changes in the

landscape proposed to occur with proposed habitat restoration. This is a critical limitation because large-scale habitat restoration is a core component of the BDCP that is intended to produce significant ecological benefits." (BDCP Page 5.G-1)

This same limitation would also be applied to the DPM.

Additionally, it seems that some of the models are incomplete:

> "The DPM results presented here reflect the current version of the model, which continues to be reviewed and refined, and for which a sensitivity analysis is underway to examine various aspects of uncertainty related to the model's inputs and parameters." (BDCP Page 5C.4-40)

There also appears to be conflicting assumptions between some of the fish models. For example, the ISI growth model accounts for salmon emigration timing differences between years (which is accurate) whereas the DPM looks to assume a uniform distribution between years (which is not accurate).

Furthermore, some of the fish models are out of date and used incorrect information. For example, documentation on the Oncorhynchus Bayesian Analysis (OBAN) model states:

> "The current operation of RBDD makes counts of winter-run Chinook salmon after closing the gates on May 15. On average, 15% of the winter run passed RBDD by May 15, but the specific percentage in a given year was as low as 3% or as high as 48% (Snider et al. 2000). Egg abundance is calculated by assuming that each adult spawner produces 2,000 eggs (Williams 2006)." (BDCP Page G-22)

The fecundity of winter-run Chinook of 2,000 eggs per female is greatly underestimated. For instance, Hallock and Fisher (1985) reported an average of 3,353 eggs per female. More recently, Poytress and Carrillo (2012) reported an average of 5,277 eggs per female based on spawning records at the Livingston Stone National Fish Hatchery for the nine-year period from 2002 through 2010. The underestimate for the OBAN model would likely generate serious errors in the model outputs. Also, the information on winter run passage at RBDD is outdated. Since 2012, the RBDD gates have been removed year-round, resulting in unimpaired salmon passage (Vogel 2012a). The resultant change in passage timing (temporal shift to earlier passage) would affect OBAN model results, adding even more mistakes in the model outputs. Additionally, it is not clear if historical RBDD gate operations and effects on winter-run Chinook delay and blockage were included as a covariate in the OBAN model. If not, it would likely significantly change the integrity of the model. RBDD gate operations had a major adverse impact on annual runs of winter-run salmon and was a primary reason the dam gates were eventually raised (removed).

The OBAN model incorporated a covariate of the <u>number of days</u> during December through March with minimum flows of 100 cfs over the Fremont Weir (BDCP Page 5.G-23) and <u>not flow</u>

rates (e.g., 1,000 cfs, 5000 cfs, etc). The OBAN model assumes that *any increase* in Yolo Bypass inundation will increase through-Delta winter-run Chinook survival (BDCP Page 5.G-80), an assumption that is unlikely to be valid as indicated by statements elsewhere that flows of greater than 4,000 cfs would be necessary (BDCP Page 5.G-23). This limitation likely greatly overestimated beneficial effects on salmonids. Also, there did not appear to be any incorporation of the consecutive daily effects of Yolo Bypass inundation in the BDCP analyses. The BDCP model approach seems counter-intuitive. Higher flow rates over more consecutive days would presumably be more beneficial to salmon than sporadic, very low levels of flow over the Fremont Weir; furthermore, the flow/benefits relationships would likely be non-linear.
There is a very confusing discussion concerning the OBAN model results where it suggests that the BDCP would adversely impact winter-run Chinook because of higher water temperatures and lower flows in the upper Sacramento River (BDCP Page 5.G-54, BDCP Page 5.G-58, BDCP Page 5.G-60). For example:

> "In the Sacramento River spawning reaches, modeled water temperatures at Bend Bridge were higher (Figure 5.G-3) and minimum flow rate were lower (Figure 5.G-4) under the ESO compared to EBC2 scenarios, particularly during the ELT. These differences in Sacramento River conditions cause lower survival in ESO scenarios relative to EBC2 scenarios in the alevin and fry stages and are ultimately reflected in lower escapement under ESO." (BDCP Page 5.G-54)

> "Therefore, the OBAN model analysis suggests that the results are driven by modeled flow modifications in the upper Sacramento River and associated effects on water temperature conditions experienced by alevins on and near the spawning grounds. However, as noted above, the BDCP does not include Shasta Reservoir operational criteria changes, and therefore does not affect how cold water pool and flows in the upper Sacramento River are managed." (BDCP Page 5.G-60)

This discussion seems to conclude that model's results demonstrate that the BDCP scenarios will adversely impact winter-run Chinook due to deleterious effects on eggs caused by reduced reservoir releases and elevated water temperatures. But then the BDCP discussion suggests those impacts will not actually take place. In other words, it sounds like the conclusion is: "Modeling results predicted adverse impacts to winter run from the BDCP, but trust us, we won't allow that to occur." This begs the question as to whether there was any utility to the modeling exercise.

Additionally, water temperature modeling indicated that there would be a 5% increase in the number of years under ESO-ELT that would be classified as a "red" level of concern for winter-run Chinook egg incubation relative to EBC2_ELT. However, those impacts are deemed insignificant because it is considered within the range of "modeling error" (BDCP Page 5C.5.2-62). Water temperature modeling is far more sophisticated, accurate, and reliable than the fish models used for the BDCP. Notably, when the BDCP fish models suggest slightly positive or negative results for salmon, the caveat of "within the range of modeling error" is not discussed in context. For example, the statement is made: "Overall, the DPM results for late fall–run Chinook salmon demonstrated that survival under the ESO scenarios generally was similar to or slightly higher than that of the EBC scenarios." (BDCP Page 5C.5.3-96). However, as can be seen from examination of BDCP Table 5C.5.3-49 (below), the incremental differences in survival between scenarios are very small. The average difference in survival between EBC2_LLT versus ESO_LLT is only 0.2 or 1%. Given all the caveats on the model limitations described in the BDCP (and others described later in these comments), the relative differences (both positive and negative) in salmon survival among the BDCP scenarios are commonly very small and should have been characterized as within modeling error.

Table 5C.5.3-49. Differences[a] between EBC and ESO Scenarios in Percentage of Late Fall–Run Chinook Salmon Smolts Surviving through the Delta, Based on Delta Passage Model

Water Year[b]	Scenarios[c]					
	EBC1 vs. ESO_ELT	EBC1 vs. ESO_LLT	EBC2 vs. ESO_ELT	EBC2 vs. ESO_LLT	EBC2_ELT vs. ESO_ELT	EBC2_LLT vs. ESO_LLT
1976 (C)	-1.3 (-6%)	0.2 (1%)	-6.4 (-26%)	-5.0 (-20%)	-4.7 (-20%)	-3.0 (-13%)
1977 (C)	0.6 (4%)	2.2 (14%)	1.4 (9%)	3.0 (20%)	0.7 (4%)	1.7 (10%)
1978 (AN)	0.0 (0%)	1.0 (5%)	0.2 (1%)	1.2 (7%)	0.4 (2%)	1.0 (5%)
1979 (BN)	1.7 (10%)	2.2 (13%)	-1.0 (-5%)	-0.5 (-3%)	-1.1 (-5%)	-1.0 (-5%)
1980 (AN)	-1.9 (-9%)	1.9 (9%)	-1.2 (-6%)	2.6 (12%)	-0.9 (-4%)	2.4 (11%)
1981 (D)	0.6 (3%)	1.6 (8%)	-0.4 (-2%)	0.6 (3%)	-0.8 (-4%)	0.3 (1%)
1982 (W)	0.5 (2%)	0.8 (3%)	0.4 (1%)	0.8 (3%)	0.7 (2%)	0.6 (2%)
1983 (W)	-7.8 (-20%)	-8.4 (-21%)	-6.7 (-17%)	-7.3 (-19%)	-4.9 (-13%)	-3.6 (-10%)
1984 (W)	-5.0 (-12%)	-5.1 (-12%)	-4.8 (-12%)	-4.8 (-12%)	-2.3 (-6%)	-1.9 (-5%)
1985 (D)	-2.1 (-7%)	-1.9 (-7%)	-3.8 (-13%)	-3.7 (-12%)	-3.9 (-13%)	-2.9 (-10%)
1986 (W)	0.3 (2%)	1.1 (6%)	0.3 (1%)	1.1 (5%)	0.4 (2%)	1.4 (7%)
1987 (D)	3.1 (18%)	4.8 (28%)	0.2 (1%)	1.8 (9%)	-0.1 (-1%)	0.7 (3%)
1988 (C)	-1.0 (-4%)	0.2 (1%)	0.4 (2%)	1.6 (8%)	0.6 (3%)	1.4 (7%)
1989 (D)	0.7 (4%)	1.2 (7%)	0.7 (4%)	1.1 (7%)	0.7 (4%)	0.6 (3%)
1990 (C)	2.4 (14%)	3.4 (20%)	2.3 (14%)	3.3 (19%)	0.9 (5%)	2.0 (11%)
1991 (C)	1.6 (11%)	3.1 (21%)	1.2 (8%)	2.7 (18%)	1.6 (11%)	2.7 (18%)
Average	-0.5 (-2%)	0.5 (2%)	-1.1 (-5%)	-0.1 (0%)	-0.8 (-3%)	0.2 (1%)
Median	0.4 (2%)	1.2 (6%)	0.2 (1%)	1.1 (5%)	0.2 (1%)	0.7 (3%)

[a] Negative values indicate lower survival under ESO scenarios than under EBC scenarios.
[b] Water-year types: W = wet; AN = above normal; BN = below normal; D = dry; C = critical.
[c] See Table 5C.0-1 for definitions of the scenarios.

In this latter regard, the BDCP analyses display a disturbing trend where favorable fish model outputs are overstated and the unfavorable outputs are downplayed. For example, the Interactive Object-Oriented Simulation (IOS) Model results suggest that the BDCP would result in negative effects to winter-run Chinook salmon (Figures 34 and 35), but those results were downplayed:

> "In general, the BDCP scenarios resulted in slightly lower through-Delta survival rates overall, with the survival rates for each scenario varying over a similar range. … The lower BDCP scenario survival rates were the result of increased flow-related mortality in specific model reaches in the Delta." (BDCP Page 5.G-68)

> "IOS estimated lower escapement of winter-run Chinook under the ESO, HOS and LOS scenarios over the ELT, with the modeled decreased through-Delta survival being the primary driver of these effects, although only flow-related effects were included in the model." (BDCP Page 5.G-81)

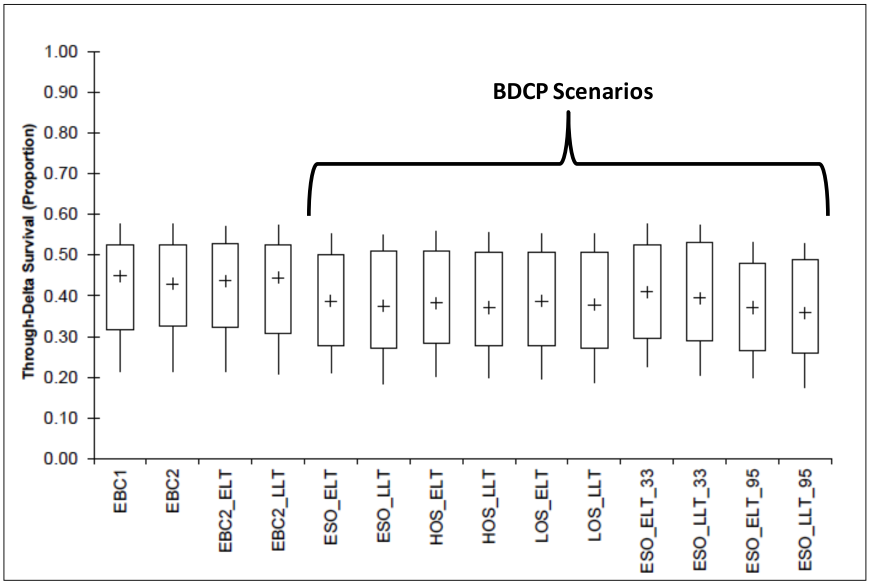

Figure 34. Box plots of Sacramento winter-run Chinook salmon smolt survival through the Delta for each model scenario (adapted from BDCP Page 5.G-69).

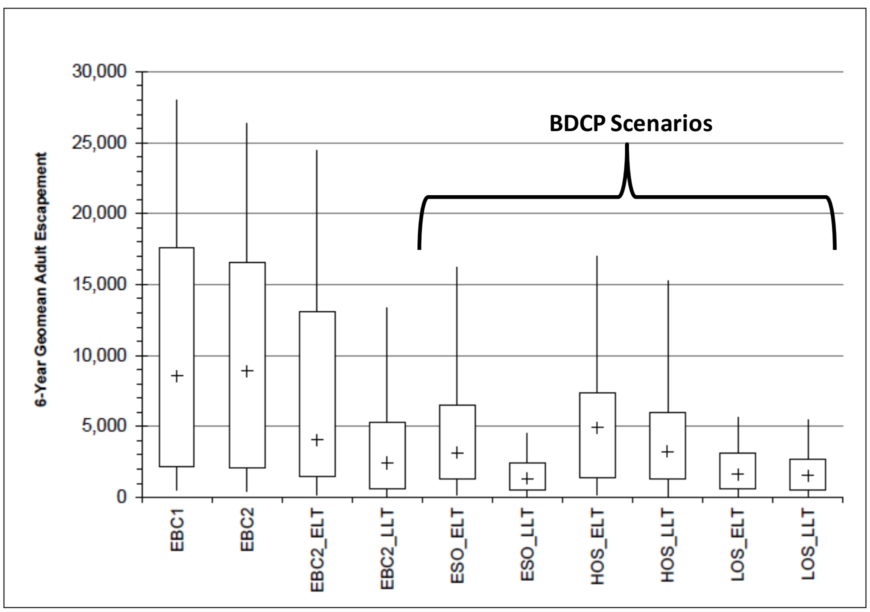

Figure 35. Box plots of 6-year geometric mean Sacramento winter-run Chinook salmon adult escapement for each model scenario (adapted from BDCP Page 5.G-74).

BDCP modeling also indicated that the BDCP would adversely impact winter-run Chinook redd dewatering:

> "The number of years with poor redd dewatering conditions would be 11% and 8% higher under ESO_ELT and ESO_LLT relative to EBC2_ELT and EBC2_LLT, respectively." (BDCP Page 5C.5.2-67)

But the BDCP concluded:

> "These results indicate that there would be a small adverse effect of the ESO on winter-run Chinook salmon". (BDCP Page 5C.5.2-67)

Normally, dewatering of winter-run Chinook redds has been considered a very serious concern by the fishery resource agencies. For example, in 2013, small numbers of winter-run redds began dewatering during the fall and USBR was required to maintain higher than normal Keswick Dam water releases until winter-run fry could emerge from the redds. As a consequence, large numbers of early-spawning fall-run Chinook laid eggs during relatively high-flow conditions on elevated benches of the riverbed. When flows subsequently and abruptly declined, it was estimated that millions of fall-run salmon eggs perished. At a May 3, 2014 Golden Gate Salmon Association Task Force meeting, a USFWS employee announced that if just five winter-run salmon redds were to begin to become dewatered during declining Sacramento River flows, it could "trigger" the need to maintain or increase reservoir releases. Apparently, the BDCP has a different opinion as to what constitutes a "small adverse effect".

However, although unfavorable consequences on winter-run Chinook are indicated on several fronts, the BDCP discounts the model outputs by providing numerous caveats suggesting the models do not reflect anything from which meaningful conclusions can be made. Furthermore, when negative impacts on fish are indicated, the BDCP adds speculative statements suggesting those impacts could be offset by unproven conservation measures such as the use of NPBs discussed previously. This points to fallacies in the BDCP analyses by assuming that proposed conservation measures with highly untenable and uncertain effects on salmon will be beneficial. The problem is then compounded when the BDCP extrapolates questionable presumed beneficial results from uncertain conservation measures to other, also uncertain, conservation measures concluding positive benefits for salmon, all the while lacking empirical foundation. In other words, the BDCP should not extrapolate the effects of one uncertain CM as an indicator for other uncertain CMs. For example:

> "These results indicate that IOS is sensitive to the beneficial effects of conservation measures like CM 16 [non-physical barriers] indicating that other conservation measures could have a similarly large effect on model outcomes if they could be incorporated into IOS or another similar life cycle model. Given this limitation, IOS results alone do not provide a sufficient basis for drawing conclusions about the overall effect of the BDCP on winter-run Chinook salmon." (BDCP Page 5.G-78)

> "Therefore IOS is likely underestimating the performance of the BDCP scenarios." (BDCP Page 5.G-80)

> "Therefore IOS results must be interpreted with caution when evaluating the potential effects of the BDCP because this analysis did not consider the beneficial effects of Delta habitat restoration or several other potentially beneficial conservation measures." (BDCP Page 5.G-81)

Overall, it seems that OBAN modeling suggests that higher mortality of winter-run Chinook occurs with the BDCP as compared to existing conditions due to egg mortality in the upper river whereas IOS modeling implies higher in-Delta mortality with the BDCP as compared to existing conditions. But then both are portrayed as not reasonable representations when it comes to negative impacts:

> "While both models predict lower overall performance for most BDCP scenarios relative to EBC2, these results must be viewed as incomplete. Neither model is fully representative of the conditions experienced by winter-run Chinook across their entire life history. Importantly, neither model considers the entire range of beneficial effects likely to occur under the BDCP." (BDCP Page 5.G-82)

None of the modeling adequately accounted for salmon fry mortality attributable to impingement on the north Delta intakes. As described previously, although it is reasonable to conclude that entrainment mortality will be zero or negligible, the opposite would be true for impingement mortality. The high certainty of adverse impacts should not be simply ignored. The BDCP provides conflicting assumptions of the sources of mortality; in some cases, the documents suggest the mortality would solely be attributable to predation and, in other cases, it is assumed to encompass predation, impingement, and entrainment. Here again, it would be useful for the BDCP to parse out and bracket potential impingement mortality with low, medium, and high estimates.

The bioenergetics modeling actually only accounted for striped bass predation which would greatly underestimate salmon losses. Salmon predation losses attributable to Sacramento pikeminnow and black bass would undoubtedly be expected. For example, Nobriga and Feyrer (2007) state: " Striped bass, largemouth bass, and Sacramento pikeminnow are three of the major predators of juvenile and small adult fishes in the Delta." Even though the BDCP mentions the fact that Sacramento pikeminnow are common in the Delta, the implication is put forth that the species is not a predator on salmon in the region[22]. However, Sacramento pikeminnow is considered a potential predator species on fish exiting the fish salvage release sites in the Delta (Odenweller and Brown 1982); DIDSON™ sonar footage has documented that occurrence (Miranda et al. (2010). Notably, Odenweller and Brown (1982) concluded that Sacramento pikeminnow is one of the most important potential predatory fish species at future fish facilities on the lower Sacramento River. The BDCP also incorrectly states: "There is, however, a bounty fishery in the upper Sacramento River to reduce predation by these fish on emigrating salmonids (Nobriga and Feyrer 2007)." A factual check of the source document did not make that statement. Several decades ago, there was a targeted sport fishery for pikeminnow, mostly associated with the Red Bluff Diversion Dam (Moyle 2002), but that has long since ended. Pikeminnow are common and a well-known predator on salmon in the Sacramento River and Delta, especially in altered environments that would be created by the north Delta intakes. Here again, the BDCP has not used the best available science.

A considerable amount of error was likely introduced when the bioenergetics modeling evidently only accounted for small striped bass predation on larger-sized juvenile salmon and not small and large striped bass predation on smaller-sized salmon:

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[22] "Sacramento pikeminnow predation on salmonids has been documented upstream (Vogel et al. 1998) but not in the Delta (Nobriga et al. 2006) …" (BDCP Page 5.F-68)

> "Loboschefsky and Nobriga (2010) provide estimates of striped bass predation rates on "small prey" and "large prey." This bioenergetics analysis incorporates only the large prey equation, although smaller salmon fry would fall under the small prey category. The large prey predation regression was based on data for small striped bass (69 to 478 millimeters [mm]); thus they mainly reflect responses of juvenile striped bass. Therefore, they are not as applicable for larger striped bass and for larger sized prey fishes." (BDCP Page 5.F-16)

Therefore, that modeling effort undoubtedly and substantially underestimated striped bass predation on salmon because high numbers of small and large striped bass can consume very large numbers of salmon fry.

The BDCP analyses apparently greatly underestimated salmon losses attributable to the south Delta water export facilities by not accounting for high prescreen predation mortality:

> "However, expanded salvage loss estimates used for analysis here [Delta Passage Model salvage juvenile salmon estimates for the SWP/CVP south Delta export facilities] do not include prescreen predation mortality, for which a multiplier of several times may be necessary." (BDCP Page 5.B-81)

The actual multiplier would be much higher than "several times". The best available information has clearly demonstrated that the prescreen predation mortality can be up to an order of magnitude greater than the direct salvage loss estimates. With such an extremely wide range of unaccounted mortality, it is not clear how the BDCP analyses would allow a useful comparison among BDCP alternatives. Here again, it would be practical for the BDCP analyses to provide a range of total mortality estimates (salvage plus predation losses) (e.g., low, medium, high) to permit more-meaningful comparisons among BDCP scenarios.

A significant error in the assumption of the timing of salmon smolt entry into the Delta for the DPM model was introduced when the model did not account for the substantial inter-annual variability in emigration timing for each salmon run. The DPM assumed the timing would be the same regardless of water year type and upstream hydrologic conditions (Figure 36). Although the documentation acknowledges the model is used only for smolts, not fry, there nevertheless are substantial differences in emigration timing of smolts between years. It appears that the DPM used a summed composite of data across different years but did not account for the variability in inter-annual salmon emigration and interrelationships with naturally occurring hydrologic conditions. This limitation is important because of how CM1 and CM2 operations would vary substantially between different water types and hydrologic variability and the resultant timing and interaction of salmon smolts with those operations. For example, the emigration of winter-run and late-fall-run Chinook salmon smolts (both of which have a more-protracted smoltification period than fall-run salmon) from the upper river to the Delta is influenced to a large degree by timing and magnitude of precipitation and consequential accretions in the upper watershed. This variability in smolt emigration timing is not captured in DPM model outputs and makes it highly problematic to use those outputs to compare alternative BDCP scenarios.

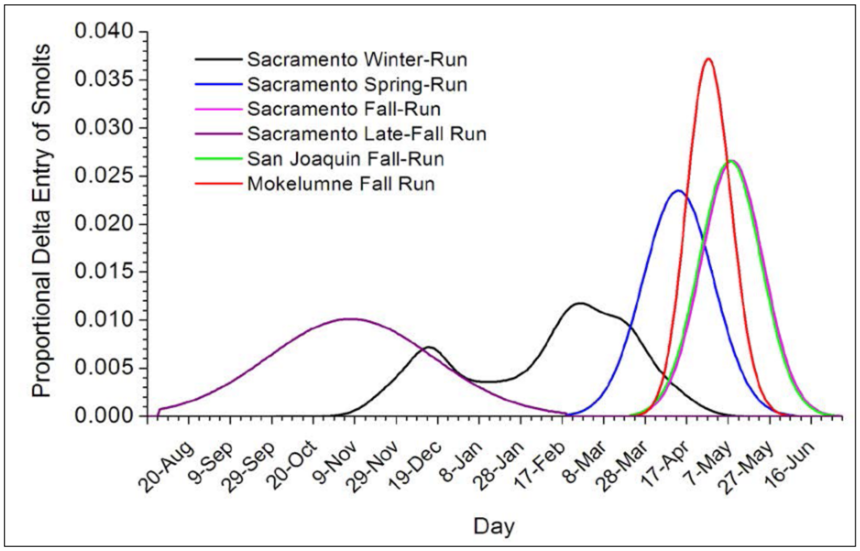

Figure 36. Delta entry distributions for Chinook salmon smolts applied in the Delta Passage Model for Sacramento River winter-run, Sacramento River spring-run, Sacramento River fall-run, Sacramento River late fall–run, San Joaquin River fall-run, and Mokelumne River fall-run Chinook salmon. (BDCP Figure 5.C.4-7)

The DPM has a significant erroneous assumption that installation of a NPB in front of the Delta Cross Channel would result in a large reduction of salmon entrainment:

> "As noted in the DPM methods, the assumption of a 67% proportional reduction in entry into the Interior Delta for late fall–run Chinook salmon actually involves assuming that there would be deterrence not only from entering Georgiana Slough but also the Delta Cross Channel, as the latter is largely open during the assumed late fall–run August-February migration period." (BDCP Page 5C.5.3-102)

There is no scientific basis to assume deterrence would be the same for the DCC as Georgiana Slough and the best available science indicates otherwise. Past telemetry studies on salmon movements at the DCC and Georgiana Slough and the areas' hydrodynamic conditions clearly demonstrate there are large differences in flow and fish entrainment at the two sites (Vogel 2002a, 2003a, 2008b, 2011a, 2011b). Discussion on the topic of non-physical barriers was previously provided within these comments (pages 53 – 63).

All of the fish models reliant on "through-Delta" salmon survival should be re-examined for consistency as to the specific salmon migration reach used for the survival estimates. Some modeling calculations used Chipps Island as the measurement end point whereas others used the Golden Gate Bridge as the end point. There are approximately 45 miles between those two end points and Michel (2010) found that there is a surprisingly high salmon mortality between Chipps Island and the Golden Gate Bridge.

Also, the BDCP fish models should be closely re-examined in an unbiased manner to assess if the models are actually rudimentary and incapable of predicting probable changes to salmon survival with the various BDCP scenarios and conservations measures. With so many questionable or erroneous assumptions built into the models based on incomplete, incorrect, or highly speculative information, one is led to believe the models, in reality, have a very low sensitivity for adequately providing the necessary comparative analyses.

Biased BDCP Analyses Based on Juvenile Salmonid Telemetry Studies in the Delta

The BDCP analyses relied heavily on outputs from a juvenile salmon "Delta Passage" computer model (DPM) to evaluate a variety of alternatives for water management in the Delta (BDCP Appendix 5C, Part 1). This dominant BDCP fish model relied on juvenile salmon acoustic-telemetry study results of Perry (2010) and a few other telemetry studies that provided estimates of acoustic-tagged juvenile salmon route selection and survival through the Delta. However, we now have a high degree of confidence that the accuracy and precision of the salmon survival estimates in those telemetry studies are not believable and, therefore, the DPM model and other models'[23] use of those study results for the BDCP analyses are unreliable.

To explain this assertion and demonstrate that the BDCP did not use the best available science, the following provides a background foundation and necessary amplification and clarification. This discussion is important to explain how the BDCP misused some past telemetry research on salmon, thereby resulting in misinterpretation of fish behavior and survival within the BDCP documents, and failed to build upon and use more-appropriate study findings. It is also essential because the BDCP indicates it will rely on future telemetry studies for its adaptive management program without disclosure of critical limitations discussed below.

Brief Background of the Use of Juvenile Salmon Telemetry in the Delta

Until the 1990s, detailed, empirical data on juvenile salmonid behavior and survival in the Delta's discrete reaches were largely unknown or severely lacking. There were widely-varying, speculative ideas on how juvenile salmonids behaved in the region's complex tidal environment. Opinions abounded, but all-important supportive data were unavailable until the mid-1990s when the first successful use of telemetry on juvenile salmonids in the Central Valley took place. Past efforts using traditional coded-wire tagging (CWT) did not, and could not, answer those critically important questions. Ultimately, from 1996 through 2010, I served as the principal scientific investigator for 22 separate research projects on juvenile salmon (including four studies of predatory fish) in the Delta using radio or acoustic telemetry as a means to acquire detailed data on fish behavior, fish movements with the tides, fish route selection at flow splits, migration through complex channels, migration rates, and estimates of fish survival (Vogel 2010a). As a result, comprehension of fish behavior has improved substantially in recent years due to breakthroughs in the creation, application and analysis of miniaturized telemetry technology for small fish. These readily-available tools have subsequently produced a proliferation of juvenile salmonid telemetry studies in the Delta.

Technological breakthroughs in miniaturization of radio transmitters allowed attachment or surgical implantation in juvenile salmonids (Figure 37). These transmitters could be

[23] For example, these errors were even propagated to particle tracking model PTM results for BDCP analyses: "For all other reaches (Geo/DCC and Yolo), reach survival is assumed to be unaffected by Delta conditions and is informed by means and standard deviations of survival from acoustic-tagging studies." 5C.4-52

programmed for individually-identifiable frequencies to discriminate between tagged fish released and monitored throughout the Delta channels. Radio signals emitting underwater can break the water/air surface interface and be detected by land- or boat-based radio receivers. Triangulation of radio signals provided locations of the migrating salmon. These initial studies quickly determined that the fish did not move as a school, but instead, dispersed, exhibiting a wide range in migratory behaviors in the complex Delta environment. Numerous revealing findings were derived from these first telemetry investigations. Salmon moved many miles back and forth each day with the ebb and flood tides and the side channels (where flow was minimal) were largely unused. Site-specific hydrodynamic conditions present when telemetered fish arrived at channel flow splits had a major affect in initial route selection. Importantly, relevant to the BDCP models, some of the juvenile salmonids were believed to have been preyed upon based on aberrant telemetry patterns (Vogel 2003b, 2004, 2010a, 2011a, 2012b). An example was a sudden attenuation in the radio signal that was caused by a salmon being eaten by a predator. These observations lead to the first documentation of predation on telemetered salmon in the Delta.

Figure 37. A radio-tagged juvenile Chinook salmon one week after surgery.

Studies in the highly complex regions of the Delta Cross Channel and Georgiana Slough in 2000 and 2001 provided some of the most extensive, detailed fish behavior (in real-time and on a micro-scale). Results of this research established the first empirical evidence showing how juvenile salmon are entrained into the DCC and Georgiana Slough. It also demonstrated how juvenile salmon may migrate past those two flow splits during ebb tide conditions only to be subsequently advected back upstream during flood tide conditions and then entrained into the DCC and Georgiana Slough (Vogel 2001a, 2002a, 2003a, 2011a, 2012b). The research also provided evidence of high entrainment of smolts into Georgiana Slough when the DCC gates were closed which was attributed to a combination of physical and hydrodynamic conditions at that flow split in conjunction with fish positions within the water column and across the river channel (Vogel 2003a). Predation on telemetered salmon was also evident.

Concerns over water management effects on salmon smolt survival in the Delta lead to four separate research projects conducted during the winters of 2000 and 2002 (north Delta), winter of 2001 (south Delta), and the spring of 2002 (central Delta). Salmon were tracked via jet boats for hundreds of miles throughout nearly every conceivable route where salmon could migrate. Triangulating radio-tagged fish locations in real time clearly demonstrated how juvenile salmon moved long distances with the tides and were advected into regions with very large tidal prisms, such as upstream into Cache Slough and into the flooded Prospect and Liberty Islands. Importantly, these studies again found that some telemetered salmon were eaten by predatory fish based on unique characteristics of telemetry data (Vogel 2001b, 2003b, 2004, 2007a, 2010a, 2011a, 2011b). Results found that some radio-tagged salmon were eaten by predatory fish in northern Cache Slough, near the levee breaches into flooded islands and that higher predation occurred in Georgiana Slough as compared to the lower Sacramento River. While past studies utilizing coded-wire tags also found that salmon released into northern Georgiana Slough were found to have a higher mortality rate than fish released in the Sacramento River downstream of the flow split (Brandes and McLain 2001), the reasons for the mortality remained unknown until these telemetry studies were performed.

In 2005, a desire to develop more-quantitative as compared to qualitative data prompted a study using a relatively new miniaturized acoustic tag that could be surgically implanted in juvenile salmon (Figure 38). Unlike radio telemetry, acoustic technology requires underwater signal detection recorded by submerged hydrophones. Based on a series of experiments and field trials in the Sacramento River and Delta, it was determined that the technology had application for fish behavior and survival studies in the Delta (Vogel 2006a). In particular, it was discovered that a unique feature of the technology (through highly detailed and meticulous data processing techniques) allowed detection of predation on salmon smolts as well as accurate depiction of multiple predation events by individual predatory fish (Vogel 2006a, 2006b, 2007a, 2011a, 2011c). The first large-scale acoustic-telemetry study took place in the north Delta in 2006 - 2007 to further expand the understanding of how fish move, not only into the DCC and Georgiana Slough, but Sutter and Steamboat Sloughs as well (Vogel 2008b).

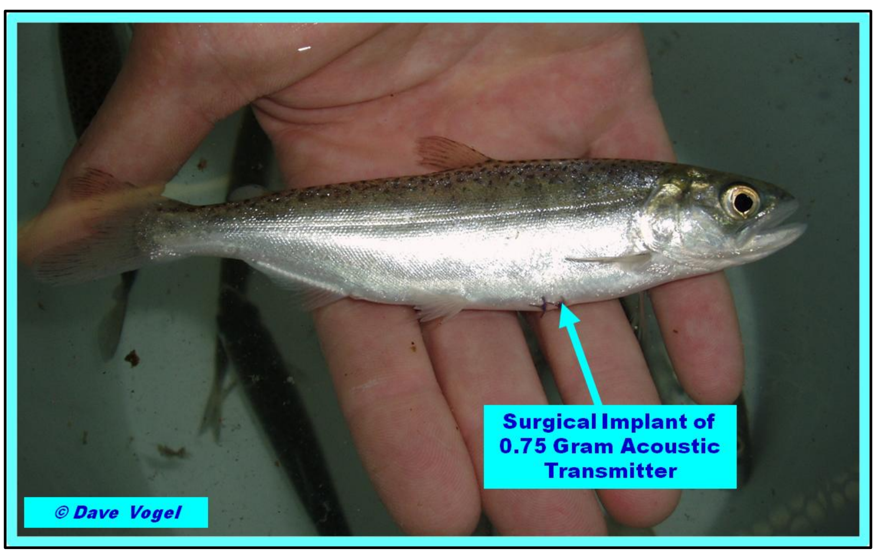

Figure 38. An acoustic-tagged juvenile Chinook salmon.

After it was demonstrated that miniaturized acoustic telemetry yielded valuable insights into juvenile salmon migratory behavior and survival/mortality, the San Joaquin River Group Authority (SJRGA) expressed interest in using the technology to supplement ongoing coded-wire tag studies that were being administered as part of the Vernalis Adaptive Management Program (VAMP). For many years, the VAMP studies were conducted by releasing groups of CWT salmon, but consistently ended in inconclusive results from poor (low) tag returns that could not inform meaningful management decisions. The SJRGA believed that the annually repeated CWT VAMP studies, by themselves, were not providing sufficient data to formulate actions to benefit salmon in the lower San Joaquin River and Delta. However, noting the success of telemetry technology, large-scale studies in the south and central Delta took place over several years (Vogel 2006b, 2007a, 2007b, 2010b, 2010c, 2011c). These latter, most-recent efforts led to a major breakthrough in the interpretation of juvenile acoustic telemetry studies in the Delta applicable to the BDCP flawed analyses and misinterpretation of research results (discussed below).

The Predation Problem and Salmon Survival Models

Limitations of the acoustic telemetry technology for salmon survival models were inadvertently discovered during experiments I conducted in 2005 by releasing acoustic-tagged juvenile salmon upstream of the Delta on the Sacramento River, then electronically recording passage of each fish at fixed-station electronic acoustic dataloggers positioned farther downstream (much like the strategy for later experiments in the Delta). Using simple presence/absence data recorded by the dataloggers (customarily and commonly applied by others in later Delta efforts), initial results indicated 100% survival. In this particular experiment, using the telemetry vendor's hardware and software, much more data than simple presence/absence of tagged fish detection was produced. It allowed close visual examination of the "echograms" or "acoustic signatures" of subtle movements of fish at a fine- or micro-scale within detection range of the dataloggers. Later, highly-detailed, manual post-processing of the study data found that three acoustic-tagged salmon released upstream at different times and locations reached the downstream dataloggers at the exact same second, a probability close to zero. Further, closer examination of the echograms showed that those three tags moved in perfect unison for extended periods (Figure 39). It was therefore confirmed that the three acoustic-tagged salmon had been eaten by a predator and the dataloggers had actually recorded the three dead fish inside the predator's stomach instead of as individual live salmon. Figure 40 depicts this problem. After manual re-examination of the echograms, the original salmon survival estimates using only presence/absence detection data changed from 100% survival to 100% mortality; all fish had been consumed by predatory fish. The findings clearly demonstrated the enormity of potential misinterpretation of telemetry results without thoughtful, careful application of the technology and understanding of fish behavior (which was not brought forth in the BDCP documents).

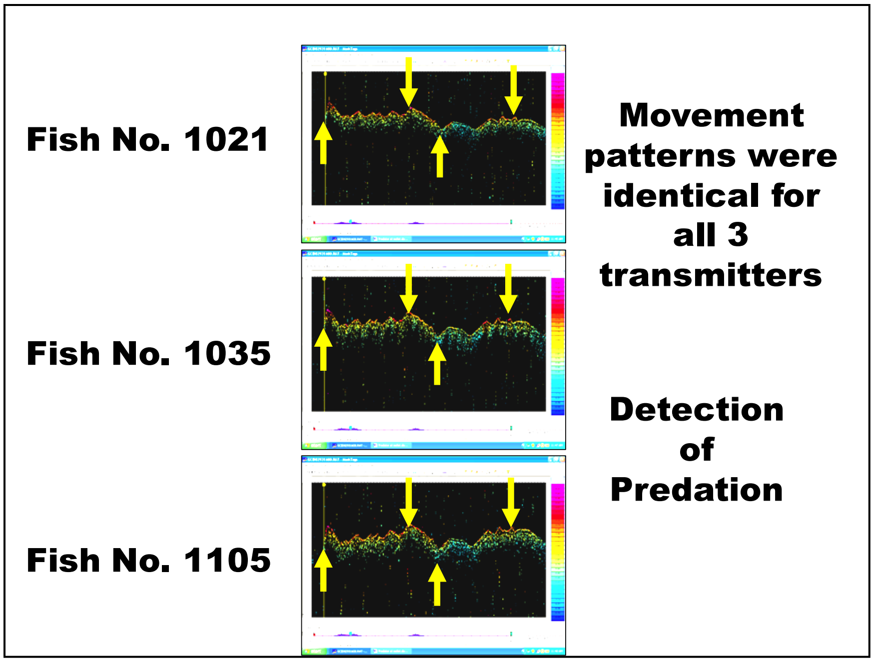

Figure 39. Three individual echograms of three different acoustic-tagged salmon (or the transmitters) during the identical time period showing changes in the amplitude and voltage of the signals (y-axis) over time (x-axis).

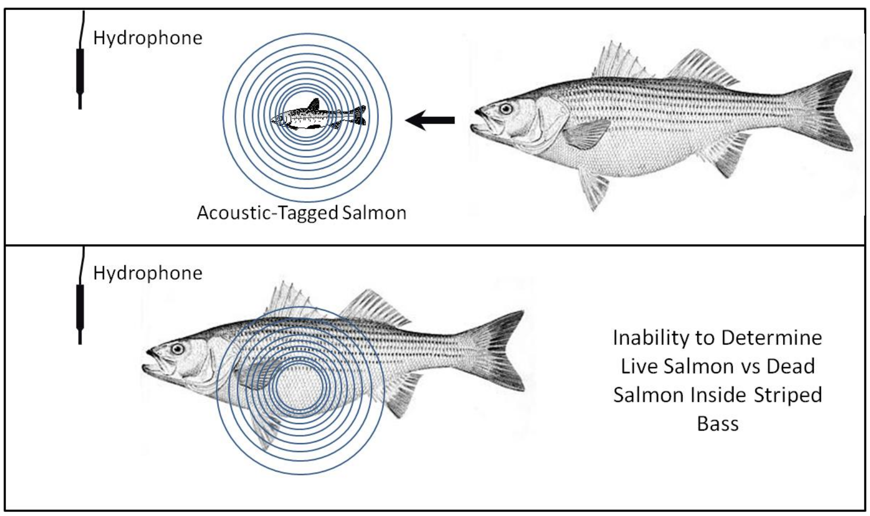

Figure 40. The problem with the inability to determine a live acoustic-tagged salmon versus a dead acoustic-tagged salmon inside a striped bass using only presence/absence tag detection data.

This major technological limitation for estimating juvenile salmon survival and fish route selection dramatically surfaced during the VAMP fish studies. Through detailed analyses of acoustic-tag echograms recorded by a large array of fixed-station dataloggers[24] distributed throughout the Delta, it was found that, in hundreds of instances, we were actually tracking the movements of dead salmon inside predatory fish, not live acoustic-tagged salmon (Vogel 2010c, 2011c). Importantly, a separate, concurrent study using different techniques for evaluating the behavior of migrating acoustic-tagged juvenile salmon during the VAMP study at the head of

[24] We chose to manually examine each and every echogram instead of reliance of simple presence/absence data because of the previously discussed discovery.

Old River estimated that approximately 50% of the tagged salmon were actually dead salmon inside predatory fish. The magnitude of potential misinterpretation of study results would have been enormous if only the usual and customary tag presence/absence data were used. A peer-review workshop of the VAMP telemetry studies stated: "On the predator problem and acoustic tags – the problem should not be understated."[25]

In an attempt to overcome this predation issue with acoustic telemetry studies in the Delta, we developed procedures to estimate whether or not individual acoustic-tagged salmon detected by fixed-station acoustic receivers positioned throughout the Delta had been preyed upon. Highly detailed evaluations of telemetered fish movements were performed which included:

1) A near-field environment within the fish transmitter detection range of telemetry receivers;
2) Medium-field observations of movements in a fine time scale between receivers in close proximity; and
3) Far-field examinations of movements throughout Delta-wide telemetry arrays.

These data were integrated with flow measurements, site-specific characteristics in migration corridors, and, very importantly, knowledge of fish behavior acquired from prior radio- and acoustic-telemetry studies (Vogel 2010c, 2011c). In each year, the severity of the predation problem was demonstrated.

Subsequently, in a recent peer-reviewed journal publication, Buchanan et al. (2013) adopted this "predator filter" technique developed by Vogel (2010c, 2011c) to estimate salmon survival through the Delta (from the San Joaquin River upstream of Mossdale to Chipps Island). For the 2010 VAMP studies, the estimated survival through the Delta without application of the predator filter was 11%. However, with application of the predator filter, salmon survival was estimated at only 5% (Buchanan et al. 2013). These results indicate the magnitude of error that can occur (and unquestionably has occurred) in Delta telemetry studies without accounting for the predator problem. The BDCP did not account for these serious errors and bias in survival estimates used in the fish models. This best available science was completely ignored in the BDCP analyses. Therefore, the accuracy and precision of BDCP modeled estimates of relative salmon survival among the alternative BDCP scenarios are undoubtedly untenable and unusable and is another major shortcoming of the BDCP analyses.

The principal predator creating these primary telemetry study limitation problems in the Delta is non-native striped bass. Some acoustic telemetry study designs performed in the Delta (e.g., Perry 2010) expected that predatory fish would be relatively stationary[26] or not move in a downstream direction (like Columbia River dam studies), and the serious predicament described here would not surface. However, that critical assumption is now known to be invalid (as described previously). In fact, striped bass can exhibit a strong tendency to migrate from the northern, interior, and south Delta regions to the west Delta and showed a strong affinity to the area around Chipps and Mallard Islands (Vogel 2012). Unfortunately, this site is where the

[25] Delta Science Program Workshop Summary, March 2 – 3, 2010.
[26] The studies also assumed that predators would only move in an upstream direction (uncharacteristic of a salmon smolt) and resultant telemetry data could be corrected for anomalous tag behavior.

western-most acoustic dataloggers were positioned as an "end point" in the hope of estimating overall salmon survival through the Delta (e.g., Perry et al. 2012). Some studies, including several in the peer-reviewed literature, have simply chosen to ignore the predation problem by assuming that no predated acoustic-tagged salmon would swim past the receivers in a downstream direction (e.g., Holbrook et al. 2009, Perry 2010, Perry et al. 2010, Perry et al. 2012). Fortunately, Buchanan et al. (2013) provided more-reliable and realistic estimates for San Joaquin River salmon survival through the Delta (accounting for the predation problem) but, to date, Sacramento River salmon studies have failed to do so. A recent study on juvenile steelhead in the Delta recognized the predation problem, but did not attempt to correct for false positive detections because of the uncertainty on how to do so (Delaney et al. 2014). These errors have subsequently been compounded and propagated sequentially through reports, science workshops, and even in peer-reviewed publications. The BDCP and its analyses fall into this category. Although this serious problem with telemetry studies has been ignored or slowly accepted, other researchers have finally acknowledged it (e.g., Michel 2010, Buchanan et al. 2013) and some have attempted to correct for the bias (e.g., Buchanan et al. 2013, Romine et al. 2014). In fact, NMFS now recognizes this major issue as well:

> "However, even acoustic telemetry estimates are not without limitations. For instance, survival measured using acoustic tags can be biased high if tagged fish are eaten by predators that subsequently move past receiver locations. Presently, there is no definitive way of determining if a tag detected at a receiver is in a live target species or in a predator." (BDCP Appendix 3.G, Proposed Interim Delta Salmonid Survival Objectives Page 6)

Unfortunately, the BDCP models and analyses did not use the best available science and ignored this dilemma. Instead, it relied on sparse, misleading information from isolated studies. As described in detail above, some telemetry studies failed to account for the severe technological limitation of the inability to differentiate between a live acoustic-tagged salmon and a dead tagged salmon inside a predator but were used for the BDCP analyses. For example, the Perry (2010) study (used for the DPM) only screened out acoustic tags found to have moved in an upstream direction and did not account for predated tags moving in a downstream direction:

> "The detection records of five tagged fish suggested they had been consumed by piscivorous predators as was evidenced by their directed upstream movement for long distance and against the flow. We truncated the detection record of these fish to the last known location of the live tagged fish. All other detections were considered to have been live juvenile salmon." (Perry 2010).

Additionally, it should be noted that the Perry (2010) study was also greatly hindered by releasing the experimental acoustic-tagged salmon during periods uncharacteristic of when salmon would normally migrate. For four of the five fish releases, river flows were unseasonably low, water turbidity was low, and the natural migration of salmon was essentially non-existent. The BDCP analyses have extrapolated results from a study not reflective of those environmental conditions when the north Delta diversions would operate (i.e., high-flow conditions). This demonstrates that caution must be used when using data that are not representative of real-world conditions and subsequently expanding those data to circumstances not applicable to how natural fish migration occurs under high riverine flows.

To further exacerbate this problem, the BDCP proposes to use acoustic telemetry in its "adaptive management" program without an understanding of the limitations.[27] Use of the technology to accurately quantify small fish survival and fish route selection in long reaches of the Delta and through the entire Delta is not viable at the present time until the major predation problem previously discussed is resolved. Therefore, the BDCP should not use any data and models derived from prior acoustic telemetry studies that have not been corrected for bias. This also illustrates the problem with a rush to publish research findings on very complex biological issues. Supposed "statistically robust" data are not useful when the underlying raw input data are simply wrong.

Because of the predation problem greatly compromising the integrity of estimates of salmon survival in the Delta (and fish survival models), I recommended that a miniaturized transmitter be developed to detect when an acoustic-tagged salmon has been eaten by a predator (Vogel 2010c). One telemetry vendor has now done so and the technology is currently being evaluated by USBR. The initial results show strong potential (Afentoulis and Schultz 2014). Also, now in recognition of the predation problem, some researchers are beginning to work on evaluative techniques to discriminate between acoustic detections of a live acoustic-tagged salmon versus a dead acoustic-tagged salmon inside a predator (Romine et al. 2014) using alternative techniques than used by Vogel (2010c, 2011c). Unfortunately, the promising methods for doing so described by Romine et al. (2014) require an extremely expensive and elaborate acoustic telemetry array with dozens of hydrophones positioned in close proximity to obtain highly detailed two- or three-dimensional movements of an acoustic transmitter. Even then, Romine (2014) could not determine if they were truly observing live acoustic-tagged salmon in their telemetry array or predators. More fundamentally and importantly, they did not address the much-larger problem with estimating Delta-wide salmon survival estimates which are reliant on single-hydrophone receivers.[28] Nevertheless, they provided further insight and corroboration into the serious nature of how this predation problem can adversely impact and bias salmon survival estimates in the Delta as described by Vogel (2010c, 2011c) that was not accounted for in the BDCP analyses.

In summary, the BDCP fish models' estimates of salmon survival and fish route selection used to evaluate various BDCP alternatives are unreliable for making management decisions among

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[27] For example: "Therefore, the level of uncertainty in using results of currently available acoustic-tag studies to establish both existing conditions and metrics within the objectives for wild-origin fall-run and late fall–run Chinook salmon is relatively high and will be the subject of additional experimental survival studies, monitoring, and analyses during the interim period." (BDCP Page 3.3-160)

[28] As an important note, Romine (2014) suggested that their techniques of using an elaborate acoustic-telemetry array could be used as an alternative approach of the "predator filter" developed by Vogel (2010). That comparison is not valid because it is an "apples and oranges" perspective between use of single hydrophones deployed independently over long distances versus dozens of integrated hydrophones deployed in close proximity. With present-day technology, installation and operation of the elaborate 2-D or 3-D telemetry arrays throughout the Delta would be expected to cost in excess of hundreds of millions of dollars and would not be feasible for the BDCP's proposed adaptive management program.

BDCP scenarios and conservation measures. Some of the salmon survival estimates used for BDCP models were undoubtedly inflated but also possessed highly questionable and unknown variance in estimated salmon route selection at critical Delta flow splits, reach-specific survival, and overall survival through the Delta. The negative ramifications of the BDCP assumptions cannot be overstated. The BDCP discussion on the topic and the associated analyses must be redone to appropriately build upon and accurately reflect the best available science.

Propagation of Errors in BDCP Fish Models Resulting from Faulty CalSim II Modeling

Much of the BDCP fish modeling efforts relied on CalSim II model outputs. An earlier version of the CalSim II model (herein after referred to as the "BDCP Model") was used as the primary analytical tool and foundation to model BDCP water project operations and water supply to compare the environmental baseline with various BDCP scenarios. In turn, comparisons of changes in water project operations and water supply were subsequently relied upon to estimate effects on fishery resources. However, a recent independent review of the BDCP Model revealed numerous significant flaws (MBK 2014) that were, unfortunately, carried through to the BDCP fish models. Some highlights of that independent modeling review, as it would undoubtedly affect BDCP fish modeling analyses[29], are summarized here.

- The CalSim II model has been substantially updated since the BDCP analyses were performed to correct technical errors and deficiencies in assumptions but the BDCP Model does not reflect the current CalSim II model.

- The BDCP Model results in impractical or unrealistic CVP and SWP operations.

- The BDCP Model High Outflow Scenario could result in releasing more stored water from upstream reservoirs.

- The BDCP Model significantly underestimates the amount of water diverted at the three north Delta intakes and overestimates the amount of water diverted at the south Delta water export facilities.

- Water diverted from the north Delta intakes could be approximately 680,000 acre-feet more than disclosed in the EIR/EIS.

- The amount of water exported from the Delta may be approximately 200,000 acre-feet/year higher than the amount disclosed in the EIR/EIS and Delta outflow would decrease by that amount.

- The BDCP Model assumed that USBR and DWR would not modify water project operations in response to adverse changes in climate and hydrology, which is an unrealistic assumption.

[29] Analyses of the specific resulting effects on each BDCP fish model would require a substantial undertaking.

The BDCP's inaccurate depiction of changes in water storage in upstream reservoirs, reservoir releases, and water exports in the north and south Delta would undoubtedly significantly alter analyses of the BDCP effects on salmonids and other fish species. Changes in reservoir storage would affect water temperatures in downstream reaches with concomitant effects on salmonid spawning and rearing. Altered timing and magnitude of instream flows would alter salmonid rearing and outmigration, as well as passage through the Yolo Bypass. Variation in the amount and timing of water diverted through the three north Delta intakes would affect factors such as fish sweeping flows, exposure to the fish screens, predation, and impingement. Changes in the amount of flow bypassed at the north Delta intakes would change salmon survival in downstream reaches. Modifications to Delta exports and outflow would alter fish survival. All of these BDCP Model errors result in an adverse cascading affect on the reliability of the BDCP fish models. Therefore the BDCP effects on salmonids were obviously mischaracterized by an unknown, but probably very severe, degree. Given the limitations and errors of the BDCP fish models described in these comments, the fish models' reliance on faulty BDCP Model outputs at the outset further adds to the undependably modeled and unknown BDCP effects.

Old and Middle River Flows

The BDCP provides some misleading statements concerning BDCP effects on Old and Middle River (OMR) flows. For example:

> "Under the evaluated starting operations, average OMR flows generally are more positive in most months under all water-year conditions compared to existing biological conditions (Figure 5.B.4-3)." (BDCP Page 5.B-17)

Based on model results provided in BDCP Appendix 5B Entrainment, it appears that OMR flows will actually be "less negative" instead of "more positive". Most of the time, OMR will stay negative (southerly direction) instead of positive (northerly direction) (BDCP Figure 5.B.4-3 below). The significance of this fact is that juvenile salmon will still move southerly toward the export facilities even with less-negative flows. The zone of influence where juvenile salmonids may be entrained southerly toward the south Delta from export operations has not yet been specifically identified, but it may extend as far north as channels leading off the San Joaquin in the central Delta with stronger influence closer to the export facilities (Vogel 2005). A recent study of juvenile steelhead movements found that high mortality occurred even with less negative OMR compared to more negative OMR (Delany et al. 2014) demonstrating the adverse impact of the south Delta exports. This issue warrants much more description and analyses in the BDCP.

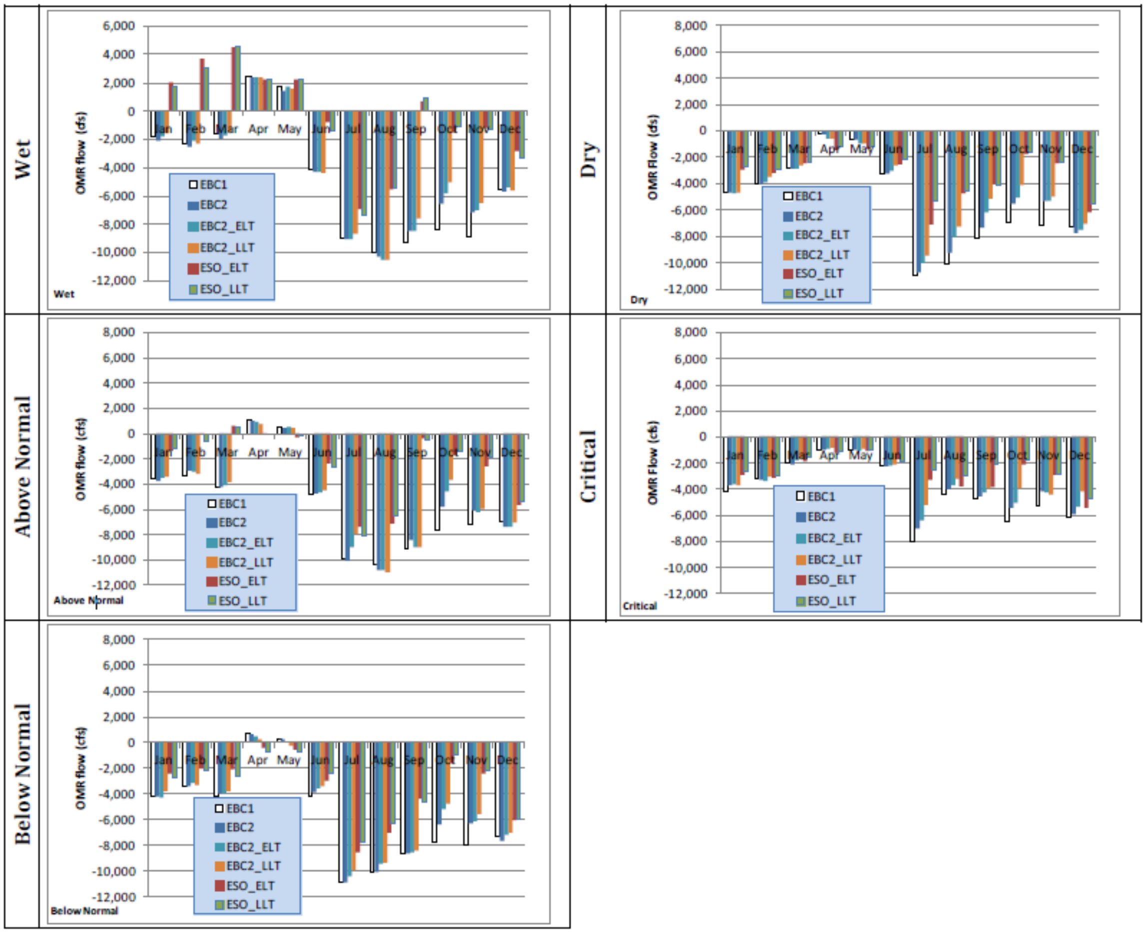

Figure 5.B.4-3. Flow (cfs) in Old and Middle Rivers under existing biological conditions (EBC) and Evaluated Starting Operations (ESO) in the Early Long-Term (ELT) and Late Long-Term (LLT) periods. (Figure from BDCP Appendix 5B, Entrainment.

Propagation of Misleading Information Concerning Salmon Behavior

Misleading information concerning juvenile salmon behavior, migration characteristics, and habitat preferences is permeated throughout the BDCP documents in the various assumptions, models, and conclusions. The popularized recent use of colorful and attractive PowerPoint graphics, computer animations, and other readily-available communication tools have often resulted in over-simplification of highly complex topics such as fish behavior. Those outside the fisheries science discipline have postulated ideas on salmon behavior and movements in the Delta and proposed remedial actions for fish that must be more-appropriately vetted through experts on Delta fishery resources. These forums have exacerbated the problem when only highly selective information is provided by individuals with inadequate training and expertise in the fishery science discipline. The problems and potential solutions "*du jour*" for fish posed by such individuals have become more frequent in recent years and runs the serious risk of erasing progress toward improved fish survival in the Delta. Once incorrect or misleading information is presented, it unfortunately propagates rapidly and widely, making it difficult to rectify; it can misdirect resources away from the most urgent problems. This issue is vital because it adds to scientific uncertainties and has negatively affected the credibility of the BDCP.

BDCP Uncertainties and Adaptive Management

It is readily apparent there is an enormous amount of ambiguity and uncertainty in the BDCP and its conservation measures. Every aspect of the potential impacts of the BDCP on salmonids is either "uncertain" or "highly uncertain". A simple search for the word or words containing "uncertain" found it mentioned *1,008 times* in the BDCP and appendices and *2,303 times* in the EIR/EIS and appendices.

As a result of all the uncertainties, the BDCP advocates the use of "adaptive management" in its implementation. In fact, the BDCP and associated EIR/EIS use the term with so much emphasis that it overwhelms the implementation strategy. Because of the enormous amount of uncertainty in impacts of the BDCP on salmon and the proposed conservation measures, the BDCP repeatedly states that if unanticipated adverse effects are found after plan implementation, adaptive management will be used to inform potential management actions in attempts to correct those defects. A simple phrase search for "adaptive management", "adaptively managed", and "adaptively mange" found it mentioned *1,314 times* in the BDCP and appendices and *2,008* times in the EIR/EIS and appendices. The following are just a few examples:

> "Adaptive management is intended to reduce uncertainty over time through a structured process that incorporates improved scientific understanding into Plan implementation. Information obtained from monitoring and research activities will be used to make recommendations regarding implementation of the conservation measures. This will continually improve the outcomes associated with water resource management and ecological restoration commitments." (BDCP Executive Summary Page 13)

> "The adaptive management and monitoring program has been designed to use new information and insight gained during the course of Plan implementation to assure that strategies employed by the BDCP can achieve the biological goals and objectives." (BDCP Page 3.1-4)

> "The adaptive management program provides a mechanism for making adjustments to avoid or minimize this effect." (BDCP Pages 5.F-iii and –iv)

> "Additionally, should a cause for not achieving a biological goal or objective be identified, adaptive management will be used to change conservation measures, if necessary, to address the cause." (BDCP Page 3.1-5)

> "Such adverse effects would be assessed through the adaptive management process, which could result in changes to the conservation measures to minimize these effects." (BDCP Page 3.2-8)

> "If results of monitoring identify adverse effects that will not support meeting the expected biological outcomes, the existing and future restoration actions will be modified and refined as part of adaptive management. In the event that a restored habitat is found to have substantial adverse effects on the reproductive success,

> growth, survival, or population dynamics of the covered fish, substantial modifications will be made to address and mitigate these adverse effects." (BDCP Page 5.3-32)

Unfortunately, the BDCP's approach to adaptive management lacks substance, credibility, and authenticity. Because the BDCP is so exceedingly reliant on adaptive management, it is highly instructive to examine recent uses of this concept in some relevant Central Valley and Delta salmon programs to determine how reliably adaptive management may actually be implemented for the BDCP. The trustworthiness of BDCP adaptive management is only as good or reliable as how the practice has recently been performed for other fishery resource projects in the Central Valley and Delta. A review of such projects is illustrative of the trustworthiness in statements in the BDCP to predict how well the BDCP will truly attain purported benefits to "achieve biological goals and objectives" and "avoid and minimize effects". The following are just some examples.

Central Valley Project Improvement Act, Anadromous Fish Restoration Program

In 1992, the Central Valley Project Improvement Act (CVPIA) was enacted by Congress and an Anadromous Fish Restoration Program (AFRP) to double the anadromous fish populations in the Central Valley by 2002 was developed. However, after twenty-two years and more than one billion dollars spent, extensive monitoring studies and the use of so-called "adaptive management", the salmon runs have not increased. Additionally, there is no measureable progress toward delisting any of the threatened or endangered anadromous fish, and the fall-run Chinook, the most abundant among the salmon runs, have now declined even further from historical levels. Some individuals have even recently suggested that the fall run may warrant listing as an endangered species (Williams 2012).

In 2008, a peer review of the CVPIA fisheries program was conducted and was highly critical of the government agencies' implementation of the anadromous fish restoration efforts. For example,

> "Yet it is also far from clear that the agencies have done what is possible and necessary to improve freshwater conditions to help these species weather environmental variability, halt their decline and begin rebuilding in a sustainable way. A number of the most serious impediments to survival and recovery are not being effectively addressed, especially in terms of the overall design and operation of the Central Valley Project system." (Cummins et al. 2008)

In particular, the review criticized the failures of implementing an effective, scientifically valid adaptive management program:

> "The absence of a unified program organized around a conceptual framework is one of the reasons the program appears to be a compartmentalized effort that lacks strategic planning and decision-making. As a result the program is unable to address the larger system issues, has a disjointed M&E [monitoring and evaluation] program, exhibits little of the traits expected from effective adaptive

management, and is unable to effectively coordinate with related programs in the region. An uncoordinated approach also creates boundaries to the free flow of useful information and program-wide prioritization. We observed that most researchers and technicians seemed unclear how or even whether their local efforts related to or contributed to the overall program." (Cummins et al. 2008)

"The CVPIA program does not use basic principles of adaptive management at a program level." (Cummins et al. 2008)

Cummins et al. (2008) provided numerous recommendations to improve implementation of the CVPIA anadromous fish restoration program. Included among those recommendations was development and utilization of an effective adaptive management program. However, it has now been six years since the review panel's report, yet the recommendations remain unimplemented by the involved agencies.

The BDCP provides no supporting rationale or guidance on how the BDCP would use adaptive management any differently than the CVPIA AFRP.

Vernalis Adaptive Management Program (VAMP)

Concluding in 2011, VAMP was a 12-year program implemented in the south Delta to evaluate and protect juvenile fall-run Chinook salmon emigrating from the San Joaquin River. The USFWS, the agency largely responsible for coordinating the salmon evaluations stated: "VAMP employs an adaptive management strategy to use current knowledge of hydrology and environmental conditions to protect Chinook salmon smolts, while gathering information to allow more efficient protection in the future."[30]

However, after spending many millions of dollars in its 12-year run, the VAMP was largely a failure and the San Joaquin salmon runs are now in worse shape than before the program. The collection and quality of data necessary to formulate protective and restorative actions for fish were insufficient. Serious mistakes made in phases of the program (too lengthy to list and describe here) were repeated year after year; lessons were not learned. Despite annual data collection demonstrating very poor salmon survival, remedial actions were not implemented and the responsible agencies simply plowed forward without recognition of the problems and changing the program. Importantly, information that was developed from VAMP that could have been used to benefit fishery resources was not acted upon using adaptive management principles. A recent peer-review of the VAMP was highly critical of the program (Hankin et al., 2010). The failure of VAMP is summarized well by Lund et al. (2011):

"The much-heralded Vernalis Adaptive Management Program (VAMP), conducted over the past decade, illustrates both[31] of these problems. VAMP paid

[30] www.fws.gov/stockton/jfmp/vamp.asp

[31] "One challenge is that management experiments often involve large changes that affect real stakeholders. If financial compensation is required to individuals or groups who stand to lose land or water resources from the experiments, the costs can be substantial. Another challenge is mustering the resources and political will to conduct the necessary scientific analysis. Often, programs are labeled "adaptive management" if they try something

> farmers on San Joaquin tributaries to release pulses of water to speed young salmon on their way to sea. Because they profited from foregoing the use of this water, participating farmers developed an interest in having this become a long-lived experiment. Fish agencies collected data and avoided regulatory conflict. Water agencies benefitted by not having to make major changes in their own diversions. But in the end, the experiment appears to have been more successful for these various individuals and entities than for the salmon. Millions of dollars were spent, yet little synthetic modeling or experimental design was conducted to evaluate the effects on fish or to improve performance over time (Hankin et al., 2010)."

Interestingly, one aspect of the peer review of the VAMP program was the review panel's praise for trying the new telemetry techniques (previously discussed) to elucidate problems for salmon.

Despite the now-defunct VAMP and the lack of meaningful progress in restoring salmon and fixing known problems, the BDCP boldly states that it will use "adaptive management" to resolve problems for fish in the Delta. The track record from VAMP undermines any confidence in the BDCP utilizing effective adaptive management.

Fish Salvage at the South Delta Federal and State Water Export Facilities

Predation mortality at Tracy Fish Facilities (FF) for the south Delta federal water export facilities is an extremely serious problem for anadromous fish and is mentioned frequently in the BDCP documents. The high juvenile salmon mortality at the site has been known for a long time and is likely much higher than reported in the BDCP (Vogel 2011a). These issues are well-described in a recent peer review of CVPIA restoration program activities, which was highly critical of the lack of significant efforts to correct the problem:

> "… the operation of the Tracy Pumping Plant and Fish Collection Facility is a serious mortality source for salmon and steelhead (and for Delta smelt). All aspects of the pump operations have significant adverse impacts on salmon and steelhead, from the way juveniles are drawn to the pumps and away from the natural migration routes out through the Delta, to predation and other mortality factors in the channels leading to the pumps, to high mortalities at the out-dated louvers screening the pumps, to even higher mortalities likely during the archaic "salvage" collection and transport operation at the pumps, to predation mortality at the point of re-release, and finally to the overall adverse effects on salmon survival and productivity from regulating and diverting that much of the natural Delta outflow. Data on direct and indirect juvenile mortality is uncertain but likely to be high, and may run as high as 50% for spring-run Chinook and steelhead, and possibly 75% for winter-run Chinook." Cummins *et al.* 2008.

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different, even if they lack the significant follow-up analysis required to improve scientific understanding and policy response." Lund et al. (2011)

The serious salmon mortality problems associated with the Tracy FF have been known since the 1950s. USBR and other agency staff have studied and attempted minor, largely unbeneficial modifications to the Tracy FF for many decades. Despite purported adaptive management over many, many years at the Tracy FF, it appears little progress toward significant improvements in fish protection has been made. And yet the BDCP states that now, unlike all the prior decades of studies and activities at the Tracy FF and expenditures of many millions of dollars, the plan will now use adaptive management to fix the facilities' complex, intertwining problems but do not describe how.

The BDCP documents also frequently identify the extremely high salmon mortality associated with Clifton Court Forebay (CCF), part of the state water project south Delta water export facilities (e.g., BDCP Page 3.4-299, BDCP Page 5.B-6). Much like the Tracy FF, the problems for salmon at CCF have been known and studied for many decades. Since the late 1970s, CDFW has been studying this pre-screen loss and attributes the fish mortality to predation, primarily by striped bass (Coulston 1993), which are the primary predator in the Forebay (IEP 1993). Recent studies using acoustic-tagged juvenile salmon and acoustic-tagged striped bass also empirically demonstrated the severe predation problem in Clifton Court Forebay. Specifically, the small area immediately behind the CCF gates was shown to harbor striped bass for extended periods and mortality was severe when salmon passed under the gates and were eaten by predators (Vogel 2010b, 2010c, 2011c). This very small isolated area undoubtedly causes the highest mortality for anadromous fish reaching the south Delta. This predator haven has been, and will continue to be, severe without corrective measures (Vogel 2010c,Vogel 2011a)

Because of the concern about predation in CCF, a workshop was held in 1993 to discuss options to reduce predatory fish in the Forebay. The principal options examined included an increase in recreational fishing opportunities and an aggressive, non-lethal removal and relocation program. Interestingly, two of the primary reasons posed for not pursuing these actions were largely policy related. Water exporters were concerned that predator removal would result in increased numbers of salmon reaching the fish salvage facilities and would penalize exports due to a perceived increase in "take" of winter-run Chinook (unless a relaxation in the NMFS pre-screen loss estimates for winter-run Chinook was initiated) (Coulston 1993). Conversely, recreational fishing interests were opposed to predator removal because of their concern that increased water exports would take place, resulting in greater indirect losses of salmon (Coulston 1993). (from Vogel 2011a)

The BDCP provides statements that specific "stressor reduction targets" at the state and federal water export facilities will be achieved to improve conditions for salmon:

> "Reduce predation in Clifton Court Forebay and at the CVP trash-racks to achieve mortality rates across Clifton Court Forebay and past CVP trash-racks equivalent to no more than 40%, as reflected in the Reasonable and Prudent Alternative in the NMFS (2009) BiOp, by year 5. Reduction in predation mortality may be achieved through a variety of actions, including, but not limited to, modification to Clifton Court Forebay operations, modifications to physical habitat conditions within Clifton Court Forebay, as well as removal of predatory fish from Clifton

> Court Forebay and the CVP intake." (BDCP Page 3.3-139, BDCP Page 3.3-151, BDCP Page 3.3-169)

In summary, no significant progress toward alleviating these serious problems at Tracy FF has been accomplished since the 1950s and, similarly, no progress has been accomplished at Clifton Court Forebay since the 1960s. It has now been five years since the 2009 BiOp and no improvements (other than reduced water exports) have been made. Now, however, the BDCP proclaims that it will dramatically reduce these long-standing problems through adaptive management and unspecified or unproven measures. Such statements clearly lack credibility based on extensive past history. Additionally, this BiOp RPA is supposed to be fulfilled anyway, regardless if the BDCP is ultimately implemented.

Coleman National Fish Hatchery Fish Releases

Coleman National Fish Hatchery (CNFH) is a salmon production facility operated by the U.S. Fish and Wildlife Service (USFWS) on Battle Creek in the upper Sacramento River basin that serves as partial mitigation for lost natural salmon production resulting from the construction of USBR's Shasta Dam. It is the largest salmon hatchery in California. CNFH currently produces fall- and late-fall-run Chinook salmon and steelhead. A satellite hatchery facility just downstream of Shasta Dam also produces winter-run Chinook. The USFWS Office in Red Bluff is responsible for planning and scheduling the juvenile fish releases from both fish production facilities. In 2011, the USFWS completed a Biological Assessment (BA) for CNFH's operations to comply with the Endangered Species Act. In that BA, the USFWS states that the agency will use "adaptive management" for the hatchery's operations. As compared to the extremely complex and highly uncertain issues associated with the BDCP's effects on salmon, one would believe that adaptively managing hatchery fish releases would be far simpler. Fish hatcheries have a high degree of control on fish growth, release timing and locations, and good predictive capabilities for riverine conditions where and when salmon are released. These circumstances create fertile ground for the use of adaptive management to increase fish survival. For example, USFWS (2011) states:

> "All artificial propagation practices used at Coleman NFH, including incubation and rearing, are managed adaptively with the goal of producing high quality fish that maximize opportunity to accomplish program goals while reducing negative impacts to natural stocks."

The production of juvenile fall-run Chinook is usually released into Battle Creek during April. Presumably, using adaptive management, the USFWS would time those fish releases with precipitation and flow events when turbidity is high to maximize survival of outmigrating salmon and minimize adverse impacts on wild fish. However, Figure 41 shows a recent example of the release of fall-run salmon from the hatchery in 2013. The hatchery released 6,000,000 fall-run salmon (half of its entire production) shortly *after* precipitation events had occurred and the river flows were dramatically declining and water clarity increased. Prior to this fish release, short-term weather models and river forecasts through the California Data Exchange Center (CDEC) clearly predicted these environmental conditions. The resultant adverse impacts on those fish releases were likely severe with low, clear flows and slow downstream fish transport timing creating ideal conditions for predation. Reports by sports fishermen in areas downstream of the hatchery in the middle Sacramento River after the hatchery release described "feeding frenzies" by striped bass readily observable from the surface. Some striped bass caught by anglers were found to have stomachs full of juvenile salmon, probably from the hatchery fish release (Figure 42). If the fish release had been made the prior week, riverine conditions would have been ideal. The USFWS claimed the agency did not have any flexibility in the fish release timing, even by several days.[32] This action did not appear to be "adaptively managed" and the hatchery fish likely suffered very high in-river mortality that could have been avoided.

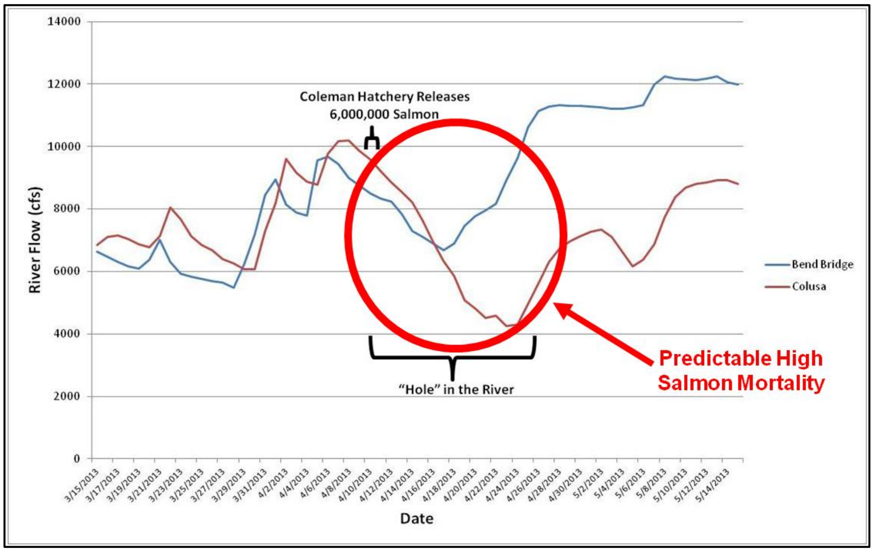

Figure 41. Timing of the release of approximately 6,000,000 juvenile fall-run Chinook salmon from Coleman National Fish Hatchery into Battle Creek on the upper Sacramento River in 2013 and Sacramento River flows downstream of the hatchery at Bend Bridge and Colusa.

[32] Meeting between the USFWS, CDFW, and the Golden Gate Salmon association on February 14, 2014, Sacramento, CA.

Figure 42. Stomach contents of a striped bass caught by an angler in the middle Sacramento River after the CNFH fish release. Most of the contents are assumed to be numerous fall-run Chinook salmon.

In another example of purported adaptive management, the 2011 USFWS BA states:

> "Releases of late-fall Chinook and steelhead from Coleman NFH are timed to coincide with high flow events in Battle Creek and the Sacramento River."

The rationale for doing so is that releasing the larger-sized hatchery salmonids in the upper Sacramento River could have deleterious impacts on wild salmonids if the river is low and clear:

> "Based on the body size of hatchery-origin late-fall Chinook salmon, size ranges of natural-origin salmonid stocks, and predator-prey size constraints (i.e., prey less than half of predator length), hatchery-origin late-fall Chinook could potentially consume natural-origin fall, spring, and winter Chinook juveniles following their release from Coleman NFH." (USFWS 2011)

> "Releases [of juvenile late-fall Chinook into Battle Creek] are conducted over the course of one or two days and are timed to coincide with high flow and turbidity events, which promote rapid emigration and afford protection to out-migrating juveniles by discouraging predation."

> "The timing of late-fall Chinook releases are scheduled to coincide with winter storm events."

The 2014 water year turned into a near record-breaking drought and provided an excellent opportunity for USFWS to exhibit adaptive management principles in the CNFH late-fall Chinook releases. If the year's hydrologic conditions were normal, Sacramento River flows and turbidity would be naturally high during January due to tributary accretions and the USFWS strategy of releasing the late-fall-run Chinook in the upper river may be justified. However, this year's unique drought situation resulted in very unfavorable environmental conditions for late-fall salmon released into Battle Creek. In recognition in advance of the adverse impacts not only on the hatchery fish, but primarily on wild salmon stocks rearing in the river downstream of the hatchery, a recommendation was made for the USFWS to transport the fish downstream of the hatchery to the middle Sacramento River where survival would likely be higher and deleterious impacts on wild fish would be ameliorated (Vogel 2014). However, the recommendation was not adopted and no response was even provided by the USFWS. Subsequently, despite the supposed implementation of adaptive management for hatchery releases and the probable impact on wild fish in the river, including the endangered winter-run Chinook, threatened spring-run Chinook, and threatened steelhead, the USFWS released 750,000 large, juvenile hatchery late-fall Chinook into Battle Creek. Those fish experienced unseasonably low flows and extremely clear water. Many of those juvenile salmon were likely unnecessarily eaten by larger predaceous fish and birds after release from the hatchery. However, most importantly, the release of 750,000 late-fall-run Chinook salmon in the upper river likely adversely impacted the endangered winter-run, threatened spring-run, threatened steelhead, and fall-run Chinook salmon. Because the watershed had not yet experienced heavy precipitation events and high river flows that would stimulate large-scale wild salmonid emigration, it is likely that the majority of wild fish still remained rearing in the upper Sacramento River at that time. Releasing high numbers of large-sized hatchery salmon directly into the heart of the rearing grounds of wild salmon undoubtedly caused competition, displacement, and predation. The problem could have been avoided by transporting the fish to a location downstream of the hatchery to decrease the mortality while simultaneously reducing the ultimate straying rate compared to releases even farther downstream. It does not appear that the late-fall salmon releases were adaptively managed.

In yet another opportunity for the USFWS to exhibit adaptive management during this drought year, the releases of juvenile steelhead could also have been managed to avoid adverse impacts on wild salmonids rearing in the river. As stated in the USFWS BA:

> "However, interactions between salmonids from Coleman NFH and natural-origin salmonids in the Sacramento River are potentially greatest for hatchery-origin steelhead because of their comparatively larger body size, a general tendency for piscivory at the time of release, and a proclivity for adopting alternate life-history patterns (e.g., residualization).
>
> "Based on the size of hatchery-origin steelhead, size ranges of natural origin salmonid stocks, and predator-prey size constraints (i.e., prey less than half of predator length), hatchery-origin steelhead could potentially capture and consume young-of-the-year fall, spring, and winter Chinook juveniles."
>
> "Juvenile steelhead are released into the mainstem Sacramento River at Bend Bridge (RM 258) in January" [to minimize combination and predation on wild salmon].

> "Environmental conditions common in the Sacramento River during January likely reduce predation by hatchery-origin steelhead. Steelhead are released from Coleman NFH during early-January, a time of year when winter storm bring high flows, elevated turbidities, and cool water temperatures."

Despite the foregoing statements, the USFWS nevertheless released the entire production of steelhead at Bend Bridge (as they have traditionally done year after year), except now in very low, and clear water thereby violating the agency's original premise. Here again, the USFWS could have released the hatchery steelhead production farther downstream from Bend Bridge (which is within the heart of the primary rearing grounds for wild salmonids) to minimize deleterious impacts on wild fish in the low, clear water, but did not adaptively manage their release procedures.

In this final example of CNFH fish releases using so-called adaptive management, winter-run Chinook salmon from the satellite facility at Livingston Stone Hatchery at the base of Shasta Dam are released with the following USFWS strategy:

> "Releases [of juvenile winter-run Chinook into the upper Sacramento River at Redding] occur generally around late January or early February; however, actual release timing may occur outside of this target window in order to time the release of winter Chinook juveniles to coincide with a high flow and high turbidity event."

The first significant precipitation events of 2014 were clearly predicted by weather forecasts and increased river flows were predicted on CDEC. However, as shown in Figure 43, the USFWS released the winter-run Chinook *after* the precipitation events in the upper Sacramento River at a location where river flows were very low and clear. The river farther downstream was high and turbid. If the USFWS had adaptively managed the fish releases, the winter-run could have been released just a few days earlier and just downstream of some nearby tributaries where accretions increased mainstem flows and turbidity. Adverse impacts to this year's hatchery winter-run Chinook outmigrants likely occurred. Again, adaptive management was not employed.

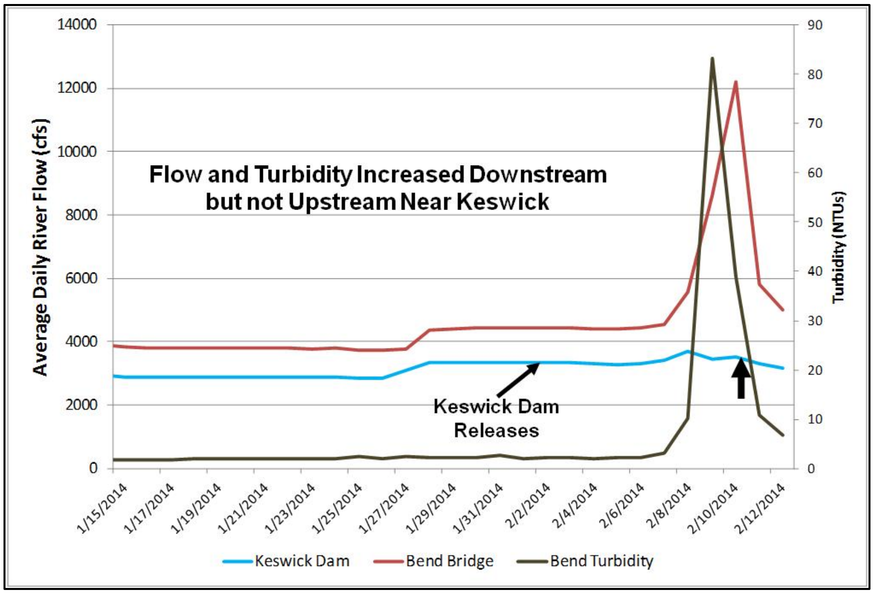

Figure 43. Release timing of juvenile winter-run Chinook salmon in the upper Sacramento River at Redding downstream of Keswick Dam (vertical pointer), Keswick Dam releases (daily cfs) and Sacramento River daily flow (cfs) and turbidity at Bend Bridge gauge 39 river miles downstream of the fish release location.

In summary, as can be seen from these foregoing recent, prominent examples, there has been a strong, consistent legacy in the Central Valley and Delta of *not* implementing adaptive management for the protection of fishery resources, even for relatively simple actions. Why would the BDCP be any different? The BDCP is far more complex and expansive than the examples provided. Again, the BDCP is entirely reliant on so-called adaptive management to attempt correction of deficiencies in the plan after it is implemented. Recent experience indicates otherwise and statements in the BDCP documents lack reliability. The BDCP must be rewritten to clearly articulate specifically how true adaptive management would be implemented during the program and describe all site-specific actions and feasible remedial counter-measures to demonstrate that the BDCP would not fail in this regard.

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EXHIBIT 1

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Education

M.S., 1979, Natural Resources (Fisheries), University of Michigan
B.S., 1974, Biology, Bowling Green State University

Experience

Dave Vogel specializes in aquatic resource assessments and resolution of fishery resource issues associated with water development. His 39 years of work experience in this field includes large-scale assessments in river systems, lakes and reservoirs, and estuaries, mostly associated with restoration of western United States fishery resources. He has designed and conducted numerous projects to determine fish habitat criteria and population limiting factors leading to development and implementation of innovative measures to increase fish populations. Mr. Vogel has worked on California's Central Valley fishery resource issues for the past 33 years. During the 1980s he served as the U.S. Fish and Wildlife Service's (USFWS) Project Leader in northern California and was responsible for expanding a one-person office in Red Bluff into a large-scale, fishery research facility. In this regard, he directed research on Sacramento River basin salmon and steelhead populations and successfully developed measures to increase fish runs.

Dave Vogel has extensive experience in the design and evaluation of large fish screening facilities. He was the project leader of a major evaluation on fish entrainment into the 2,700 cfs Tehama-Colusa Canal and Corning Canal diversions which lead to the design and installation of state-of-the-art fish screening and fish bypass facilities. Mr. Vogel was a key individual in the development of the biological criteria and associated bioengineering design for those facilities. As a member of multi-agency groups which have developed the concepts and designs of new screening facilities, he is thoroughly familiar with modern-day fish screen technologies. Dave Vogel was the Principal Investigator in a study of fish entrainment at the largest unscreened agricultural diversion in Oregon and developed the conceptual design that ultimately led to a fish screen and bypass facility on the A-Canal in the Klamath Irrigation Project. Mr. Vogel also served as the Principal Scientific Investigator for biological evaluations of the largest riverine diversion in the Central Valley at Glenn-Colusa Irrigation District's (GCID) pumping facility and worked on the bioengineering designs of the retrofits for the old and interim screens and ultimate final 3,000 cfs fish screen facility. On behalf of state and federal agencies and GCID, he developed and implemented the pre- and post-project biological evaluations. This multi-year program involved extensive testing of the new fish screens and bypass systems using fish mark-recapture techniques as well as radio- and acoustic-telemetry, electrofishing, angling, juvenile and adult fish traps, direct underwater SCUBA observations, underwater hand-held videography, surface-deployed underwater videography, surface observations, and extensive use of a dual-frequency identification sonar camera. Additionally, he evaluated the new associated Sacramento River gradient facility by capturing, tagging and monitoring the telemetered movements of adult green and white sturgeon at the site, as well as examining the relative distribution, abundance, and habitats of predatory fish over many years. Dave Vogel has conducted many dozens of underwater inspections of large fish screens, evaluating biological performance, juvenile salmon and predatory fish behavior, characteristics on sedimentation, screen seals, debris loading, and water velocities. Much of his work has led to improved fish screen designs elsewhere.

Dave Vogel has served as a Principal Scientific Investigator for 22 research projects in the north, central, and south Sacramento – San Joaquin Delta. He was the first scientist to successfully employ miniaturized radio- and acoustic-telemetry technology to evaluate juvenile salmon migratory behavior, migration pathways, and survival. He also developed breakthroughs on use of the technology to detect predation on salmon. He served on the Delta Cross Channel Work Team as the principal scientist evaluating the movements of juvenile salmon at the Delta Cross Channel and Georgiana Slough using both radio- and acoustic-telemetry methods. Mr. Vogel was also a Principal Scientific Investigator for the Vernalis Adaptive Management Program from 2006 through 2010 and developed innovative field and analytical techniques toward the end of the program (https://sites.google.com/site/vamp2009team/). He recently conducted four research projects on the behavior and movements of predatory fish in the Delta. Based on his extensive field experience, he has acquired a highly specialized knowledge of the Delta, including fish habitat characteristics, migratory pathways utilized by salmon and fish mortality by reach, juvenile salmon and predatory fish behavior, site-specific sources of fish mortality, and Delta hydrodynamic conditions. He has used a Natural Resource Scientists, Inc. DIDSON™ sonar camera extensively throughout the Delta to study fish habitats, water diversions, agricultural siphons, waste water treatment outfalls, artificial and natural in-channel structures, and predator/prey interactions.

Mr. Vogel served as Task Manager on numerous projects for the U.S. Bureau of Reclamation (USBR), Mid-Pacific Region, to define interrelationships of fishery resources and water project operations. He developed a life history guide for salmon in California's Central Valley to improve interagency coordination and communication concerning fishery and water resource management. He also assessed techniques to estimate the annual run sizes of the endangered winter Chinook salmon to recommend improved methodologies to enhance population restoration. He was the Task Manager for the original Biological Assessment of the federal Central Valley Project and the principal author of biological portions of the original Biological Assessment for the USBR's Klamath Project. Dave Vogel served as the Task Manager to assess options for the disposition of the Tehama-Colusa Fish Facilities. Recently, under contract for the USBR, Mr. Vogel completed a comprehensive in-river survey of all the unscreened water diversions in the Sacramento River between Verona and Red Bluff using a DIDSON® sonar camera and an Acoustic Doppler Current Profiler.

Mr. Vogel has participated in various work teams to evaluate numerous proposed projects in the Delta. He has served on the CALFED Integration Panel and other committees to evaluate and recommend ecosystem restoration projects. He also worked on the Bay/Delta Oversight Committee's technical team. He has been involved with evaluations of proposed water projects and facilities in the Delta using particle tracking model results and other analytical tools.

Dave Vogel has strong expertise in designing and implementing multifaceted projects to sample entrainment of juvenile fish in small, medium, and large unscreened water intakes. Recently, Mr. Vogel has been serving as the Principal Scientific Investigator on behalf of the State/federal Anadromous Fish Screen Program for multi-year evaluations of fish entrainment in unscreened diversions on the Sacramento River. He is an expert in the design and fabrication of complex fish sampling equipment for installation and operation at challenging field sites capable of withstanding powerful hydraulic forces and heavy debris loading. He personally builds the structures using metal inert gas welding, plasma cutting, and oxyacetylene.

He is an expert SCUBA diver possessing standard, advanced, and research diver world-wide recognized certifications. He is a professional underwater videographer and his footage has been shown on nationwide, prime-time televisions shows, instructional videos, and environmental documentaries. He is a voluntary member of the Tehama County Search and Rescue Team for recovery of drowning victims in northern California rivers and reservoirs. Based on this training and experience, Dave Vogel developed innovative underwater survey techniques to map riverbed substrates on the Sacramento River in deep, swift water. He and his dive team mapped Sacramento River salmon spawning habitats in the three-mile reach downstream of Keswick Dam and in the vicinity of numerous Sacramento River bridges.

Dave Vogel is very knowledgeable of provisions of the federal Endangered Species Act (ESA) having served on the original National Marine Fisheries Service's Winter-Run Chinook Salmon Recovery Team and the U.S. Fish and Wildlife Service's Endangered Lost River Sucker and Shortnose Sucker Working Group. He developed the framework for the original winter-run Chinook salmon restoration program and has worked on projects associated with the endangered monk seal, threatened green sea turtle, bald eagle, and other species. He has given public presentations to a wide variety of groups concerning the ESA including Congressional testimony on three separate occasions. He frequently works on ESA consultations and permitting associated with threatened and endangered fish.

Mr. Vogel previously worked for the U.S. Government in the USFWS's Fishery Research Division and the Fishery Resources Division. He received the "Fishery Management Biologist of the Year" award for six western states and numerous outstanding and superior achievement awards. He served as Chairman of the USFWS SCUBA Diving Control Board for six western states during an eight-year period. Mr. Vogel designed and conducted evaluations of Federal and state fish hatcheries to improve their effectiveness. He was Chairman of the Sacramento River Steelhead Trout Technical Committee for six years. He also developed and directed numerous projects to improve the survival and contribution of hatchery salmon and represented the USFWS on the California Department of Fish and Game's Salmon Smolt Quality Committee during the 1980s.

Mr. Vogel frequently serves as a volunteer for environmental issues. He serves on the Board of Directors for the Fishery Foundation of California. Dave Vogel was a member of the California

4th Senatorial Environmental Advisory Committee and has provided presentations to California legislative committees on several occasions. Mr. Vogel served as a peer reviewer for the Interim and Final reports of the National Academy of Sciences' National Research Council Klamath Committee (Interim Report: Scientific Evaluation of Biological Opinions on Endangered and Threatened Fish in the Klamath River Basin; Final Report: Endangered and Threatened Fish of the Klamath River Basin: Causes of Decline and Strategies for Recovery). He has given many formal presentations on environmental issues to diverse organizations.

Dave Vogel's clients have included municipal, county, state and federal agencies, water districts, water user organizations, universities, Indian tribes, private landowners, engineering and environmental consulting firms, the timber industry, watershed conservancies, resource conservation districts, law firms, and non-governmental environmental organizations. He is presently working for the Golden Gate Salmon Association and northern California water districts to develop a salmon re-building program for the Sacramento River basin in concert with state and federal agencies and non-governmental organizations.

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EXHIBIT E

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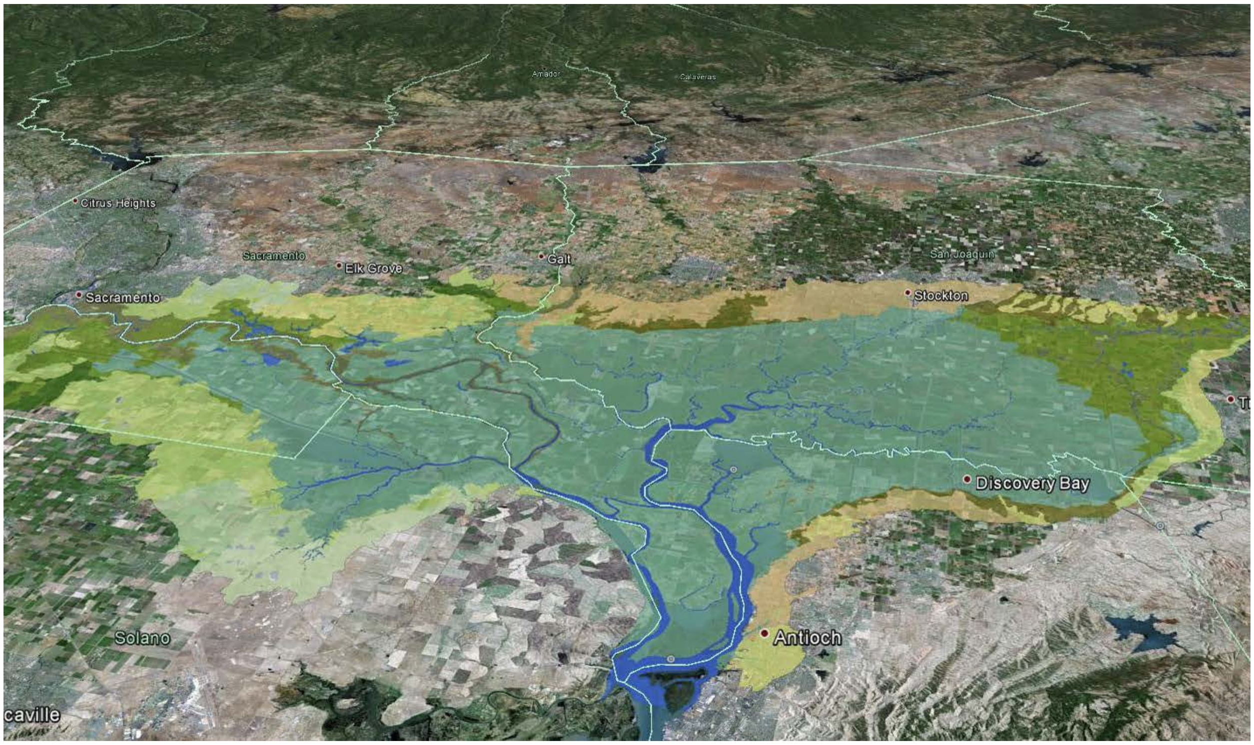

Image from Whipple et al. 2013, Sacramento-San Joaquin Delta Historical Ecology Investigation: EXPLORING PATTERNS AND PROCESS

Delta Science Program Independent Review Panel Report

BDCP Effects Analysis Review, Phase 3

A report to the

Delta Science Program

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March 2014

Delta Stewardship Council
Delta Science Program

Delta Science Program Independent Review Panel Report: BDCP Effects Analysis Review, Phase 3

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Executive Summary

Under the auspices of the Delta Science Program, the seven-member Independent Scientific Review Panel (Panel) reviewed the adequacy of the Effects Analysis component of the Bay Delta Conservation Plan (BDCP or Plan). This report represents the third phase of the Effects Analysis review; the Phase 1 (completed in November 2011) and Phase 2 reviews (completed June 2012) were partial reviews of the Effects Analysis and were completed as the Conceptual Foundation and Analytical Approach were still under development. These documents are available online at: http://deltacouncil.ca.gov/science-program/independent-review-draft-bay-delta-conservation-plan-effects-analysis. The present, Phase 3 review covers the first complete public draft of the BDCP Chapter 5 Effects Analysis and its associated technical appendices, made available in December 2013.

Four broad themes emerged from the Panel's review of the BDCP Effects Analysis. Firstly, the long, highly detailed document was difficult to review and comprehend. The vastness of the Effects Analysis report and appendices are both its strength and weakness. Although highly improved from the documents that the Panel reviewed during Phase 2, Chapter 5 continues to be fragmented in its presentation and sometimes inconsistent with the technical appendices. While the sheer scope of the analysis is impressive, the inefficient organization and incomplete cross-referencing among sections within the Effects Analysis (e.g., the 8 supporting appendices, totaling ~4500 pages) as well as with the larger BDCP planning documents make interpretation of anticipated net effects of BDCP implementation difficult at best. The 745-page Chapter 5: Effects Analysis does not represent a stand-alone document and it relies extensively on the associated appendices and other chapters for the presentation of scientific information, with insufficient guidance for the reader. As concluded from the Phase 2 report, the Panel universally believes that by itself, Chapter 5: Effects Analysis inadequately conveys the fully integrated assessment that is needed to draw conclusions about the Plan, in part because of incomplete information on factors affecting the covered species.

The second theme in the Panel's review is an apparent disconnect between the assessments of the levels of scientific uncertainty presented in Chapter 5 versus what is characterized in the technical appendices. In many cases, the Panel felt that there was appropriate characterization of high uncertainty within the technical appendices but Chapter 5 did not sufficiently acknowledge or articulate this reality, especially when using professional judgment to reach overall net effects of the BDCP on key species. In particular, the Panel observed that the critical uncertainties associated with presumed beneficial effects of tidal wetland restoration were not recognized in the Chapter 5 summary. Given the magnitude of the BDCP, the inherent natural and anthropogenic complexity in the Bay-Delta ecosystem, and the long time horizon for BDCP implementation and rehabilitated community development, most of the potential BDCP effects carry a relatively high level of uncertainty. For these reasons, the Effects Analysis must provide clear guidance for conceptual models, monitoring, metrics that assess underlying ecosystem processes, explicit thresholds and triggers, alternative hypotheses, special studies to address critical information gaps, and structured decision making in the form of a rigorously institutionalized adaptive management process.

The third major theme of this review is the lack of an integrated or quantitative assessment of net effects, echoing a similar review comment in the Phase 2 review. The Panel acknowledges that considerable effort has been made in documenting the complex information used to determine net effects. However, in the case of covered species, effects could not be quantified and only two of the sixteen existing life cycle models were deemed to be relevant to BDCP. For these and other reasons, a systematic approach to synopsize the overall net effect on each species was not used. Instead, professional judgment was used instead of a ranking approach to quantify a synthesis of cumulative effects and associated certainty in the projected outcome. Finally, in one paragraph, Chapter 5 accurately portrayed the anticipated BDCP effects: "*These expectations represent a working hypothesis of the relationship between actions, stressors, and biological performance*". However, this statement was not emphasized throughout the document.

The fourth major theme reflected on the need to address the extensive uncertainties associated with the assumptions and predictions of the beneficial effects of the BDCP conservation measures. While the Phase 2 Effects Analysis accurately reflected the detailed process and implementation structure to apply an adaptive management approach to resolve uncertainties, the Panel was concerned that it defaulted to rather "passive learning" instead of a rigorous, institutionalized adaptive management process that resolved effects on covered species and their requisite ecosystems through an active, experimental approach.

Together with background obtained during Phase 1 and 2 of the BDCP Effects Analysis review, the Panel provides the following synopsis of the Panel's responses to their General Charge Questions; further responses to specific issues and the adequacy of supporting documents are provided in the body of the report.

1. How well does the Effects Analysis meet its expected goals?

The Phase 3 review-version of the Effects Analysis is a much improved and impressive compilation of background material and scientific and technical knowledge about the Bay-Delta that provides a plausible basis for the conservation measures. The Panel concluded that much of the available data and arguments for the rationale behind the Effects Analysis assumptions and conclusions are contained within the BDCP documents. However, we suggest that the Effects Analysis (Chapter 5) itself is still poorly substantiated and leaves too much to appendices and other BDCP chapters without explicit cross-references. The lack of accessibility to information within the chapter or clear reference to supporting detail inhibits rather than elucidates comprehension of the findings and thus conveys an unsatisfying "trust us" message.

Our conclusion of the Effects Analysis is that many of the critical assumptions in modeling effects and justifications behind the supposed benefits of the conservation measures are highly uncertain. Much of the conservation measures center around restoration activities and management actions to improve current conditions. Our impression, therefore, is that the foundation of the BDCP is weak in many respects and the default burden to ensure covered species benefit, if not recovery, depends on adaptive management. The adequacy of the BDCP therefore rests not in the intent and development of the conservation measures, but in the rigor and application of adaptive management to ensure that the critical uncertainties are addressed and strategically incorporated into a progressively refined Plan.

2. How complete is the Effects Analysis; how clearly are the methods described?

Chapter 5 provides a comprehensive overview of the spatial and temporal scope of the analysis, definitions of project baselines that differ depending on regulatory authority, recognition of climate change information, identification of a variety of models used to evaluate effects, treatment of viable salmon population criteria, and the approach to determining net effects on fish and wildlife. As might be expected, with the size of the Effects Analysis task, the quality of the assessments ranged in scientific rigor based on the amount of available data and best available science. Some aspects of the assessment, such as water quality and flow, were quantitatively assessed using sophisticated mathematical models. Some aspects of the Chinook salmon assessments were also based on empirical data and process-based models. However, for many of the other fish species and their potential stressors, conceptual models supported by the scientific literature were the only recourse.

3. Is the Effects Analysis reasonable and scientifically defensible? How clearly are the net effects results conveyed in the text, figures and tables?

The approach to net effect conclusions needs to be reconsidered and revamped. The Effects Analysis assessment of net effects, particularly for covered fish, tries to incorporate information on potentially beneficial or detrimental effects covering 12 different stressors, 32 attributes, and multiple life stages using best available information and science. Only a perfect life-cycle model with perfect information on all the effects and their interactions could possibly weight the results correctly and draw unambiguous conclusions. A serious limiting factor of the current consolidation of Net Effects is a near complete absence of any weighting of the biological importance to particularly sensitive life history stages of the many attributes under consideration. As a result, whether and how any critical life stages or attributes are being adversely affected by the BDCP is generally unclear. The net effects conclusions for a fish species needs to therefore take into account the relative importance of the various life history stages, make them explicit, and interpret Plan effects within that context on a species-by-species basis. Similarly, the simple summation of the number of acres of suitable habitat that are removed or restored for each species by the conservation measures does not consider landscape-level effects such as connectivity and patch size, nor does it take into account variation in habitat quality.

The net effects analysis tends to overreach conclusions of positive benefits for covered fish species, given the inability to quantify the over-all net effects and the realization of high uncertainty. In particular, it does not adequately defend conclusions regarding the net effects of habitat restoration. Restoration of tidal wetlands (and other communities) is highly uncertain and at least an extremely long process. The Effects Analysis does not adequately justify the critical assumption of the benefit of tidal wetland restoration as a food web subsidy for covered pelagic fish given the uncertainties of tidal wetland restoration itself. A critical issue is the implicit expectation that restoration activities will result in increases in abundance of lower trophic levels, but it is uncertain whether the resulting increased production will result in food web pathways supporting covered species. The presentation of phytoplankton-based and tidal wetland macrophyte detritus-based food webs as alternative ecosystem processes, rather than as an integrated system, also significantly complicates the interpretation of the potential benefit of BDCP restoration. For foraging salmonids, the Effects Analysis did not evaluate the reduced extent to which salmonids would have access to rehabilitated habitat when the north Delta intakes are operating and flows are reduced.

Only one configuration of Restoration Opportunity Areas (ROAs) were modeled by the hydrodynamic models and the locations of these assumed Restoration Opportunity Areas are not available. Some details of the hydrodynamic modeling, especially where 1D and 2D models did not agree or situations where counter-intuitive results were reported, could not be evaluated due to the limited information provided.

4. How well is uncertainty addressed? How could communication of uncertainty be improved?

A broad consensus exists among the Panel that Chapter 5 does not adequately acknowledge the extensive uncertainty associated with the BDCP's assumptions and predictions. In its current form, at the level of detail conveyed, in the models used, and in the verbal assessments and conclusions, the level of uncertainty is often downplayed. Within appendices sometimes more explicit discussion of uncertainties can be found, but there is a disconnect between the summary pages with the conclusions drawn in Chapter 5. In situations in which an array of outcomes may be possible, only the more beneficial outcomes are used in conclusions about the BDCP. Communication of uncertainty would be improved by consideration of a range of potential outcome values in models.

5. How well does the Effects Analysis describe how conflicting model results and analyses in the technical appendices are interpreted?

The Panel found models describing salmonid Delta passage and habitat suitability for terrestrial species to be appropriate and any conflicting results adequately explained. Because hydrodynamic models are sensitive to how the open water regions are represented and how they are connected to the adjacent channels, and because the panel was not provided the bathymetric configuration of the ROAs or the order in which the ROAs were established, it is not feasible for the Panel to evaluate the sensitivity of the models to the placement of the Restoration Opportunity Areas.

Overall, the Panel found the Chapter 5 text describing the two life cycle models (IOS and OBAN), which provide alternative views of BDCP effects compared with other analyses, to be complicated and somewhat confusing. It was not clear whether or not the models were appropriately applied to evaluate a portion of the BDCP attributes.

The Effects Analysis modeling of salmon sensitivity to water temperature during egg incubation in the Sacramento River is not clear, given that the BDCP has no effect on upstream conditions according to some sections of Chapter 5. The Chapter 5 evaluation needs clarification, including a clear description of how the BDCP might affect flow and temperature in this area.

6. How well does the Effects Analysis link to the adaptive management plan and associated monitoring programs?

While both the need for and operative structure of adaptive management is identified considerably more in the Phase 3 review version of the Effects Analysis, it remains characterized as a silver bullet but without clear articulation about how key assumptions will be vetted or uncertainties resolved to the point that the BDCP goals and objectives are more assured. The concept of adaptive management is appropriately described and allocated a prominent role in the implementation structure. However, the commonly acknowledged process of adaptive management is easily misunderstood and misapplied, often resulting in a loss of rigor and commitment in application. Because of the extensive uncertainties surrounding the assumptions and predictions of the BDCP, the Panel strongly emphasizes institutionalizing an exceedingly rigorous adaptive management process. This is critical in order to avoid the high risk associated with ecological surprises that will be difficult or impossible to reverse once they have occurred. BDCP must make a commitment to the fundamental process, and specifically the required monitoring and independent science review, not just the concept of adaptive management.

Introduction

This report describes the results of an independent scientific review of the Bay Delta Conservation Plan (BDCP) Effects Analysis. At the request of the BDCP participants, the Delta Science Program convened an Independent Science Review Panel (Panel) to assess the scientific soundness of the BDCP Effects Analysis, guided by a Panel Charge with explicit questions to address.

Background and History

The BDCP Working Draft was initially released November 18, 2010 without a detailed effects analysis. This review has been conducted in three phases and was initiated in October 2011. The Panel's initial (Phase 1) review was conducted on the Draft BDCP Effects Analysis' Conceptual Foundation and Analytical Framework and the Entrainment Appendix as an example of the application of the conceptual understanding, methods and analyses discussed in the Conceptual Foundation and Analytical Framework. In the most recent drafts of the BDCP Effects Analysis, the Foundation and Framework (originally Appendix A) concepts were incorporated into Chapter 5: Effects Analysis. During Phase 2, the Panel reviewed drafts of the BDCP Chapter 5: Effects Analysis and drafts of many of the associated technical appendices. Appendices 5.E: Habitat Restoration and 5.G: Fish Life Cycle Models were not reviewed during the Phase 2 review. The BDCP Chapter 5: Effects Analysis and all of its associated technical appendices were reviewed during the Phase 3 review that is summarized in this report.

BDCP Goals and Role of Effects Analysis

The overall goal of the BDCP is to restore and protect ecosystem health, water supply, and water quality within a stable regulatory framework. Component goals include:

- provide for the conservation and management of Covered Species within the Plan Area;
- preserve, restore and enhance aquatic, riparian and associated terrestrial natural communities and ecosystems that support Covered Species within the Plan Area through conservation partnerships;
- allow for projects to proceed that restore and protect water supply, water quality, and ecosystem health within a stable regulatory framework;
- provide a means to implement Covered Activities in a manner that complies with applicable State and Federal fish and wildlife protection and laws, including California Endangered Species Act and Federal Endangered Species Act, and other environmental laws, including the California Environmental Quality Act and National Environmental Policy Act;
- provide a basis for permits necessary to lawfully take Covered Species;
- provide a comprehensive means to coordinate and standardize mitigation and compensation requirements for Covered Activities within the Planning Area;
- provide a less costly, more efficient project review process which results in greater conservation values than project-by-project, species-by-species review; and,
- provide clear expectations and regulatory assurances regarding Covered Activities occurring within the Planning Area.

The Effects Analysis is a critical component for the BDCP. Its purpose is to provide the best scientific assessment of the likely effects of BDCP actions on the species of concern and ecological processes of the Bay-Delta system. The Effects Analysis will, out of necessity, rely heavily on the application of models to quantify the likely results of the BDCP. These include conceptual, numerical, hydrodynamic, operational, and species models. The BDCP Effects Analysis is being conducted and documented through Chapter 5: Effects Analysis and a series of technical appendices centered on common stressors or groups of similar effects. The draft appendices reviewed in Phase 1 of the Effects Analysis review included the Conceptual Foundation and Analytical Framework Appendix (Foundation and Framework) and the Entrainment Technical Appendix. The Foundation and Framework described the high-level vision, purpose, and regulatory foundation for the Effects Analysis. It also provided an overview of the proposed methods to accomplish the analysis. In the most recent drafts of the BDCP Effects Analysis, the Foundation and Framework (originally Appendix A of the BDCP) concepts have been incorporated into Chapter 5: Effects Analysis.

Panel Members

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The Panel member's biographies are included in Appendix A of this report.

Charge to Panel

The Panel was charged with assessing the scientific soundness of Chapter 5: Effects Analysis and the associated technical appendices, including recommendations for how these might be improved with respect to achieving their stated goals (Appendix B). The charge directed the Panel to address six general questions on Chapter 5: Effects Analysis and review of eight specific topics that had been formulated by the BDCP agencies. In addition, seven other questions were addressed on the approach, analysis and models described in the Chapter 5 technical appendices.

Review Schedule

- October 2011
    - The Panel convened in Sacramento to discuss the Foundation and Framework and Entrainment Technical Appendix and made initial recommendations.
- November 2011
    - Phase 1 Panel report completed November 28, 2011.
- April/ May 2012
    - The Panel reconvened in Sacramento to discuss BDCP Chapter 5: Effects Analysis and the many of the technical appendices. Appendices 5.E:

Habitat Restoration and 5.G: Fish Life Cycle Models were not reviewed at this time.

- June 2012
    - Phase 2 Partial Review Panel report completed.
- December 2013
    - An informational briefing was provided for the Panel. It included an overview of changes to the Effects Analysis and associated technical appendices since the Phase 2 review, including the changes made in response to the Panel's previous comments.
- January 2014
    - The Panel convened in Sacramento to discuss the BDCP Chapter 5: Effects Analysis and technical appendices on January 28-29.
- March 2014
    - Phase 3 report completed.

Organization of Report

We have sought to organize the Panel's review comments and recommendations around the questions framing the Charge to the Panel (Appendix B). Given the extensive volume of review material in Chapter 5 and its associated appendices, our ability to draw on other chapters in the entire BDCP document and all other supplemental material provided to the Panel was considerably limited and inconsistent. However, we attempted to reduce our own uncertainties by exploring the whole body of the BDCP as much as was feasible within the constraints on our time and resources.

For each of the Panel Charge questions we provide a brief ***summary*** section, a series of bulleted ***recommendations***, and a ***comments*** section with more detailed discussion. In order to maintain this structure throughout the report, there is some redundancy, particularly between the summary comments and detailed comments sections.

Summary observations

Reponses to Phase 1 and Phase 2 Panel recommendations

Many of the recommendations from the Phase 2 report should still be referenced while developing the adaptive management plan and initial rules for operating the north Delta diversion facility. Highlighted below are some Phase 2 recommendations that are relevant in this Phase 3 report.

Recommendation 1: Analysis of biological effects needs more consistency and specificity

In some respects, the current draft of the Effects Analyses lacks even more specificity than before, although it may be that sections were moved to other chapters. The 'multi-author' problem is apparent in the variation in assessments found in different locations. Most biological objectives for covered fishes were not fully evaluated in Chapter 5 because information was deemed to be insufficient (Table 5.2.8). Requests for full aquatic food webs were followed and a reasonable conceptual food web was provided, but it was incomplete.

Recommendation 2: Net Effects Analysis needs greater objectivity

Regardless of the degree of uncertainty and the number of linkages without analyses, the conclusion is often overstated as the most beneficial result. Many biological models were analyzed without any sensitivity analyses; consultants would say, 'there's no data,' but they could have said, 'what if we were just 90% correct here, or 60% correct', or 'what if the benefits of restoring wetlands are delayed 10-15 years over our most positive perspective' – but none of those alternative scenarios were considered.

Recommendation 3: Increase consistency of stressor analysis across covered species, and provide more detail.

Chapter 5 identified a ranking approach that addressed: 1) importance of attribute to the population; 2) effect of stressor on individuals; and, 3) certainty of 1 & 2. However, the analysis did not transparently follow through with this approach.

Recommendation 4: Chapter 5 must be a "stand alone" document

The synthesis quality of the Effects Analysis was improved. But reference to specific sections of technical appendices and other supporting documentation could be improved in many sections. Given uncertainty in effects analysis, more description of monitoring and adaptive management would be worthwhile to show that the BDCP would adequately address the uncertainty.

Recommendation 5: Clarify the baseline

The baseline(s) was described, although the baselines vary with regulatory agency. This complicated an already very complicated and lengthy Effects Analysis.

Recommendation 6: Provide systematic understanding and planning for conservation actions, especially restoration

Achieving beneficial conservation measures requires understanding limiting factors, ecosystem processes, sequencing, adaptive management responses, thresholds for certain actions, and interactions and other consequences of these actions. Otherwise, this isn't a conservation plan, but rather a conservation menu that generally fails to describe how major uncertainties will be resolved. For instance, while the Effects Analysis recognizes that suspended sediment has been declining in the Sacramento River and that the new diversions would remove an additional 8-9%, all analyses used a high and constant amount with no mention of downstream sediment effects on either Suisun or San Francisco Bay. Similarly, the uncertainty about being able to remove *Egeria* or other invasive species is not directly addressed in Chapter 5. *Egeria* is certainly poorly considered in the context of the aquatic food webs. Bivalves are not incorporated into aquatic food web analyses, although they're mentioned as 'uncertainties'.

While the conceptual model of food web enhancement support of covered species through restoration of tidal wetlands is more thoroughly covered, potential changes in the contributions of different food web sources and subsidies are still treated as disparate. Discussion of the Delta's potential food web structure and dynamics under BDCP conservation measures still fails to treat the Delta as a system, with spatially and temporally integrated sources of phytoplankton-based and detritus-based secondary production. There remains the need to provide a synthetic view of the potential benefit of restoration to the covered species that represents the integrated ecosystems and processes that fuel that food web, and potentially enhance it under the BDCP.

No additional detail has been provided for the Restoration Opportunity Areas (ROAs), other than their general locations. There is very little mention of how they will be connected, interact or be sequenced. What criteria have been developed to provide that guidance, or is it entirely dependent on opportunity (real estate costs, availability, public land, etc.)? Ultimately, adaptive management incorporating an extensive management structure and large representation of stakeholders will need to be implemented in order to resolve issues and uncertainties. There is a tremendous trust embodied in an ill-defined adaptive management process.

Recommendation 7: Include indirect effects of contaminants as part of Appendix 5.D: Contaminants

Indirect effects of contaminants on covered species via food web effects (i.e., contaminant effects on the microorganisms that make up the food web that covered species depend on) are almost certainly important.

Recommendation 8: Accurately characterize food resources and food webs

While there is now more comprehensive assessment of both phytoplankton- and detritus-based food web pathways proposed to be enhanced by BDCP conservation measures, the Effects Analysis still leaves the impression that phytoplankton and macrophyte (e.g., tidal marsh) production are separate, almost “opposing” alternative food webs. Only a simple depth model is used for phytoplankton production, nothing else incorporated. Many things are now mentioned in the text, no analyses incorporated, no discussion of potentially modified planktonic composition, etc.

Recommendation 9: The hydrodynamic modeling needs to capture the entire domain of effects

1) New guidelines will need to be put in place to regulate tidal (and maybe tidally averaged reverse flows) in the north Delta channels including Steamboat, Sutter, and Georgiana Sloughs. The operation of the Delta Cross Channel also needs to be rethought. These new guiding regulations need to be in place *before* exports start to occur in the system.

2) The current Effects Analysis does not consider the influence of shifting timing of withdrawals on San Francisco Bay circulation patterns and ecology. This is a significant omission with ecologically important implications.

Recommendation 10: Incorporate life cycle models for all species, as quantitatively as possible

Appendix 5.G identified a number of life cycle models, but eliminated all but two to be used in the effects analysis. The Panel questioned whether some models were inappropriately dismissed. The two models used in Chapter 5 both involved winter Chinook salmon. Thus, the large majority of covered species were not evaluated with life cycle models. The Panel asks why the BDCP did not develop life cycle models when beginning the process.

Recommendation 11: Consider salmonids at stock and life history scale

This aspect of the Effects Analysis was also improved. Each salmonid stock was evaluated. “Forager” versus “migrant” life histories were compared and evaluated, but proportions of each life history type did not seem to be considered in the analysis of net effects. Furthermore, the relative proportion of wild versus hatchery fish contributing to each life history type was not considered.

Recommendation 12: Identify analytical tools that need to be developed to address the extremely high uncertainty involved with calculating sediment supply and turbidity

Multiple statements within Chapter 5 and Appendix 5.C indicate that turbidity distribution is largely unknown.

Recommendation 13: Levels of uncertainty are not adequately addressed

The Effects Analysis provides an improved recognition of uncertainty, but there’s not better resolution of uncertainty than in previous drafts and the more complete discussion of uncertainty is often buried in the appendices. As a result, Chapter 5 reflects the lowest common denominator in terms of uncertainty. The level of uncertainty was often mentioned when evaluating the effect of a stressor on a species. Uncertainty was also mentioned when estimating net effects. However, conclusions regarding covered fish often overstated potential beneficial effects while not adequately addressing the lower-end effects.

Recommendation 15: Include sensitivity analyses and model validation in the effects analysis for covered fish species

While sensitivity analyses would have informed the Effects Analysis in the case of some of the biological models, this recommendation was generally not followed.

Recommendation 16: Provide more detail about the specific approaches that will be used when implementing adaptive management

Given the tremendous levels of uncertainty associated with critical assumptions and predictions inherent in the Effects Analysis, the burden of sustaining or enhancing covered species will seemingly fall almost entirely on adaptive management, particularly “active” adaptive management where explicit interventions may be required. However, it remains unclear how many of the critical uncertainties can or will be addressed as explicit experiments. While the Adaptive Management Plan is appropriately, and often effectively, designed to specifically address the major uncertainties, thresholds, triggers and alternative measures need to be explicitly derived from conceptual and numerical models. In some cases, metrics or success criteria have yet to be identified (e.g., Table 3.D.2). Furthermore, the critical monitoring that would be required for effective decision making and adjustments are often relegated to research actions rather than mandated effectiveness monitoring, which presents potential lack of commitment or delay in timely resolution of critical uncertainties. Given the critical importance of monitoring and adaptive management to BDCP success, it would be worthwhile to have an explicit section within Chapter 5 that specifies how monitoring and adaptive management has been designed and implemented to address specific uncertainties, test critical assumptions and predictions and sequenced to improve the chance of success.

Recommendation 17: Ensure a declining fish population (e.g., longfin smelt) does not decline further while waiting for possible beneficial effects of habitat restoration

The key assumption is that food production will be the primary benefit to longfin smelt from habitat restoration measures. Winter-spring flow is also believed to be key factor affecting abundance. Chapter 5 states that the key question is the extent to which abundance can be increased through improved food production and how these improvements interact with the spring outflow-abundance relationship. Recognition of the length of time needed to restore habitats and increase food production for longfin smelt could be strengthened in Chapter 5.

Accessibility of Effects Analysis elements

The Panel recognizes that the complexities involved in the process to develop and the ultimate structure of the BDCP are enormous, and as a consequence reviewing one component such as the Effects Analysis can be inhibited by lack of clear knowledge of the other components, expanded detail or underlying rationale. Furthermore, the Panel found it difficult to readily track down key information in the 745 page Effects Analysis (Chapter 5), which was supported with eight appendices containing an additional 4,500 pages. In general, in spite of its length, we often found assumptions or conclusions stated in the Effects Analysis to be lacking in sufficient detail to stand alone without links to Effects Analysis appendices or other BDCP chapters that provided the necessary detail or background. Although outside the charge of the Panel, we often found after digging further into the BDCP documents that the Effects Analysis was supported with some information. We recommend that for recognition of the voluminous and detailed information supporting the Effects Analysis, and ease of migrating through it, a simple system of (appendix/chapter and page-line number) cross referencing be employed to point the reader to that supporting information.

General Charge Questions

1. How well does the Effects Analysis meet its expected goals?

Summary

Compared to the initial development of the BDCP Effects Analysis, the Panel consensus is that the Phase 3 version is a much improved and impressive compilation of background material and scientific and technical knowledge about the Bay-Delta that provided a plausible basis for the conservation measures. The Panel concluded that all of the available data and arguments for the rationale behind the Effects Analysis assumptions and conclusions are contained within the BDCP documents, although we suggest that the Effects Analysis (Chapter 5) itself is still poorly substantiated and leaves too much to appendices and other BDCP chapters without explicit cross references. The lack of accessibility to information conveys a “trust us” message.

Evaluation of BDCP effects was typically systematic in that it attempted to identify key attributes affecting Covered Species and described, to the extent possible, the importance of that attribute, the potential effect of the BDCP on the attribute, and uncertainty regarding the evaluation. Findings from multiple approaches taken to assess potential effects were described and strengths and shortcomings were identified when possible. However, this level of detail, which sometimes included conflicting information, inhibits rather than elucidates comprehension of the findings.

The tenuous conclusion drawn from the Effects Analysis is that many of the critical justifications behind the supposed benefits of the conservation measures are highly uncertain. Other than the impression that the foundation of the BDCP is weak in many respects, the default burden to ensure Covered Species benefit, if not recovery, rests on adaptive management. The adequacy of the BDCP therefore rests not in the intent and development of the conservation measures, but in the rigor and application of adaptive management to ensure that the critical uncertainties are addressed and strategically incorporated into a progressively refined Plan.

There is great potential in the area of decreasing invasive aquatic vegetation (IAV) abundance. Control of extremely invasive IAV, such as *Egeria densa* (Brazilian waterweed) and *Eichhornia crassipes* (water hyacinth), could be substantial and effective if the Plan follows through on its actions. The prospects of success with predator control appear marginal and then only if hotspot actions are followed through year after year. The effects of water withdrawals by the Plan may lead to expanded populations of the non-indigenous, invasive clams *Potamocorbula amurensis* and *Corbicula fluminea* without further direct actions to control their population growth. The fate of *Microcystis aeruginosa* is also not promising. Between trends in climate warming and planned water withdrawals, the prospects for *Microcystis* blooms appear to remain unchanged or slightly worse under the Plan, although the direction of these potential outcomes is highly uncertain.

The Effects Analysis develops a robust conceptual model of aquatic food webs and the diverse linkages that may impact the net production of food for covered fish species. Yet, the Effects Analysis contains a number of assumptions, some of which are inappropriate (such as the magnitude and location of invasive clam depression of phytoplankton production), and others highly uncertain. Uncertainties are mentioned, but no effort was made to include conservation efforts reaching only a portion of the biological objectives and goals. Thus the analysis of effects further assumes only the most beneficial potential results, but doesn’t incorporate other possibilities. Other aspects of food webs in aquatic habitats are described but remain unanalyzed, some of which may enhance, while others may inhibit achievement of biological objectives. While the overall conceptual model is adequate, integration and synthesis is lacking. Consequently the conclusions and net effects are not appropriate given the gaps in analyses and the uncertainties.

For terrestrial communities and covered species, the Effects Analysis provides a simple accounting of the number of acres of natural communities and suitable habitat that will be removed and restored but very little information is provided about the management actions that will be implemented to maintain them over the duration of the conservation plan.

Recommendations

- Provide detailed cross-referencing and indexing between Chapter 5 and the associated technical appendices as well as other chapters of the BDCP, especially the Adaptive Management Plan.
- Improve reporting of uncertainty levels within Chapter 5 Effects Analysis, including within the Executive Summary.
- Identify the most relevant monitoring indicators necessary to evaluate the trajectory of outcomes with respect to the biological objectives,
- Complete work on biological objectives.
- Provide triggers for adaptive management
- Guide the scientific community by highlighted research priorities to address critical information gaps.
- Improve on the systematic approach for integrating net effects for Covered Species.
- Develop life cycle models for each of the Covered Species in order to evaluate BDCP effects

Comments

The length and detail of the text and accompanying tables indicate considerable effort to document information used to determine the net effects. However, this level of detail, which sometimes included conflicting information, inhibits rather than elucidates comprehension of the Effects Analysis findings.

Overall, the BDCP and the 22 conservation measures have the goal to enhance fish and wildlife species in the Plan Area. Twenty-one of the conservation measures involve actions intended to restore habitat and benefit Covered Species. Conservation Measure 1 (Water Facilities and Operation) also has the goal to benefit covered species but this specific action involves activities that may adversely impact species (e.g., water removal and construction activities) while also benefiting some species (e.g., reduced entrainment at the south Delta pumps). Therefore, a key goal of the BDCP Effects Analysis is to determine whether the overall positive effects of the conservation measures outweigh the adverse effects of water removal and project construction, and if so, to what degree.

The Effects Analysis attempted to evaluate the effects of the BDCP on each covered fish species in an open, unbiased manner. Sixteen life-cycle models for Covered Species were examined for applicability to the BDCP, but only two were deemed to be relevant. It was not clear why life cycle models were not developed for the specific purpose of evaluating BDCP effects on each of the Covered Species. Quantitative effects could not be described, rather effects of each attribute were ranked as zero, low, moderate, or high effect. A systematic approach to synopsize the overall net effect on each species was not used even though a ranking approach that could have been used in a systematic roll-up was described. Instead, professional judgment was used to assess the overall net effect.

If there is one area of general scientific consensus among the Panel about the implementation of the Bay Delta Conservation Plan is that its <u>outcomes remain highly uncertain</u>. As such, one would expect that the Effects Analysis would reflect this general conclusion by stressing a high level of uncertainty around all of its conclusions. There is also general consensus among stakeholders that the high level of uncertainty should not be an impediment to any action in the restoration of the Bay Delta ecosystem. The only way to address the highly uncertain outcomes of BDCP implementation is through rigorous monitoring and adaptive management. The BDCP Effects Analysis should better integrate where uncertainty exists, identify the most relevant monitoring indicators necessary to evaluate the trajectory of the outcome, provide triggers for adaptive management and guide the scientific community by highlighted research priorities to address critical information gaps. On these points the Effects Analysis as a stand-alone document falls short.

Table 5.2-8 identifies the biological objectives for each of the covered fish species and whether or not the Effects Analysis was able to assess the likelihood of the BDCP achieving the objectives. Some of the biological objectives were quantitative, thereby providing a specific metric that could be evaluated both prior to BDCP implementation and after implementation. For example, for winter-run Chinook originating in the Sacramento River, the objective is to achieve a 5-yr geometric mean survival through the Delta of 52% by year 19 (from an estimated 40% at present), to 54% by year 28, and to 57% by year 40. Although the table notes that this objective is interim and subject to possible change as new data are collected, the Review Panel complements the BDCP team for developing <u>quantitative biological objectives to be achieved within specific time periods</u>. Ideally, the Effects Analysis should evaluate likelihood of the BDCP achieving each biological objective.

The inability to fully evaluate the likelihood of achieving each biological objective at this time highlights the need for a rigorous monitoring and Adaptive Management Plan. Chapter 5 seems to recognize this need in light of the incomplete evaluation of biological objectives. The Panel was not tasked with reviewing monitoring and adaptive management plans. Nevertheless, monitoring efforts should be designed to quantify whether or not the biological objectives are being achieved. The adaptive management plan needs to be linked to monitoring with identified trigger points and actions to steer the effort towards achievement of the biological objectives.

For terrestrial communities and covered species, the Effects Analysis, for the most part, provides a simple accounting of the number of acres of natural communities and suitable habitat that will be removed and restored but very little information about the management actions that will be implemented to maintain them over the duration of the conservation plan. The estimates of habitat restoration assume that restoration targets for the different habitats will be achieved with certainty, an assumption that unlikely to be met. In addition, the contribution of natural community restoration to species habitat restoration is estimated by multiplying the percentage of modeled habitat comprising the natural community by the total acres of natural community restoration in the plan area. This approach, however, confounds the spatially explicit nature of many of the species distributions within the Plan Area. For instance, only the riparian woodland south of Highway 4 within the Plan Area is considered potential riparian woodrat habitat which makes sense given their current distribution. The riparian woodland in this region currently comprises approximately 12.1% of the riparian woodland in the entire Plan Area. It is inappropriate to apply this percentage the estimate the amount of restored habitat in the Plan Area that will be available to riparian woodrats. If none of the restored habitat occurs south of Highway 4 then none of it will be potentially available to riparian woodrats. It makes much more sense to identify only riparian woodland restored south of Highway 4 as potential riparian woodrat habitat. Because the distribution of many of the species in the Plan Area is limited by their current distribution and dispersal abilities, the potential for colonization of restored areas should be identified using spatially explicit information. In the case of the riparian brush rabbit and riparian woodrat, a specified number of acres of riparian woodland should be restored within their potential range in the Plan Area.

The issue of the management of terrestrial communities and covered species is addressed in very broad terms in Chapter 5. In some cases there is mention of maintaining communities in a successional state that will make it suitable for a particular species (e.g., early successional riparian forest for riparian brush rabbits and western yellow-billed cuckoo), but many of the uncertainties surrounding long-term management of species and habitats are subsumed into adaptive management. Adaptive management is unlikely to succeed unless clear targets and thresholds for alternative management approaches are identified.

2. How complete is the Effects Analysis; how clearly are the methods described?

Summary

The Effects Analysis is a monumental effort incorporating over 745 pages of text and another 4,500 page of supporting appendices. The assessment covers potential changes in the physical environment, natural communities (12), fish (11 species), wildlife (25) and plant (12) species associated with BDCP. For fish species, 12 different categories of stressors and 32 attributes were examined over four different life stages. As many as 14 different operating scenarios were examined from the status quo to the long-term effects of BDCP implementation with climate change. For terrestrial species, areas of habitat loss and gained through management actions were examined.

Chapter 5 provides an overview of the spatial and temporal scope of the analysis, definitions of project baselines that differ depending on regulatory authority, recognition of climate change information, identification of a variety of models used to evaluate effects, treatment of viable salmon population criteria, and the approach to determining net effects on fish and wildlife. Biological goals and objectives were identified; this is important because the Effects Analysis should address each biological objective.

As might be expected, with the size of the Effects Analysis task, the quality of the assessments ranged in scientific rigor based on the amount of available data and best available science. Some aspects of the assessment, e.g., such as water quality and flow, were quantitatively assessed using sophisticated mathematical models. Aspects of the Chinook salmon assessment were also based on empirical data and process-based models. However, for many of the other fish species and their potential stressors, conceptual models supported by the scientific literature were the only recourse. In the case of Effects Analysis on fish, a workshop of professional biologists was used to incorporate feedback and to better express levels of uncertainty associated with assessment conclusions. The distinction between conclusions drawn from quantitative models and conceptual models was made clear.

The vastness of the Effects Analysis report and appendices is both its strength and weakness. In order to draw conclusions regarding effects of individual stressors or net effects on a species, it was often necessary in the report to draw on information from a number of appendices or other sections of the report. In many cases, these sections were not referenced or the specific findings of those sections not restated. This leaves the reader to hunt for the pertinent facts. It also appears at times that conclusions are based on a select subset of the facts that influence both the strength and certainty of the conclusions.

Because the variety of topics that the BDCP covers, how clearly the methods are described varies between topics. Several panelists gave input into Question 2 based on their areas of expertise.

Covered Fish

Approximately 72% of the objectives for covered fish could not be fully evaluated at this time due to insufficient information. The overall net effects conclusion for each species seemed to be based on the judgment of the authors, rather than a systematic ranking of attribute importance, change in response to the BDCP, and uncertainty in the rankings. Sixteen life cycle models for Covered Species were examined for applicability to the BDCP, but only two were deemed to be relevant, although the Panel is concerned about the exclusion of some life-cycle models. A systematic approach for synthesizing the net effect on each Covered Species was not used even though a ranking system was described that could have been used as a semi-quantitative scoring approach. Instead, professional judgment was used to assess the overall net effect.

In section 5.5, the text describes a numeric ranking for evaluating the importance of the attribute to the species, and the effect of the BDCP action on the attribute. The summary table (e.g., Fig. 5.5.1-5) was extremely difficult to read, used text to describe the effect (zero to high) and color to describe certainty. A small, essentially illegible “-“ sign identified negative rankings. This summary table needs to be redesigned to improve readability.

No major omissions for the scientific literature or failure to use best available data were found in the Effects Analysis. However, the Effects Analysis did not develop new methods when gaps in assessment capabilities were encountered. For example, no attempt was made to modify any of the existing delta smelt models for the express purpose of this assessment.

An inevitable risk in using any mathematical model is extrapolation outside the range of the model. This extrapolation is likely whenever projecting to environmental conditions that have not yet occurred such as the changes that could be brought about by the BDCP. It is imperative that model-based assessments clearly state when such extrapolation is occurring and the potential direction of bias that might likely arise.

Hydrodynamics

The coupling of the multi-D, DSM2, and CALSIM II models is not a standard method that would naturally be understood by the reader. The documentation for this coupling is part of the EIS documentation, not part of the BDCP documentation. A short summary of the method should be included in Chapter 5.

Terrestrial species

The methods for the terrestrial species are adequately described in the various appendices (but see specific comments on the description of the methods for the habitat restoration in Appendix 5.J.B).

Recommendations

Over-arching recommendations

- Include a table of cross-references for each section or appendix referenced in the Net Effects.
- Add formal comparisons of model results in the Effects Analysis and appendices.
- Include within the Net Effect sections, discussions of contradictions or non-supportive facts in order to better capture some of the uncertainty in the conclusions.
- Emphasize the following Effects Analysis statement: "*These expectations represent a working hypothesis of the relationship between actions, stressors, and biological performance.*"

Covered fish

- Model-based assessments should clearly state when extrapolation is occurring and the potential direction of bias that might likely arise.
- Redo the format of the effects on attributes summary tables (e.g., Fig. 5.5.1-5) to improve readability.

Hydrodynamics

- A short summary of the method to inter-link multi-D hydrodynamic models, 1-D (DSM2) models, and CALSIM II should be included in Chapter 5.

Comments

Effects on Covered Fish

Chapter 5 addressed topics that it should address given information available at this time. Chapter 5 provides an overview of the:

- spatial and temporal scope of the analysis
- definitions of project baselines that differ depending on regulatory authority
- recognition of climate change effects on future conditions
- identification of BDCP actions
- identification of a variety of models and their limitations for evaluating BDCP effects
- an ESA take assessment including effects on viable salmon population criteria
- a qualitative approach for determining effects of each attribute on species habitat and performance
- an approach for classifying certainty of the effects analysis, and
- a description of the approach for evaluating overall net effects of the BDCP on each fish and wildlife species.

Additionally, biological goals and objectives were identified in Chapter 5. Identification of biological goals and objectives in Chapter 5 is important because the Effects Analysis should address the ability of the BDCP to achieve each biological objective. However, Chapter 5 states that approximately 72% of the objectives for covered fish could not be fully evaluated at this time due to insufficient information. It is noted in Chapter 5 that these information needs would be incorporated into monitoring and research actions, which are described in Section 3.6 (not reviewed by the Panel). Given the incomplete information, the Effects Analysis states, "*These expectations represent a working hypothesis of the relationship between actions, stressors, and biological performance.*" This is an important statement that should be highlighted in Chapter 5 rather than in the middle of a paragraph on page 5.2-36.

Implementation of methods for evaluating BDCP effects was not readily transparent. Section 5.5 describes a numeric ranking approach for evaluating 1) the importance of the attribute to the species, and 2) the effect of the BDCP action on the attribute. Rankings reportedly ranged from -4 to +4. These two values were reportedly multiplied to develop a ranking of effect for each attribute. Certainty was reportedly evaluated using the same numerical ranking approach for both the importance of the attribute on the species and the BDCP effect on the species attribute. This approach seems reasonable given the limitations of existing information, and the evaluation would be transparent. However, the numeric values of these rankings were not presented or discussed in the BDCP. Instead, figures were presented (e.g., Fig. 5.5.1-5) that used text to describe the effect (zero to high) and color to describe certainty. A small, essentially illegible "-" sign identified negative rankings. It was not clear whether this summary figure incorporated the importance of the attribute to the population, although importance of the attribute was often described in the text.

The numeric ranking approach described above was not used to evaluate net effects of the BDCP on each species, even though it seems that it could have been used and compared with the professional judgment evaluations. Instead, the overall net effects conclusion for each species seemed to be based on the judgment of the authors, rather than a systematic ranking of attribute importance, change in response to the BDCP, and uncertainty in the rankings. Chapter 5 notes that its conclusions were compared with professional judgments of agency personnel provided during a series of workshops in August 2013. This is worthwhile, but a table showing the variability in the judgments would have been useful as a means for indicating variability in the assessment rankings.

The Panel does not provide comments on methodologies presented in the technical appendices, except when discussed below. The level of detail in the descriptions of methodologies in the appendices varies considerably. In many cases, the original document must be consulted for a description of the methodology. Given the variety of information sources, referral to the original report for methodology was not unexpected.

Hydrodynamics

One of the issues that had to be worked through with the hydrodynamic models for the Effects Analysis was how to use hydrodynamic models that were designed for the current bathymetric configuration of the Delta and the watershed. The CALSIM II model is a watershed optimization model that has operational criteria based on salinity intrusion into the Delta. Changing main point of diversion in Conservation Measure 1, adding ROAs in Conservation Measure 3, and factoring in climate change (especially sea level rise), all change the circulation patterns in the Delta and the associated salinity intrusion. It is necessary to use the physically based multi-dimensional hydrodynamic models to first calculate hydrodynamic parameters (stage and flow) and salinity throughout the system. Because the multi-dimensional models are computationally intensive to run, the results of the multi-dimensional models are used to calibrate the DSM2 (1-D) model. The DSM2 (1-D) model is then used to create the relationship between salinity intrusion and river input flows. This river inflow-salinity intrusion relationship is what CALSIM II needs for optimization.

The coupling of the multi-D, DSM2, and CALSIM II models is not a standard method that would naturally be understood by the reader. The documentation for this coupling is part of the Environmental Impact Statement documentation, not part of the BDCP documentation. A short summary of the method should be included in Chapter 5.

Effects on Terrestrial Species

The methods for the terrestrial species are adequately described in the various appendices (but see specific comments on the description of the methods for the habitat restoration in Appendix 5.J.B).

3. Is the Effects Analysis reasonable and scientifically defensible? How clearly are the net effects results conveyed in the text, figures and tables?

Summary

The effects analysis covers a multitude of topics. Each panelist provided input into Question 3 based on their areas of expertise.

Overall approach to determine net effects

The Effects Analysis, particularly for covered fish, tries to incorporate information on potentially beneficial or detrimental effects covering 12 different stressors, 32 attributes, and multiple life stages using best available information and science. Only a perfect life cycle model with perfect information on all the effects and their interactions could possibly weight the results correctly and draw unambiguous conclusions. Any and all actual effects analyses are far from that measure of perfection, including the BDCP. The effect summary figures (e.g., Figure 5.5.2-5) attempt to illustrate the multidimensional aspects of the assessment process and, along with the Net Effect narratives, try to convey an overall assessment conclusion. A serious limiting factor of the current cumulative Net Effects is a near complete absence of any explicit weighting (in summary tables) of the biological importance of the many attributes under consideration (e.g., Figure 5.5.1-5). Size and direction of anticipated effects on the attributes is provided in the summary figures, along with color coding levels of certainty. Even though summary tables show values for each life stage, what cannot be discerned is whether any critical life stages or attributes are being adversely affected by the BDCP. Consequently, it is also unclear whether the Net Effects conclusions are correctly taking critical life stages into account when deriving overall Net Effects conclusions.

The approach to net effect conclusions needs to be reconsidered and revamped. The net effect summary figure (e.g., Figure 5.5.2-5) does not include the relative importance of the categories (e.g., food, entrainment, etc.). Without incorporating their relative importance in the summary figure, net effect conclusions are potentially meaningless and uncertainty cannot be characterized. The net effect conclusions for a fish species need to therefore take into account the relative importance of the various categories, make them explicit, and interpret Plan effects within that context on a species-by-species basis.

Covered Fish

The Effects Analysis does not adequately defend conclusions regarding the net effects of the BDCP, including habitat restoration. Habitat restoration certainly has the potential to increase the productivity of species such as salmonids, but the literature contains relatively few studies documenting the population response of salmonids to habitat restoration. The conclusion statements from Chapter 5 (and/or the Executive Summary) tend to overstate the beneficial effects of BDCP for many different fish populations (e.g., salmonids, delta smelt, green and white sturgeon). The net effects analysis tends to over-reach conclusions of positive benefits for covered fish species, given the inability to quantify the overall net effect and the realization of high uncertainty.

Key issues/questions that still need to be address for covered fish include:

1. The importance of interactions between BDCP flows and habitat restoration.
2. Will the migrant life history sufficiently benefit from conservation measures to offset moderate negative impacts related to reduced spring flows? Migrant salmonids may benefit less from conservation measures, and may experience a negative net effect.
3. To what extent is foraging habitat and exposure of foraging salmonids to predators affected by reduced spring flows?
4. The text does not distinguish between hatchery versus wild salmonids in the analysis.

Conceptual Models

In general, the conceptual models for dissolved oxygen and contaminants are well developed, although consideration of nutrient form and nutrient ratios (e.g., Glibert *et al.* 2011) would be a nice addition given the interest and recent publications on these topics. Also, algal toxins could be an attribute for monitoring to reduce uncertainty in contaminants and food web conceptual models.

Although there are good synthetic conceptual models developed for the Bay-Delta longfin smelt population encapsulated in the Effects Analysis (e.g., Baxter 2010; Rosenfield 2010), the conceptual model is still constrained by the lack of a life-history model that would elucidate the role of prey composition and abundance in population dynamics.

Food Webs

Restoration of tidal wetlands (and other communities) is highly uncertain and at least an extremely long process. The Effects Analysis does not adequately justify the critical assumption of the benefit of tidal wetland restoration as a food web subsidy for covered pelagic fish given the uncertainties of tidal wetland restoration itself. The conceptual model of the food web appears to include many of these processes. However, within the narrative current understanding as well as the implications of inherent uncertainties are not fully explored.

Organic matter subsidies to the Delta Food Web

There is an expectation that restoration activities will result in increases in abundance of lower trophic levels but the structure of the lower food web will be critical in whether this increased production can support covered species. Not only quantity, but also quality of the primary production that is supported by restoration activities is important. Water residence time within ROAs and other characteristic transport timescales for Delta channels are not the only factors to consider. The type of phytoplankton primary production that is stimulated is highly uncertain and likely dependent upon water temperature, nutrient concentrations, vertical mixing and grazing. In addition, an increased residence time may promote toxigenic cyanobacteria (*Microcystis aeruginosa*).

Hydrodynamics and physical changes at export facilities

For hydrodynamic modeling, only one set of ROAs were modeled. Because the locations of these assumed ROAs are not being presented to the public, there are details of the hydrodynamic modeling that cannot be factored into the Panel's evaluation of the Effects Analysis.

Conservation Measure 1 now includes significant modifications to Clifton Court Forebay. This region has been identified as a predation hot spot by multiple studies. Reduction in predation hot spots should be considered in the physical design.

Terrestrial species

The Effects Analysis for terrestrial species focuses almost exclusively on a simple summation of the number of acres of suitable habitat that are removed or restored for each species by the conservation measures. The simple accounting approach does not consider landscape-level effects such as connectivity and patch size nor does it take into account differences in habitat quality.

Recommendations

Overall approach to determine net effects

- Clearly indicate on effect summary figures (e.g., Figure 5.5.2-5) both beneficial (+) and detrimental (–) effects.
- In order to incorporate biological importance into the Net Effects process, the rows (i.e., categories, attributes) of the effects figures (e.g., Figure 5.5.21-5) could be ranked or rearranged in clusters according to biological importance for the specific species (e.g., high, medium, low). In this way, it would be easier to assess whether any biologically important attributes are likely to be negatively impacted and at what level of impact. It will also allow readers to discern whether any biologically important attributes also have high levels of uncertainty assigned to them.
- From the August 2013 Covered Fish workshops, it would be valuable to include in the Net Effects summary, what fraction of the attendees agreed with the Net Effects conclusions (i.e., direction, amplitude and level of certainty).

Covered fish

- Examine and re-write conclusion statements about population net effects in both Chapter 5 and the Executive Summary to objectively express the range in anticipated population effects.
- Evaluate effects of conservation measure attributes on species while considering all other potentially interacting conservation measures.
- Consider relative abundance of salmon life histories when evaluating net effects on each species.
- “Wild” salmonids should be considered separately from hatchery fish whenever possible.

Conceptual Models

- Consideration of nutrient form and nutrient ratios (e.g., Dugdale *et al.* 2007; Glibert *et al.* 2011) would be a nice addition to food web models given the interest and recent publications on these topics.
- Algal toxins could be an attribute for monitoring to reduce uncertainty in contaminants and food web conceptual models.

Food Web

- A simple surface area versus water volume calculation would provide a first-order estimate of potential food subsidy to open water habitats of the low salinity zone.
- Evaluate and compare the magnitude and temporal and spatial variation in the multiple organic matter subsidies to the Delta food web.
- Incorporate into the Effects Analysis the idea that tidal wetland restoration may mitigate some of the nutrient loading into Delta by acting as a nutrient sink through emergent vegetation production, phytoplankton production as well as fluxes to the atmosphere via denitrifcation.
- Estimate the potential food web subsidy attained based on the degree to which habitats are connected hydraulically to Suisun and Grizzly Bays. These areas could serve as “proof of concept” for other, unidentified Restoration Opportunity Areas.

Hydrodynamics and physical changes at export facilities

- When Conservation Measure 3 is implemented, the details of the connection between the Restoration Opportunity Areas and the adjacent channels and the order in which the Restoration Opportunity Areas are established need to be top design criteria.
- Since Conservation Measure 1 is proposing significant physical changes be made to Clifton Court Forebay, the identified predation hot spots within Clifton Court Forebay should be considered in the re-design.

Terrestrial species

- Landscape-level effects should be considered.

Comments

Effects on Covered Fishes

A Comprehensive Summary Figure Would Be Useful. For specific actions affecting covered fishes, the Effects Analysis summarizes findings of multiples investigations when available and often qualifies the findings with opinion statements of how important the attribute might be and how certain the finding is. This assessment by the authors of the Effects Analysis is often compared with a summary of conclusions, including a statement of uncertainty, developed from a workshop with agency personnel in August 2013. This approach is reasonable given the information available, but as noted elsewhere, improvements could be made to systematically summarize 1) the relative importance of the attribute, 2) the level of change caused by BDCP implementation, and 3) the certainty of this evaluation. The relative importance of an attribute was often provided within the narrative of Chapter 5, but a comprehensive table or figure summarizing this metric was not presented along with the effect of the BDCP on the attribute and the certainty associated with the rankings. A comprehensive summary figure is a key step leading to the overall net effect determination for each species. This figure would also enhance transparency in the final professional judgment of net effects. Furthermore, some sections of the Effects Analysis did not seem to reach a conclusion or describe the certainty about the findings, e.g., text description of Feather River flow effects on spring Chinook (see Feather River discussion below).

Salmonid Life History Increases Uncertainty. Salmonids have a variety of juvenile life history types that result in differential use of Delta habitats over time. The Effects Analysis characterized these life history types as foragers and migrants. Foraging juvenile salmonids are younger, smaller and typically inhabit shallower habitats compared with larger, older yearling salmonids that pass through the Delta relatively quickly. Recognition and consideration of these two life history strategies in the BDCP Effects Analysis (e.g., Fig. 5.5.3-4) is important. However, as noted below, the complex life history of salmonids, including life history differences between wild and hatchery origin fish, leads to greater uncertainty in the overall net effect of the BDCP actions on salmonid populations.

Literature Shows Major Restoration Needed to Improve Fish Populations. The Effects Analysis does not adequately defend conclusions regarding the net effects of the BDCP, such as habitat restoration, on fish species. Habitat restoration certainly has the potential to increase the productivity of species such as salmonids, but the literature, including published papers and technical reports, contains relatively few studies documenting the population response of salmonids to habitat restoration (see reviews by Roni *et al.* 2008, 2011). Findings in the literature on the response of salmonid populations to habitat restoration was not adequately addressed in the Effects Analysis when describing the net effect of each species, although the methods section (5.2.7.10.3) did provide a reference by NMFS stating that quantitative linkages between specific habitat actions and viable salmonid population criteria is difficult. The difficulty in documenting population responses to habitat restoration should be recognized and addressed with large and strategic habitat restoration projects and detailed monitoring. For example, in a comprehensive evaluation of salmon responses to habitat restoration in Puget Sound, Roni *et al.* (2011) concluded:

> "Given the large variability in fish response (changes in density or abundance) to restoration, 100% of the habitat would need to be restored to be 95% certain of achieving a 25% increase in smolt production for either species. Our study demonstrates that considerable restoration is needed to produce measurable changes in fish abundance at a watershed scale."

Conclusions Often Overstate Beneficial Effects. The Panel believes that the net effects analysis tends to over-reach conclusions of positive benefits for covered fish species, given the uncertainty and inability to quantify the overall net effect. Given the findings of Roni *et al.* (2011), it may be inappropriate to extend an uncertain but potentially positive effect conclusion to statements about species conservation, especially under future climate scenarios. For example, the following grand conclusion statements from Chapter 5 (and/or the Executive Summary) tend to overstate the beneficial effects of BDCP:

> "The magnitude of benefits for winter-run Chinook salmon at the population level cannot be quantified with certainty. Nonetheless, the overall net effect is expected to be a positive change that has the potential to increase the resiliency and abundance of winter-run Chinook salmon relative to existing conditions."

Statements about increased resiliency and abundance are inappropriate given the high uncertainty expressed in the initial sentence. The statements tend to focus on the upper end of beneficial effects rather than a balanced analysis that might capture the range in net effects. The Panel underlined the questionable text.

"The BDCP should help conserve the species in the Plan Area and help it cope with expected climate change…." The term "conserve" implies a large beneficial population effect for salmon that may help the population recover from ESA listing. Maybe the BDCP will lead to a positive effect, but the magnitude of the effect is uncertain, as stated above, so it seems inappropriate to imply the BDCP would eliminate attributes in the Delta that cause lower population viability. The life cycle models suggested climate change effects would overwhelm the evaluated BDCP actions on winter Chinook salmon.

The following conclusion for delta smelt overstates and over-emphasizes the potential for significant beneficial effects (by emphasizing great potential) while also noting the conflicting conclusion of high uncertainty in the net effect: "While there is great potential for large benefits for delta smelt, there is a high level of uncertainty regarding the resulting effects. However, combined with the Fall X2 decision tree, the BDCP will have at least a minor beneficial effect on the species, but a great potential for larger benefits depending on actual food production and location of delta smelt population in relation to restored areas." The high-end benefit is emphasized in the BDCP text. Perhaps there is higher certainty for a positive versus negative net effect but there is high uncertainty for the net effect of actions on the delta smelt population, ranging from little to high population effect. This evaluation would benefit by the removal of "great".

For green and white sturgeon, the BDCP concluded: "Therefore, the BDCP is expected to conserve both species in the Plan Area through improvements in abundance, productivity, life history diversity, and spatial diversity." The term "conserve" implies a large beneficial population effect that was not supported by the evaluation. The conclusion statement also implies and therefore overstates measureable positive changes to four population viability criteria. These benefits may reflect the goals of the BDCP, but the uncertain magnitude of benefits to sturgeon should not be described as improving abundance, productivity, life history diversity, and spatial diversity.

Interactions between conservation measures. Interactions between BDCP flows and habitat was not adequately addressed in the report. For example, Table 5.5.3-4 shows that habitat units typically increased for foraging salmonids in response to habitat restoration, but the habitat analysis did not appear to consider whether salmonids would have access to the habitat during reduced flows under the BDCP scenarios (see Table 5.E.4-1). For example, flows were expected to be ~15% to 20% lower during January to April when many foraging salmonids are rearing in the Delta area. In other words, how much rearing habitat is available and what is the habitat quality for foraging salmonids when flows have been reduced 10-20%? The Cache Slough region is one example where key habitat restoration sites might be affected by reduced river flows. Perhaps tidal fluctuations overwhelm river flows in some of the lower habitats, but this should be stated in the report. For foraging salmonids, do reduced flows of the BDCP negate the reported habitat gains from some restoration activities? Recommendation: evaluate effects of conservation measure attributes on species while considering all other potentially interacting conservation measures. This approach was taken for some measures (e.g., Delta Passage Model evaluations) but not all.

Migrant salmonids may benefit less from conservation measures and may experience a negative net effect. The effect of each attribute on migrant versus forager salmonids was examined in Chapter 5, but summary Figure 5.5.3-2 did not capture differences in the assumed relative abundances of these life histories among the species. Plan area flows were typically ranked as a moderate negative effect on migrant salmonids in the Sacramento River and a low negative effect on foragers. However, this attribute was ranked the same for each salmonid species regardless of the proportion migrants versus foragers assumed in the population. The negative impact of reduced plan area flows should have been greater on Sacramento River species such as spring Chinook and steelhead that are dominated by migrant life histories.

Migrant life histories are less likely to benefit from habitat restoration activities, which are a key focus of the BDCP conservation measures. This implies that spring Chinook and steelhead may experience less benefit from BDCP actions than other salmonid species, or they may even experience a negative net effect in response to reduced spring flows. The key question, which deserves more attention in the BDCP, is whether the migrant life history will sufficiently benefit from conservation measures to offset moderate negative impacts related to reduced spring flows. This question is key for spring Chinook and steelhead that are composed mostly of migrant life histories.

Characterize uncertainty in plan area flow effects on salmonid life history types. The Delta Passage Model (DPM) is a key tool for this evaluation because it predicts survival of migrant salmonids while considering river flows, passage into interior areas, entrainment to pumps, and passage into the Yolo Bypass. The survival model is largely based on Chinook salmon exceeding 140 mm in fork length, therefore the DPM does not represent foragers or smaller migrants, which are the target of the habitat restoration activities.

The Effects Analysis states that it was assumed with moderate certainty that flow has high importance to foraging winter Chinook salmon, then notes that the moderate level of uncertainty reflects the relative lack of investigation on the influence of flows on smaller salmonids (Page 5.5.3-24, line 39-41). Moderate uncertainty is quite different from moderate certainty, which is also concluded in each salmonid summary figure (e.g., 5.5.3-4). If there is no information on how flows affect survival of smaller foraging salmonids in the Delta, it is difficult to accept a moderate level of certainty associated with the low negative impact of flows on foraging juveniles salmonids, especially when data suggest flow has a significant effect on larger salmonid (migrant) survival (Fig. 5C.5.3-4). To what extent is foraging habitat and exposure of foragers to predators affected by reduced spring flows? For winter Chinook and fall Chinook, the forager life history is the dominant type, indicating less certainty about the net effect of BDCP flows on these species compared with species dominated by migrant life histories that have been tagged and analyzed, e.g., Fig. 5C.5.3-4.

Hatchery versus "wild" origin salmonids. The presence of hatchery salmonids is typically noted in the introductory descriptions of each salmonid species in Chapter 5. The degree to which hatchery salmonids contribute to the two life history types was not described, though hatchery fish are released as migrants. For example, 80% of juvenile spring Chinook were assumed to be migrants. To what extent was this due to the release of migrants from hatcheries given that some of the natural population produces primarily foragers? The text does not otherwise distinguish between hatchery versus wild salmonids in the analysis. Although some hatchery stocks are protected by the ESA, it would seem that wild salmonids would have a higher priority than hatchery-produced salmonids, even though hatchery runs provide important role in the Central Valley and ocean fisheries. Perhaps resolution of effects and uncertainty inhibit analyses specific to wild salmonids. Nevertheless, wild salmonids should be considered independently from hatchery salmonids when possible.

Do habitat actions only affect salmonid capacity and not productivity? Fig. 5.5.3-2 shows BDCP effects on productivity of each salmonid species by attribute. No effect is shown for habitat attributes such as channel margin, floodplain, riparian, etc. In contrast, these attributes are scored in other Figures for each species, e.g., Fig. 5.5.3-4. Does this reflect an opinion that these habitat actions only increase the capacity of the habitat to support salmonids rather than habitat quality?

Obtain more information from life cycle models. Life cycle simulations were only performed for winter-run Chinook salmon using the OBAN and IOS models. Comparison of through-delta survival and adult returns by management scenario (Table 5.G-2) was very useful. One way to compare and evaluate the two models is to assess consistency in the management scenario rank (best to worst) for the various response variables. For instance, if the same management scenario always ranks first, then that would indicate high level of consistency and support for that conclusion. On the other hand, if management scenario rankings varied greatly between assessments then conclusions would have high degrees of uncertainty (See Table 1, below).

Some life cycle models inappropriately excluded. Appendix 5G excluded delta smelt life cycle models in the Effects Analysis without adequate justification. Based on the premise of using the "best available science," it is unclear how none of the delta smelt models could have reached that level of acceptance. One justification was that none of the models used zooplankton data; however, the BDCP Net Effects assessment indicated zooplankton was only of moderate importance to delta smelts (Figure 5.5.1-5). It would therefore seem that some assumptions about zooplankton could have been made, allowing life-cycle modeling to be performed. Robustness studies could have accompanied the modeling process. Furthermore, if the BDCP team felt none of the delta smelt models to be adequate, why was there no investment made in model development for such an important species of interest?

Net Effects

The Net Effects summary figures (e.g., Figures 5.5.1-5, 5.5.2-5, etc.) are very useful for synopses for each fish species, but they are incomplete. It would be visually helpful to explicitly include both positive (+) and negative (–) signs for each combination of life stage and category. There continue to be discrepancies between conclusions regarding certainty and level of effect between the text and summary tables. The quantitative scoring method described on page 5.5.1 seems to be largely ignored. Instead, a qualitative ocular assessment of the summary tables seems to be applied separately to the certainty and level of effect dimensions. For salmonid species, weighting is discussed for migrant vs. foraging forms, but this too is seemingly ignored (or at least not mentioned) in the Net Effect conclusions.

The approach to Net Effects conclusions needs to be reconsidered and revamped. The Net Effects summary figures (e.g., Figure 5.5.2-5) do not include the relative importance of the categories (e.g., food, entrainment, etc.). Without incorporating their relative importance, Net Effects conclusions are potentially meaningless and uncertainty cannot be characterized. Levels of uncertainty have different weight depending on the importance of the various categories. An assessment might have high uncertainty for all low importance categories and still have high overall certainty if all the important categories carry with them high certainty. Conversely, the overall assessment would have low certainty, if one or more of the high importance categories carry high uncertainty. The Net Effects conclusions for a fish species needs to therefore take into account the relative importance of the various categories, make them explicit, and interpret Plan effects within that context on a species-by-species basis. Uncertainty plus uncertainty is more uncertainty. Uncertainty never averages or cancels out uncertainty; any more than noise plus noise is less noise. One graphical approach to conveying importance of the various categories and attributes is to order or group the rows of the figures according to their importance for a particular fish species. It would then be possible to see if any detrimental effects of the BDCP are associated with any important biological processes or not.

Life-cycle simulations were only performed for winter-run Chinook salmon (i.e., models OBAN and IOS). Comparison of through-Delta survival and adult returns by management scenario (Table 5.G-2) was very useful. One way to characterize model consistency is to assess how consistent the management scenarios rank (best to worst) across the models and different response variables. For instance, if the same management scenario always ranks first, then that would indicate a high level of consistency and support for that conclusion. On the other hand, if management scenario rankings varied greatly between assessments, conclusions would have a high degree of uncertainty.

Restoration of tidal wetlands (and other communities) is highly uncertain or at least an extremely long process

Restoration of tidal wetlands is considered in detail in the section on aquatic food webs (Question 12). In general, tidal wetland restoration of biological function is quite difficult with respect to ecosystem processes beyond tidal flux and especially with respect to ecological equivalency to comparable natural wetlands. This has been reviewed in a number of studies and conclusions have remained consistent over the past two or three decades (e.g., Kentula 1996, Simenstad and Thom 1996, Zedler and Callaway 1999, BenDoer *et al.* 2009, Moilanen *et al.* 2009).

Lack of specificity in Restoration Opportunity Areas limits conclusions of many aspects of Effects Analysis

For the hydrodynamic modeling, only one set of Restoration Opportunity Areas were modeled. (See discussion of implementation of models in Question 2.) Because the locations of these Restoration Opportunity Areas are not being presented to the public, there are details of the modeling that cannot be factored into the Panels evaluation of the Effects Analysis. As examples: 1) in Panel Question 7, the placement of the Restoration Opportunity Areas influences reverse flows in Georgiana Slough, 2) the calibration of the 1-D model based on the 2-D model results is sensitive to Delta Cross Channel operations, which could be the result of Restoration Opportunity Areas representation in the system. (See question 5 Restoration Opportunity Areas modeling discussion.) When Conservation Measure 3 is implemented, the details of the connection between the Restoration Opportunity Areas and the adjacent channels and the order in which the Restoration Opportunity Areas are established need to be top design criteria.

Clifton Court Forebay physical changes need more evaluation before implementation because of its reputation as a predation hotspot

Conservation Measure 1 now includes significant modifications to Clifton Court Forebay. These modifications include building a wall in Clifton Court Forebay to create two separate regions, the north region would receive water from the North Delta pump facilities and the south region would receive water from the existing south Delta channels. In addition, the current size of the Clifton Court Forebay would also be enlarged by flooding an adjacent tract of land to the south. Based on the public panel discussion with ICF and the Fish agencies on January 29, 2014, the philosophy behind the modifications is that the water coming from the North Delta facilities will have already been pre-screened for critical fish species. Therefore, there would be significant savings in not filtering north Delta diversion (NDD) water through the south Delta fish screening facility.

ICF acknowledged that this is a newer element of the design for Conservation Measure 1. There was no documentation in Appendix 5.H (Aquatic Construction and Maintenance Effects) regarding this construction. The building of a dam in the center of Clifton Court Forebay and dredging another tract should be considered in Appendix 5.H.

Clifton Court Forebay has been identified as a predation hot spot by multiple studies. The Fish Predation science panel (Grossman *et al.* 2013) stated in their final report that: “Clifton court Forebay (CCFB) has been identified by multiple sources as an inhospitable location for salmonids. Within CCFB several areas are particularly hazardous including: 1) the deep scour hole just inside CCFB by the radial gates; 2) the trash gates in front of the Tracy Fish Collection Facility; and 3) section of Old River adjacent to the radial gates.” Since Conservation Measure 1 is proposing significant physical changes be made to Clifton Court Forebay, these predation hot spots should be considered in the re-design.

Delta Food Web

5.3.38 Cache Slough and Suisun Marsh Restoration Opportunity Areas are suggested as areas of substantial increase in Prod-Acres. Given that these Restoration Opportunity Areas are defined, some work could be done to estimate the potential food web subsidy attained based on the degree to which habitats are connected hydraulically to Suisun and Grizzly Bays. These areas could serve as “proof of concept” for other, unidentified Restoration Opportunity Areas. An interesting outcome of such an exercise would be a determination of the potential for export and trophic transfer (a positive outcome) versus localized cultural eutrophication, increased biochemical oxygen demand and dissolved oxygen sags in tidal sloughs (negative outcome).

The discussion of water residence time throughout the Delta (Section 5.3.36) suggests an increase of 3 to 4 days as compared to the current configuration. But this analysis is also site-specific. The approach used to calculate residence time is also of concern. The residence time in each Restoration Opportunity Areas is a function of bathymetry, the exchange between the Restoration Opportunity Area and the adjacent channels. The 1-D DSM2 model does not have the capability to calculate this parameter. In addition, because the specific locations and configurations of the Restoration Opportunity Areas are not presented in the Effects Analysis, the panel has no basis to comment on the validity of the approach.

The phytoplankton productivity model that results in Prod-Acres is limited in terms of prediction or certainty in outcomes. Again, it comes down to a question not only of quantity but also quality of the primary production that is supported. The result of longer residence time is likely to increase phytoplankton primary production (i.e., “slower is greener”) this may not hold when invasive clams are introduced to the system (Lucas and Thompson, 2012). Additionally, the type of phytoplankton primary production that is stimulated is highly uncertain and likely dependent upon water temperature, nutrient concentrations, vertical mixing and grazing. Lehman *et al.* (2013) suggested that increased residence and warmer water temperatures in excess of 19 - 20° C will promote toxigenic cyanobacteria including *Microcystis aeruginosa*. It should be recognized that *Microcystis* is only one potentially important toxigenic cyanobacteria in the Bay-Delta – *Aphanizomenon* was abundant in 2011 and 2012 in the Bay-Delta (Karobe *et al.* 2013).

Tidal wetland restoration may mitigate some of the nutrient loading into the Delta by acting as a nutrient sink through emergent vegetation production, phytoplankton production as well as fluxes to the atmosphere via denitrifcation. These ideas are not considered within the Effects Analysis. The decay of large amounts of invasive aquatic vegetation (a result of control measures) also has the potential to increase biochemical oxygen demand and inorganic and organic nutrient supply; this may shift phytoplankton community composition and promote local eutrophication. This issue is raised in a single bullet point on page 5.F-130, line 26

Terrestrial Species

Rather than using current estimates of habitat occupancy within the Plan Area to estimate occupancy of restored habitat, we recommend using spatially explicit occupancy models (see comments under question 4). In addition, the minimum width and maximum distance of riparian habitat corridors should be identified for terrestrial mammals that are restricted to riparian habitats (riparian woodrat and riparian brush rabbit). Persistence of these species in the Plan Area requires riparian habitat patches that are sufficiently large to support stable populations as well as riparian corridors that will allow movement between suitable habitat patches. Both the minimum patch size and minimum corridor parameters (width, distance, overstory cover) should be specified to ensure long-term occupancy of restored riparian habitat.

4. How well is uncertainty addressed? How could communication of uncertainty be improved?

Summary

A broad consensus exists among the Panel that Chapter 5 does not adequately address uncertainty. In its current form, at the level of detail conveyed, in the models used, and in the verbal assessments and conclusions, the level of uncertainty is downplayed. Within appendices sometimes more explicit discussion of uncertainties can be found, but a disconnect exists between the summary pages with the conclusions drawn in Chapter 5. In situations in which an array of outcomes may be possible, only the more beneficial outcomes are quantitatively assessed or used in conclusions about the BDCP. Communication of uncertainty would be improved by consideration of a range of potential outcome values in models.

The Panel cannot determine whether the conclusions about covered fish species or other species in the BDCP are accurate. Detailed monitoring is needed to evaluate the BDCP conclusions, in addition to the outcomes for the biological objectives that could not be fully evaluated at this time in the BDCP. The BDCP effects analyses are qualitative and conclusions regarding net effects on each species typically reflect professional opinion. Therefore, the Effects Analysis does not lend itself to evaluation of chained statistical uncertainties. The tremendous length of the documents did not reduce the uncertainty in the overall net effects.

Recommendations

- Unknowns and research needs should be incorporated into the BDCP as explicit conservation measures, in other words, as a required part of the BDCP.
- Monitoring needs, timing and intensity also need more explicit incorporation into the BDCP. While often well explicated in an appendix (e.g., within Appendix 5.F-Biological stressors on covered fish), they are frequently absent within the material discussed in Chapter 5 or treated as an uncertainty.
- Research needs are often mentioned as sections within appendices. These should be consolidated within Chapter 5. This would help guide future research priorities for the Delta.

Comments

Effects on Covered Fishes

For covered fishes, when evaluating the importance of an attribute to a species and evaluating the effect of the BDCP on that attribute, the Effects Analysis was typically careful to describe the level of certainty associated with this evaluation. The evaluation of certainty was typically a judgment by the BDCP authors rather than a quantitative measure of certainty (e.g., standard deviation), therefore estimates of certainty have their own level of uncertainty. The Effects Analysis did not lend itself to evaluation of "chained statistical uncertainties" as identified in the charge questions addressed to the Panel because the effects analyses were not quantitative. Nevertheless, the judgments of certainty have value, though they could be improved upon (see below).

Judgments of certainty were also compared with judgments provided by California agency scientists at the August 2013 workshops. However, identification of agency certainty seemed to be the interpretation by the BDCP authors of the agency response rather than a systematic evaluation of certainty scores. At the January 2014 Effects Analysis Panel meeting, ICF noted that they did not think it was possible to consistently document variability in Effects Analysis evaluations by agency personnel at the August 2013 workshops. As a result, evaluation of certainty of BDCP effects on attributes of each species is limited to the interpretation of the BDCP authors.

Please see discussion above on the overall net Effects Analysis for each species. Although conclusion statements typically stated high uncertainty in the overall net effects, they also tend to ignore uncertainty when highlighting the potential benefits to conservation without also stating the lower end of the effects range.

Monitoring and Research

As an example of the high uncertainty in the BDCP to achieve biological goals and objectives, many of the sections of appendices have sections on monitoring and research needs. These often highlight impacts of conservation measures in which the outcomes may have a range of positive to negative impacts. The unknowns and research needs should be better incorporated into the analyses of biological impacts of the BDCP. At a minimum they should be required as an explicit conservation measure. In a number of instances, especially in Appendices, for example Appendix 5.F, needs are highlighted for a robust monitoring and evaluation program, coupled with a detailed, prescriptive adaptive management plan. BDCP success will depend on monitoring and evaluations and responding to issues as they emerge. Furthermore, high uncertainty in the outcomes for the covered species means that budgets for monitoring and adaptive management must be developed with uncertainty in mind.

Disconnect between uncertainty and BDCP conclusions

Frequently, explicit modeling is reduced to small portions of conceptual models. When a range of potential outcomes may result from uncertainties in multiple conditions, only the most beneficial outcome is considered when coming up with a conclusion or summary. Some of these are discussed in other sections of this report. One example can be found in Appendix 5.F. When considering the impacts of some of the conservation measures, for example, Conservation Measure 13, removal of *Egeria* is discussed with multiple potential effects (Appendix 5.F, p. 5.F-48 and following), some beneficial, such as removing habitat for predators of covered fish, while others may exacerbate populations problems for covered fish, such as cascading effects through the food chain of the loss of some invertebrates that feed on *Egeria*, shifts in aquatic web linkages, and the rapid replacement of *Egeria* by other invasive submerged aquatic vegetation. Nonetheless, these uncertainties are simply ignored when it comes to conclusions, where it is determined that only the beneficial results of control invasive aquatic vegetation will result from the BDCP (pp. 5.F-48-49). To be fair, occasionally the poorer results dominate conclusions; for example, *Microcystis* may increase due to management activities inside and outside the region but these conclusions fail to emerge in the discussion of the aquatic food webs within Chapter 5.

The discussion of the aquatic food webs is based on a good conceptual model, but the dynamics of the food web are ignored and only a single component, phytoplankton productivity, is modeled as a result of restoration efforts in the relatively near- and far-term. Detrital contributions could also enhance food webs, but are not considered in any detail. Phytoplankton productivity is unrealistically modeled, and assumed to essentially be consumed along linkages that connect directly to covered fish. Chapter 5 does mention invasive bivalves, but fails to incorporate their potential as direct competitors for plankton within the food web, even though that potential is discussed. In other words, the BDCP is inconsistent in how models and analyses handle uncertainty and model assumptions, making it difficult to complete assessment.

Restoration

Because this is discussed in other sections, we will only mention that there is great uncertainty associated with the restoration of the wide range of ecosystems slated for restoration. Many of these systems have a poor record of achieving restoration, especially in short-to-moderate time periods. This range of ecosystems also varies considerably in the degree of difficulty of restoring functions. Nonetheless, the outcomes for conservation measures and their interaction and effectiveness are glossed over and uncertainties are not apparent in conclusions and summary discussions. For example, wetland restoration will require considerable input of sediment in the short-term to meet the outcomes described in the BDCP. Yet Chapter 5 models tidal wetland restoration with a constant concentration of suspended sediment, even though the document discusses the fact that sediment has been declining over the past decades, and further that the operations of the north Delta pumps may remove 8-9% more. In other words, there is considerable inconsistency between a discussion of uncertainty and how uncertainty is incorporated into the conclusions.

Similarly, restoration of many of the terrestrial habitats for other covered species also involves considerable uncertainty, especially as to the rate at which function will return that will be recognized by covered species. Consequently uncertainty of the occupancy targets for terrestrial species are not addressed. In all cases, a single value of number of acres that will be occupied is provided. No estimates of the uncertainty of achieving stated restoration goals nor uncertainty of the proportion of the restored habitat that will be occupied are included.

North Delta Diversion

In addition, the validity of the primary assumption that there will be no entrainment of fish at the north Delta diversion (NDD) should be evaluated. In reality, there will be some fish lost at the transfer point; therefore, the empirical relationship would be altered including this additional transfer point.

Water Clarity and Suspended Sediments

Section 5.3-24 (lines 31-38) correctly identifies a low level of certainty around changes in water clarity but does not include the potential positive or negative implications for changes in water clarity.

Suspended sediment is one of two key components driving the development of tidal wetlands in the Delta, especially under sea level projections, yet Delta inflow has been experiencing a decline in suspended sediment and operations of the NDD may remove 8-9% more. BDCP indicates there may not be sufficient sediment for marsh restoration (Chap. 5, p. 109).

The NDD operations should factor in suspended sediment into the operational criteria. Adaptive management should consider the possibility operating the NDD such that the first flush, which contains a large sediment load, is not exported.

5. How well does the Effects Analysis describe how conflicting model results and analyses in the technical appendices are interpreted?

Summary

The Effects Analysis covers a multitude of topics. Each panelist gave input into Question 5 based on their areas of expertise.

Hydrodynamics

Hydrodynamic models are sensitive to how the open water regions are represented and how they are connected to the adjacent channels. Because the panel was not provided the bathymetric configuration of the Restoration Opportunity Areas or the order in which the Restoration Opportunity Areas were established, it is not feasible to evaluate the sensitivity of the models to the placement of the Restoration Opportunity Areas. DSM2 (1-D) and RMA/TRIM (mult-D) hydrodynamic models represent Restoration Opportunity Areas is differently. This could be a significant source of error, especially when Delta Cross Channel gates configuration is open.

Life cycle models: winter Chinook salmon

No formal comparison of output from the OBAN and IOS models was provided, either on an absolute scale or relative scale. It should be acknowledged that adult escapement differs between models by a factor of 5. Through-Delta survival projects were also fractionally different between models. In neither case was an explanation for the discrepancy provided. The relative ranking of the different BDCP scenarios (Table 5.G-2) between models should be provided in the report, and certainly should be assessed, in part, based on the degree of consistency in predictions of the BDCP scenario ranks between models.

Salmonids: Delta Passage Model

For salmonids, the Delta Passage Model Salvage Estimates and the Salvage Density methods produced reasonably consistent estimates. Variance calculations need to be corrected. There appear to be analytical errors in expressing uncertainty.

Salmonids: Temperature Model

The text is not clear how the models predict these changes associated with the BDCP during egg incubation, if the BDCP has no effect on upstream conditions, as reported in sections of Chapter 5. In spite of these conflicting results, Figure 5.5.4-1 shows that there would be zero effect on eggs in the Sacramento River with moderate to high certainty in this conclusion. This evaluation needs clarification and should be consistent with the Appendix.

Terrestrial Species

Suitable habitat for each species in the Plan Area was based on expert opinion and therefore there are no model results to interpret. The plan adequately addresses conflicting estimates of the number of sandhill cranes that may be killed by collisions with powerlines.

Recommendations

Covered fish

- A direct comparison of the output from competing models should be presented.
- Clarify confusing and conflicting text related to salmon models.
- Explanation for the large discrepancies in predictions in adult returns (i.e., factor of 5) should be provided and possible consequences to Effects Analysis. Use of relative effects does not eliminate systematic biases of models.

Hydrodynamics

- Identify which Restoration Opportunity Areas are represented differently between the DSM2 and the RMA/TRIM models, especially in the Mokelumne system, which is sensitive to Delta Cross Channel operations.
- Publications from that CASCaDE (http://cascade.wr.usgs.gov/index.shtm) would be resources to guide the evaluation of propagation errors in the BDCP Effects Analysis.

Comments

Life-cycle models

When discussing IOS and OBAN life cycle modeling results, the Effects Analysis stated:

> "*The results of both models suggest future climate change effects would dominate changes in adult winter-run Chinook salmon escapement in the future, which is of appreciable concern for the species. Factoring in climate change, relatively small differences in upstream conditions between the BDCP LLT scenarios and EBC2_LLT resulted in greater adult escapement under HOS_LLT or lower adult escapement under ESO_LLT and LOS_LLT. These results reflect what appears to be appreciable model sensitivity to relatively small changes in estimated upstream conditions because, as noted above, <u>the BDCP does not change Shasta Reservoir and upper Sacramento River operating criteria</u>, so that changes in upstream areas derived from modeling, be they positive or negative, may not be fully reflective of the nature of actual changes that could occur*." (pg. 5.5.3-45, lines 38-46)

The above statement about climate change impacts on Chinook abundance is clear and noteworthy, but the text below it is confusing and should be clarified (did the model receive inaccurate information for upstream conditions?).

Chinook salmon

For egg incubation of spring Chinook, Chapter 5 describes conflicting results (pg. 5.5.4-14). The text states, “Several models show no change in upstream condition as a result of BDCP”. In the same paragraph, it states that SacEFT predicts a 12% reduction in egg incubation “condition” based on water temperature effects on egg survival. In contrast, the Reclamation Egg Mortality model predicts no effect due to the BDCP except in below normal water years (12% reduction in survival). SALMOD predicts negligible impacts of the BDCP on eggs, fry and smolt. The text concludes that the adverse impacts are related to high sensitivity of some models to small changes in upstream conditions. The text is not clear when describing how the models might predict these changes during egg incubation, if the BDCP has no effect on upstream conditions as reported in portions of Chapter 5. In spite of these conflicting results, Figure 5.5.4-1 shows that there would be zero effect on eggs in the Sacramento River with moderate to high certainty in this conclusion. This evaluation needs clarification.

- Habitat and flow modeling efforts in the Delta were not linked. As noted above, habitat suitability modeling indicates somewhat large habitat increases for foraging salmonids in response to restoration activities. However, these estimates of habitat did not account for reduced flows that would occur when juvenile salmonids are present in the Delta area, especially in wet years. In other words, will reduced BDCP flows affect access by juvenile salmonids to the habitat identified in Table 5.5.3-4, or do tidal fluctuations overwhelm river flows in all of these habitats?

Lack of consideration of propagation of errors or sensitivity analysis in linked models

A direct comparison of the output from competing models is rarely presented. Results from different models are rarely formally compared on either an absolute or a relative scale. When different models projections exist, the BDCP rarely attempts to explain why the discrepancies are occurring or describe the direction of the expected errors.

Uncertainty plus more uncertainty produces even more uncertainty. Uncertainty never averages or cancels uncertainty any more than noise plus additional noise produces less noise. The propagation of errors will not be a simple sum of uncertainties in most cases. One can use variance in stages formula

$$Var(\hat{\theta}) = E_2\left[Var_1(\hat{\theta}|2)\right] + Var_2\left[E_1(\hat{\theta}|2)\right]$$

to propagate errors over multiple processes or sequentially linked models and where 1 and 2 denote sources of error in estimating the parameter θ by $\hat{\theta}$. Levels of uncertainty have different credence depending on the importance of biological stressors or attributes. An assessment might have high uncertainty for all low-importance attributes and still have overall high certainty if all the important attributes carry with them high certainty. Conversely, the overall assessment would have low certainty if one or more high-importance attributes carry high uncertainty. Overall uncertainty will never be less than the highest level of uncertainty for the more important biological attribute being considered.

There are several different cases in the Effects Analysis where multiple models are linked together. Each model has inherent errors either due to assumptions made in the modeling or numerical method errors. One of the best examples of how to link models in the Delta system is the U.S. Geological Survey's CASCaDE project (http://cascade.wr.usgs.gov/index.shtm). Publications from that project would be resources to guide the evaluation of propagation errors in the BDCP Effects Analysis.

> *The assumptions made in hydrodynamic models TRIM/ RMA versus DSM2 or CALSIM2 result in a range of outcomes; their analysis is limited to only one set of ROA configurations*

During the hydrodynamics presentation on 1/28, the calibration of the DSM2 (1-D) model compared to the TRIM/RMA (multi-d) models showed that the models agreed better when the Delta Cross Channel was closed than when the Delta Cross Channel was open. When the Delta Cross Channel is open, transport is influenced more by the circulation in the Mokelumne channels on the east side of the Delta.

The fact that the two models do not match well when the Delta Cross Channel is open indicates that the representation of Restoration Opportunity Areas is different between the 1-D and 2-D models. Hydrodynamic models are sensitive to how the open water regions are represented and how they are connected to the adjacent channels.

Because the panel was not provided the bathymetric configuration of the Restoration Opportunity Areas or the order in which the Restoration Opportunity Areas were established, it is not feasible to evaluate the sensitivity of the models to the placement of the Restoration Opportunity Areas.

6. How well does the Effects Analysis link to the adaptive management plan and associated monitoring programs?

Summary

While the adaptive management plan is considerably more developed in the BDCP Phase 3, it remains characterized as a silver bullet but without clear articulation about exactly how key assumptions will be vetted or uncertainties resolved to the point that the BDCP goals and objectives are more assured. The concept of adaptive management is appropriately described and allocated a prominent role in the implementation structure. However, as is increasingly documented, the commonly acknowledged process of adaptive management continues to be misunderstood and misapplied (Allen *et al.* 2011; Fontaine 2011; Westgate *et al.* 2013), often resulting in a loss of rigor and commitment in application. The consequence hasn't improved much since Walter's (1986) description of the adaptive management process as beginning:

> "…*with the central tenet that management involves a continual learning process that cannot conveniently be separated into functions like research and ongoing regulatory activities, and probably never converges to a state of blissful equilibrium involving full knowledge and optimum productivity*."

In the case of the uncertainties surrounding the assumptions and predictions of the BDCP, the Panel emphasizes that BDCP needs to recognize the risks of **not** institutionalizing an exceedingly rigorous adaptive management process in order to avoid ecological surprises that will be difficult or impossible to reverse once they have established (Lindenmayer *et al.* 2010; Westgate *et al.* 2013). BDCP must make a commitment to the fundamental process, and specifically the required monitoring, not just the concept of adaptive management. As Murphy and Weiland (2014) counsel:

> *"…adaptive management that targets listed species represents a complex process that can be resource intensive, including in its demand for guidance from research, monitoring, and modeling, therefore requiring substantial technical and institutional capacity. That considered, adaptive management has a great potential to improve the effectiveness and efficacy of resource management actions provided it is properly implemented."*

In the final assessment of the Effects Analysis, the Panel found the cautionary conclusion of Olden *et al.* (2014) about large-scale flow experiments to be particularly germane:

> "…*managers and policy makers must embrace both the scientific uncertainty and surprise learning opportunities that inevitably arise from these experiments, and not purposely ignore uncertainty to avoid complicating their message to stakeholders, only to later invoke this issue when flow experiments fail to deliver expected ecological or social outcomes*."

Recommendations

- The Effects Analysis effectively communicates the important principles and implementation stages of adaptive management, but the specific process whereby adaptive management would be utilized to ensure BDCP meets its goals and objectives by rigorous adaptive management need to be described in much more detail. There needs to be a more obvious commitment to active adaptive management.
- There is explicit linkage between key uncertainties underlying the assumptions of the Effects Analysis and the monitoring and research that need to address them through adaptive management. However, many of the critically uncertain ecosystem processes, population responses, etc. that are identified as adaptive management targets are delegated to research, rather than monitoring. Any metric upon which decisions about the expected or predicted performance of a management measure will be made should be a foundational monitoring metric, not a focus of research, which is often vulnerable to competing priorities.
- To facilitate an active adaptive management plan that has some chance of ensuring the beneficial result of BDCP conservation measures, each and every key uncertainty should be "fleshed out" into implementable adaptive management "experiments" where the following are specifically described: (1) a conceptual model, or components of an existing model, that characterizes the uncertainty and what it influences; (2) assessment of the relationship between the uncertainty and the BDCP goals and objectives; (3) sensitivity of the proposed implementation to the uncertainty; (4) success criteria, monitoring metrics, baseline levels, thresholds and trigger points that will identify whether or when the performance of the conservation measure is deviating significantly from the anticipated target or prediction; (5) alternative hypotheses and how they affect the original conceptual model; and, adaptation of the (6) implementation action or (7) adaptation of the goals and objectives.

- Linkages between scientific development of the Effects Analysis and adaptive management should continue, if not expand, with implementation of the BDCP. At the minimum, consider the necessity to guarantee independent science review at the interface between the Adaptive Management Team and the Implementation Office, to ensure close to real time tracking of adaptive management experiments and decisions.

Comments

Perhaps the largest challenge to achieving the stated goals and objectives of the BDCP is how many of these critical uncertainties can be addressed by adaptive management given the baseline and the required monitoring? For example, some of the key uncertainties identified in the Effects Analysis (Appendix 3.D), often associated with conservation measures 4, 5, 7, and 11, include:

- The ability of the restored habitat to meet the objectives and expected outcomes, including the time it takes to meet the biological objectives. (Can this be addressed by both magnitude and siting of restoration action?)
- The risk that the restored habitat will be colonized by invasive species such as nonnative submerged vegetation, nonnative predatory fish, and/or clams. (Hardly uncertain, but controllable?)
- The change in magnitude of predation mortality on covered fish. (Doesn't this require an existing reliable estimated of predation mortality?)
- Food web responses to habitat restoration actions on both a local and a regional scale.
- The risk of adverse effects resulting from unsuitable changes in water quality and exposure to toxic contaminants. (How much can be modeled?)
- The proportion of the covered species population that actively inhabit restored habitats and the change in growth rate, survival, abundance, life-history strategies, and population dynamics. (A very difficult baseline to quantify!)

The Effects Analysis provided explicit associations of such key uncertainties with each conservation measure and linked these to "potential research actions" (BDCP, Table 3.D-3).

The context of a "phased approach to serve as a large-scale experimental program" in adaptive management context implies conceptual models, baselines and thresholds?

Linkages between scientific development of the Effects Analysis and adaptive management should continue, if not expand, with implementation of the BDCP. In particular, it will be important to ensure that there is direct science input to the adaptive management process, and preferably an independent science body that has no conflict of interest in interpreting and adapting conservation measures. In the proposed implementation structure, the Science Manager chairs the Adaptive Management Team and coordinates with the Delta Science Program, and the Delta Independent Science Board may also be consulted about *"…matters relating to these monitoring activities and research efforts*." (Chap. 7-25, pp. 7-25). However, the Delta Independent Science Board is not engaged to the extent that they could deal with extensive monitoring and research results and adaptive management decisions in real time. We would doubt that the adaptive management process would be efficient, timely and evaluated without an independent scientific advisory body that reports to the Adaptive Management Team, Science Manager, Program Manager and the Delta Science Program.

Review of Specific Analyses

7. Are the analyses related to the north Delta diversion facilities appropriate and does the Effects Analysis reasonably describe the results? In particular:

Q. Was existing empirical information such as Perry *et al.* 2010 and Newman 2003 incorporated appropriately into the modeling? Where model runs required extrapolation beyond existing data ranges, were assumptions and interpretations appropriate?

Summary

The empirical information in Perry (2010) and Newman (2003) must be guardedly and cautiously applied in the modeling in future cases when north Delta diversion is operational. These empirical relationships are based on the best available information regarding current physical and operational configuration of the Delta. We assessed the validity of four model assumptions. The panel concluded: 1) the assumption of a 3-day moving average to characterize flow on the Sacramento below Georgiana Slough is not valid in the new configuration, 2) exporting water at the north Delta diversion facilities will change circulation patterns at the important north Delta channel junctions (i.e. Steamboat, Sutter, Delta Cross Channel, Georgiana), 3) an additional transfer point out of the Sacramento at the north Delta diversion will alter the empirical relationship, and 4) there are issues with original assumptions in Newman (2003). The concerns raised above, at best, add additional uncertainty to the conclusion drawn by BDCP. At worst, these concerns may result in systematic biases in the model projections. The direction of the net effect of these biases is unknown.

Recommendations

- Consult with Russell Perry and Ken Newman on their perspectives regarding the applicability of their models to the Effects Assessment.
- Perform more hydrographic modeling below the anticipated north Delta diversion to determine whether the nature of the outflow will violate assumptions or parameterizations of the Perry (2010) model and alter model output.
- Additive simulations should be performed varying the parameterization and possible structure of the relationships with Perry (2010) and Newman (2003) to determine robustness of the model results to changes in Sacramento River outflow under the BDCP.

Comments

The empirical relationships, derived in Perry (2010) and Newman (2003), are based on the best available information regarding current physical and operational configuration of the Delta. For these relationships to be useful, they also need to describe the Delta under BDCP. To assess the validity of these relationships, we must examine how the system will change with the addition of the north Delta diversion. There are four primary sets of questions to address: 1) Will the system continue to have a “quasi-steady state” condition or the will the timescale of flow variance change? Is a 3-day moving average to characterize flow on the Sacramento below Georgiana Slough a legitimate assumption?, 2) Will the circulation patterns change at the important channel junctions (i.e., Steamboat, Sutter, Delta Cross Channel, Georgiana) as a result of north Delta diversion operations?, 3) Will the north Delta diversion be another transfer point out of the Sacramento river migration corridor?, and 4) Are the assumptions used in the original analysis valid?

Will the system continue to have a “quasi-steady state” condition or will the timescale of flow variance change as the result of north Delta diversion operations?

In the current configuration of the system, the north Delta is in a quasi-steady state. In general, flows on the Sacramento at Freeport change slowly over time (i.e., on the order of days). The only operation that can dramatically alter circulation patterns is the opening or closing of the Delta Cross Channel gates. The position of this gate is not frequently changed. And, when changed, the system reaches a different quasi-steady state condition after about a day. A visual example of this step change is found in Perry (2010, Fig. 3). Therefore, the assumption of a three-day moving average to characterize flow on the Sacramento below Georgiana Slough seems reasonable for the current configuration (flow and operations) of the North Delta.

When the north Delta diversion facilities become operational, the North Delta will no longer be in a quasi-steady state condition. The flows will behave more like what is currently observed in the South Delta as the pumping will not be continuous throughout the day. And, pump volume will also change at least daily. The timescale of flow variance will change more rapidly over time (i.e., on the order of hours). Therefore, the three-day moving average flow assumption is not valid in the new configuration with the north Delta diversion.

Will the circulation patterns change at the important channel junctions (i.e., Steamboat, Sutter, Delta Cross Channel, and Georgiana) as a result of north Delta diversion operations?

We know that opening and closing the Delta Cross Channel changes the circulation patterns in the north Delta. Exporting water at the north Delta diversion facilities will also change circulation patterns at the important channel junctions (i.e., Steamboat, Sutter, Delta Cross Channel, Georgiana). The DSM2-Hydro simulations that were used for the analysis of this issue in section 5C.5.3.5 are capable of outputting data even on a 15 minute time step. This model resolution should be able to quantify these differences. If the circulation patterns change, the proportion of fish distributed to each downstream channel will be altered as well. Therefore, the empirical relationship created for the current configuration of the Delta is not valid for the future configuration.

Will the north Delta diversion be another transfer point out of the Sacramento migration corridor?

Throughout the analysis in 5C.5.3.5, there is an assumption of zero entrainment of as a result of 100% effective diversion screens. However, the north Delta diversion will be pumping water. Therefore, empirical relationship between the flow at Sacramento below

Georgiana and the number of fish present will be different from the current empirical relationship using the current (no north Delta diversion) configuration.

In addition, the validity of the primary assumption that there will be no entrainment of fish at the north Delta diversion should be evaluated. In reality, there will be some fish lost at the transfer point, therefore, the empirical relationship would be altered including this additional transfer point.

Are the assumptions used in the original analysis valid?

Newman (2003), Table 2 presents a summary of the covariates used in his modeling. There are two columns, mean and sample standard deviation. In this table, he reports a mean value for Delta Cross Channel gates of 0.61 with a sample standard deviation of 0.49. The Delta Cross Channel gate signal is a binary signal. It should be either open (1) or closed (0). Under no circumstances should that variable be reported as something other than 0 or 1. This analysis should have been broken into two time periods: gate open and gate closed conditions. This table raises a significant concern that the author did not have a basic understanding of how the Delta Cross Channel gate changes flow patterns (and migration patterns) in the Delta.

The concerns raised above, at best, add additional uncertainty to the conclusion drawn by the Plan. At worst, these concerns may result in systematic biases in the model projections. The direction of the net effect of these biases is unknown.

Q. Does the analysis of the frequency of reverse flows at Georgiana Slough accurately characterize changes in hydrodynamics due to changes in river stage, sea level rise, and Delta habitat restoration?

Modified question based on 1/29/2014 meeting discussion: Will the operation of the north Delta diversion change the circulation patterns around the Sacramento junctions with the Delta Cross Channel and Georgiana Slough such that fish (particularly migrating fish) have a higher likelihood of being diverted into the interior of the Delta via Georgiana Slough or the Delta Cross Channel due to tidal flood/ebb flows in this region?

Summary

We know, based on long-term field observations and hydrodynamic modeling, that the transition point from uni-directional flow and bi-directional flow at the tidal timescale occurs somewhere between Sacramento River above the Delta Cross Channel (RSAC128) and Sacramento River below Georgiana (RSAC123) for the current configuration and operations of the Delta. The operation of the north Delta diversion facility will reduce the amount of freshwater flow in the region of the Delta Cross Channel and Georgiana junctions. Hydrodynamic modeling will likely show that transition point between uni-directional and bi-directional flow will move upstream as a result of north Delta diversion operations. This transition location is also a function of whether the Delta Cross Channel is open or closed. If bi-directional flow occurs more frequently near the Sacramento junctions with the Delta Cross Channel and Georgiana Slough, fish will have a higher likelihood of being diverted into the interior of the Delta via Georgiana Slough or the Delta Cross Channel.

Recommendations

The DSM2 simulations should be re-run for the ELT and LLT simulations with bathymetry that does not include the Restoration Opportunity Areas but driven with ELT or LLT river flow and tidal stage boundary conditions and operations. These simulations would clearly show how north Delta diversion operations change circulation patterns near Georgiana Slough and the Delta Cross Channel.

Comments

During the Effects Analysis Panel presentation on 1/29/2014, one of the Panel members (N. Monsen) asked for clarification of Question 7b. Based on that discussion, we concluded that the main questions that the Fish Agencies would like to see the panel address were:

> *"Will the operation of the north Delta diversion change the circulation patterns around the Sacramento junctions with the Delta Cross Channel and Georgiana Slough such that fish (particularly migrating fish) have a higher likelihood of being diverted into the interior of the Delta via Georgiana Slough or the Delta Cross channel due to tidal flood/ebb flows in this region?*
>
> *Will this change in flow regime as a result of north Delta diversion operations result in fish encountering this junction multiple times rather than just once, thus increasing the probability of the fish being diverted into the interior Delta?"*

It should be noted that these rephrased questions are very different than what the analysis in Sections 5C.4.3.2.6 and Section 5C.5.3.8.1 of the Effects Analysis addressed. The following suggest an approach to answer the modified question and comment on the analysis in Sections 5C.4.3.2.6 and Section 5C.5.3.8.1.

Part A: Suggested approach to address the modified 7b question

For this discussion, please refer to the Draft Environmental Impact Report/Environmental Impact Statement Appendix 5A that has examples of observed tidal stage and flow time series data from three key locations along the Sacramento River (Appendix C of this document).

The Sacramento River throughout the Delta has a tidal signal for both stage and flow. The Sacramento observation station at Freeport (RSAC155), above the proposed north Delta diversion intakes, has a tidal flow signal (Appendix 5A-D1, p. 128). At Freeport, both the tidal and tidally-averaged flow is always uni-directional downstream. Therefore, a neutrally-buoyant particle going with the flow at this location will always be traveling downstream, although the velocity at which it moves is dependent on the phase of the tides.

In the current bathymetric configuration and operations of the Delta Cross Channel (no north Delta diversion facilities), the observation station on the Sacramento above the Delta Cross Channel (RSAC128, Appendix 5A-D1, p. 129) also has downstream uni-directional flow both for the tidal and the tidally-averaged timescale. However, the flow signal on the Sacramento below Georgiana Slough (RSAC123, Appendix 5A-D1, p. 130) has reversing tidal flows. Therefore, even though the tidally-averaged flow at RSAC123 is downstream. A particle moving with the velocity field in the region of RSAC123 will flow both upstream and downstream. Therefore, the tidal excursion or range that a neutrally-buoyant particle will move upstream and downstream, at

RSAC123 is important to determine how many times the particle will encounter junctions (such as Georgiana and Delta Cross Channel).

The Sacramento River above the Delta Cross Channel (RSAC128) and the Sacramento River below Georgiana (RSAC123) are only 5 river km apart and yet the flow signals at these stations are very different. These flow signals are distinctly different because there are two junctions, the Delta Cross Channel and Georgiana Slough, between these measurement stations where a portion of the water is diverted towards the Central Delta. The flow signal at RSAC123 also changes depending on whether the Delta Cross Channel is open or closed.

Therefore, we know, based on long-term field observations and hydrodynamic modeling, that the transition point between uni-directional flow and bi-directional flow at the tidal timescale occurs somewhere between RSAC123 and RSAC128 for the current configuration and operations of the Delta.

To determine how the north Delta diversion operations will change circulation patterns around the Delta Cross Channel and Georgiana Slough, the DSM2 model can be used to determine the location along the Sacramento where the flow transitions from unidirectional and bi-directional tidal flows. This transition location will also be a function of whether the Delta Cross Channel is open or closed. It is also useful to determine the extent of tidal excursion to determine whether particles would encounter either the Delta Cross Channel junction or the Georgiana Slough junction multiple times.

The operation of the north Delta diversion facility will reduce the amount of freshwater flow in the region of the Delta Cross Channel and Georgiana junctions. Modeling will likely show that transition point between unidirectional and bi-directional flow will be moved upstream. This transition point may be even as far upstream as RSAC128 (Sacramento above DCC).

Part B: Comments related to the analysis in Sections 5C.4.3.2.6 and 5C.5.3.8.1

The approach taken for the analysis in Sections 5C.4.3.2.6 and 5C.5.3.8.1 focused only on the exchange between the Sacramento River with Georgiana Slough. The approach of analyzing flow direction every 15 minutes was a reasonable approach given the original 7b question. However, the analysis did not attempt to also look at the exchange through the Delta Cross Channel, which should be done for the modified 7b question.

The bigger issue with this particular analysis is the assumed Delta bathymetry used for the ELT and the LLT simulations. For both the ELT and LLT simulations, Restoration Opportunity Areas are included in the bathymetry. The tidal field is significantly changed by the inclusion of these Restoration Opportunity Areas. Note that these Restoration Opportunity Areas are only one possible configuration. As of this BDCP draft, the final locations of the Restoration Opportunity Areas, the order of construction the Restoration Opportunity Areas, and the bathymetric connections between the Restoration Opportunity Areas and the adjacent channels have not been established.

In the BDCP conclusion for this analysis states:

> *"Ongoing research is investigating link is between the distribution of energy dissipation and the distribution of tidal prism within the context of Plan Area restoration and other factors (DeGeorge pers. comm.). … it is unknown whether the presently limiting conveyance capacity of a number of Delta channels for tidal*

> *flows may become enlarged by scouring in response to Plan Area changes in geometry resulting from habitat restoration. These factors may have consequences for the hydrodynamics at the Sacramento River-Georgiana Slough divergence and other locations."* (5C.53-331, lines 22-29)

This conclusion indicates that the present hydrodynamic modeling does not separate the effects of the north Delta diversion from the preliminary Restoration Opportunity Areas configuration in the ELT and LLT simulations.

One of the best reasons to use hydrodynamic modeling as an analysis tool is that models have the capability of isolating individual effects. The DSM2 simulations should be re-run for the ELT and LLT simulations with bathymetry that does not include the Restoration Opportunity Areas but does have the ELT or LLT river flow and tidal stage boundary conditions and operations. These simulations would clearly show how north Delta diversion operations change circulation patterns near Georgiana Slough and the Delta Cross Channel.

8. How should the effects of changes in Feather River flows on fish spawning and rearing be characterized? In particular, how should the trade-off between higher spring flows and lower summer flows be interpreted? Does the analysis adequately capture the expected benefits of CM 2, Yolo Bypass Fishery Enhancement?

Summary

Chapter 5 correctly recognized that flow/habitat relationships are necessary for evaluating changes in Feather River flow and temperature on salmonids. However, relationships between flow and habitat were not presented in Chapter 5, therefore it was not possible for the Panel to evaluate changes in spawning and rearing habitat. Most salmonids reportedly inhabit the low flow channel which will reportedly experience little change. BDCP effects relate primarily to the fraction of salmonid populations inhabiting the high flow channel plus fish exposure to the high flow reach during upstream and downstream migrations.

Chapter 5 provides a reasonable discussion of the approximate benefits of increasing flow into Yolo Bypass and allowing more juvenile salmon, especially foragers, to utilize this rearing habitat. Potential adverse effects on migrating adults should be monitored.

Recommendations

- Develop flow/habitat relationships for salmonids in the Feather River high flow channel, approximate the proportion of the population that uses this habitat, and correct inconsistencies in the text and summary figure.
- The Yolo Bypass evaluation should recognize that natural origin Chinook salmon have a higher fraction of foraging type juveniles compared with migrant Chinook produced in hatcheries. Natural origin juveniles would likely benefit more than hatchery fish.

Comments

Feather River

Salmon and Steelhead. Chapter 5 provided a summary of beneficial and adverse effects of Feather River flows on juvenile and spawning spring Chinook salmon. The analysis was based on expected changes in monthly flows in the low and high flow channels and associated changes in water temperature. The text recognizes that salmon habitat area and quality are important (see introductory paragraph), but the evaluation did not attempt to convert predicted flow and temperature scenarios to habitat units for steelhead and Chinook salmon. Lack of habitat data for each species reduces the certainty of the anticipated effects, except when flows and temperature are expected to experience little change, as in the low flow channel. Key to this analysis is the reportedly high use by salmonids of the low flow channel relative to the high flow channel, given that the low flow channel is expected to experience relatively little change.

The text states that juvenile spring Chinook salmon may be present in the Feather River from November through June. Chapter 5 also concludes that juvenile migration would not be affected by BDCP flows, which are higher in spring and lower in summer in the high flow channel during BDCP operations. Why is juvenile migration not affected by higher spring flows and lower summer flows? To what extent is rearing habitat in the high flow channel affected by higher flows and to what extent are juveniles using this habitat? There is no mention of the actual temperature experienced by the fish in the Feather River.

It is not clear how the low positive effect with moderate certainty (Figure 5.5.4-1) was derived, given that there was no presentation on flow/habitat relationships, which were discussed as being key to the analysis. Chapter 5 states that real-time operations could be used to minimize adverse effects in the Feather River, but there is no mention of whether this will be done and what the criteria might be to protect salmon. The Chapter 5 description of Feather River effects on salmonids did not incorporate information related to exceedance of minimum flows that was discussed in Appendix 5C.5.2.

For steelhead, the analysis and text involving Feather River flows are somewhat more conclusive. A key statement is that the vast majority of steelhead reportedly spawn and rear in the low flow channel which would receive little effect from the BDCP (what percentage of steelhead rear in the high flow channel?). Adult and juvenile steelhead may experience somewhat higher flows during migration, but there is no judgment of whether this is beneficial or not. The text also states that summer flows in the high flow channel would be reduced by 50%, a period that includes year-round rearing of steelhead. The Panel notes that steelhead prefer higher velocities than other salmonids, but changes in the amount of habitat in relation to velocity was not presented. The text concludes with moderate certainty that there would be a <u>low negative effect</u> in the Feather River (the text should clearly identify that it is the rearing stage in the high flow channel that is affected). However, Figure 5.5.6-1 shows zero effect on rearing steelhead and <u>low positive</u> effect on migration. The results in this figure are not consistent with the text.

Yolo Bypass

Chapter 5 provides a reasonable discussion of the approximate benefits of increasing flow into Yolo Bypass and allowing more juvenile salmon, especially foragers, to utilize this rearing habitat. Reported data indicate only ~12% of the juvenile population would utilize the habitat. For spring Chinook salmon, the analysis assumed 80% of the juveniles were migrant rather than foraging Chinook. These values apparently included hatchery spring Chinook salmon which are mostly migrants and less likely to utilize rearing habitat and benefit from Yolo Bypass compared with wild Chinook salmon that are more likely to be foragers that benefit from the Yolo Bypass. Yolo Bypass is more likely to benefit wild Chinook (to the extent that they are "foragers") than hatchery Chinook salmon, and it would be worth discussing this in Chapter 5.

Potential adverse effects of Yolo Bypass on juveniles, such as stranding, were described. Potentially adverse temperature effects or predation affects (if predators are attracted to the Bypass) were not described, but BDCP authors stated at the January meeting that temperature and predator attraction are not likely to pose a problem within Yolo Bypass. Adult salmonids could be adversely affected in Yolo Bypass, as discussed in Chapter 5; these fish should be monitored to ensure safe migration.

9. Does the analysis adequately describe the predation and other screen-related effects of the proposed north Delta diversion structures? Is the application of the observed mortality rate at the fish screen of the Glenn-Colusa Irrigation District (GCID) an appropriate assumption for expected mortality at the proposed BDCP north Delta intakes? Are there other studies on salmonid survival at positive barrier fish screens that would be appropriate to apply?

Summary

Chapter 5 concluded that there is a low negative impact related to contact and impingement of salmonids with the north Delta diversion screens, but the technical appendix states that this effect could not be evaluated. Regarding predation, the Panel believes that there is uncertainty about the extent to which juvenile salmon and predators will aggregate near the intakes, and this is an issue that must be monitored. Positive barrier fish screens are widely used throughout the Pacific Northwest to protect juvenile salmonids from entrainment into water diversions, and this information should be readily available to the BDCP team.

Recommendations

- Correct inconsistency in conclusions in Chapter 5 and the Appendix regarding impingement.
- Monitor predator aggregation and predation rates at north Delta intakes.
- Conduct literature search on positive barrier fish screens, which are widely used.

Comments

Screen contact and impingement

The Effects Analysis stated in regard to fish contact and impingements at the north Delta intakes:

"It is concluded with moderate certainty that there will be a low negative change to the north Delta intakes attribute to foraging and migrating juvenile salmonids as a result of contact and impingement at the north Delta diversions".

A reasonable summary of information leading to this conclusion was presented, although more information on relative abundances of foraging Chinook (smaller & more susceptible fish) versus migrant Chinook could have been presented. It was stated that monitoring would occur during operation as a means to ensure low adverse effects. This monitoring is important because debris build-up might alter contact and impingement rates. However, Appendix 5.B: Entrainment stated:

"Because of the lack of an established relationship between passage time, screen contact rate and injury or mortality, it is not possible to conclude with certainty what the effects of the north Delta intakes may be on juvenile Chinook salmon or indeed on juvenile steelhead…".

Therefore, information presented in Chapter 5 on injuries related to the north delta intakes was inconsistent with information presented in the supporting Appendix. This inconsistency needs to be corrected.

Predation at north delta intakes. The Effects Analysis presents some findings that indicate mortality of salmonids associated with predation is uncertain at the north delta intakes and that monitoring and adaptive management would address this issue. The use of monitoring and adaptive management to address the predation issue is important, and implementation of these activities is key to minimizing predation risk. The Panel believes that there is uncertainty about the extent to which juvenile salmon and predators will aggregate near the intakes.

One of the predation analyses relied upon information collected in relation to salmon losses at the Glenn Colusa diversion and screen. Application of the Glenn Colusa analysis to the north delta intake suggested a cumulative loss of 12% of the juvenile winter-run Chinook salmon at the north Delta intake, a value that is high for a relatively short reach of river. Relatively few details about the Glenn Colusa predation study were presented in Chapter 5 or in the supporting appendix (5F: Biological stressors), therefore the Review Panel cannot directly address the question above on this issue. Nevertheless, the Glenn Colusa study seems to indicate that predators may aggregate near fish screens and consume many salmonids. The study at Glenn Colusa highlights the need to monitor fish predation at the north Delta intakes.

Positive barrier fish screens are widely used throughout the Pacific Northwest to protect juvenile salmonids from entrainment into water diversions, and fish screening criteria are widely applied. The BDCP team could access relevant documents on the web. However, regarding predation at the north intake, salmon and predator behavior in response to flow and habitat conditions along the screen intakes will likely be the key determinants of salmon mortality at the intakes. This information must be gathered during project implementation.

10. Does the Effects Analysis provide a complete and reasonable interpretation of the results of physical models as they relate to upstream spawning and rearing habitat conditions, particularly upstream water temperatures and flows resulting from proposed BDCP operations?

Summary

A valid approach was used to calculate daily flow and daily temperatures in the upstream locations. However, the presentation of the temperature results and the synthesis of the results should be improved to aid understanding. The Fish Agencies should also refine the types of analysis they need to best show the temperature impact on fish as the result of BDCP actions. Currently, the temperature analysis includes: 1) a comparison of *mean monthly* temperatures categorized by water year type, 2) exceedances of water temperature thresholds for the different fish species calculated for each month and categorized by water year type, and 3) the number of years where the exceedance occurred categorized by the level of concern (Table 5C.4-4, pgs. 5C4-19, example Table 5C.5.2-42, pgs. 5C5.2-79).

Recommendations

- Question 10 is one of the topics in the Effects Analysis where the data is presented in individual species and life stage sections. It is very hard to synthesize the results in this format.
- To help the reader understand what locations, which species, what life stages are most likely to be impacted by temperature as a result of upstream reservoir operations in response to north Delta diversion requirements, a synthesis section in the main Effect Analysis Chapter 5 should be included. This synthesis should address the summary of the problem presented in Section 5C.4 (5C.4-16 lines 26-32).
- Most charts in this section are hard to visually synthesize the temperature data. Color coding the charts would help guide the reader. Table 5C.5.2-197 (pg. 5C.5.2-364) is a good example of how to improve chart readability.
- Table 5C.5.2-32 (p. 5.C.5.2-79) show compares the level of exceedance for the different scenarios. This table is not effective at communicating that the level of exceedance is shifting between different categories. For example, less “orange” classifications may mean that there are more “red” classifications. It would be helpful to re-visit how this information is presented.
- Another potential key statistic that could be extracted from the model data is the number of *consecutive* days in which water temperature is greater than the threshold level.

Comments

Approach to calculating upstream flows and water temperatures:

The CALSIM II watershed model was used to specify the monthly flows in each of the upstream rivers. These monthly results were then “downscaled” to daily values based on the historical records at three historical locations in the watershed. These flows are used as inputs into the Sacramento River Water Quality Model (SRWQM) or the Reclamation Temperature model, depending on the location. This downscaling approach seems to be reasonable approach to estimate flows. The temperature models used are specific to this region and have been used in other applications.

The temperature analysis included: 1) a comparison of *mean* monthly temperatures categorized by water year type; 2) exceedances of water temperature thresholds for the different fish species calculated for each month and categorized by water year type; and, 3) the number of years where the exceedance occurred categorized by the level of concern (Table 5C.4-4, pgs. 5C4-19, example Table 5C.5.2-42, pgs. 5C5.2-79).

Analysis and synthesis of the Temperature modeling:

Question 10 is one of the topics in the Effects Analysis where the way the data is presented makes it very hard to synthesize the results. The topic of temperature was evaluated in the Upstream Habitat Results Section 5C.5.2 (548 pages long) for each species and life stage. In many cases the description of the results were very repetitive and did not explain how the results differed from other species.

To help the reader understand what locations, which species, what life stages are most likely to be impacted by temperature as a result of upstream reservoir operations in response to north Delta diversion requirements, a synthesis section in the main Effect Analysis Chapter 5 should be included. The current summary of upstream temperature (Table 5.3-5, p. 5.3-21) is too general to be useful. It is not a sufficient synthesis of the information contained in Section 5C.5.2. This synthesis should address the summary of the problem presented in Section 5C.4 (5C.4-16 lines 26-32).

11. Does the Effects Analysis use a reasonable method for “normalizing” results from the salvage-density method to the population level for salmonid species?

Summary

The normalization approach seems to simply adjust entrainment values based on relative population size over the years of observation so that entrainment values <u>relative to water export</u> may be more comparable from year to year. The normalization should be used for qualitative purposes but not for modeling purposes, because it will mask some of the variation and uncertainty. This standardization has utility for the purpose of calculating entrainment per volume of exported water, but it provides only a partial view of the pumping effect on fish populations. The percent of the populations entrained is more important. This value has more relevance to Effects Analysis on the population. It also appears the variance calculations for salvage abundance and entrainment index are being calculated incorrectly.

Recommendations

- Calculation of salvage density and entrainment need to be revisited and the variance calculations corrected. Current variance calculations for salvage density are underestimating actual variance and uncertainty.

Comments

The salvage-density method was developed to provide an index to entrainment that reflects the volume of export, taking into account fish species abundance. The method assumes a linear relationship between entrainment and export flows. There is some evidence this assumption of linearity may not be correct over the total range of conditions (Kimmerer 2008).

An estimate of total salvage abundance (S_i) for year i is estimated by the product

$$\hat{S}_i = \widehat{D}_i \cdot V_i$$

where

$\widehat{D}_i$ = estimate of fish salvages per volume of water export,

V_i = volume of water export.

The estimate of salvage loss is then "normalized" for an average population size of the fish according to the formula

$$\tilde{S}_i = \left(\frac{S_i}{N_i}\right)\overline{N}$$

where

N_i = fish abundance for the ith year,

$\overline{N}$ = average fish abundance over the years of inference.

Ideally, the fish abundance values should be based on the same population as the fish being salvaged. For example, winter-run Chinook where normalization is based on juvenile production estimates. In the case of fall and late fall-run and spring-run Chinook salmon, the normalization is based on adult run size and in the case of longfin smelt, a trawl index. For each of these latter cases, there is the additional assumption that juvenile abundance is proportional to either adult abundance or the trawl index, i.e.,

$$N_i = cA_i \;\; V_i$$

or

$$N_i = cT_i \;\; V_i$$

where

A_i = adult abundance in year i,

T_i = trawl index in year i, and

V_i = water volume in year i.

The normalized values, $\tilde{S}_i$, can be used in indices of annual salvage numbers but should not be used in subsequent simulations or the calculations of interval estimates. The normalization process has dampened the variability among annual values such that any subsequent variance calculations will underestimate the actual magnitude of the uncertainty (i.e., confidence interval [CI] width).

The entrainment index (E_i) is calculated

$$E_i = \frac{\hat{S}_i}{V_i}$$

per Section 5.B.5.4.3. It is unclear whether the actual salvage abundance $\left(\hat{S}_i\right)$ estimate or the normalized value $\left(\tilde{S}_i\right)$ is used in these calculations.

The variance calculations for the entrainment index (Section 5.B.5.4.3, lines 8–17) appear to be wrong. Based on the description, the average index value is calculated by taking the entrainment density for all relevant water years $(D_i, i = 1, \cdots, n)$ multiplying these values by alternative water volumes from CALSIM $\left(V_j, j = 1, \cdots, m\right)$, then averaging over all nm. The variance is based on the empirical variance using the nm values, i.e.,

$$\widehat{\text{Var}}\left(\hat{\hat{S}}\right) = \frac{s_{S_{ij}}^2}{nm},$$

per the plan, and where the S_{ij} are all possible values over n and m, then

$$E\left(\frac{s_{S_{ij}}^2}{nm}\right) = \frac{\bar{V}^2\sigma_D^2}{nm} + \frac{\bar{D}^2\sigma_V^2}{nm} + \frac{\sigma_V^2\sigma_D^2}{nm}.$$

However, based on the stratified nature of the calculations, the correct variance has the form

$$\text{Var}\left(\hat{\hat{S}}\right) = \frac{\bar{V}^2\sigma_D^2}{n} + \frac{\bar{D}^2\sigma_V^2}{nm} + \frac{\sigma_V^2\sigma_D^2}{nm}$$

where

$\bar{V}$ = average water volume,

σ_V^2 = variance in water volume values,

$\bar{D}$ = average density,

σ_D^2 = variance in density values.

The report variance is too small.

The variance of the total salvage estimate also appears to be wrong (pages 5.B-65 and 66). The calculation of total salvage (S) was based on the description to be:

$$S = \widehat{\text{density}} \cdot \text{Volume}$$

where the estimator of density was based on a linear regression of log salvage density vs. day of inundations. The report then states that the confidence intervals were then computed using the 95% confidence levels of the estimates of the regression." This calculation, as described, is wrong. The calculations should be based on the variance estimate for the back-transformed estimate of density from the regression, i.e.,

$$\text{Var}\left(\hat{S}\right) = \text{Var}\left(\widehat{\text{density}} \cdot \text{Volume}\right)$$

$$= \text{Volume}^2\ \text{Var}\left(e^{\hat{y}}\right)$$

$$\doteq \text{Volume}^2\ \text{Var}\ (\hat{y})\left(e^{\hat{y}}\right)^2$$

where $y = \ln\text{(density)} = \alpha + \beta x$.

See Appendix D for appropriate variance calculations for the salvage model.

12. Are the assumptions of the analysis of aquatic habitat restoration food web effects appropriate for covered fish species? Are the conclusions and net effects appropriate?

Summary

The BDCP develops a robust conceptual model of aquatic food webs and the diverse linkages that may impact the net production of food for Covered Fish. Yet the BDCP contains a number of assumptions, some of which are inappropriate, others of which contain considerable uncertainty. Uncertainties are mentioned, but no effort was made to include whether conservation efforts reach only a portion of the goals of biological objectives. Thus the analysis of effects further assumes only the most beneficial potential results in any calculations, but doesn't incorporate other possibilities. Other processes of food webs in aquatic habitats are described but remain unanalyzed, some of which may enhance, while others of which would inhibit their biological objectives. While the overall conceptual model is adequate, integration and synthesis is lacking. Consequently the conclusions and net effects are not appropriate given the gaps in analyses and the uncertainties.

Recommendations

- Model the potential flow of energy through the pelagic food web – baseline information
- Assume a variety of primary production flows to covered species due to competitors or environmental issues – to what extent might their optimistic scenarios vary from equally potential realities
- Assume shifts in composition of plankton from favorable to unfavorable species (with respect to covered species) – even with potentially higher productivity by plankton, what happens if energy flows into other pathways other than nearly immediately into the covered species
- Incorporate a detrital energy flow – this might shift energy flow back toward covered species
- The direction of restoration in these systems that would support phytoplankton is not simple and linear, adaptive management would need to be an aggressive component of the BDCP with authority to take immediate actions, regardless of what those might be

Comments

The conceptual model of the food web appears to contain all the significant compartments required for an adequate assessment of the impact of the BDCP. The BDCP contains a number of conservation efforts that have the potential to provide considerable enhancement of the populations of covered fish. These include increasing habitat, providing a diversity of habitat conditions that may enhance different life history stages, as well as allowing for potential increases in food web services for covered species. However, other than estimates made for phytoplankton production, no other assessments are made. First we review some of the assumptions inherent in the BDCP consideration of food webs.

An overarching assumption is that Conservation Measures have rapid and positive impacts. With respect to food webs, wetland and aquatic systems restoration are assumed to be effectively restored and functional immediately or in a short time frame and meet the biological objectives of the BDCP. This result is based on a number of additional assumptions, all of which contain considerable uncertainty. Similarly, while potentially negative impacts on the success of restoration are considered in passing, e.g., invasive bivalves, none of their potential effects are incorporated into their analyses or conclusions. The simplest effects perspective of the BDCP is that it edits out all potential outcomes except for the most favorable one.

Restoration of natural ecosystems, however, is difficult and fraught with great uncertainties and some systems that are assumed to have a positive influence on covered species are particularly difficult. The contingency of ecological communities means they will not automatically assemble in some predictable manner (Parker 1997). Chapter 5 contains even less information this time concerning details about timing and sequencing required to evaluate potential impacts. Understanding the sequences is also critical because they have major influences (Drake 1990, 1991; Hobbs and Cramer 2008). For example, the BDCP implies a consistent increase in restoration acreage through time, but without strong management intervention prior to opening of new wetland or shallow aquatic habitat, submerged aquatic invasive species such as bivalves, *Egeria*, or other newly detected species may expand rapidly into the new tidal habitat. The result would be a much larger management problem without the food web benefits proposed by the BDCP.

The assumption of rapid positive food web benefits from restoration of aquatic habitat is a potential benefit, but the degree of benefit, its timing, and even whether benefits will accrue is uncertain. Restoration even may be on a pathway to achieving desired biological objectives, but the time frame may be considerable and beyond the 50-year period of the BDCP. Similarly, changing the order of different conservation measures may push ecological systems onto different trajectories. Usually these cannot be predicted, and requires an integrated monitoring and adaptive management with considerable authority and manpower. Restoration rarely achieves immediate conservation or biodiversity goals (Hobbs and Cramer 2008, Hobbs *et al.* 2011). While tidal water as a process can be achieved by opening dikes, restoration of biological function is actually quite difficult with respect to ecosystem processes beyond tidal flux and especially with respect to ecological equivalency to comparable natural wetlands (Kentula 1996; Simenstad and Thom 1996; Zedler and Callaway 1999; Lockwood and Pimm 1999). More recent studies substantiate these evaluations (Burgin 2008; BenDoer *et al.* 2009; Moilanen *et al.* 2009).

The BDCP further ignores critical data that should have been incorporated into trajectories concerning the restoration of wetland and associated aquatic habitat. This is a crucial piece because the restoration that is planned is critical key to increasing suitable habitat and food web productivity. The issue is sediment supply for these restorations. The BDCP assumes a constant sediment concentration for the time period of the plan (Appendix 5.E, pp. 43-44: turbidity held constant in models and interpretations), yet they indicate that sediment concentration has been declining over the past 50 years (p. 109) and that the BDCP conservation measures will further reduce the sediment supply by an additional 8-9%. While in their discussion of sediment supply, they also conclude that declining sediment concentration and the impact of CM1 will mean much lower sediment supply, these issues have no impact on the BDCP analysis and inference. Yet the loss of sediment supply creates great uncertainties in the rate and potential for restoration of these habitats, while only the most optimal circumstances are modeled or estimated.

Similarly, the BDCP uses a simple depth-productivity model to quantify how habitat restoration may impact primary production (Figure 5.E.4-85, Relationship between Phytoplankton Growth Rate and Depth, in Appendix 5.E, Habitat Restoration). This assumes the relationship between phytoplankton growth rate and depth developed by

Lopez *et al.* (2006) is accurate. The analysis focused solely on the relationship between phytoplankton and depth, while recognizing that other factors may influence phytoplankton production in particular locations (p. 121).

Ironically, the literature they rely on, Lopez *et al.* (2006) and Lucas and Johnson (2012), indicate that biomass and production of phytoplankton in the Delta do not fit this simple model expectations. A major limitation of the depth-productivity model is the impact bivalve grazing on available net production. Net phytoplankton production (in excess of potential grazing) peaked at different depths and at much lower rates depending on overall habitat depth and water residence time. Assumptions of phytoplankton production and their conversion to zooplankton and invertebrates as food sources for covered species in aquatic systems consequently lack realism.

A third assumption involves the production of food for covered fish. Food produced in the restoration areas is assumed to directly benefit covered fish and indirectly by export. The restoration of these areas are predicted to create better habitat and food for juvenile Chinook salmon, splittail, sturgeon, delta smelt, and longfin smelt. Two issues arise from this assumption, one is their analysis of phytoplankton production and the second is that the analysis never includes potential competitors.

In contrast to their assumption, they cite literature that models the impact of introduced clams and their rate of filtering of phytoplankton and other aquatic organisms. These models suggest 1) that the depth-productivity model they used is completely inaccurate in the context of invasive clams and 2) remind us that while the potential impact of clams are mentioned as an uncertainty, only the most optimal scenario without clams is used for conclusions about the short and long-term benefits of the BDCP.

Beyond the analysis of assumptions, the other compartments of the food web are not incorporated into their analyses. For example, the potential for detritus as a major source of food web production was reviewed at some point and mentioned during the discussion of food webs. However, no incorporation or estimation of potential detritus production was made, nor was the detrital web discussed any further. Ironically, this could be a significant and positive impact on covered species.

Similarly, the role of SAV and emergent vegetation were not assessed although they were mentioned. The issue of competitors was not assessed. No incorporation was made of anthropogenic nitrogen influences on phytoplankton community composition (for example increasing the proportion of *Microcystis*). While the BDCP generally has a review of most of these compartments that they illustrate in the conceptual model, no quantitative models, nor estimates derived from the literature review were developed to allow a variety of scenarios that might indicate the potential robustness of the impacts of the conservation measures. Thus, some quantitative detail on one or a few compartments, complete with large tables showing all the numbers produced, lacks significant meaning when other compartments are merely discussed. The overall impression is that these compartments live in conceptual isolation, lacking the integration of multiple and linked processes/interactions together into a synthesis. Consequently the BDCP analyses are ambiguous and conclusions and estimates of net effects overestimate the net positive impacts of conservation measures.

13. Is the analysis of food web benefits to longfin smelt from habitat restoration appropriate? How well do the analyses link intended food web improvements to improvement in the longfin smelt spring Delta outflow/recruitment relationship?

Summary

While the Effects Analysis develops an appropriate logic train suggesting that restoration actions (e.g., CM4) would result in the production and export of increased longfin smelt "food", this objective is constrained by considerable uncertainty (acknowledged as only "Partial" assessment) because the data is lacking to quantitatively estimate the relationship between longfin smelt production and what might be exported from tidal wetland restoration and converted to food web linkages to the smelt. Although there are good, synthetic conceptual models developed for the Bay-Delta longfin smelt population encapsulated in the Effects Analysis (e.g., Baxter *et al.* 2010; Rosenfield 2010), this uncertainty is further constrained by the lack of a life-history model that would elucidate the role of prey composition and abundance in population dynamics. Delta smelt are principally planktivorous, feeding on copepods, cladocerans and mysids in the Bay-Delta (Moyle 2002; Feyrer *et al.* 2003; Hobbs *et al.* 2006). A potentially significant change in the viability of food web support of longfin smelt by the shift from the native *Eurytemora affinis* to non-indigenous species such as *Pseudodiaptomus forbesi* and *Sinocalanus doerri* is implicated in declining availability of natural prey for longfin smelt. However, these changes were also confounded by flow diversions and restriction of the mixing zone and potential increased entrainment into water diversions and the increased predation of the overbite clam *Potomocorbula amurensis* on mysids and other zooplankton prey after its introduction in 1986 (Alpine and Cloern 1992; Kimmerer 2002).

Recommendations

- Strengthen the documented data and other evidence supporting the presumption that export of detrital matter would specifically contribute to food web linkages supporting longfin smelt.

Comments

While there is viable evidence that poor survival and growth are a major cause of longfin smelt decline (Bennett and Moyle 1996; Sommer *et al.* 2007), the mechanism and magnitude of increased production of desired longfin smelt prey contributed by restoring tidal natural communities and other proposed BDCP restoration actions is still highly uncertain (see response, above, to Question 12). As discussed elsewhere, the contribution of restoring shallow water tidal wetlands to net phytoplankton production and increased plankton abundance available to longfin smelt is basically hypothetical because of the uncertainties of primary consumption within the restoring ecosystems, especially by non-indigenous clams, and whether these systems would be sources or sinks for any increased production. The Effects Analysis does acknowledge that tidal wetland restoration is also likely to export detrital organic matter, as well as macroinvertebrates, but the potential contribution of these food web sources to longfin smelt production is equally uncertain without more explicit and quantitative linkages to the longfin smelt prey potentially involved, such as mysids.

From that standpoint of linking food web benefits to the longfin smelt spring Delta outflow/recruitment relationship, the Effect Analysis does provide a reasonable rationale for smelt post-larvae and juveniles to benefit from exported production from the Suisun Marsh ROA, albeit with the same uncertainty associated with the utility of that exported production. Current understanding of juvenile longfin smelt occupancy of the Suisun Bay and West Delta subregions during March through June, before moving further into San Francisco Bay proper, suggests that linking the outflow/recruitment relationship to the management of spring (March-May) Delta outflow (Chap. 2, Section 2.4.1.4.4 Decision Trees) could be a management strategy.

14. How well does the analysis address population-level effects of the BDCP on white sturgeon?

Summary

The analysis does an excellent job of summarizing what is currently known about the life history and ecology of white sturgeon (southern distinct population segment) using the most recent analyses and peer-reviewed publications. In addition, the conclusions regarding the level of certainty about the effects of the different conservation measures on white sturgeon, based the expert panel convened in August 2013, are thoroughly discussed in the text and well summarized in Figure 5.5.8-2.

Estimating the effects of the BDCP on white sturgeon population levels is very difficult because of: 1) the lack of a thorough understanding of the effects of flow regimes on downstream migration and year class recruitment; 2) considerable uncertainty about white sturgeon sensitivity to water quality and whether current water quality conditions constitute negative impacts; (3) a poor understanding of the role of intertidal and subtidal habitat on food availability for migrating juveniles; and 4) little information about factors influencing growth and survival of adults in San Francisco Bay and the ocean. Given these limitations, the Effects Analysis does an adequate job of using existing information to predict the effect of the various conservation measures on white sturgeon.

Recommendations

- Implement measures to improve estimates (reduce uncertainty) of adult survival and population size of white sturgeon in the Delta.
- Undertake research studies to identify the reason(s) for the observed association between high flows and high recruitment.
- Initiate studies to understand the links (or lack thereof) between water quality and intertidal and subtidal habitat on growth and survival of 1) migrating juveniles and 2) adults.

Comments

The life history of white sturgeon, high adult survival and fecundity in combination with episodic recruitment in high water years, suggests that the multiple approach to conservation measures should promote increased adult survival and ensuring high recruitment when conditions are favorable. We agree with the conclusions of the Effects Analysis that reduction of illegal harvest (CM 17) and reduction of entrainment at the Fremont weir (CM 2) are both highly likely to have a positive effect on adult survival. Similarly, we agree that the restoration of tidal wetlands under CM4 are very likely to provide significantly increased rearing habitat and epibenthic and benthic food resources. Perhaps more than the pelagic covered species, white sturgeon could also derive significant benefits from enhanced and exported detrital organic matter from tidal wetland restoration because much, if not most, of their natural (and unnatural given the non-indigenous clams contributions to their diets) prey on mudflats and in adjacent channels are detritivores.

Quantitatively estimating the effects of these conservation measures on adult survival will require more rigorous, focused sampling efforts. The large confidence intervals associated with recent estimates of adult survival will make it nearly impossible to document effects of the conservation measures. The effects of water diversion and changes in flow regimes on white sturgeon recruitment are much more difficult to predict and will require a more thorough understanding of the mechanisms behind the correlation between recruitment and flow volume.

Adequacy of Technical Appendices

Appendix 5.B—Entrainment

Summary

Section 5.B.4.1 (p. 5.B-11 lines 18-23) has the most important statement of the entire appendix. This conclusion that should be the first conclusion in the executive summary:

“Under the ESO (Evaluated Starting Operations), in the wetter water years (wet and above-normal water years…), most of the combined total exports would come from the new north Delta facility and exports from the south Delta facility would be lower than existing biological conditions … The use of the north Delta pumps would be lower in the dryer years with most pumping going from the south Delta pumps in dry and critical water year… Less use of the north Delta pumps in drier water years reflects requirements to maintain adequate bypass flows at the north Delta diversions.” (5.B-11, lines 18-23)

This conclusion is the basis of most of the entrainment analysis in Appendix 5.B for the South Delta facilities. There may be different approaches to come up with the regression between export rate and salvage, but the simplistic conclusion is that when the pump operations are lower, so is the entrainment of fish. However, in the dry and critical years, entrainment at the South Delta facilities will be higher because the north Delta facilities’ operations will be limited.

The next question to ask, therefore, is how often we will be under dry or critical year conditions. Will California have more frequent dry water years, resulting in fewer times when the north Delta diversion facilities can be operated?

Recommendations

- The conclusion stated above in the summary Section 5.B.4.1 (p. 5.B-11 lines 18-23) should be the first conclusion in the Appendix 5.B executive summary and should be included in Chapter 5.

- The Climate Change (Appendix 5.A) portion of the Effects Analysis needs to address the question for frequency of dry/critical water years and relate it back Appendix 5B.
- The documentation of the DSM2 and particle tracking model (PTM) model in this appendix should be greatly expanded to provide clarity in their approach.

Comments

Section 5.B.4.1 (p. 5.B-11 lines 18-23) has the most important statement of the entire appendix. This conclusion that should be the first conclusion in the executive summary:

“Under the ESO (Evaluated Starting Operations), in the wetter water years (wet and above-normal water years…), most of the combined total exports would come from the new north Delta facility and exports from the south Delta facility would be lower than existing biological conditions … The use of the north Delta pumps would be lower in the dryer years with most pumping going from the south Delta pumps in dry and critical water year… Less use of the north Delta pumps in drier water years reflects requirements to maintain adequate bypass flows at the north Delta diversions.” (p. 5.B-11, lines 18-23)

This conclusion is the basis of most of the entrainment analysis in Appendix 5.B for the South Delta facilities. There may be different approaches to come up with the regression between export rate and salvage, but the simplistic conclusion is that when the pump operations are lower, so is the entrainment of fish. However, in the dry and critical years, entrainment at the South Delta facilities will be higher because the north Delta facilities operation will be limited.

The next question to ask, therefore, is how often we will be under dry or critical year conditions. Are we going to have more frequent drier water years, resulting in fewer times when the north Delta diversion facilities can be operated? The Climate Change (Appendix 5.A) portion of the Effects Analysis needs to address this question and relate it back to this Appendix.

In this appendix, the first conclusion stated is: “The BDCP would substantially change the amount and pattern of water exports from the south Delta SWP/CVP facilities, which generally would be expected to lower the number of fish of all species entrained relative to existing biological conditions.” (Appendix 5.B, p. 5.B-iii, lines 38-40)

We agree that the south Delta export patterns will change substantially, especially in wet and above normal years. However, it is also important to look at how the flow patterns will also change in the north Delta. This is an equally important piece of evaluation that should be included in the entrainment analysis. The use of the DSM2 PTM is a first attempt at this type of analysis. However, the documentation of the DSM2 PTM model in this appendix should be greatly expanded to provide clarity in their approach. Some of this documentation may already be in Appendix 5.C, however, the present documentation is not sufficient to allow Appendix 5.B to act as a stand-alone document.

Appendix 5.C—Flow, Passage, Salinity, and Turbidity

Summary

Appendix 5.C has been a catch-all appendix ever since Phase 1 of this Effects Analysis review. Unlike the Entrainment or Contaminants appendices, this appendix does not have an individual issue that it is trying to address. This appendix is 2,636 pages long and spans a laundry list of topics including flows in river, salmon migration through the Delta, Delta Cross Channel and Georgiana Slough circulation, non-physical barriers, temperature modeling, water clarity, turbidity, invasive species, nutrients, dissolved oxygen, and algae. This appendix should have been divided into multiple appendices in previous iterations of the BDCP document. At this point, the division of the appendix will likely never happen. As a result, this is a very difficult appendix to review. In general, the Panel read through portions of this appendix to answer specific questions for the main charge questions for Chapter 5.

Recommendations

- Most Appendix 5.C recommendations are included in the Chapter 5 questions.
- Guiding operational rules in place for the current configuration of the Delta, such as E/I ratios, need to be reviewed to see if they still make sense for the combined system.
- The calculation of transport time scales should be done with relation to a particular question being addressed rather than calculated as a bulk parameter.
- Improve the synthesis of results in Section 5C.5.3.1: Passage, Movement, and Migration Results, Flow Summary.
- Water clarity and suspended sediment should have been in an appendix all its own rather than being buried in Part 6 of Appendix 5.C.

Comments

Baseline operations (Section 5C.2.2)

The Effects Analysis used two different baseline conditions, one that was consistent with the USGFWS BiOp RPA actions (EBC2) and one in which the USFWS RPA (Fall X2 action) was not included (EBC1). The panel will not comment the details of the baseline operations that were used to represent current conditions because this level of detail is beyond the area of expertise of the panel. We defer this issue to public comments by interested stakeholders, state and federal agency personnel that have more understanding of these details.

Proposed operations, Maximum Allowable Export Rules (Section5C.2.2.2.1)

Before the north Delta diversion facility is operational, the operating criteria for both the North and South facilities need to be established. Guiding operational rules in place for the current configuration of the Delta, such as E/I ratios, need to be reviewed to see if they still make sense for the combined system. For instance:

“For the BDCP cases, the [Export/Import] E/I ratio was assumed to apply only to south Delta exports; the north Delta intake diversions were assumed to exempt form E/I rule because the north Delta diversions are controlled by the bypass flow rules. The south Delta pumping was limited by the E/I calculated with the inflow minus the north Delta diversions; this would allow slightly higher total exports during periods when Sacramento River flows are high and north Delta diversion are high." (p. 5C.2-3, lines 41-42; p. 5C.2-4 lines 1-3)

Residence Time (Section 5C.4.4.7)

The residence times calculated using 38 particle release sites using the DSM2 PTM model is of limited use. The calculation of transport time scales should be done with relation to a particular question being addressed. For example, how long will water reside in a specific Restoration Opportunity Area and how does that transport timescale compare to other important timescales, such as phytoplankton growth rates, contaminant reaction time, etc.

The Delta is a very diverse mosaic of regions. Each sub-section of the Delta has unique characteristics. Transport timescales in each sub-region is a function of operations (such as the operation of the Delta Cross Channel and the placement of temporary barriers, flooding in the Yolo Bypass), bathymetry, and connectivity to adjacent regions. Transport timescales calculated in sub-regions rather than full Delta "average" residence time will give much more detailed information about changes in circulation patterns as a result of alterations to the system as a result changes in operations and additions of restoration opportunity areas.

Passage, Movement, and Migration Results, Flow Summary (Section 5C.5.3.1, Pages 5C.5.3-1 through 5C.5.3-64)

Please improve the synthesis of results in this section. These pages contain only charts with no dialogue or graphs to aid the reader. This section likely contains very important information about how the circulation changes in the Delta will change as a result of the Conservation Measures at key locations throughout the Delta.

Attachment 5C.D (Water Clarity-Suspended Sediment Concentration and Turbidity) (5C.D-1 through 5C.D-64)

Water clarity and suspended sediment should have been in an appendix all its own rather than being buried in Part 6 of Appendix 5.C. This is a topic is as important as Entrainment and Contaminants. This section is a good resource to read for background on issues related to sediment transport in the Delta.

Appendix 5.D—Contaminants

Summary

Currently, the contaminants section of Chapter 5 comprises 1 ½ pages of a 745 page document with most of the information related to contaminant effects contained in a single table. There are many caveats to consider with contaminants and this topic should get more attention within Chapter 5. Appendix 5D has a very well written introduction that lays out the key issues related to both mercury and selenium in the Delta. This introduction should be included in Chapter 5 where it will be read and considered. This list of potential contaminants seems reasonable and the conceptual model for contaminants (Fig 5D.3-1) is well developed. The growing list of contaminants of emerging concern is a clear sign that additional contaminants may need consideration in the future.

The Executive Summary of Appendix 5.D (p. 5.D-i, lines 24 -29) states that quantitative analyses were applied where available but were not sufficient to fully examine the potential for contaminant effects. This statement is important for characterizing the level for which potential contaminant effects can be assessed, however this is not part of the bulleted summary within the Executive Summary (p. 5.D.ii, lines 35-42).

The Contaminants Appendix is limited to direct contaminant effects on covered species even though it is recognized that both direct and indirect contaminant effects must be considered (p. 5.2.3, lines 5-7). The Effects Analysis authors indicate that indirect contaminant effects are handled within Appendix 5.F: Biological Stressors on Covered Fish. Given the degree to which indirect contaminant effects are presently covered in Appendix 5.F this is not satisfactory. A Phase II Panel recommendation was to incorporate grey literature where needed in the contaminants section, especially for indirect contaminant effects. These recommendations were not taken and stand from the original review.

The separation of direct and indirect contaminant effects lead to strange splits in organization, including for *Microcystis* which is included as a “contaminant” in the contaminant conceptual model but is not part of the discussion in Appendix 5.D: Contaminants. Rather, *Microcystis* is considered in Appendix 5.F.

Both Conservation Measure 15: Methylmercury Management (pp. 4-257) and AMM27 Selenium Management (p. 5.D-37, line 18) should be evaluated by contaminants experts to determine if these approaches will be acceptable for mitigation. The modeling of Methylmercury effects are highly uncertain due in large part to site-specific characteristics that cannot be modeled at present.

Recommendations

- Provide more information with Chapter 5: Effects Analysis rather than relying heavily on Appendix 5.D: Contaminants.
- Include both indirect and direct contaminant effects within Contaminants Appendix (Phase II recommendation).
- Methylmercury Management and Selenium Management should be evaluated by contaminants experts.
- Incorporate grey literature where needed (especially herbicide application for control of Invasive Aquatic Species).
- Provide clear statements within Chapter 5 and the Executive Summary of Appendix 5.D about the high level of uncertainty associated with contaminant effects as a result of site-specific details that cannot be modeled without explicit information about the location and connectivity of ROAs.

Comments

The Contaminants Appendix is limited to direct effects of contaminants on covered species despite the recognition (Chap. 5, pg. 5.2-3, lines 5-7) that that both direct and indirect contaminant effects must be considered. Appendix 5.D states that with the exception of herbicides used to control Aquatic Vegetation, the BDCP does not add any contaminants to the Plan Area. Nonetheless, as stated (Chapter 5, page 5.3-26, lines 29-30) BDCP activities will alter freshwater flow and alter water residence times at various locations in the Delta. These changes can result in major changes in how contaminants interact with the Delta ecosystem by changing the local concentration of a given contaminant or duration of exposure. For these reasons, restricting the analysis to direct effects on covered species is inadequate.

The inherent challenges in navigating a document of this size could be overcome by placing all of the contaminant effects under the Appendix entitled “Contaminants”. This was a recommendation made during the Phase 2 review. Indirect effects are handled elsewhere in the Effects Analysis (Appendix 5.F: Biological Stressors on Covered Fish) however at present discussion of potential indirect contaminant effects are not sufficient in scope, detail, or characterization of uncertainty. Ammonia (NH3) / ammonium (NH4) effects, as written in Appendix 5.D, appear to consider indirect effects of ammonia/ium which is inconsistent with the authors’ intent for Appendix 5.D.

Appendix 5.D has a very well written introduction that lays out the key issues related to both mercury and selenium in the Delta. The analysis was very careful to separate out the effects of Conservation Measure 1 (north Delta diversion facilities) from the effects of Conservation Measure 2 (Establishment of ROAs). In general, the environmental effects related to constructing ROAs are a bigger concern for contaminants than the north Delta diversion. However, in the case of selenium, changing the pumping operation location in conjunction with the establishment of ROAs in the South Delta has a potential significant effect. Changing to the north Delta diversions shifts the primary source of water in the South Delta to San Joaquin derived water rather than Sacramento source water under certain conditions.

It is recognized that Methylmercury concentrations would continue to exceed criteria under the BDCP and restoration actions are likely to increase production, mobilization and bioavailability of Methylmercury (5.D-24, lines 41-44). There is considerable uncertainty related to Methylmercury production resulting from BDCP activities. This is due in large part to site-specific information needed to construct reasonable models and trophic interactions from various sources are not easily modeled (5.D-22, lines 11-17)

DSM2 is a one-dimensional model that represents open water areas as well-mixed, continuously stirred tank reactors. In addition, the location of the ROAs and how these areas are connected to the adjacent channels is unknown.

Currently, dissolved Se in the San Joaquin is an order of magnitude higher than in the Sacramento River. (Monsen *et al.* 2007) Therefore, even if the proportion of San Joaquin discharge relative to the Sacramento River is low, the increase in Se concentration could still be significant. This conclusion should be reviewed. There is much uncertainty in the DSM2 results, especially for residence times in the newly established open water regions.

Section 5.D.43 (lines 8-10) on the impact of restoration on ammonium suggest that restoration will not have an impact on NH4 concentrations – This is overly simplistic as tidal wetlands are known to be important in nitrogen biogeochemistry, acting as a source via sediment re-mineralization (Cornwell *et al.* 2014) or clam excretion (Kleckner 2009) or as a sink via organic matter production or coupled nitrification – denitrifcation (Cornwell *et al.* 2014).

Conservation Measure 13: Invasive Aquatic Vegetation Control is discussed in Section 5.F-6. There is little consideration of the potential effects on lower trophic levels (algal primary producer) due to herbicide applications. This issue is raised in a single bullet on page 5.F-130 Line 24-25. While the literature is not well developed for the SFE there is at least some indication that herbicide applications are detrimental to photosynthetic organisms (phytoplankton). This should be addressed as a possible effect with implications for adaptive management.

Appendix 5.F—Biological Stressors on Covered Fish

Summary

Appendix 5.F examines the effects of 10 conservation measures on four key biological stressors: invasive aquatic vegetation (IAV), predation, invasive mollusks, and *Microcystis*. Effects of these actions on fishes was largely based on professional opinion while utilizing available information. While intentions of these actions is good, the outcome for fishes is uncertain, indicating the need to monitor and adapt. Key issues include expansion of invasive clams that consume phytoplankton, more favorable conditions for *Mycrocystis and harmful algal blooms,* and continuous effort needed to control invasive aquatic vegetation and predator abundances.

Recommendations

- Page 5.F-107, last paragraph, first sentence, and Executive Summary: The 1% to 12.8% range in predation effects due to the north Delta diversion is a mixture of population-level and localized effects and should not be treated as measuring the same quantity. That range estimate is deceptive and technically incorrect.
- Monitor progress and maintain efforts to control invasive species than impact covered fishes.

Comments

Biological stressors can result from “competition, herbivory, predation, parasitism, toxins and disease.” The objective of the conservation measures is to reduce the negative effects of key biological stressors on covered fish species. Appendix F examines the effects of 10 conservation measures on four key biological stressors: invasive aquatic vegetation (IAV), predation, invasive mollusks, and *Microcystis*. This review is designed around the four biological stressors and the prospects for change under the BDCP plan.

<u>Invasive Aquatic Vegetation (IAV).</u> The plan states controlling IAV is expected to reduce densities of largemouth bass but could enhance open water conditions favorable to striped bass. The control of IAV should increase turbidity which should be beneficial to foraging by juvenile fish and reduce predation. Brazilian waterweed (*Egeria densa*) and water hyacinth (*Eichhornia crassipes)* are the two most abundant IAV in the Delta. The CM13 proposes to treat approximately 1,700–3,400 acres of *Egeria* per year in and near restored habitat. Currently, *Egeria* is increasing at a rate of approximately 15% per year. Efforts will need to be sustained and focused to be effective.

Assessments of the benefits of IAV control were based on “scientific literature,” consultations with local experts, and conceptual models of key processes, habitat, and covered fish species. There is also practical experience to draw from. At Franks Tract, *Egeria* control was 47% effective (5.F-40), while Delta-wide *Egeria* continues to expand at about 15%/year. Annual treatment of 1500 acres/year would be expected to maintain the status quo.

Figure 5.F.5-3 projects it would take approximately 10 years to eradicate *Egeria* under a high treatment scenario and a 20% annual expansion rate. Some of this benefit may be offset by the fact that habitat restoration under the Plan would also create susceptible *Egeria* habitat. Water hyacinth control, on the other hand, appears to be already successful.

<u>Predation.</u> Predation control is to be locally focused on predator hotspots. Ten spots have been specified, along with the new north Delta water diversion facilities and nonphysical barriers. It is unclear how effective these localized remodels will be because the predators being controlled (i.e., largemouth bass and striped bass) are moderately to highly mobile.

For the north Delta diversion facilities, two approaches were used to estimate predation-related effects: bioenergetics modeling and fixed estimate of 5% predation loss at each of three intakes screens. The Executive Summary states predation losses at north Delta intakes should be from less than 1% to 12.8%. However, this range is contradicted by the simple fixed estimate model: Assuming three intakes each with a 5% independent rate of loss, then the overall rate is $1 – (1 – 0.05)^3 = 0.1426$ or 14.26%. The bioenergetics model was considered the Plan's best approach to assessing predation near the intakes. However, the fourth assumption of this model (p. 5.F-15) states predation was assumed to be proportional to the prey's relative abundance. This is in contrast with most energetics models that assume consumption has a lower threshold dependent on the predator's physiology and size. Predation is then proportional to predator abundance. The analysis also apparently ignores smaller size prey (assumption 6, p. 5.F-16). This analysis was also based on guesstimates of expected predator abundance at the future north Delta intake facilities. The model also assumes all prey are at equal risk, regardless of their location in the channel.

Using the bioenergetics models to express the effects of predation at the north Delta intakes as a percentage of total juvenile predation can be misleading (p. 5.F-75). Localized predation rates are more useful and can be compared to the 5% design specifications. Alternatively, the effect of predation at the intakes could be expressed in terms of proportional change in through-delta survival. Under the fixed predation loss method, it is unclear how proportions of 11.7%, 12.1%, and 12.8% for various fish stocks are estimated (p. 5.F-77) when a simple model based on independent intake events estimates $(1 – (1 – 0.05)^3 \times 100\% = 14.26\%$.

The predator removal program at the north Delta intakes and elsewhere is projected to remove 8,840 striped bass annually. The net effect is a project reduction in 13,320 juvenile salmonids being consumed. The Plan does not estimate the fraction of striped bass removal in the delta (i.e., another measure of relative reduction in predation). The Plan states it is uncertain how long such a removal effort could be sustained, and that predator removal treatments are likely short lived.

The effects of habitat restoration on predator control are uncertain. Effects on turbidity, flow, etc., may be much localized. In addition, it is unclear whether restoration actions will benefit prey, predators, or both.

<u>Invasive Mollusks.</u> The overbite clam (*Potamocorbula amurensis*) currently dominates the brackish transition zone of the delta estuary. Its presence has dramatically altered the zooplankton community. It can filter the entire water column once a day in delta

channels. The decline in phytoplankton has been subsequently correlated with declines in copepods and mysid shrimp, a food source of the delta smelt and longfin smelt. The overbite clam has a salinity range of tolerance that could be affected by the Plan's water operations. There is expected to be "generally little difference (25%) in average suitable habitat for the clam between EBC2 scenarios and ESO scenarios . . . ." However, there is risk of *Potamocorbula* expansion:

> "*For ESO without Fall X2 (modeled as ALT1_ELT and ALT1_LLT), the area of suitable abiotic habitat for Potamocorbula would increase 7 to 9% in wet water-year types compared with the EBC1 baseline, but would be little different for all other water-year types. Suitable abiotic habitat for clams would increase in wet and above normal water-year types by about 18 to 28% in early long-term compared with EBC2 baselines (EBC2, EBC2_ELT) and increase 11 to 30% in late long-term*." (Appendix 5.f, page 5.F-117, lines 7-11)

Restoration actions to produce more shallow water habitat may not have a net positive effect. While shallow water habitat produce phytoplankton, the presence of *Corbicula* may result in a phytoplankton sink (p. 5.F-121). One of the few management options is to manipulate salinity which is a function, in part, of river flow. The water withdrawals from the north Delta Diversion should not help the situation. Decision whether to implement the Fall X2 will affect the area of notable colonization by *Potamocorbula*.

Mycrocystis. *Microcystis* blooms can have an adverse effect on phytoplankton, zooplankton, and fish. Factors associated with blooms include high water temperature, high water transparency, low flows, high nutrient concentration, and high nitrogen/phosphorus (N/P) ratios. Runoff from land use contributes to these favorable conditions. *Microcystis* affects fish populations through declines in food sources, mortality, and reduced fecundity. Water operations that reduce flow and increase water residence time may promote *Microcystis*. Shallow water habitat reduction may also promote *Microcystis*. Actions that increase water velocity and turbidity are helpful in controlling *Microcystis* blooms. ESO_ELT and LOS_ELT scenarios are projected to increase average water residence time (Table 5.F.8-2), which would have a detrimental effect in trying to control *Myrcocystis*. Submerged aquatic vegetation (SAV) control may produce water conditions unfavorable to *Microcystis*. Climate warming may be a significant driver in *Microcystis* trends in the future.

Appendix 5.G—Fish Life Cycle Models

Summary

It is not clear to the Panel why life cycle models were not developed specifically for the evaluation of the BDCP. The Panel previously identified a number of expectations for the life cycle model appendix, which had yet to be released. The Panel also recognized that these expectations might not be achieved, and noted that the inability to achieve these expectations would indicate higher uncertainty in the ability of the BDCP to achieve the biological goals and objectives.

Recommendations

- Provide more detailed description of the 14 different scenarios modeled (Table 5.G-2) than shown on p. 5.G-17. For instance, specify what are the low- and high-flow operations specified in scenarios HOS and LOS.
- Check survival estimates. The 94-98% or 96-98% survival values (inconsistent text, p. 5.6-42 and Table 5.G-3) between ocean entry and age 2 seem very high. Rechisky *et al.* (2009), for instance, found early ocean survival of yearling Chinook salmon smolts from the Columbia River to be as low as 0.28 within the first month. Rechisky *et al.* (2012) reported early ocean survival of yearling Chinook salmon smolts to range from 0.04–0.29.
- Clarify what information and how the information from Michel (2010) and Perry *et al.* (2013) were incorporated in the IOS models (page 5.G-44).
- Perform a sensitivity analysis at to generate confidence intervals at the north delta intakes using mortality values at existing structures (Perry 2010) (p. 5.G-46). The 95% survival value used in simulations of the north Delta intake is an engineering specification.
- Consider describing extinction rates. OBAN – Adult Escapement (pp. 5.G-51 to 5.G-61). Examination of plots (Figure 5.G-15, p. 5.G-19) suggests extinction rates for winter-run Chinook salmon would be very high for all long-term (LLT) scenarios and not insignificant for short-term (ELT) scenarios.
- Compare model output as described below. Escapement values for OBAN (Tables 5.G-8 and 5.G-12) and IOS (Table 5.G-24) models differ by roughly a factor of 5. No formal comparison of the model projections from the IOS and OBAN models was presented. A ranking of model output for median adult escapement of the two models shows reasonable agreement (see Table 1 below). The two models flip the number 1 and 2 ranks of scenarios EBC1 and EBC2. The largest discrepancy was in scenario HOS-LLT with alternative rankings of 5 and 8. Such a table should be included in the report, along with an analogous comparison of through-Delta survival. A comparison of scenarios ranks is in keeping with the sentiment that only the relative output of the models be considered.

Table 1 Relative ranking of alternative model scenarios for medial adult escapement based on the IOS and OBAN models (1 = highest, 10 = lowest).

	EBC 1	EBC 2	EBC2 -ELT	EBC2 -LLT	ESO-ELT	ESO-LLT	HOS-ELT	HOS -LLT	LOS-ELT	LOST -LLT
IOS	1	2	3	7	6	10	4	5	8	9
OBAN	2	1	3	7	4	9	5	8	6	10

- Define ES0 95 ELT. Sensitivity analysis (p. 5.G-79) refers to a model (i.e., ES0 95 ELT) not defined in Table 5.G-2 at the beginning of the Appendix.
- Evaluate and compare sensitivity of populations to a broader range in mortality at the north delta intakes and passage through the Delta. A 5% mortality at the north Delta intake is projected to cause a 58 to 61% reduction in adult escapement (i.e., EBC2- ELT or EBC2-LLT vs. ESO-95-ELT or ESO-95-LLT). This is a huge effect

that would have to be mitigated by other BCDP conservation actions. Presently, 5% entrainment is based on engineering specifications and is lower than at other intake facilities (Perry 2010). These results are also in sharp contrast when through-Delta mortality was increased by 5% and escapement changed by only 0 to 4.6% in the OBAN model. Additional analyses ***must*** be done over a wider range of mortality values, 1% to 10%, to assess how bad the intake problem could be and how well must the intake function. In addition, the discrepancy between the effects of the 5% north Delta intake mortality and the 5% through-Delta mortality needs to be reconciled. It is unclear why these sensitivity results noted in the Conclusion (5.G.4) were not reconciled. They appear to be an important finding of the life cycle analysis.

Comments

A total of 17 candidate life cycle models were considered for use in the Effects Analysis (seven Chinook, eight smelt, one splittail, and one steelhead model). Appendix 5.G reviewed a number of life history models in the Central Valley, but concluded that only two of the Chinook models (i.e., Interactive object-oriented simulation [IOS] model and *Oncorhynchus* Bayesian analysis [OBAN]) were applicable to the BDCP. The OBAN model for winter Chinook involved factors such as water temperature in the Sacramento River (Bend Bridge), exports at the south Delta pumps, days of flow in Yolo Bypass, Delta Cross Channel operation, striped bass (predator) abundance, ocean harvest and ocean upwelling. None of the smelt models were selected, despite the fact that four models (state-space, multivariate autoregression, Bayesian change point, and smolt survival regression) met their five selection criteria. Given the relative importance of the delta smelt, it is unclear how none of the models met the criteria of best available science. It is also unclear, given the important of BDCP, why the plan did not invest in independent model developed tailored to its objectives or invest in modifying one or more of the existing models to better meet the objectives of the plan. The IOS and OBAN models were used to assess effects only on winter-run Chinook salmon.

Under the BDCP, the ISO and OBAN models were used to simulate the projected effects of:

a. Benefits of CM 2 Yolo Bypass Fisheries Enhancement
b. Benefits of SM 15 Nonphysical Barriers (assumed 67% diversion away from Georgiana Slough)
c. Detrimental effects of juvenile entrainment at north Delta intakes (assumed 5% mortality)

No other BDCP conservation measures were considered. How the benefits of Yolo Bypass Fisheries Enhancement were modeled is unclear.

The OBAN model “cannot account for north Delta exports” and “does not include any Delta flow-based covariates other than export (EXPT) and Yolo Bypass inundation (YOLO) and, therefore, cannot account for any potential changes in survival below the north Delta diversions, e.g., because of changes in water velocity” (p. 5.G-32). Consequently, the effect of lower flows due to water withdrawal or slower water velocities and subsequent increased smolt predation were not incorporated in the OBAN modeling. Appendix 5.G goes on to state that because of these modeling limitations, all performance measures should be compared on a relative basis.

However, ratios of model output (i.e., relative differences) will not eliminate biases due to structural defects in the model under alternative scenarios.

The IOS model also assumed “survival and travel times during River Migration are independent of flow” (p. 5.G-44). However, the IOS model does model the effects of flow and route selection and water exports on smolt survival in the Delta (p. 5.G-33). Such assumptions are very important because water withdrawals will affect flows which, in turn, are known to affect the travel time and survival of salmon smolts.

Calibration of the models was limited by available data which, in turn, can limit the range in valid model response. Nevertheless, model descriptions are generally adequate as a whole. Primary model outputs considered median through-Delta survival and annual escapement. In population assessments of endangered or listed species, it is common to include 50-year or 100-year extinction rates. Increasing median escapement has limited value if a salmon population continues to have an unexceptionally high probability of extinction in the future. The simulations should also be summarized in terms of extinction rates under the 14 different operational/environmental scenarios (Table 5.G-2).

The appendix does not include a formal comparison of model output for OBAN and IOS, either on an absolute scale or relative scale. It should be acknowledged that adult escapement differs between models by a weighting factor of 5. More importantly, the relative ranking of the different BDCP scenarios (Table 5.G.-2) between models should be included in Appendix 5.G. Certainty should be assessed, in part, based on the degree of consistency in model predictions.

Appendix 5.J—Effects on Natural Communities, Wildlife, and Plants

Summary

In general, the Panel felt that the information in Appendix 5.J was clearly presented in the tables and figures. Because so much of the information in the appendix depends on the accuracy of the GIS database, the authors should provide a reference or preferably a link to a description of the database and an analysis of its accuracy. As discussed in other sections of our review, providing a single value for the number of acres of habitat that will be occupied by each species is scientifically questionable.

Recommendations

- The description of the methods used to arrive at the number of acres of restored habitat that will be occupied needs to be revised.
- Consider including a range of values (minimum and maximum) of potential occupied habitat rather than a single value.

Comments

Appendix 5.J is divided into five sections each of which addresses a different conservation issue related to natural communities. Our comments on some sections are rather brief and some questions are not relevant to a section so we have included our comments on each section under each question. If there are no comments on a section under a particular question, we felt there was no need to address it.

a. *How well are the proposed analytical tools defined, discussed and integrated?*

Construction-Related Nitrogen Deposition on BDCP Natural Communities

The analysis of construction-related nitrogen deposition is thorough and sufficient. It is clear that the amount of nitrogen produced by construction-related activities of the BDCP will be negligible relative to the amount that is currently being contributed by the surrounding urban and agricultural areas.

Natural Community Restoration and Protection Contributing to Covered Species Conservation

The estimates of the current distribution of natural vegetation types in the Plan Area depend on the accuracy of the GIS database that used for the analysis. Provide a citation for the database and a brief discussion of the error associated with the different community types. In addition, the description of the approach that was used to estimate the amount of habitat for each species (pp. 5J.B-1 and 5J.B-2) is poorly worded and needs revising. The description should state that the details of the approaches used to develop the species-specific habitat models are provided in the species accounts in Appendix 2A.

Analysis of Potential Bird Collisions at Proposed BDCP Powerlines

The authors did an excellent job of integrating spatially explicit information about roost and foraging sites in the Plan Area to estimate the number of potential encounters with power lines and combining this with information in the scientific literature on mortality estimates from each encounter.

Indirect Effects of the Construction of the BDCP Conveyance Facility on Sandhill Crane

The authors considered all of the important indirect effects of the construction on sandhill cranes in the Plan Area. The analytical tools they used were appropriate for the analyses. Most of the estimates of indirect effects came from studies in other regions but that is unavoidable because no detailed studies have been conducted in the Plan Area.

Estimation of BDCP Impact on Giant Garter Snake Summer Foraging Habitat (Acreage of Rice) in the Yolo Bypass

This section is a simple accounting of the number of acres that are planted to rice within the Yolo bypass that may be removed when the bypass is inundated. Rice fields are used as foraging habitat by giant garter snakes and therefore could result in a loss of this habitat for the snake in the Plan Area. By intersecting the maximum amount of rice that was planted in area with the inundation level that results in the maximum amount of rice removed, the analysis provides an estimate of the maximum amount of potential foraging habitat that will be removed. We feel this approach is adequate to address this very specific question.

b. How clear and reasonable is the scale of analysis?

Natural Community Restoration and Protection Contributing to Covered Species Conservation

The scale of vegetation distribution information (1 acre, from Appendix 2A) is reasonable for most species. Although some wildlife species may use habitat patches that are < 1 acre, it is unlikely that those patches contribute significantly to the amount of suitable habitat in the Plan Area.

c. How well were the Panel's earlier comments addressed and applied in the technical appendices/analyses?

Natural Community Restoration and Protection Contributing to Covered Species Conservation

Earlier comments were addressed to some degree. The previous version of this appendix did not have any text at the beginning describing the methods that were used to arrive at the numbers presented in the tables. The description, however, needs to be edited and should specify that the assumptions behind the approaches used when developing habitat models can be found in Appendix 2A.

The other sections of this appendix were not previously reviewed.

d. How well did the technical appendix evaluate the effects of potential BDCP conservation measures on the specified variable(s)?

Natural Community Restoration and Protection Contributing to Covered Species Conservation

As discussed in our review of Chapter 5, the estimate of the amount of habitat that will be occupied by a species following restoration is questionable. The number of acres of suitable habitat that are temporarily or permanently removed and restored are clearly conveyed in the tables in Appendix 5.J. But, the approach used in Appendix 5.J assumes that the proportion of the appropriate habitat that is within the current range of the species in the Plan Area is an appropriate estimate of the proportion of suitable habitat that will be occupied when habitat restoration measures are completed. However, if habitat restoration does not occur within the potential range of the species in the Plan Area, none of it will be occupied. The best way to address this is to set specific goals for habitat restoration within the potential range of the species in the Plan Area and to identify occupancy thresholds.

e. Were the conclusions drawn from the results accurate and did these conclusions appropriately consider uncertainty, including chained statistical uncertainties?

Natural Community Restoration and Protection Contributing to Covered Species Conservation

As discussed in our review of Chapter 5, uncertainty was not considered when estimating the number of acres of restored habitat that a species would occupy following restoration.

f. Were appropriate models used in the technical appendices? If model results conflicted, was this clearly stated and was the conflict appropriately addressed?

Analysis of Potential Bird Collisions at Proposed BDCP Powerlines

The authors considered all 12 bird species that are covered by the BDCP when addressing collision risk. They concluded, and we concur, that the only species that may suffer significant mortality from BDCP-related power lines in the areas is the sandhill crane. The authors used the highest estimate of the probability of mortality due to power line collisions from the published literature when making their computations. In addition, their estimates of the number of potential encounters between cranes and power lines were based on spatially explicit data from the BDCP region. We feel their estimate of potential crane mortality from new power lines that will be constructed is appropriate based on the information available from the site and the literature. We also feel that the estimates of the reduction in crane mortality due to placing bird diverters on existing lines are appropriate. We emphasize, however, that crane mortality from power line collisions should be closely monitored in the Plan Area and additional bird diverters should be put in place if targets for overall reduction in crane collisions are not achieved.

g. How well are the models and analyses described, interpreted and summarized?

Analysis of Potential Bird Collisions at Proposed BDCP Powerlines. The results of their analyses are well described and are well summarized in Tables 2-7 of Appendix 5.J.C. Their estimates of the mitigation from marking power lines are also well described and summarized in section 5.0 of Appendix 5.J.C.

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Appendices

Appendix A—BDCP Effects Analysis Scientific Review Panel members biographies

Nancy Monsen – Delta Hydrodynamics, Stanford University

Dr. Monsen's research has focused on multi-dimensional hydrodynamic modeling of the Sacramento-San Joaquin Delta for twenty years. Her PhD research was based on the TRIM3D hydrodynamic model. She also has consulting experience with the DELFT3d hydrodynamic model. She is currently Visiting Scholar in the Environmental Fluid Mechanics Laboratory, part of the Civil and Environmental Engineering Department, at Stanford University. Over the prior two years, Dr. Monsen worked as a Stanford Research Associate on a Delta Science program funded research project to develop a multi-dimensional hydrodynamic model of the Sacramento-San Joaquin Delta using Stanford's SUNTANS model. Prior to working at Stanford, she worked for ESA PWA (formerly Philip Williams and Associates) for a year and a half and at the U.S. Geological Survey (Menlo Park, National Research Program) for ten years. Dr. Monsen earned her doctorate in Civil and Environmental Engineering at Stanford University in 2001.

Greg Ruggerone – Anadromous Fish

Dr. Ruggerone has investigated population dynamics, ecology, and management of Pacific salmon in Alaska and the Pacific Northwest since 1979. He was the Project Leader of the Alaska Salmon Program, University of Washington, from the mid-1980s to early 1990s where he was responsible for conducting and guiding research at the Chignik and Bristol Bay field stations. Most of his research involves factors that affect survival of salmon in freshwater and marine habitats, including climate shifts, habitat degradation, predator-prey interactions, and hatchery/wild salmon interactions. He is currently a member of the Columbia River Independent Scientific Advisory Board and the Independent Scientific Review Panel. He recently served as the fish ecologist on the Secretary of Interior review of dam removal on the Klamath River.

(http://www.nrccorp.com/staff/staff_ruggerone.htm).

Charles (Si) Simenstad – Pelagic/Native Fish

Charles ("Si") Simenstad, Research Professor at the University of Washington's School of Aquatic and Fishery Science (SAFS), is an estuarine and coastal marine ecologist and coordinator of the Wetland Ecosystem Team (WET). Si has studied the organization and function of estuarine and coastal marine ecosystems throughout Puget Sound, Washington, Oregon and California, 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 biotic communities, and the associated ecological processes and community dynamics that are responsible for enhancing their production and life history diversity. Recent research has integrated such ecosystem interactions with applied issues such as restoration of estuarine and coastal wetland ecosystems, and ecological approaches to evaluating the success of coastal wetland restoration from ecosystem to landscape scales. He is presently Co-Editor in Chief of

Estuaries and Coasts, on the Editorial Board of *San Francisco Estuary and Watershed Science*, volume co-editor for the “Treatise on Estuarine and Coastal Science”, a standing member of the Scientific Advisory Group (SAG) of the Interagency Ecological Program (IEP) in the San Francisco Bay-Delta, and was recently appointed to Environmental Advisory Board to the Chie of Engineers, US Army Corps of Engineers; (http://fish.washington.edu/people/simenstd/).

John Skalski – Fishery population dynamics and modeling

Dr. Skalski is a Professor of Biological Statistics in the School of Aquatic & Fishery Sciences, College of the Environment, at the University of Washington. He is also an adjunct professor in Quantitative Ecology and Resource Management and Wildlife Sciences, and an instructor in the Center for Quantitative Sciences. His expertise is in sampling theory, parameter estimation, mark-recapture theory, and population dynamics. His research focuses on the development of sampling methodology, field designs, and statistical tests for human-induced and natural effects on organismic and ecological systems. He is the statistician in charge of survival compliance testing at all 13 major hydroprojects in the Snake-Columbia River system. He has authored or coauthored over 100 technical reports on salmonid survival studies and over 40 peer-reviewed articles on tagging studies. Dr. Skalski is a member of the American Statistical Association, The Wildlife Society, and the American Fisheries Society. He is also a Certified Wildlife Biologist through The Wildlife Society.

Alex Parker – Aquatic Ecology/Food Webs

Alex Parker is an Assistant Professor of Oceanography at the California Maritime Academy, CSU and a Research Associate at the Romberg Tiburon Center, San Francisco State University. His Ph.D. work (College of Marine Studies, University of Delaware) focused on microbial biogeochemistry in the Delaware Estuary, a highly modified estuary on the US East Coast. Dr. Parker was a CALFED Post-Doctoral Science Fellow. His work in the San Francisco Estuary includes the study of pelagic phytoplankton rate processes, wetland primary producers, the dynamics of heterotopic bacteria and the carbon and nitrogen physiology of cyanobacteria in the SFE Delta. Additionally, Dr. Parker has carried out research in coastal and equatorial upwelling areas as well as polar environments.

Tom Parker, Plant Communities

Thomas Parker is Professor of Ecology and Evolution at San Francisco State University who studies the ecology and evolution of plant communities, focusing on their dynamics. Current research includes the effects of climate change on tidal wetlands of the San Francisco Bay-Delta, and the ecology and evolution of *Arctostaphylos* species in chaparral and other communities (http://bio.sfsu.edu/people/v-thomas).

T. Luke George, Terrestrial Ecology

Dr. George has been a faculty member in the Department of Wildlife at Humboldt State University since 1991. He specializes in the design, implementation, and analysis of demographic, population monitoring, and habitat selection studies of terrestrial vertebrates. His recent work has focused on estimating demographic parameters and modeling habit selection of threatened and at risk species including the San Clemente sage sparrow, northern spotted owl, greater sage grouse, and tricolored blackbird. Dr. George assisted with the development of a population viability analysis (PVA) of the San Clemente sage sparrow and has served as an advisor on PVAs of Western snowy plovers and San Clemente loggerhead shrikes. He has conducted research on habitat selection and space use of Steller's jays and common ravens in Redwood National and State Parks and has advised state and federal agencies on strategies to reduce nest predation by corvids on marbled murrelets, Western snowy plovers, and other threatened and endangered species in California.

Appendix B—Charge to the Delta Science Program Independent Review Panel for the BDCP Effects Analysis Review, Phase 3 (dated 2/12/2014)

The Panel will be charged with assessing the scientific soundness of Chapter 5: Effects Analysis and the associated technical appendices. The Panel will make recommendations for how these might be improved with respect to achieving their stated goals. Specific attention will be given to the following questions:

Chapter 5: Effects Analysis

General Questions

1. How well does the Effects Analysis meet its expected goals?
2. How complete is the Effects Analysis; how clearly are the methods described?
3. Is the Effects Analysis reasonable and scientifically defensible? How clearly are the net effects results conveyed in the text, figures and tables?
4. How well is uncertainty addressed? How could communication of uncertainty be improved?
5. How well does the Effects Analysis describe how conflicting model results and analyses in the technical appendices are interpreted?
6. How well does the Effects Analysis link to the adaptive management plan and associated monitoring programs?

Review of Specific Analyses

7. Are the analyses related to the north Delta diversion facilities appropriate and does the effects analysis reasonably describe the results? In particular:

- Was existing empirical information such as Perry *et al.* 2010 and Newman 2003 incorporated appropriately into the modeling? Where model runs required extrapolation beyond existing data ranges, were assumptions and interpretations appropriate?
    - Does the analysis of the frequency of reverse flows at Georgiana Slough accurately characterize changes in hydrodynamics due to changes in river stage, sea level rise, and Delta habitat restoration?

8. How should the effects of changes in Feather River flows on fish spawning and rearing be characterized? In particular, how should the trade-off between higher spring flows and lower summer flows be interpreted? Does the analysis adequately capture the expected benefits of CM 2, Yolo Bypass Fishery Enhancement?
9. Does the analysis adequately describe the predation and other screen-related effects of the proposed north Delta diversion structures? Is the application of the observed mortality rate at the fish screen of the Glenn-Colusa Irrigation District (GCID) an appropriate

assumption for expected mortality at the proposed BDCP north Delta intakes? Are there other studies on salmonid survival at positive barrier fish screens that would be appropriate to apply?

10. Does the effects analysis provide a complete and reasonable interpretation of the results of physical models as they relate to upstream spawning and rearing habitat conditions, particularly upstream water temperatures and flows resulting from proposed BDCP operations?
11. Does the effects analysis use a reasonable method for "normalizing" results from the salvage-density method to the population level for salmonid species?
12. Are the assumptions of the analysis of aquatic habitat restoration food web effects appropriate for covered fish species? Are the conclusions and net effects appropriate?
13. Is the analysis of food web benefits to longfin smelt from habitat restoration appropriate? How well do the analyses link intended food web improvements to improvement in the longfin smelt spring Delta outflow/recruitment relationship?
14. How well does the analysis address population-level effects of the BDCP on white sturgeon?

Technical Appendices

For each Chapter 5 technical appendix:

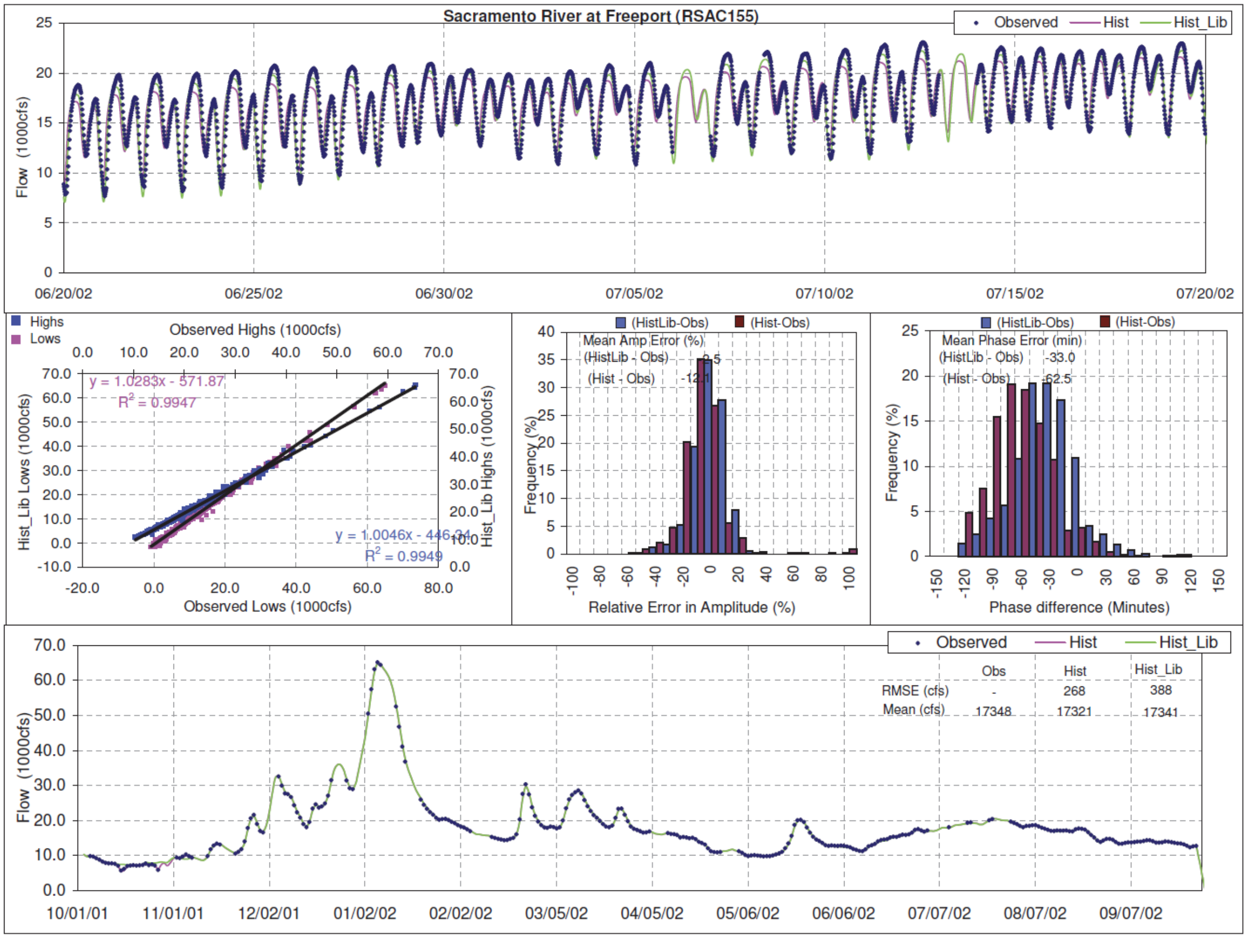
Approach and Analysis

a. How well are the proposed analytical tools defined, discussed and integrated?
b. How clear and reasonable is the scale of analysis?
c. How well were the panel's earlier comments addressed and applied in the technical appendices/analyses?
d. How well did the technical appendix evaluate the effects of potential BDCP conservation measures on the specified variable(s)?
e. Were the conclusions drawn from the results accurate and did these conclusions appropriately consider uncertainty, including chained statistical uncertainties?

Models

f. Were appropriate models used in the technical appendices? If model results conflicted, was this clearly stated and was the conflict appropriately addressed?
g. How well are the models and analyses described, interpreted and summarized?

Appendix C—Observed tidal stage and flow time series data from three key locations along the Sacramento River (from BDCP Appendix 5A-D1, pp. 128-129)



Appendix D—Variance Calculations Associated with Salvage Model

Estimator of average salvage:

$$\hat{\hat{S}} = \frac{\sum_{i=1}^{n}\sum_{j=1}^{m} D_i V_j}{nm} \qquad (1)$$

Then, the variance of this average salvage value is as follows:

$$\text{Var}\left(\hat{\hat{S}}\right) = \text{Var}\left[\frac{\sum_{i=1}^{n}\sum_{j=1}^{m} D_i V_j}{nm}\right]$$

$$= \text{Var}_n\left[E_m\left[\frac{\sum_{i=1}^{n}\sum_{j=1}^{n} D_i V_{ij}}{nm}\middle| n\right]\right] + E_n\left[\text{Var}_m\left[\frac{\sum_{i=1}^{n}\sum_{j=1}^{n} D_i V_{ij}}{nm}\middle| n\right]\right]$$

$$= \text{Var}_m\left[\frac{\sum_{i=1}^{n} D_i \bar{\bar{V}}}{n}\right] + E_m\left[\frac{\sum_{j=1}^{m} \bar{D}_i^2 \sigma_i^2}{n^2 m}\right]$$

$$= \frac{\bar{V}^2\sigma_D^2}{n} + \frac{\sigma_V^2}{m} E\left[\frac{\sum_{i=1}^{n} \bar{D}_i^2}{n^2}\right]$$

$$= \frac{\bar{V}^2\sigma_D^2}{n} + \frac{\sigma_V^2}{m} \cdot \frac{\left(\sigma_{D_i}^2 + \bar{D}^2\right)}{n}$$

$$= \frac{\bar{V}^2\sigma_D^2}{n} + \frac{\bar{D}^2\sigma_V^2}{mn} + \frac{\sigma_V^2\sigma_D^2}{m}. \qquad (2)$$

However, if the variance of $\hat{\hat{S}}$ is calculated based on the empirical variance of the nm values, the variance has the expected value as follows:

$$E\left(\frac{s_{S_{ij}}^2}{nm}\right) = \frac{E\left(s_{ij}^2\right)}{nm} = \frac{\text{Var}(S_{ij})}{nm}$$

$$\frac{\text{Var}(\hat{S}_{ij})}{nm} = \frac{1}{nm}\{\text{Var}_n[E_m(S_{ij}|n)] + E_n[\text{Var}_m(S_{ij}|n)]\}$$

$$= \frac{1}{nm}\{\text{Var}_n[E_m(D_i V_{ij}|n)] + E_n[\text{Var}_m(D_i V_{ij}|n)]\}$$

$$= \frac{1}{nm}\left\{Var_n[D_i\bar{V}] + E_n\left[D_i^2\sigma_{V_{ij}}^2\right]\right\}$$

$$= \frac{1}{nm}\{\bar{V}^2\sigma_D^2 + \sigma_V^2 \cdot E[D_i^2]\}$$

$$= \frac{1}{nm}\{\bar{V}^2\sigma_D^2 + \sigma_V^2 \cdot E[\sigma_D^2 + \bar{D}^2]\}$$

$$= \frac{\bar{V}^2\sigma_D^2}{nm} + \frac{\bar{D}^2\sigma_V^2}{nm} + \frac{\sigma_V^2 \cdot \sigma_D^2}{nm} \qquad (3)$$

Note variance as calculated (3) is smaller than the correct variance (2). The first term of Equation (3) is inappropriately divided by m. Hence, CI width and uncertainty will be underestimated.

Report on Review of Bay Delta Conservation Program Modeling

Foreword

Since December 2012, MBK Engineers and Dan Steiner (collectively "Reviewers") have assisted various parties in evaluating the operations modeling that was performed for the Bay Delta Conservation Plan (BDCP). To assist in understanding BDCP and the potential implications, stakeholders[1] requested that the Reviewers review the CalSim II modeling studies performed as part of the BDCP (hereafter "BDCP Studies" or "BDCP Model").

An initial review led the Reviewers to conclude that the BDCP Model, which serves as the basis for the environmental analysis contained in the BDCP Environmental Impact Report/Statement (EIR/S), provides very limited useful information to understand the effects of the BDCP. The BDCP Model contains erroneous assumptions, errors, and outdated tools, which result in impractical or unrealistic Central Valley Project (CVP) and State Water Project (SWP) operations. The unrealistic operations, in turn, do not accurately depict the effects of the BDCP.

The Reviewers revised the BDCP Model to depict a more accurate, consistent version of current and future benchmark hydrology so that the effects of the BDCP could be ascertained. The BDCP Model was also revised to depict more realistic CVP and SWP operations upon which to contrast the various BDCP alternatives. The Reviewers made significant efforts to coordinate with and inform the U.S. Bureau of Reclamation (Reclamation) and the California Department of Water Resources (DWR) managers and modelers, and CVP and SWP operators of the Reviewers' modifications, assumptions, and findings. Where appropriate, the Reviewers also used Reclamation and DWR's guidance and direction to refine the Reviewers' analysis.

This Report summarizes: (1) the Reviewers' independent analysis and review of the BDCP Model, publicly released for the BDCP's Draft EIR/S in December 2013, (2) the Reviewers' updates and corrections made to the BDCP Model, and (3) comparisons between the original BDCP Model and the independent Model as revised by the Reviewers.

[1] The entities who funded this report are Contra Costa Water District, East Bay Municipal Utility District, Friant Water Authority, Northern California Water Association, North Delta Water Agency, San Joaquin River Exchange Contractors Water Authority, San Joaquin Tributaries Authority, and Tehama Colusa Canal Authority.

Contents

1 EXECUTIVE SUMMARY

Purpose of this Report

The CalSim II model is the foundational model for analysis of the BDCP, including the effects analysis in the Draft BDCP and the impacts evaluation in the Draft BDCP Environmental Impact Report/Statement (EIR/S). Results from CalSim II are used to examine how water supply and reservoir operations are modified by the BDCP. The results are also used by subsequent models to determine physical and biological effects, such as water quality, water levels, temperature, Delta flows, and fish response. Any errors and inconsistencies identified in the underlying CalSim II model are therefore present in subsequent models and adversely affect the results of later analyses based on those subsequent models.

The purpose of this Report is to examine the underlying CalSim II model used in support of the BDCP EIR/EIS and to analyze proposed operational scenarios contained in the BDCP. In undertaking the analysis for this Report, the Reviewers examined the model used in support of BDCP, the 2010 version of the CalSim II Model (BDCP Model), as well as the information contained in the Public Review Draft BDCP, released in December 2013. There are three basic reasons why the BDCP Model cannot be used to determine the effects of the BDCP: 1) the no action alternatives do not depict reasonable operations due to climate change assumptions, 2) operating criteria used in the BDCP Alternative 4 result in unrealistic operations, and 3) updates to CalSim II since the BDCP modeling was performed almost 4 years ago alter model results.

Given that it was not possible to determine how the BDCP may affect CVP and SWP operations or water system flows and conditions using the BDCP Model, independent modeling was performed to assess the potential effects of the BDCP. The first phase of this independent modeling effort was development of an updated without project baseline, which is similar to the no action alternative but with current, improved assumptions. The 2010 version of the CalSim II Model was used as the basis for the BDCP Model. The most recent version of CalSim II is the 2013 version used by DWR in its 2013 State Water Project Water Delivery Reliability Report (2013 CalSim II Model), and has undergone significant revision to not only correct errors in the 2010 model, but also to reflect regulatory changes that adversely affect the accuracy and dependability of the 2010 CalSim II Model. The BDCP was developed and analyzed using the 2010 CalSim II Model, and the changes and improvements reflected in the 2013 CalSim II Model were not used for the BDCP. For the purpose of the Reviewers' analysis and this Report, the 2013 CalSim II Model was further modified to incorporate additional updates, assumptions, and fixes. Some of these most recent Reviewer modifications have been accepted by both DWR and Reclamation, and are now incorporated into the CalSim II models that DWR and Reclamation use in conducting their own analyses. The second phase of the independent modeling effort (described in Section 4.2) incorporated the facilities and operations for the BDCP described as Alternative 4 H3 in the Draft EIR/EIS.

The manner in which the CVP and SWP are operated in the "With Project" and "Without Project" modeling scenarios significantly influences the BDCP "effects analysis". Modeling scenarios must depict how the actual system operates or how it might operate so that realistic effects can be determined. Modeling results from CalSim II are used to examine the effects of BDCP on water supply and reservoir operations, and the modeling results are also used by subsequent models to determine physical and biological effects, such as water quality, water levels, temperature, Delta flows, and fish response. If CalSim II modeling does not appropriately characterize operations in both the "With Project" and "Without Project" scenarios, the effects based on CalSim II will also not be appropriately characterized. The independent model provides a more accurate platform to assess the operations of the BDCP and isolates the effects of the BDCP from climate change. Comparing the results of the independent model to those of the BDCP model reveals significant differences in water operations and potential environmental impacts.

Key Conclusions

Assumptions, errors, and outdated tools used in the BDCP Model results in impractical or unrealistic CVP and SWP operations. Therefore, the BDCP Model provides very limited useful information to illustrate the effects of the BDCP.

Methodology used to incorporate climate change contains errors and does not incorporate reasonably foreseeable adaptation measures:

Climate change assumptions were incorrectly applied, yielding non-sensible results.

Climate change hydrology in the Upper San Joaquin River basin was incorporated incorrectly into the BDCP Model. Although inflow to Millerton Lake is expected to *decrease* under future climate scenarios, the error in the BDCP Model causes the amount of stored water in Millerton Lake to *increase* by inappropriately reducing water deliveries to the Friant Division. BDCP erroneously overestimates Millerton Lake storage, which causes an overestimation of reservoir releases and available water downstream. Because overall CVP operations and the San Joaquin River are interconnected, this error causes problems throughout the CVP system. With the coordinated operations of the CVP and SWP, this error can affect the SWP system.

Incorporation of climate change ignores reasonably foreseeable adaptation measures.

The BDCP Model uses assumed future climate conditions that obscure the effects of implementing the BDCP. The future conditions assumed in the BDCP model include changes in precipitation, temperature, and sea level rise. The result of this evaluation is that the modeled changes in water project operations and subsequent environmental impacts are caused by three different factors: (1) sea level rise; (2) climate change; and (3) implementation of the alternative that is being studied.

Including climate change, without adaptation measures, results in insufficient water needed to meet all regulatory objectives and user demands. For example, the BDCP Model results that include climate change indicate that during droughts, water in reservoirs is reduced to the minimum capacity possible. Reservoirs have not been operated like this in the past during extreme droughts and the current drought also provides evidence that adaptation measures are called for long in advanced to avoid draining the reservoirs. In this aspect, the BDCP Model simply does not reflect a real future condition. Foreseeable adaptations that the CVP and SWP could make in response to climate change include: (1) updating operational rules regarding water releases from reservoirs for flood protection; (2) during severe droughts, emergency drought declarations could call for mandatory conservation and changes in some regulatory criteria similar to what has been experienced in the current and previous droughts; and (3) if droughts become more frequent, the CVP and SWP would likely revisit the rules by which they allocate water during shortages and operate more conservatively in wetter years. The modifications to CVP and SWP operations made during the winter and spring of 2014 in response to the drought supports the likelihood of future adaptations. The BDCP Model is, however, useful in that it reveals that difficult decisions must be made in response to climate change. But, in the absence of making those decisions, the BDCP Model results themselves are not informative, particularly during drought conditions. With future conditions projected to be so dire without the BDCP, the effects of the BDCP appear positive simply because it appears that conditions cannot get any worse (i.e., storage cannot be reduced below its minimum level). However, in reality, the future condition will not be as depicted in the BDCP Model. The Reviewers recommend that Reclamation and DWR develop more realistic operating rules for the hydrologic conditions expected over the next half-century and incorporate those operating rules into any CalSim II Model that includes climate change.

The BDCP Model does not accurately reflect reasonably foreseeable conditions and changes in CVP and SWP operations due to the BDCP:

<u>BDCP's "High Outflow Scenario" is not sufficiently defined for analysis.</u>

The effects of many critical elements of the BDCP cannot be analyzed because those elements are not well-defined. The Reviewers recommend that the BDCP be better defined and a clear and concise operating plan be developed so that the updated CalSim II model can be used to assess effects of the BDCP.

The High Outflow Scenario (HOS) requires additional water (Delta outflow) during certain periods in the spring. The BDCP Model places most of the responsibility for meeting this new additional outflow requirement on the SWP. However, the SWP may not actually be responsible for meeting this new additional outflow requirement. This is because the Coordinated Operations Agreement ("the COA") would require a water allocation adjustment that would keep the SWP whole. Where one project (CVP or SWP) releases water to meet a regulatory requirement, the COA requires a water balancing to ensure the burden does not fall on only one of the projects. The BDCP Model is misleading because it fails to adjust project operations, as required by the COA, to "pay back" the water "debt" to the SWP due to these additional Delta outflow requirements. Unless there is a significant revision to COA, the BDCP Model overstates the impacts of increased Delta outflow on the SWP and understates the effects on the CVP.

Furthermore, after consulting with DWR and Reclamation project operators and managers, the Reviewers conclude that there is no apparent source of CVP or SWP water to satisfy both the increased Delta outflow requirements and pay back the COA "debt" to the SWP without substantially depleting upstream water storage. It appears, through recent public discussions regarding the HOS, that BDCP anticipates additional water to satisfy the increased Delta outflow requirement and to prevent the depletion of cold water pools will be acquired through water transfers from upstream water users. However, this approach is unrealistic. During most of the spring, when BDCP proposes that Delta outflow be increased, agricultural water users are not irrigating. This means that there is not sufficient transfer water available to meet the increased Delta outflow requirements and therefore, additional release of stored water from the reservoirs would be required. Releasing stored water to meet the increased Delta outflow requirements could potentially impact salmonids on the Sacramento and American River systems due to reductions in the available cold water pool.

<u>Simulated operation of BDCP's dual conveyance, coordinating proposed North Delta diversion facilities with existing south Delta diversion facilities, is inconsistent with the project description.</u>

The Draft BDCP and associated Draft EIR/EIS specify criteria for how much flow can be diverted by the new North Delta Diversion (NDD) facilities and specify when to preferentially use either the NDD facilities or the existing South Delta diversion (SDD) facilities. However, the BDCP Model contains an artificial constraint that prevents the NDD facilities from taking water as described in the BDCP project description. In addition to affecting diversions from the NDD, this artificial constraint contains errors that affect the No Action Alternative (NAA) operation. This error has been fixed by DWR and Reclamation in the more recent 2013 CalSim II Model; however, the error remains in the BDCP Model. Additionally, the BDCP Model does not reflect the summer operations of the SDD that are described in the Draft EIR/EIS as a feature of the BDCP project intended to prevent water quality degradation in the south Delta. The net effect of these two errors is that the BDCP Model significantly underestimates the amount of water diverted from the NDD facilities and overestimates the amount of water diverted from the SDD. The further decrease in flows through the Delta, in comparison to what is presented in the BDCP Draft EIR/EIS, would likely result in even greater degradation in Delta water quality than reported.

The BDCP Model contains numerous coding and data issues that significantly skew the analysis and conflict with actual real-time operational objectives and constraints

Operating rules used in the BDCP Model, specifically regarding Alternative 4, result in impractical or unrealistic CVP and SWP operations. Reservoir balancing rules cause significant drawdown of upstream reservoirs during spring and summer months while targeting dead pool level in San Luis from September through December resulting in artificially low Delta exports and water shortages. CVP allocation rules are set to artificially reduce south of Delta allocations during wetter years resulting in underestimates of diversions at the NDD and the SDD. Operating rules for the Delta Cross Channel Gate do not reflect how the gates may be operated in "With Project" conditions.

Operational logic is coded into the CalSim II model to simulate how DWR and Reclamation would operate the system under circumstances for which there are no regulatory or other definitive rules. This attempt to specify (i.e., code) the logic sequence and relative weighting so that a computer can simulate "expert judgment" of the human operators is a critical element to the CalSim II model. In the BDCP version of the CalSim II model, some of the operational criteria for water supply allocations and existing facilities such as the Delta Cross Channel and San Luis Reservoir are inconsistent with real-world conditions.

The BDCP Model, as modified by the Reviewers, corrected some of the inconsistencies between the operational criteria in the BDCP Model and real-world conditions, and confirmed these changes with CVP and SWP operators. By correcting the operational criteria, the modified BDCP model (Independent Model) output is more accurate and consistent with real-world operational objectives and constraints.

Independent modeling of the BDCP revealed differences in CVP and SWP operations and water deliveries from the analysis disclosed for the Draft EIR/EIS.

The independent model provides a more accurate platform to assess the operations of the BDCP and isolates the effects of the BDCP from climate change. Comparing the results of the independent model to those of the BDCP model reveals significant differences in water operations and potential environmental impacts. The independent model "Without Project" baseline was compared to the independent model's version of Alternative 4 H3-ELT of the BDCP. The updated changes in water operations from the independent model are compared to changes in operations reported in the BDCP Draft EIR/EIS for the equivalent alternatives. The difference between the updated independent model results and those reported in the BDCP Draft EIR/EIS are presented below.

- The amount of water exported (diverted from the Delta) may be approximately 200 Thousand Acre-Feet (TAF) per year *higher* than the amount disclosed in the Draft EIR/S. This total represents:
    - approximately 40 TAF/yr more water diverted and delivered to the SWP south of Delta contractors, and
    - approximately 160 TAF/yr more water diverted and delivered to the CVP south of Delta contractors.
- The BDCP Model estimates that, under the No Action Alternative at the Early Long Term (NAA – ELT) (without the BDCP), total average annual exports for CVP and SWP combined are estimated to be 4.73 million acre-feet (MAF) and in the Independent Model Future No Action (FNA) combined exports are 5.61 MAF. The BDCP Model indicates an increase in exports of approximately 540 TAF and the Independent Model shows an increase of approximately 750 TAF in Alt 4.

- Delta outflow would decrease by approximately 200 TAF/yr compared to the quantity indicated in the Draft EIR/S.
    - This lesser amount of Delta outflow has the potential to cause more significant water quality and supply impacts for in-Delta beneficial uses and additional adverse effects on species. To determine the potential effects of the reduced amount of Delta outflow, additional modeling is needed using tools such as DSM2.
- The BDCP Model does not accurately reflect the location of the diversions that the SWP and CVP will make from the Delta.
    - When the errors in the BDCP Model are corrected, the Independent Model reveals that the NDD could divert approximately 680 TAF/yr more than what is disclosed in the BDCP Draft EIR/S.
    - Conversely, the quantity of water diverted through the existing SDD would be approximately 460 TAF/yr less than what is projected in the BDCP Draft EIR/S.
    - This difference in the location of diversions has the potential to reduce water quality in the Central and South Delta in ways that were not analyzed in the BDCP Draft EIR/S

Additional Observations and Recommendations

This review identified and remedied several modeling deficiencies that should be used by others as the BDCP and other projects move forward. However, the work done to date by the Reviewers does not capture all of the improvements necessary to depict the effects of the BDCP accurately. There are many operational uncertainties in the BDCP that require attention and must be addressed. The Reviewers offer several recommendations so that future CalSim II modeling of the BDCP will yield more meaningful results.

1. Ensure model operations of existing facilities are consistent with contemporary real world operations to the extent possible.
    a. Ensure reservoirs are not routinely drawn down to dead pool as part of ‘normal’ operations.
2. Given the expected changes in hydrologic conditions over the next half century, realistic operating rules for all CVP and SWP facilities, including the BDCP, must be developed.
    a. Develop a ‘drought’ operations plan that includes adaptations.
    b. Alter reservoir flood release operations to match the assumed shift in precipitation patterns.
    c. Perform a sensitivity analysis using a range of possible future climates.
3. BDCP operations must be defined in a clear and concise manner.
    a. Transfer water required to make an alternative feasible should be identified so the effects of that transfer can be determined.
    b. Adaptive management limits and targets must be better defined
    c. Changes to the existing COA to accommodate the BDCP must be defined.
    d. Modeled export operations spilt between the north and south intakes must be consistent with the project description.
    e. Changes in the DCC operations should be defined.
    f. Refined reservoir balancing rules

The BDCP Model must be revised prior to drawing conclusions regarding the environmental effects of the BDCP. The BDCP Model is an outdated version of the CalSim II model, which contains known errors. Only by incorporating the changes made to date by the Reviewers, incorporating the additional recommended changes above, and potential additional refinements can the effects of the BDCP be determined. Reasonable conclusions can only be drawn once these changes are made to the BDCP Model; therefore, the Reviewers recommend that Reclamation and DWR make these changes.

2 INTRODUCTION

The Public Draft BDCP has been prepared by DWR, with assistance and input from Reclamation and various entities that receive water from the SWP and CVP. The BDCP is being prepared to comply with the federal Endangered Species Act, and certain other federal and state mandates. The BDCP proposes a number of Conservation Measures that, if implemented, are believed to provide some benefit to various species covered by the BDCP in the Delta. The Conservation Measures proposed in the Public Draft BDCP include new conveyance facilities and modified operations of the SWP and CVP, as well as other Conservation Measures addressing water quality, predation, and other habitat-related measures. The BDCP has been in development for several years. DWR also has prepared a Public Draft EIR/EIS in an attempt to satisfy CEQA and NEPA. Both the Public Draft BDCP and the Public Draft EIR/EIS were released for public review and comment in December 2013. This Report analyzes the BDCP as proposed and analyzed in the documents released in December 2013.

The Public Draft EIR/EIS considered several water facility and operational configurations, ultimately identifying "Alternative 4" as the preferred alternative under CEQA. (Public Draft EIR/EIS, Section 3.1.1) In addition to identifying physical facilities, the Public Draft EIR/EIS identifies an operational scenario (Alternative 4, Operation Scenario H) as the proposed operation regime for the new and existing facilities. (Public Draft EIR/EIS, Section 3.1.1, Section 5.3.3.9.) Alternative 4, Operational Scenario H is further divided into four sub-operational scenarios, which vary depending on Fall and Spring Delta outflow requirements. Those sub-scenarios are: Alternative 4 Operational Scenario H1 (Alternative 4 H1); Alternative 4 Operational Scenario H2 (Alternative 4 H2); Alternative 4 Operational Scenario H3 (Alternative 4 H3); and Alternative 4 Operational Scenario H4 (Alternative 4 H4). (Public Draft EIR/EIS, section 5.3.3.9.)

In general the differences between the various operational sub-scenarios are as follows. Alternative 4 H1 does not include enhanced spring outflow requirements or Fall X2 requirements. Alternative 4 H2 includes enhanced spring outflow requirements but not Fall X2 requirements. Alternative 4 H3 does not include enhanced spring outflow requirements but includes Fall X2 requirements. Alternative 4 H4 includes both enhanced spring outflow requirements and Fall X2 requirements. (Public Draft EIR/EIS, section 5.3.3.9.) This Report focuses on Alternative 4 H4 and Alternative 4 H3.

The task of the Reviewers was to review the CalSim II modeling which provides the foundational analysis of the BDCP. Results from CalSim II are used to examine how water supply and reservoir operations are modified by the BDCP, and the results are also used by subsequent models to determine physical and biological effects, such as water quality, water levels, temperature, Delta flows, and fish response. Any errors and inconsistencies identified in the underlying CalSim II model are therefore present in subsequent models and adversely affect the results of later analyses based on those subsequent models.

The model used in support of BDCP is the 2010 version of the CalSim II Model (BDCP Model), as well as the information contained in the Public Review Draft BDCP, released in December 2013. Since its development in 2010, the 2010 version of the CalSim II Model has undergone significant revision to not only correct errors in the model, but also to reflect regulatory changes that adversely affect the accuracy and dependability of the 2010 CalSim II Model. The updated version of CalSim II is the model used by DWR in its 2013 State Water Project Water Delivery Reliability Report (2013 CalSim II Model). The BDCP was developed and analyzed using the 2010 CalSim II Model; the changes and improvements reflected in the 2013 CalSim II Model were not used for the BDCP.

The initial review conducted by the Reviewers led to the conclusion that the BDCP Model provides very limited useful information to illustrate the effects of the BDCP. Assumptions, errors, and outdated tools used in the BDCP Model result in impractical or unrealistic CVP and SWP operations. Because of the unrealistic operations included in the BDCP Model, the Reviewers revised the BDCP Model to depict a more accurate, consistent version of current and future benchmark hydrology. The BDCP Model was also revised to depict more realistic CVP and SWP operations upon which to contrast the various BDCP alternatives. The Reviewers made significant efforts to coordinate with or inform Reclamation and DWR managers and modelers, and CVP and SWP operators of the Reviewers' modifications, assumptions, and findings. Where appropriate, the Reviewers also used Reclamation's and DWR's guidance and direction to refine the Reviewers' analysis. Although there are many models used to evaluate various effects of BDCP, this analysis and review focused on water operations analysis using the BDCP Model (CalSim II).

Purpose and Use of the CalSim II Model

The CalSim II model is a computer program jointly developed by DWR and Reclamation. CalSim II presents a comprehensive simulation of SWP and CVP operations, and it is used by DWR as a planning tool to predict future availability of SWP water. CalSim II is widely recognized as the most prominent water management model in California, and it is generally accepted as a useful and appropriate tool for assessing the water delivery capability of the SWP and the CVP.

Broadly speaking, the model estimates, for various times of the year, how much water will be diverted, will serve as instream flows (e.g., flow in the rivers at various locations, such as Delta outflow), and will remain in the reservoirs. Within the context of the BDCP, the CalSim II model is also used to estimate the amount of water that will be diverted from BDCP's proposed NDD facilities. Thus, for BDCP, the CalSim II model estimates how much water will be diverted at the NDD facilities, how much flow will remain in the Sacramento River below Hood (the approximate location of the NDD facilities), how much water will be diverted through the existing SDD facilities at Tracy, how much flow will leave the Delta by flowing out to the Bay, and how much water will remain in storage in the reservoirs. The location and timing of the diversion and the amount of water remaining instream are significant because they can cause impacts on species, water quality degradation, and the like.

The coding and assumptions included in the CalSim II model drive the results it yields. Data and assumptions, such as the amount of precipitation runoff at a certain measuring station over time or the demand for water by specific water users over time, are input into the model. The criteria that are used to operate the CVP and the SWP (including current regulatory requirements) are included in the model as assumptions; because of the volume of water associated with the CVP and the SWP, these operational criteria significantly influence the model's results. Additionally, operational logic is coded into the CalSim II model to simulate how DWR and Reclamation would operate the system under circumstances for which there are no regulatory or otherwise definitive rules (e.g., when to move water from upstream storage to south of Delta storage). This attempt to specify (i.e., code) the logic sequence and relative weighting that humans will use as part of their "expert judgment" is a critical element to the CalSim II model.

The model's ability to reliably predict the effects of a proposed action depends on the accuracy of its coding and its representation of operations criteria. In other words, the model's results will be only as good as its data, coding, assumptions, and judgment and knowledge of the modelers. For this reason, a detailed operating plan of existing facilities and the proposed facility is essential to create an accurate model of how a proposed action will change – i.e., affect – existing water operations. In reviewing the BDCP Model it became apparent that coding errors and operating assumptions are inconsistent with the actual purposes and objectives of the CVP and SWP, thus limiting the utility and accuracy of the results. Through collaboration and verification with CVP and SWP operators, the BDCP Model flaws were corrected in the revised BDCP Model (Independent Model) and the potential effects of the BDCP were re-analyzed.

3 REVIEW OF BDCP CALSIM II MODELING

The CalSim II model is the foundational model for analysis of the BDCP, including the effects analysis in the Draft BDCP and the impacts evaluation in the Draft EIR/EIS. Results from CalSim II are used to examine how water supply and reservoir operations are modified by the BDCP, and the results are also used by subsequent models to determine physical and biological effects, such as water quality, water levels, temperature, Delta flows, and fish response. Any errors and inconsistencies identified in the underlying CalSim II model are therefore present in subsequent models and adversely affect the results of later analyses based on those subsequent models.

The Reviewers' analysis of the BDCP Model is summarized in three categories: (3.1) assessment of climate change assumptions, implementation, and effects; (3.2) assessment of general assumptions and operations; and (3.3) assessment of the assumptions and operational criteria for inclusion of the new BDCP facilities. The issues discussed in (3.1) and (3.2) are relevant for all modeling scenarios, both baseline scenarios that do not include BDCP and with project scenarios that evaluate BDCP or the Alternatives. The issues discussed in (3.3) are specific to the inclusion of the BDCP as defined in the Draft Plan and identified as Alternative 4 in the Draft EIR/EIS.

3.1 Climate Change

Implementation of Climate Change

The analysis presented in the BDCP Documents attempts to incorporate the effects of climate change at two future climate periods: the early long term (ELT) at approximately the year 2025; and the late long term (LLT) at approximately 2060. As described in the BDCP documents[2], other analytical tools were used to determine anticipated changes to precipitation and air temperature that is expected to occur under ELT and LLT conditions. Projected precipitation and temperature was then used to estimate runoff into from the watersheds over an 82-year period of variable hydrology; these time series were then used as inputs into the BDCP Model. A second aspect of climate change, the anticipated amount of sea level rise, is incorporated into the BDCP CalSim II model by modifying flow-salinity relationships that estimate salinity within the Delta based on sea level and flows within Delta channels.

This Report does not evaluate the analytical processes by which reservoir inflows and runoff were developed, nor does it evaluate the modified flow-salinity relationships that are assumed due to sea level rise; those items could be the focus of another independent review. This Report is limited to evaluating how the modified flows were incorporated into the BDCP Model and whether the operation of the CVP and SWP water system in response to the modified flows and the modified flow-salinity relationship is reasonable for the ELT and LLT conditions. This work reviews the assumed underlying hydrology and simulated operation of the CVP/SWP, assumed regulatory requirements, and the resultant water delivery reliability.

Assessment of Climate Change Assumptions and Implementation

To assess climate change, the three Without Project (or "baseline" or "no action") modeling scenarios were reviewed: No Action Alternative (NAA)[3], No Action Alternative at the Early Long Term (NAA – ELT), and No Action Alternative at the Late Long Term (NAA –LLT). Assumptions for NAA, NAA-ELT, and NAA-LLT are provided in the Draft BDCP EIR/EIS Appendix 5A, Section B, Table B-8. The only difference between these scenarios is the climate-related changes made for the ELT and LLT conditions (Table 1).

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[2] BDCP EIR/EIS Appendix 5A, Section A and BDCP HCP/NCCP Appendix 5.A.2

[3] NAA is also called the Existing Biological Conditions number 2 (EBC-2) in the Draft Plan.

Table 1. Scenarios used to evaluate climate change

	Climate Change Assumptions	
Scenario	**Hydrology**	**Sea Level Rise**
No Action Alternative (NAA)	None	None
No Action Alternative at Early Long Term (NAA-ELT)	Modified reservoir inflows and runoff for expected conditions at 2025	15 cm
No Action Alternative at Early Long Term (NAA-LLT)	Modified reservoir inflows and runoff for expected conditions at 2060	45 cm

The differences between the NAA and NAA-ELT reveal the effects of the climate change assumptions under ELT conditions; similarly, the differences between the NAA and NAA-LLT reveal the effects of the climate change assumptions under LLT conditions. Numerous comparisons between NAA, NAA-ELT, and NAA-LLT are discussed in the Technical Appendix of this report; issues that shaped our conclusions are discussed below.

Climate change implementation is incorrect, yielding non-sensible results.

Climate change hydrology in the Upper San Joaquin River basin (above Friant Dam) was incorporated incorrectly into the BDCP Model, resulting in non-sensible results. Because overall CVP operations and the San Joaquin River are interconnected, this error causes problems throughout the CVP system. With the coordinated operations of the CVP and SWP, this error can affect the SWP system.

Specifically, under climate change, inflow to Millerton Lake is expected to decrease (BDCP DEIR/S, Appendix 29B). However, when climate change was implemented into the BDCP Model, it was done incorrectly such that: (1) the inflow into Millerton Lake *was not adjusted* for climate change and is thus overestimated, and yet (2) the flood control operations and water allocation decisions for Millerton Lake *were adjusted* for climate change as if the inflow was reduced. The net effect is that storage in Millerton Lake is overestimated; in fact, the BDCP model indicates that the amount of water stored in Millerton Lake will actually be increased as a result of climate change even though the inflow to the lake is projected to be reduced (i.e., non-sensible). This error results in the overestimation of Millerton Lake storage causing an overestimation of reservoir releases for flood control purposes and available water downstream at the Mendota Pool; these unreasonably high flood releases are then diverted by CVP exchange contractors in lieu of taking CVP Delta water, which means that either CVP Delta exports are reduced or the water is backed up into San Luis Reservoir (SLR), overestimating SLR storage. Furthermore, any excess water from the Millerton Lake that is not diverted at Mendota Pool would continue downstream and ultimately increase Vernalis flow, which subsequently affects Delta exports. Ultimately, changes in exports have the potential to affect upstream reservoir releases (i.e., from Lake Shasta) as well.

This is a situation where one seemingly minor error cascades through the entire system. This error exists in all BDCP Model scenarios (baselines and project alternatives) that have climate change incorporated at either ELT or LLT conditions. In other words, all model results reported in the BDCP and associated Draft EIR/S contain this error, with the only exception of the Existing Biological Conditions baselines numbers 1 and 2 (EBC1 and EBC2), which are evaluated in the BDCP.

Effects of climate change create unrealistic operations.

Review of the BDCP Model output for the Without Project condition with climate change assumptions for the ELT or LLT (NAA-ELT and NAA-LLT, respectively) reveal that the model is operated beyond its usable range. The purpose of CalSim II is to simulate how the CVP and SWP systems would be operated in order to meet regulatory requirements and water delivery objectives based on a certain amount of precipitation and runoff. When the precipitation patterns and resultant runoff were changed in the BDCP Model for climate change, the logic regarding how the system is operated to meet the regulatory and water delivery objectives was not changed. The net effect is that neither the regulatory criteria nor the delivery objectives are met.

With rising temperatures and shifting precipitation patterns with less snow, temperature criteria on the Sacramento River will become increasingly more difficult to meet. For instance, the BDCP Model includes an assumption that equilibrium temperatures in the Sacramento River between Shasta and Gerber will increase on an average annual basis by 1.6°F by 2025 (ELT) by 3.3°F by 2060 (LLT). NMFS 2009 Biological Opinion specifies temperature targets of 56°F in the Sacramento River between Balls Ferry and Bend Bridge for the protection of salmon. Because of lower storage conditions in Shasta Lake and the magnitude of temperature increase in the assumptions is so large, the BDCP Model shows that the probability of exceeding the mortality threshold in the Sacramento River at Bend Bridge in August and September increases from approximately 80% in the No Action Alternative to 90% to 95% by 2025 (under ELT conditions) and to 95% to 100% by 2060 (under LLT conditions). This significant difference shows the overwhelming influence that the climate change assumptions have on the BDCP Model results.

Reservoir Storage: Under the climate change scenarios, reservoir storage (particularly in the CVP system) is operated very aggressively so that the reservoirs are drawn down to an extremely low level (termed “dead pool”) in approximately 1 of every 10 years, even without the BDCP. At dead pool level, little or no water can be released from the reservoir – not for fish, not for drinking water, not for agriculture. For example, since Folsom Reservoir became operational in 1955, the storage has never been drawn down to reach dead pool (which is approximately 100,000 acre-feet); the lowest storage level on record was 147,000 acre-feet at the end of September 1977. However, the BDCP Model predicts that, under climate change, the reservoir will be about 100,000 acre-feet or about 30% lower than its historical low in 10% of years. Some municipalities, such as the city of Folsom, are entirely dependent on reservoir releases for drinking water. Reaching dead pool would cut municipal deliveries below the level required to maintain public health and safety. In reality, and to avoid such dire circumstances, the CVP and SWP would likely request that regulatory agencies modify standards to conserve storage and would likely mandate conservation (or rationing) by water users. Similar steps were taken in early in 2014 to reduce water diversions and reservoir releases for fishery needs and Delta requirements. Emergency measures such as these are not simulated in the model, so the BDCP Model does not reflect reasonable future operations with climate change.

With the predicted changes in precipitation and temperature implemented in the BDCP Model, there is simply not enough water available to meet all regulatory objectives and water user demands. Yet the BDCP Model continues its normal routine and thus fails to meet its objectives. In this aspect, the BDCP Model simply does not simulate reality. For instance, if the ELT and LLT conditions actually occur, the CVP and SWP would likely adapt to protect water supplies and the environment. Examples of reactions to climate change would likely include: (1) updating operational rules regarding water releases for flood protection; (2) during severe droughts, emergency drought declarations could call for mandatory conservation and changes in some regulatory criteria similar to what has been experienced in the current and previous droughts ; and (3) if droughts become more frequent, the CVP and SWP would likely revisit the rules by which they allocate water during shortages and operate more conservatively in wetter years. The likelihood of an appropriate operational response to climate change is supported by the many modifications to CVP and SWP operations made during the winter and spring of 2014 to respond to the current drought. The BDCP Model is, however, useful in that it reveals that difficult decisions must be made.

Conclusions Regarding Climate Change Assumptions and Implementation

Water Code section 85320, subdivision (b)(2)(C) requires consideration of, among other things, the “potential effects of climate change, possible sea level rise up to 55 inches, and possible changes in total precipitation and runoff patterns on the conveyance alternatives and habitat restoration activities considered in the environmental impact report". In examining the possible effects of climate change, it is not appropriate to assume that current project operations will remain static and not respond to climate change. The BDCP's simplistic approach of assuming a linear operation of the CVP and SWP produces results that are not useful for dealing with the complex problem of climate change because it does not reflect the way in which the CVP and the SWP would actually operate whether or not the BDCP is implemented. The Reviewers recommend a sensitivity analysis be conducted to develop a better understanding of the range of possible responses to climate change by the CVP and SWP, and the regulatory structures that dictate certain project operations.

Including climate change, without adaptation measures, results in insufficient water needed to meet all regulatory objectives and user demands. For example, the BDCP Model results that include climate change indicate that during droughts, water in reservoirs is reduced to the minimum capacity possible. Reservoirs have not been operated like this in the past during extreme droughts and the current drought also provides evidence that adaptation measures are called for long in advanced to avoid draining the reservoirs. In this aspect, the BDCP Model simply does not reflect a real future condition. Foreseeable adaptations that the CVP and SWP could make in response to climate change include: (1) updating operational rules regarding water releases for flood protection; (2) during severe droughts, emergency drought declarations could call for mandatory conservation; and (3) if droughts become more frequent, the CVP and SWP would likely revisit the rules by which they allocate water during shortages and operate more conservatively in wetter years. The modifications to CVP and SWP operations made during the winter and spring of 2014 in response to the drought supports the likelihood of future adaptations. The BDCP Model is, however, useful in that it reveals that difficult decisions must be made in response to climate change. But, in the absence of making those decisions, the BDCP Model results themselves are not informative, particularly during drought conditions. With future conditions projected to be so dire without the BDCP, the effects of the BDCP appear positive simply because it appears that conditions cannot get any worse (i.e., storage cannot be reduced below its minimum level). However, in reality, the future condition will not be as depicted in the BDCP Model. The Reviewers recommend that Reclamation and DWR develop more realistic operating rules for the hydrologic conditions expected over the next half-century and incorporate those operating rules into the any CalSim II Model that includes climate change.

3.2 General Assumptions and Operations

BDCP CalSim II Assumptions

The assumptions for these runs are defined in the December 2013 Draft BDCP[4] and associated Draft EIR/S.

Each of the no action alternatives assumes the same regulatory requirements, generally representing the existing regulatory environment at the time of study formulation (February 2009), including Stanislaus ROP the National Marine Fisheries Services (NMFS) Biological Opinion (BO) (June 2009) Actions III.1.2 and III.1.3, Trinity Preferred EIS Alternative, NMFS 2004 Winter-run BO, NMFS BO (June 2009) Action I.2.1, SWRCB WR90-5, CVPIA (b)(2) flows, NMFS BO (June 2009) Action I.2.2, ARFM NMFS BO (June 2009) Action II.1, no SJRRP flow modeled, Vernalis SWRCB D1641 Vernalis flow and WQ and NMFS BO (June 2009) Action IV.2.1, Delta D1641 and NMFS Delta Actions including Fall X2 Fish & Wildlife Service (FWS) BO (December 2008) Action 4, Export restrictions including NMFS BO (June 2009) Action IV.11.2v Phase II, OMR FWS BO (December 2008) Actions 1-3 and NMFS BO (June 2009) Action IV.2.3v.

The modeling protocols for the recent USFWS BO (2008) and NMFS BO (2009) have been cited as being cooperatively developed by Reclamation, NMFS, U.S. Fish and Wildlife Service (USF&WS), California Department of Fish and Wildlife (CDF&W), and DWR.

[4] BDCP EIR/EIS Appendix 5A

Each of the BDCP no action alternatives (NAA, NAA-ELT, and NAA-LLT) uses the same New Melones Reservoir and other San Joaquin River operations. At the time of these studies' formulation, the NMFS BO (June 2009) had been recently released. Also, the San Joaquin River Agreement (SJRA), including the Vernalis Adaptive Management Program (VAMP) and its incorporation into D1641 for Vernalis flow requirements were either still in force or being discussed for extension. As a component of study assumptions, the protocols of the SJRA and an implementation of the NMFS BO for San Joaquin River operations (including New Melones Reservoir operations) are included in the studies. These protocols, in particular the inclusion of VAMP which has now expired, are not appropriate as an assumption within either the No Action or Alternative Scenarios within a full disclosure of BDCP impacts. Although appropriate within the identification of actions, programs and protocols present at the time of the NOI/NOP, they are not representative of current or reasonably foreseeable operations. Also, the BDCP Model assumes no San Joaquin River Restoration Program releases in the future operation of the Friant Division of the CVP. While assuming no difference in the current and future operation of the Friant Division avoids another difference in existing and projected future hydrology of the San Joaquin River, the assumption does not recognize the existence of the San Joaquin River Restoration Program. Results of CVP and SWP operations, in particular as affected by export constraints dependent on San Joaquin River flows and their effect on OMR, E/I and I/E diversion constraints, would be different with a different set of assumptions for San Joaquin River operations, in a manner similar to the cascading effect described above in connection with climate change.

Finally, the habitat restoration requirements in the 2008 FWS BO and the 2009 NMFS BO are not included in the NAA baselines. Although the restoration is required to be completed either with or without completion of the BDCP, the restoration was only analyzed as part of the with project scenarios.

Conclusions Regarding General Assumptions and Operations

<u>The benchmark study upon which the BDCP Model was built contains inaccuracies that affect the analysis.</u>

CalSim II is continuously being improved and refined. As the regulatory environment changes and operational and modeling staff work together to improve the model's capability to simulate actual operations, the model is continually updated. The BDCP Model relied upon a version of CalSim II that dates back to 2009, immediately after the new biological opinions (BiOps) from the NMFS and the United States Fish and Wildlife Service (USFWS) significantly altered the operational criteria of the CVP and SWP. In the last 4 to 5 years, DWR, Reclamation, and outside modeling experts have worked together to improve the model. Changes include better (more realistic) implementation of the new BiOps and numerous fixes to the code. Since CalSim II is undergoing continual improvements, there will always be "vintage" issues in that by the time a project report is released, the model is likely slightly out of date. However, in this case - with the major operational changes that have occurred in the new regulatory environment – many issues have been identified and fixed in the last 4 to 5 years that have a significant effect on model results. CalSim II modeling for the DWR 2013 Delivery Reliability Report contains numerous modeling updates and fixes that significantly alter results of the BDCP Model. A key modeling revision in the 2013 DWR modeling was fixing an error regarding artificial minimum instream flow requirements in the Sacramento River at Hood. An "artificial" minimum instream flow requirement had been specified; the requirement is artificial in that it does not represent a regulatory requirement, but rather is a modeling technique to force upstream releases to satisfy Delta needs.

3.3 Assumptions and Operational Criteria for inclusion of proposed BDCP facilities

To evaluate the assumptions and operations of the proposed BDCP facilities, the Reviewers analyzed the output from the BDCP Model and examined the internal workings of the models. This approach allows for evaluation of not only the possible effects of the BDCP, also but whether the assumptions and operational criteria are implemented appropriately to reflect the project description and reasonably foreseeable actions.

Assessment of Assumptions and Operations in coordination with new BDCP facilities

BDCP's Alternative 4 has four possible sets of operational criteria, termed the Decision Tree, that differ based on the "X2" standards[5] that they contemplate:

- Low Outflow Scenario (LOS), otherwise known as operational scenario H1, assumes existing spring X2 standard and the removal of the existing Fall X2 standard;
- High Outflow Scenario (HOS), otherwise known as H4, contemplates the existing Fall X2 standard and providing additional outflow during the spring;
- Evaluated Starting Operations (ESO), otherwise known as H3, assumes continuation of the existing X2 spring and fall standards;
- Enhanced spring outflow only (not evaluated in the December 2013 Draft BDCP), scenario H2, assumes additional spring outflow and no Fall X2 standards.

While it is not entirely clear how the Decision Tree would work in practice, the general concept is that prior to operation of the new facility, implementing authorities would select the appropriate Scenario (from amongst the four choices) based on their evaluation of targeted research and studies to be conducted during planning and construction of the facility.

For this analysis, the Reviewers analyzed the HOS (or H4) scenario because the BDCP[6] indicates that the initial permit will include HOS operations that may be later modified at the conclusion of the targeted research studies. The HOS includes the existing Fall X2 requirements but adds additional outflow requirements in the spring. The model code was reviewed and discussed with DWR and Reclamation, who acknowledged that although the SWP was bearing the majority of the responsibility for meeting the additional spring outflow in the modeling, the responsibility would need to be shared with the CVP[7]. In subsequent discussions, DWR and Reclamation have suggested that the additional water may be purchased from other water users. However, the actual source of water for the additional outflow has not been defined. While not how the projects would actually be operated, since the BDCP Model assumes that the SWP bears the majority of the responsibility for meeting the additional outflow, the Reviewers' analysis of the BDCP Model results for HOS is limited to the evaluation of how the SWP reservoir releases on the Feather River translate into changes in Delta outflow and exports.

Our remaining analysis examines the ESO (or H3) scenario (labeled Alt 4-ELT or Alt 4-LLT in this section) because it employs the same X2 standards as are implemented in NAA-ELT and NAA-LLT. This allowed the Reviewers to focus the analysis on the effects of the BDCP operations independent of the possible change in the X2 standard.

The differences between the without project scenario (NAA-ELT) and the corresponding with project scenario (Alt4 H3-ELT) should reveal the effects of the project under ELT conditions. However, as discussed above, implementation of climate change assumptions and the occurrence of unrealistic operations likely obfuscates the effects of the BDCP. Although the modeling approach may provide a relative comparison between equal foundational operations, the Reviewers are hesitant to place any confidence in the computed differences shown between the NAA-ELT and Alt4-ELT Scenarios. Numerous comparisons between NAA-ELT and Alt4 H3-ELT are discussed in the technical appendix of this report; issues that shaped our conclusions are discussed below.

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[5] X2 is a salinity standard that requires outflows sufficient to attain a certain level of salinity at designated locations in the Delta at certain times of year.
[6] Draft BDCP, Chapter 3, Section 3.4.1.4.4
[7] August 7, 2013 meeting with DWR, Reclamation, and CH2M HILL

Assumptions for the "High Outflow Scenario" are unrealistic.

The HOS is one branch of the BDCP Decision Tree, also identified as Alternative 4, operational scenario H4 in the DEIR/EIS. The HOS requires additional water (Delta outflow) during certain periods in the spring, in excess of the current regulatory requirements. The BDCP Model assumes that if the required additional Delta outflow cannot be met by reducing exports, this increased Delta outflow will be met by releases made by the SWP's Oroville Reservoir. The assumptions regarding how much water to release from Oroville to attempt to meet the proposed regulations and how much and when to refill Oroville are unrealistic.

According to the Draft EIR/EIS[8], the HOS will reduce SWP south of Delta water deliveries for municipal and industrial (M&I) water users 7% below the level that they would receive without the BDCP (on average). During dry and critical years, SWP south of Delta water deliveries for M&I and agricultural water users will drop 17% below the level that they would receive without the BDCP. In other words, according to the BDCP Model results SWP Contractors would get less water than they would otherwise get without BDCP.

CVP and SWP obligations for providing flow to satisfy Delta outflow requirements is described in the Coordinated Operations Agreement (COA). Because the CVP and SWP share responsibility for meeting required Delta outflow based on specific sharing in the agreement, it is not reasonable to conclude that CVP water supplies would increase an average of 70 TAF while SWP water supplies decrease on average of 100 TAF under the HOS. The manner in which this alternative is modeled is inconsistent with existing agreements and operating criteria. If the increases in outflow were met based on COA, there would likely be reductions in Shasta and Folsom storage that would likely cause adverse environmental impacts, which have not been modeled or analyzed in the BDCP EIR/S.

Furthermore, there is no apparent source of water to satisfy the increased outflow requirements and pay back the COA debt. It appears, through recent public discussions regarding the HOS that BDCP anticipates additional water to satisfy the increased Delta outflow requirement and to prevent the depletion of cold water pools will be acquired through water transfers from upstream water sources. However, this approach is unrealistic. During most of the spring, when BDCP proposes that Delta outflow be increased, agricultural water users are not irrigating. This means that there is not sufficient transfer water available to meet the increased Delta outflow requirements without releasing stored water from the reservoirs.

San Luis Reservoir operational assumptions produce results that are inconsistent with real world operations.

San Luis Reservoir (SLR) is an off-stream reservoir located south of the Delta and jointly owned and operated by CVP and SWP. The reservoir is used to store water that is exported from the Delta when available and used to deliver water to CVP and SWP Contractors when water demands exceed the amount of water that can be pumped from the Delta. The decision of when to move water that is stored in upstream reservoirs, such as Shasta, Folsom, or Oroville, through the Delta for export to fill SLR is based on the experience and expert judgment of the CVP and SWP operators.

CalSim II attempts to simulate the expert judgment of the operators by imposing artificial operating criteria; the criteria are artificial in the sense that they are not imposed by regulatory or operational constraints but rather imposed as a tool to simulate expert judgment. One such artificial operating criteria is the SLR target storage level: CalSim II attempts to balance upstream Sacramento Basin CVP and SWP reservoirs with storage in SLR by setting artificial target storage levels in SLR, such that the CVP and SWP will release water from upstream reservoirs to meet target levels in SLR. The artificial target storage will be met as long as there is ability to convey

[8] Draft EIR/EIS, Appendix 5A-C, Table C-13-20-2

water (under all regulatory and physical capacity limits) and as long as water is available in upstream reservoirs. SLR target storage criteria are also sometimes described in section 4.2 as the “San Luis rule-curve”.

In the BDCP Model, CVP and SWP reservoir operating criteria for Alternative 4 H3 ELT differ from the corresponding without project scenario (e.g. NAA-ELT). The difference in criteria and result is primarily driven by changes to the artificial constraint used to determine when to fill SLR: the SLR target storage. In Alternative 4 H3 ELT, SLR target storage is set very high in the spring and early summer months, and then reduced in August and set to SLR dead pool from September through December. This change in SLR target storage relative to the no action alternative causes upstream reservoirs to be drawn down from June through August and then recuperate storage by cutting releases in September. This change to the artificial operating criteria SLR target storage causes changes in upstream cold water pool management and affects several resource areas.

In addition to changes in upstream storage conditions, changes in SLR target storage cause SLR storage to drop below a water supply concern level (300,000 acre-feet) in almost 6 out of every 10 years under ELT conditions and more than 7 out of every 10 years under LLT conditions for Alternative 4 H3. When storage in SLR drops below this 300,000 acre-foot level, algal blooms in the reservoir often cause water quality concerns for drinking water at Santa Clara Valley Water District. The change in SLR target storage also causes SLR levels to continue to drop and reach dead pool level for the SWP in 4 out of every 10 years and also dead pool level for the CVP in 1 out of every 10 years under the ELT conditions.

Reaching dead pool level in SLR creates shortages to water users south of the Delta. Although some delivery shortages are due to California Aqueduct capacity constraints, the largest annual delivery shortages are a result of inappropriately low SLR target storage. Average annual Table A shortages due to artificially low SLR storage levels increased from 3 TAF in the NAA-ELT scenario to 35 TAF in the Alt4-ELT scenario. Such shortages occurred in 2% of simulated years in the NAA-ELT scenario and 23% of years in the Alt4-ELT scenario. In addition to the inability to satisfy Table A allocations, low storage levels cause loss of SWP Contractors’ Article 56 water stored in SLR. Average annual Article 56 shortages were 43 TAF in the Alt4-ELT scenario because of low San Luis storage and 5 TAF in the NAA-ELT scenario. Low San Luis storage causes Article 56 shortages in 27% of simulated years in the Alt4-ELT scenario as compared to 5% of simulated years in the NAA-ELT. Another consequence of low storage levels in SLR is a shift in water supply benefits from Article 21 to Table A.

In summary, the operational assumptions for SLR are unrealistic in Alternative 4 because they create problems in upstream storage reservoirs and create shortages for south of Delta water users that would not occur in the real world. In reaching this conclusion, the Reviewers met with operators from CVP and SWP to review the BDCP Model results and discussed real-time operations. The operators provided guidance in selection of superior assumptions, which results in more realistic operations in the independent model (see Section 4).

Delta Cross Channel operational assumptions overestimate October outflow

When south Delta exports are low due to regulatory limits, and upstream reservoirs are making releases to meet the instream flow objectives at Rio Vista, operators have the ability to close the Delta Cross Channel (DCC) in order to reduce the required reservoir releases (by closing the DCC a greater portion of water released from the reservoirs stays in the Sacramento River to meet the Rio Vista requirements). As long as the Delta salinity standards are met, operators have indicated that they would indeed close the DCC in this manner (as was done in October and November 2013). In the BDCP Model, the DCC is not closed in this manner. The net result is that the BDCP Model overestimates outflow under such circumstances typically occurring in October.

The overestimated outflow leads to incorrect conclusions regarding the effects of BDCP. For instance, an actual increase in fall outflow could be beneficial for the endangered fish species delta smelt (USFWS, 2008). Therefore, by overestimating outflow in October, the BDCP studies likely overestimate the benefit to delta smelt (Mount et al, 2013). Similarly, an actual increase in fall outflow would reduce salinity in the western Delta, which could be beneficial for in-Delta diverters; therefore, overestimating outflow in October artificially reduces salinity, incorrectly reducing the net impacts on in-Delta diverters.

Conclusions Regarding Assumptions and Operations in coordination with new BDCP facilities

BDCP's "High Outflow Scenario" is not sufficiently defined for analysis.

The HOS requires additional water (Delta outflow) during certain periods in the spring. The BDCP Model places most of the responsibility for meeting this new additional outflow requirement on the SWP. However, the SWP may not actually be responsible for meeting this new additional outflow requirement. This is because the COA, as it is currently being implemented, would require a water allocation adjustment that would keep the SWP whole. Where one project (CVP or SWP) releases water to meet a regulatory requirement, the COA requires a water balancing to ensure the burden does not fall inappropriately among the projects. The BDCP Model is misleading because it fails to adjust project operations, as required by the COA, to "pay back" the water "debt" to the SWP due to these additional Delta outflow requirements. Unless there is a significant revision to COA, the BDCP Model overstates the impacts of increased Delta outflow on the SWP and understates the effects on the CVP.

Furthermore, after consulting with DWR and Reclamation project operators and managers, the Reviewers conclude that there is no apparent source of CVP or SWP water to satisfy both the increased Delta outflow requirements and pay back the COA "debt" to the SWP without substantially depleting upstream water storage. It appears, through recent public discussions regarding the HOS, that BDCP anticipates additional water to satisfy the increased Delta outflow requirement and to prevent the depletion of cold water pools will be acquired through water transfers from upstream water users. However, this approach is unrealistic because during most of the spring, when BDCP proposes that Delta outflow be increased, agricultural water users are not typically irrigating. This means that there is not sufficient transfer water available to meet the increased Delta outflow requirements without releasing stored water from the reservoirs. Releasing stored water to meet the increased Delta outflow requirements could potentially impact salmonids on the Sacramento and American River systems.

Simulated operation of BDCP's dual conveyance, coordinating proposed North Delta diversion facilities with existing south Delta diversion facilities, is inconsistent with the project description.

The Draft BDCP and associated Draft EIR/EIS specify criteria for how much flow can be diverted by the new NDD facilities and specify when to preferentially use either the NDD facilities or the existing SDD facilities. However, the BDCP Model contains an artificial constraint that prevents the NDD facilities from taking water as described in the BDCP project description. In addition to affecting diversions from the NDD, this artificial constraint contains errors that affect the NAA operation. This error has been fixed by DWR and Reclamation in more recent versions of the model; however, the error remains in the BDCP Model. Additionally, the BDCP Model does not reflect the Summer operations of the SDD that are described in the Draft EIR/EIS as a feature of the BDCP project intended to prevent water quality degradation in the south Delta. The net effect of these two errors is that the BDCP Model significantly underestimates the amount of water diverted from the NDD facilities and overestimates the amount of water diverted from the SDD.

BDCP Model contains numerous coding and data issues that skew the analysis and conflict with actual real-time operational objectives and constraints

Operational logic is coded into the CalSim II model to simulate how DWR and Reclamation would operate the system under circumstances for which there are no regulatory or other definitive rules. This attempt to specify (i.e., code) the logic sequence and relative weighting so that a computer can simulate "expert judgment" of the human operators is a critical element to the CalSim II model. In the BDCP Model, some of the operational criteria for water supply allocations and existing facilities such as the Delta Cross Channel and SLR are inconsistent with real-world conditions.

4 INDEPENDENT MODELING

The Independent Modeling effort originally stemmed from reviews of BDCP Model during which the Reviewers discovered that the BDCP Model did not provide adequate information to determine the effects of the BDCP. There are three basic reasons why the Reviewers cannot assess how the BDCP will affect water operations: 1) NAAs do not depict reasonable operations under the described climate change assumptions, 2) operating criteria used in the BDCP Alternative 4 result in unrealistic operations, and 3) updates to CalSim II since the BDCP modeling was performed almost 4 years ago will likely alter model results to a sufficient degree that conclusions based on the BDCP modeling will likely be different than those disclosed in the Draft EIR/EIS. Given that it is not possible to determine how BDCP may affect CVP and SWP operations or water system flows and conditions with the BDCP model, Independent Modeling was performed to assess potential effects due to the BDCP.

To revise the models, the Reviewers consulted with operators at DWR and Reclamation to improve the representation of operational assumptions. Additionally, the Reviewers consulted with modelers at DWR and Reclamation to share findings, to strategize on the proper way to incorporate the guidance received from the operators, and to present revised models to DWR and Reclamation for their review. This collaborative and iterative process differed considerably from a standard consulting contract where the work product is not shared beyond the client-consultant until a final version is complete. To the contrary, consultations with agency experts were conducted early and repeatedly to ensure the revisions would reflect reasonable operations and to provide an independent review.

The first phase of this Independent Modeling effort (described in Section 4.1) was development of an updated without project baseline (similar to the NAA but with current, improved assumptions). The Independent Modeling does not incorporate climate change because the climate change hydrological assumptions developed by BDCP cause unrealistic operation of the system absent commensurate changes to operating criteria.

After the baseline was complete and reviewed, the second phase of this effort (described in Section 4.2) incorporated the facilities and operations for the BDCP described as Alternative 4 H3 in the Draft EIR/EIS, and otherwise known as the Evaluated Starting Operations (ESO) scenarios in the BDCP. During this phase, the issues that were identified during the Reviewers' initial review were corrected (see Section 3.3) along with corrections made to resolve additional issues that were revealed as improvements were incorporated. Finally, results of the Independent Modeling and potential effects of the BDCP on water supply and instream flows are discussed in Section 4.3.

4.1 Improvements to CalSim II Assumptions

For this effort, the most up to date modeling tools were provided by DWR and Reclamation and further improvements were added to the CalSim II assumptions in coordination with DWR and Reclamation staff. Many of the improvements have since been incorporated into DWR and Reclamation's model and others are under review.

Revisions incorporated by DWR and Reclamation for the 2013 baseline

DWR and Reclamation provided CalSim II models used for the 2013 SWP Delivery Reliability Report (DRR) for use in this Independent Modeling effort. The 2013 SWP DRR, Technical Addendum, and associated models are now available on DWR's website[9]. Assumptions used for this Independent Modeling effort are consistent with the 2013 SWP DRR and are listed in Table 4 of the Technical Addendum.

[9] http://baydeltaoffice.water.ca.gov/swpreliability/

CalSim II is continuously being improved to better represent CVP and SWP operations and fix known problems. The Technical Addendum to the 2013 SWP DRR contains a list of updates and fixes that have occurred since the last SWP DRR was released in 2011. Among these changes and fixes are key items that directly affect operation of facilities proposed in the BDCP Alternative 4; these items are listed on pages 4-6 of the 2013 SWP DRR Technical Addendum.

A key component of this package of modeling revisions was fixing an error regarding artificial minimum instream flow requirements in the Sacramento River at Hood. An “artificial” minimum instream flow requirement had been specified; the requirement is artificial in that it does not represent a regulatory requirement, but rather is a modeling technique.

Additional Revisions to CalSim II Assumptions

As part of the Independent Modeling effort, a number of changes were made to the 2013 SWP DRR version of CalSim II to better represent the existing facilities, regulatory requirements, and water user demands. These revisions are described in the Technical Appendix and summarized here:

- San Joaquin River Restoration Program (SJRRP) was not incorporated. This modification was made to be consistent with the BDCP assumptions, but also allows the identification of the separate effect of the BDCP void of the combined effect with SJRRP flows. Although inclusion of the SJRRP is necessary in the documentation of BDCP, the Independent Modeling did not include it.
- VAMP operations were not incorporated because the VAMP program has expired and is no longer being implemented.
- Tuolumne River basin was updated.
- Folsom Reservoir operations for flood control were updated.
- Additional water demands on the Feather River were incorporated to represent existing agricultural diversions used for rice decomposition.
- Diversions by East Bay Municipal Utility District (EBMUD) from the Sacramento River at Freeport were modified to better represent the EBMUD CVP water service contract.
- Minimum flow requirements for Wilkins Slough and Red Bluff were corrected for September 1933.
- CVP M&I demands are updated to reflect current assumptions used by Reclamation.
- Modifications were made to more accurately reflect refilling of New Bullards Bar Reservoir in coordination with transfers made under the Yuba Accord.
- Los Vaqueros Reservoir capacity was updated to reflect a recent expansion of the reservoir that was completed in 2012.

4.2 Improvements to BDCP Operations

After the baseline was completed and reviewed (as summarized above in Section 4.1), the facilities and operations associated with BDCP Alternative 4 H3 in the Draft EIR/EIS, otherwise known as the Evaluated Starting Operations (ESO) scenarios in the Draft Plan, were incorporated into the model. During this phase, the issues that were identified during the Reviewers’ initial review (see Section 3.3) were corrected along with correcting additional issues that were revealed as improvements were incorporated. These revisions are described in the Technical Appendix and summarized here:

- San Luis Reservoir operation
- Delta Cross Channel gate operation in October
- Delivery allocation adjustment for CVP SOD contractors

- Folsom/Shasta balance
- North Delta Diversion bypass criteria
- Wilkins Slough minimum flow requirement

In the Independent Modeling, San Luis rule-curve logic was refined for both SWP and CVP operations. San Luis rule-curve is used to maintain an appropriate balance between San Luis Reservoir (SLR) storage and North of Delta reservoirs. The key considerations in formulating rule-curve are 1) ensuring that sufficient water is available in SLR to meet contract allocations when exports alone are insufficient due to various operational constraints and 2) minimize SLR carryover storage to low point criteria (both CVP and SWP) and Article 56 carryover (only SWP). The basic premise is to maintain SLR storage no higher than necessary to satisfy south of Delta obligations to avoid excessive drawdown of upstream storage.

In the BDCP NAA and the Independent Modeling FNA, the model has a priority to release excess stored water that will likely be released for flood control purposes from Shasta and Folsom storage for export at Jones Pumping Plant to storage in SLR in the late summer and early fall months. The purpose was to get a head start on filling SLR for the coming water year if there is a high likelihood of Shasta or Folsom spilling. This was an assumed CVP/SWP adaptation to the export reductions in the winter and spring months due to the salmon and smelt biological opinions. However, with the NDD facility in Alt 4, winter and spring export restrictions impact CVP exports much less and there is no longer a reason to impose this risk on upstream storage. As such, the weights, or prioritizations, of storage in Shasta and Folsom were raised so that excess water would not be released specifically to increase CVP San Luis storage Reservoir above rule-curve. This was changed in Alt 4 and not the FNA to better reflect how the system may operate under these different conditions.

The BDCP Alt 4 results in significantly more October surplus Delta outflow as compared to the baseline. The cause of this Delta surplus at a time when the Delta is frequently in balance is a combination of proposed through-Delta export constraints Old and Middle River (OMR) flow criteria and no through-Delta exports during the San Joaquin River October pulse period), Rio Vista flow requirements, and DCC gate operations. In DWR's BDCP studies, it was assumed that the DCC gates would be open for the entire month of October thereby requiring much higher Sacramento River flows at Hood in order to meet the Rio Vista flow requirement than if the DCC gates were closed. Whereas in the Independent Modeling of the BDCP it was assumed that the DCC gates were closed for a number of days during the month such that the 7,000 cfs NDD bypass criteria would be sufficient to meet the weekly average Rio Vista flow requirements. The intent was to minimize surplus Delta outflow while meeting Delta salinity standards and maintaining enough bypass flow to use the NDD facility for SDD. This is an approximation of what is likely to occur in real-time operations under similar circumstances. Further gate closures may be possible as salinity standards allow if operators decide to preserve upstream storage at the expense of NDD diversions. This type of operation would require additional model refinements.

CVP SOD Ag service and M&I allocations are limited by both system wide water supply (storage plus inflow forecasts) and Delta export constraints; whereas similar CVP NOD allocations are dependent solely on water supply. This frequently results in SOD water service contractors receiving a lower contract year allocation than NOD water service contractors, especially under the Biological Opinion export restrictions. However, with the NDD facility operations as proposed under Alt 4 H3, the CVP can largely bypass these Delta export restrictions and the export capacity constraint on CVP SOD allocations was determined to be overly conservative. Therefore, the export capacity component of CVP SOD allocations was removed in the BDCP Alternative and both SOD and NOD CVP allocations are equal and based only on water supply.

For the Independent Modeling, CVP operations were refined in the BDCP Alternative to provide maximum water supply benefits to CVP contractors while protecting Trinity, Shasta, and Folsom carryover storage in the drier years. As a whole, this was accomplished with refinements to allocation logic and San Luis rule-curve. However, in the initial study runs, an imbalance between Folsom and Shasta was created; while there was a total positive impact to upstream storage in dry years, there was a negative impact to Folsom storage. This was resolved by inserting Folsom protections in the Shasta-Folsom balancing logic. With these protections, the positive carryover impacts were distributed to Trinity, Shasta, and Folsom.

The daily disaggregation method for implementing NDD bypass criteria as implemented in DWR's BDCP model was left mostly intact for the Independent Modeling. However, to properly fit the bypass criteria implementation within the latest CalSim operations formulation certain modifications were made. Modifications are as follows:

1. No NDD operations occur in cycles 6 through 9 so that Delta operations and constraints can be fully assessed without NDD interference.
2. Cycles 10 and 11 (Daily 1 and Daily 2 respectively) were added to determine NDD operations given various operational constraints including the NDD bypass criteria.
3. From July to October, bypass criteria are based on monthly average operations (no daily disaggregation). Given the controlled reservoir releases at this time and the constant bypass criteria (5,000 cfs from July to September and 7,000 cfs in October), this was determined to be a reasonable assumption. This also simplified coordination of DCC gate operations with NDD in October which will be discussed later.
4. When warranted by conditions in cycle Daily 1 (cycle 10), the bypass criteria in May and June were allowed to be modeled on a monthly average basis in cycle Daily 2 (cycle 11). This allowed a reduction in the number of cycles necessary to determine the fully allowed diversion under the bypass criteria when the Delta was in balance and additional upstream releases were made to support diversions from the North Delta.

Currently in CalSim II, relaxation of the Wilkins Slough minimum flow requirement is tied to CVP NOD Ag Service Contractor allocations. This does not reflect actual operations criteria where relaxation of the flow requirement is dependent solely on storage conditions at Shasta. From the comparative analysis perspective of our CalSim planning studies, this introduces a potential problem: changes in CVP NOD Ag Service allocations can result in unrealistic changes in required flow at Wilkins Slough, and such changes in Wilkins Slough required flow can result in unrealistic impacts to Shasta storage. To bypass this problem, we assumed that the required flow at Wilkins Slough in the alternative was equal to the baseline.

4.3 Independent Modeling output and analysis of BDCP Effects

Analysis for this effort was focused on BDCP Alt 4 with existing spring and Fall X2 requirements, which corresponds to "Alternative 4 H3" in the Decisions Tree. This modeling is performed without climate change, and includes refined operating criteria for the NDD, CVP and SWP reservoirs, DCC gate closures, and water supply allocations. This modeling includes all Project features that are included in Alt 4 in the BDCP Model. The key Project features incorporated into BDCP are displayed in Figure 1 and summarized as:

- North Delta Diversion capacity of 9,000 cfs
- NDD bypass flow requirements
- 25,000 acres of additional tidal habitat
- Notched Fremont Weir to allow more flow into Yolo Bypass
- Additional positive Old and Middle River flow requirements
- Removal of the San Joaquin River I/E ratio (NMFS 2009)
- Changed location for Emmaton water quality standard in SWRCB D-1641
- Additional Sacramento River flow requirement at Rio Vista

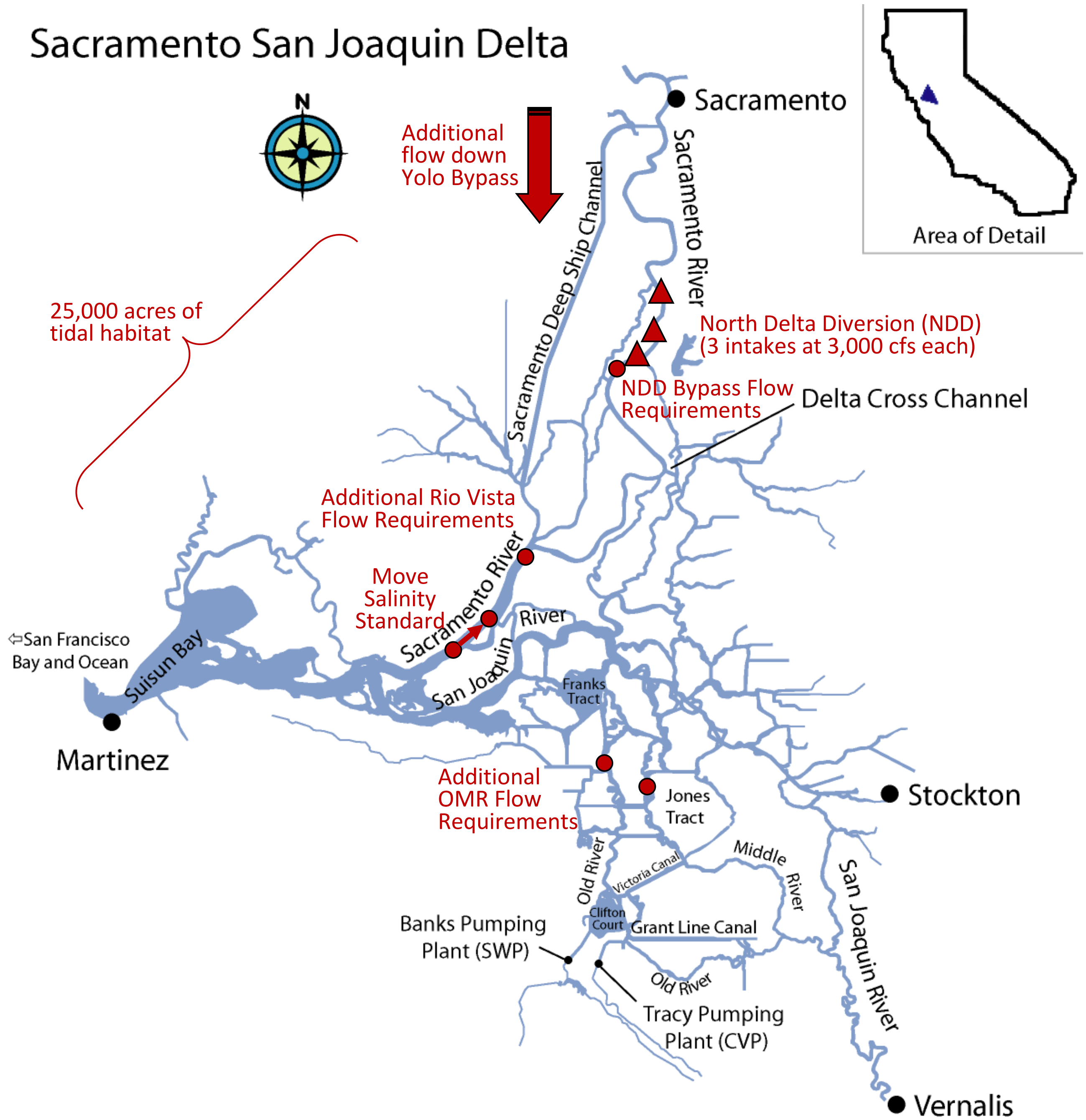

Figure 1. Map of Delta with location of key BDCP facilities and regulatory changes
Annual maximum and minimum storage in San Luis for the (a) CVP and (b) SWP under ELT conditions for the no action alternative (NAA_ELT) and BDCP Alternative 4 H3 (Alt4_ELT).

For the purpose of describing results of the Independent Modeling, the revised baseline scenario without climate change, originally termed No Action Alternative (NAA) in the BDCP Draft EIR/EIS, is referred to as the Future No Action (FNA) in this discussion. Additionally, in the Independent Modeling, Alternative 4 operational scenario H3 without climate change is simply referred to as "Alt 4". The results for the Independent Modeling are illustrated in the Technical Attachment. Key results are presented below.

The change in conditions between FNA and Alt 4 is indicative of the effects of the BDCP on water supply and Delta flows. An effect of the BDCP is an anticipated increase in Delta export and corresponding decrease in Delta Outflow. Table 2 illustrates the estimated change in Delta Outflow by year type, amounting to an average annual 0.76 MAF. Table 3 illustrates the corresponding change in exports by year type, and also illustrates the estimated change in geographical source of export water. With the BDCP it is anticipated that exports from the South Delta (via through Delta conveyance) will decrease by 2.53 MAF. Exports derived from the North Delta (via the tunnels) will amount to 3.28 MAF.

Table 2. Change in Delta outflow due to the BDCP (Alt 4 minus FNA) (Million Acre-Feet)
Reduction in the quantity of water that leaves the Delta by flowing west into San Francisco Bay by water year type.

Water Year Type	FNA Delta Outflow	Change in Delta Outflow
Wet	28.6	-1.2
Above Normal	17.1	-1.0
Below Normal	9.9	-0.68
Dry	7.3	-0.39
Critical	5.1	-0.13
Average	15.6	**-0.76**

Table 3. Change in quantity of water exported due to the BDCP (Alt 4 minus FNA) (Million Acre-Feet)
Reduction in the quantity of water exported from the existing South Delta export facilities and corresponding increase in the quantity exported from the proposed facilities in the North Delta, by water year type.

Water year Type	FNA Total Delta Export	Change in South Delta Exports (through Delta)	Change in North Delta Exports (through tunnels)	Change in Total Exports
Wet	6.0	-3.8	5.0	1.2
Above Normal	5.2	-2.9	4.4	1.5
Below Normal	5.1	-2.4	3.2	0.8
Dry	4.2	-1.8	1.8	0.07
Critical	2.8	-0.7	0.7	0.02
Average	**4.9**	**-2.53**	**3.28**	**0.75**

Table 4. Change in quantity of CVP water exported by SWP facilities (Alt 4 minus FNA) (Thousand Acre-Feet)
Quantity of water exported at Banks Pumping Plant for later use by CVP contractors is increased in all water year types except the driest years (critical designation).

Water Year Type	FNA CVP water exported by SWP	Change in CVP water exported by SWP
Wet	58	229
Above Normal	44	208
Below Normal	66	117
Dry	86	7
Critical	38	-9
Average	60	**123**

The Independent Modeling shows that implementation of the BDCP could shift a portion of the SWP exports from summer to winter and spring because the proposed NDD facilities can export water at times when the existing SDD facilities are constrained due to fishery concerns. As a result of this shift in timing, capacity is available at the SWP facilities during the summer months. The BDCP Model assumes that CVP could utilize the SWP facilities (Table 4) at any time when the CVP facilities are fully utilized; this sharing of diversion facilities is termed "joint point of diversion" or JPOD. Additional criteria to meet specific water quality and water level objectives are defined in response plans required by the State Water Board's water right decision D-1641. BDCP Model assumes that these additional criteria are met; the Independent Modeling continues this assumption without making any judgment as to whether the criteria would be met. An evaluation of this would require additional hydrodynamic modeling.

The Independent Modeling shows higher average annual CVP carryover (end of September) storage than the NAA by about 28 TAF. During dryer years when upstream storage is lower there is an increase in carryover and during wetter years when storage is higher there are storage decreases (Table 5). Upstream SWP storage, Table 6, behaves in a similar manner as CVP storage, there are decreases in wetter years and increased in dryer years.

CVP San Luis Reservoir fills in about 40% of years in Alt 4 compared to about 20% in the FNA. CVP San Luis reaches dead pool in about 25% of years in both the FNA and Alt 4. SWP San Luis Reservoir fills in about 43% of years in Alt 4 compared to about 18% in the FNA. SWP San Luis reaches dead pool in about 25% of years in Alt 4 and about 30% of years in the FNA.

Table 5. Change in CVP upstream carryover storage (Alt 4 minus FNA) (Thousand Acre-Feet)
CVP carryover (end of September) storage decreases in wetter years when FNA storage is highest and increases in dryer years when FNA storage is lowest

Water Year Type	FNA CVP Upstream Storage	Change in CVP Upstream Storage
Wet	5578	-8
Above Normal	5200	-150
Below Normal	4717	-1
Dry	4049	66
Critical	2285	258
Average	4558	**28**

Table 6. Change in SWP upstream carryover storage (Alt 4 minus FNA) (Thousand Acre-Feet)
SWP carryover (end of September) storage decreases in wetter years when FNA storage is highest and increases in dryer years when FNA storage is lowest

Water Year Type	FNA SWP Upstream Storage	Change in SWP Upstream Storage
Wet	2407	33
Above Normal	1934	-150
Below Normal	1517	14
Dry	1194	157
Critical	968	127
Average	1709	**44**

5 COMPARING INDEPENDENT MODELING AND BDCP MODEL

The Independent Modeling effort originally stemmed from reviews of DWR's BDCP Model where the Reviewers through their independent analysis found that BDCP Model does not provide adequate information to determine how BDCP may affect the system. Based on the premise that the Independent Modeling portrays a more accurate characterization of how the CVP/SWP system may operate under Alt 4, this comparison is meant to demonstrate the differences between results of a more accurate and realistic analysis and the BDCP Model. Differences in results between these modeling efforts are believed to provide insight regarding how effects that BDCP will have on the actual CVP/SWP system differ from modeling used to support the Draft EIR/S.

Although thorough comparisons of modeling were performed, only key differences are illustrated for the purpose of this comparison.

Conclusions regarding BDCP effects

Based on the Independent Modeling, the amount of water exported (diverted from the Delta) may be approximately 200 thousand acre-feet (TAF) per year higher than the amount disclosed in the Draft EIR/S. This total represents

- approximately 40 TAF/yr more water diverted and delivered to the SWP south of Delta contractors, and
- approximately 160 TAF/yr more water diverted and delivered to the CVP south of Delta contractors.

The BDCP Model estimates that, under the NAA ELT (without the BDCP), total average annual exports for CVP and SWP combined are estimated to be 4.73 million acre feet (MAF) and in the Independent Modeling FNA combined exports are 5.61 MAF. The BDCP Model indicates an increase in exports of approximately 540 TAF and the Independent Modeling shows an increase of approximately 750 TAF in Alt 4.

The Independent Modeling suggests that Delta outflow would decrease by approximately 200 TAF/yr compared to the amount indicated in the Draft EIR/S.

- This lesser amount of Delta outflow has the potential to cause greater water quality and supply impacts for in-Delta beneficial uses and additional adverse effects on species. To determine the potential effects of the reduced amount of outflow, additional modeling is needed using tools such as DSM2.

The BDCP Model does not accurately reflect the location of the diversions that the SWP and CVP will make from the Delta.

- When the errors in the model are corrected, it reveals that the North Delta intakes could divert approximately 680 TAF/yr more than what was disclosed in the BDCP Draft EIR/S, and
- the amount of water diverted at the existing South Delta facilities would be approximately 460 TAF/yr less than what is projected in the BDCP Draft EIR/S.

Hydrologic modeling of BDCP alternatives using CalSim II has not been refined enough to understand how BDCP may affect CVP and SWP operations and changes in Delta flow dynamics. Better defined operating criteria for project alternatives is needed along with adequate modeling rules to analyze how BDCP may affect water operations. Without a clear understanding of how BDCP may change operations, affects analysis based on this modeling may not produce reliable results and should be revised as improved modeling is developed.

6 GLOSSARY

acre-foot The volume of water (about 325,900 gallons) that would cover an area of 1 acre to a depth of 1 foot. This is enough water to meet the annual needs of one to two households.

agricultural water supplier As defined by the California Water Code, a public or private supplier that provides water to 2,000 or more irrigated acres per year for agricultural purposes or serves 2,000 or more acres of agricultural land. This can be a water district that directly supplies water to farmers or a contractor that sells water to the water district.

annual Delta exports The total amount of water transferred ("exported") to areas south of the Delta through the Harvey O. Banks Pumping Plant (SWP) and the C. W. "Bill" Jones Pumping Plant (CVP) in 1 year.

appropriative water rights Rights allowing a user to divert surface water for beneficial use. The user must first have obtained a permit from the State Water Resources Control Board, unless the appropriative water right predates 1914.

Article 21 water Water that a contractor can receive in addition to its allocated Table A water. This water is only available if several conditions are met: (1) excess water is flowing through the Delta; (2) the contractor can use the surplus water or store it in the contractor's own system; and (3) delivering this water will not interfere with Table A allocations, other SWP deliveries, or SWP operations.

biological opinion A determination by the U.S. Fish and Wildlife Service or National Marine Fisheries Service on whether a proposed federal action is likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction or adverse modification of designated "critical habitat." If jeopardy is determined, certain actions are required to be taken to protect the species of concern.

CalSim-II A computer model, jointly developed by DWR and the U.S. Bureau of Reclamation, that simulates existing and future operations of the SWP and CVP. The hydrology used by this model was developed by adjusting the historical flow record (1922–2003) to account for the influence of changes in land uses and regulation of upstream flows.

Central Valley Project (CVP) Operated by the U.S. Bureau of Reclamation, the CVP is a water storage and delivery system consisting of 20 dams and reservoirs (including Shasta, Folsom, and New Melones Reservoirs), 11 power plants, and 500 miles of major canals. CVP facilities reach some 400 miles from Redding to Bakersfield and deliver about 7 million acre-feet of water for agricultural, urban, and wildlife use.

cubic feet per second (cfs) A measure of the rate at which a river of stream is flowing. The flow is 1 cfs if a cubic foot (about 7.48 gallons) of water passes a specific point in 1 second. A flow of 1 cubic foot per second for a day is approximately 2 acre-feet.

Delta exports Water transferred ("exported") to areas south of the Delta through the Harvey O. Banks Pumping Plant (SWP) and the C. W. "Bill" Jones Pumping Plant (CVP).

Delta inflow The combined total of water flowing into the Delta from the Sacramento River, San Joaquin River, and other rivers and waterways.

exceedence plot For the SWP, a curve showing SWP delivery probability (especially for Table A water)—specifically, the likelihood that SWP Contractors will receive a certain volume of water under current or future conditions.

incidental take permit A permit issued by the U.S. Fish and Wildlife Service or National Marine Fisheries Service, under Section 10 of the federal Endangered Species Act, to private nonfederal entities undertaking otherwise lawful projects that might result in the "take" of an endangered or threatened species. In California, an additional permit is required and take may be authorized under Section 2081 of the California Fish and Game Code through issuance of either an incidental take permit or a consistency determination. The California Department of Fish and Wildlife is authorized to accept a federal biological opinion as the take authorization for a State-listed species when a species is listed under both the federal and California Endangered Species Acts.

riparian water rights Water rights that apply to lands traversed by or adjacent to a natural watercourse. No permit is required to use this water, which must be used on riparian land and cannot be stored for later use. Riparian rights attach only to the "natural" flow in the water course and do not apply to abandoned flows or stored water releases.

State Water Project (SWP) Operated by DWR, a water storage and delivery system of 33 storage facilities, about 700 miles of open canals and pipelines, four pumping-generating plants, five hydroelectric power plants, and 20 pumping plants that extends for more than 600 miles in California. Its main purpose is to store and distribute water to 29 urban and agricultural water suppliers in Northern California, the San Francisco Bay Area, the San Joaquin Valley, the Central Coast, and Southern California. The SWP provides supplemental water to 25 million Californians (almost two-thirds of California's population) and about 750,000 acres of irrigated farmland. Water deliveries have ranged from 1.4 million acre-feet in a dry year to more than 4.0 million acre-feet in a wet year.

SWP Contractors Twenty-nine entities that receive water for agricultural or municipal and industrial uses through the SWP. Each contractor has executed a long-term water supply contract with DWR. Also sometimes referred to as "State Water Contractors."

Table A water (Table A amounts) The maximum amount of SWP water that the State agreed to make available to an SWP Contractor for delivery during the year. Table A amounts determine the maximum water a contractor may request each year from DWR. The State and SWP Contractors also use Table A amounts to serve as a basis for allocation of some SWP costs among the contractors.

urban water supplier As defined by the California Water Code, a public or private supplier that provides water for municipal use directly or indirectly to more than 3,000 customers or supplies more than 3,000 acre-feet of water in a year. This can be a water district that provides the water to local residents for use at home or work, or a contractor that distributes or sells water to that water district.

Water Rights Decision 1641 (D-1641) A regulatory decision issued by the State Water Resources Control Board in 1999 (updated in 2000) to implement the 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta. D-1641 assigned primary responsibility for meeting many of the Delta's water quality objectives to the SWP and CVP, thus placing certain limits on SWP and CVP operations.

water year In reports on surface water supply, the period extending from October 1 through September 30 of the following calendar year. The water year refers to the September year. For example, October 1, 2010, through September 30, 2011 is the 2011 water year.

Review of Bay Delta Conservation Program Modeling

by MBK Engineers and Daniel B. Steiner, Consulting Engineer

Technical Appendix

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Tables

1 INTRODUCTION

Since December 2012, MBK Engineers and Dan Steiner (collectively "Reviewers") have assisted various parties in evaluating the operations modeling that was performed for the Bay Delta Conservation Plan (BDCP). To assist in understanding BDCP and the potential implications, stakeholders[1] requested that the Reviewers review the CalSim II modeling studies performed as part of the BDCP (hereafter "BDCP Studies" or "BDCP Model").

An initial review led the Reviewers to conclude that the BDCP Model, which serves as the basis for the environmental analysis contained in the BDCP Environmental Impact Report/Statement (EIR/S), provides very limited useful information to understand the effects of the BDCP. The BDCP Model contains erroneous assumptions, errors, and outdated tools, which result in impractical or unrealistic Central Valley Project (CVP) and State Water Project (SWP) operations. The unrealistic operations, in turn, do not accurately depict the effects of the BDCP.

The Reviewers revised the BDCP Model to depict a more accurate, consistent version of current and future benchmark hydrology so that the effects of the BDCP could be ascertained. The BDCP Model was also revised to depict more realistic CVP and SWP operations upon which to contrast the various BDCP alternatives. The Reviewers made significant efforts to coordinate with and inform the U.S. Bureau of Reclamation (Reclamation) and the California Department of Water Resources (DWR) managers and modelers, and CVP and SWP operators of the Reviewers' modifications, assumptions, and findings. Where appropriate, the Reviewers also used Reclamation and DWR's guidance and direction to refine the Reviewers' analysis.

This technical appendix summarizes: (1) the independent review of the CalSim II modeling publicly released for the BDCP's Draft Environmental Impact Report/Statement (EIRS), (2) the corrections and revisions made to the assumptions in the CalSim II model, and (3) comparisons between the BDCP and independent modeling results. The detailed information in this appendix is summarized in our main report.

[1] The entities who funded this report are Contra Costa Water District, East Bay Municipal Utility District, Friant Water Authority, Northern California Water Association, North Delta Water Agency, San Joaquin River Exchange Contractors Water Authority, San Joaquin Tributaries Authority, and Tehama Colusa Canal Authority.

2 REVIEW OF BDCP CALSIM II MODELING

2.1 Climate Change

Implementation of Climate Change

The analysis presented in the BDCP Documents attempts to incorporate the effects of climate change at two future climate periods: the early long term (ELT) at approximately the year 2025; and the late long term (LLT) at approximately 2060. As described in the BDCP documents[2], other analytical tools were used to determine anticipated changes to precipitation and air temperature that is expected to occur under ELT and LLT conditions. Projected precipitation and temperature was then used to determine how much water is expected to flow into the upstream reservoirs and downstream accretions/depletions over an 82-year period of variable hydrology; these time series were then used as inputs into the CalSim II operations model. A second aspect of climate change, the anticipated amount of sea level rise, is incorporated into the CalSim II model by modifying a subroutine that determines salinity within the Delta based on flows within Delta channels. The effects of sea level rise will manifest as a need for additional outflow when water quality is controlling operations to prevent seawater intrusion.

This report does not review the analytical processes by which reservoir inflows and runoff were developed, nor does it evaluate the modified flow-salinity relationships that are assumed due to sea level rise; those items could be the focus of another independent review. This review is limited to evaluating how the modified flows were incorporated into CalSim II and whether the operation of the CVP and SWP water system in response to the modified flows and the modified flow-salinity relationship is reasonable for the ELT and LLT conditions. This work reviews the assumed underlying hydrology and simulated operation of the CVP/SWP, assumed regulatory requirements, and the resultant water delivery reliability.

CalSim II Assumptions

To assess climate change, the three without Project (or “baseline” or “no action”) modeling scenarios were reviewed: No Action Alternative (NAA)[3], No Action Alternative at the Early Long Term (NAA – ELT), and No Action Alternative at the Late Long Term (NAA –LLT). Assumptions for NAA, NAA-ELT, and NAA-LLT are provided in the Draft EIR[4]. The only difference between these scenarios is the climate-related changes made for the ELT and LLT conditions (Table 1).

Table 1. Scenarios used to evaluate climate change

	Climate Change Assumptions	
Scenario	**Hydrology**	**Sea Level Rise**
No Action Alternative (NAA)	None	None
No Action Alternative at Early Long Term (NAA-ELT)	Modified reservoir inflows and runoff for expected conditions at 2025	15 cm
No Action Alternative at Early Long Term (NAA-LLT)	Modified reservoir inflows and runoff for expected conditions at 2060	45 cm

[2] BDCP EIR/EIS Appendix 5A, Section A and BDCP HCP/NCCP Appendix 5.A.2
[3] NAA is also called the Existing Biological Conditions number 2 (EBC-2) in the Draft Plan.
[4] BDCP EIR/EIS Appendix 5A, Section B, Table B-8

The differences between the NAA and NAA-ELT reveal the effects of the climate change assumptions under ELT conditions; similarly, the differences between the NAA and NAA-LLT reveal the effects of the climate change assumptions under LLT conditions.

Regulatory requirements

Each of the no action alternatives assumes the same regulatory requirements, generally representing the existing regulatory environment at the time of study formulation (February 2009), including Stanislaus ROP NMFS BO (June 2009) Actions III.1.2 and III.1.3, Trinity Preferred EIS Alternative, NMFS 2004 Winter-run BO, NMFS BO (June 2009) Action I.2.1, SWRCB WR90-5, CVPIA (b)(2) flows, NMFS BO (June 2009) Action I.2.2, ARFM NMFS BO (June 2009) Action II.1, no SJRRP flow modeled, Vernalis SWRCB D1641 Vernalis flow and WQ and NMFS BO (June 2009) Action IV.2.1, Delta D1641 and NMFS Delta Actions including Fall X2 FWS BO (December 2008) Action 4, Export restrictions including NMFS BO (June 2009) Action IV.11.2v Phase II, OMR FWS BO (December 2008) Actions 1-3 and NMFS BO (June 2009) Action IV.2.3v.

The modeling protocols for the recent USFWS BO (2008) and NMFS BO (2009) have been cited as being cooperatively developed by Reclamation, NMFS, U.S. Fish and Wildlife Service (USF&WS), California Department of Fish and Wildlife (CDF&W), and DWR.

Each of the BDCP no action alternatives (NAA, NAA-ELT, and NAA-LLT) uses the same New Melones Reservoir and other San Joaquin River operations. At the time of these studies' formulation, the National Marine Fisheries Services (NMFS) Biological Opinion (BO) (June 2009) had been recently released. Also, the San Joaquin River Agreement (SJRA, including the Vernalis Adaptive Management Program [VAMP]) and its incorporation into D1641 for Vernalis flow requirements were either still in force or being discussed for extension. As a component of study assumptions, the protocols of the SJRA and an implementation of the NMFS BO for San Joaquin River operations (including New Melones Reservoir operations) is included in the studies. These protocols, in particular the inclusion of VAMP which has now expired, is not appropriate as an assumption within either the No Action or Alternative Scenarios. Although appropriate within the identification of actions, programs and protocols present at the time of the NOI/NOP, they are not representative of current or reasonably foreseeable operations. Also, modeling of the future operation of the Friant Division of the CVP assumes no San Joaquin River Restoration Program releases. While assuming no difference in the current and future operation of the Friant Division avoids another difference in existing and projected future hydrology of the San Joaquin River, the assumption does not recognize the existence of the San Joaquin River Restoration Program. Results of CVP and SWP operations, in particular as affected by export constraints dependent on San Joaquin River flows and their effect on OMR, E/I and I/E diversion constraints, would be different with a different set of assumptions for San Joaquin River operations.

Finally, the habitat restoration requirements in the 2008 FWS BO and the 2009 NMFS BO are not included in the No Action Alternative baselines. Although the restoration is required to be completed either with or without completion of the BDCP, the restoration was only analyzed as part of the with project scenarios.

Model Results

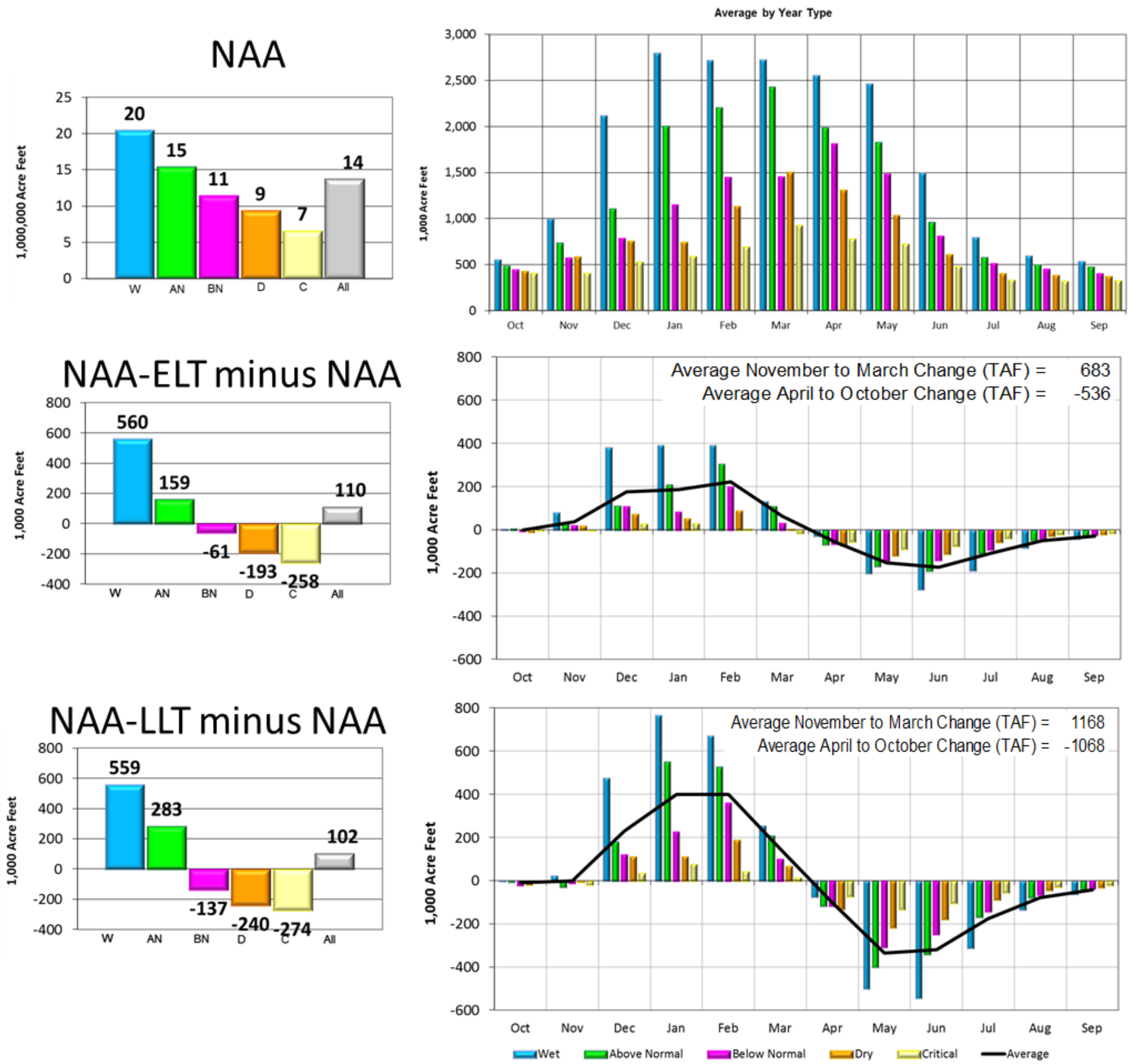
Inflow and Reservoir Storage in the Sacramento River Basin

The significance of changed hydrology between the three without project baselines is illustrated in Figure 1 below. The figure illustrates the projected combined inflow of Trinity, Shasta, Oroville, and Folsom Reservoirs under the three NAA baselines. Numerous modeling projections for climate change have been developed, and in this BDCP group of Scenarios Trinity, Shasta, and Oroville inflow are projected to increase overall, but with a significant shift from spring runoff to winter runoff and increases in wetter years with decreases in dryer years. Folsom Reservoir inflow is projected to remain about the same at the time of the NAA-ELT Scenario but decreases by the time of the NAA-LLT Scenario. The spring to winter shift in runoff is also projected for Folsom Reservoir inflow.

If climate change resulted in such drastic inflow changes, there is argument that certain underlying operating criteria such as instream flow requirements and flood control diagrams would require change in recognition of the changed hydrology. Regarding current environmental flow requirements carried into the NAA Scenarios, we question an assumed operation that continues to attempt to meet temperature targets when flow releases are unlikely to meet the target and thus a sustainable operation plan is not possible. For example, the CVP and SWP are unlikely to draw reservoirs to dead pool as often as the models depict. The NAA-ELT and NAA-LLT model Scenarios show project reservoirs going to dead pool in 10% of years; such operation would result in cutting upstream urban area deliveries below what is needed for public health and safety in 10% of years and would lead to water temperature conditions that would likely not achieve the assumed objectives. Again in short, the Scenarios that include climate change do not provide a reasonable underlying CVP/SWP operation with a changed hydrology from which to impose a Project upon to understand how BDCP Alternatives will affect the water system and water users.

In our opinion, the CalSim II depicted operations that incorporate climate change are not reasonably foreseeable and do not represent a likely future operation of the CVP/SWP. Although an argument is typically made that these study baselines will be used in a comparison analysis with Project Alternatives tiering from these baselines, we believe that the depicted operations do not represent credible CVP/SWP operations and we have no confidence in the results and they are inappropriate as the foundation of a Project Alternative. As such, although the modeling approach may provide a relative comparison between equal foundational operations, we are apprehensive to place much confidence in the computed differences shown between the NAA and Project Alternative Scenarios.

Figure 1. Projected Inflow to Trinity, Shasta, Oroville, and Folsom Reservoirs – NAA, NAA-ELT and NAA-LLT



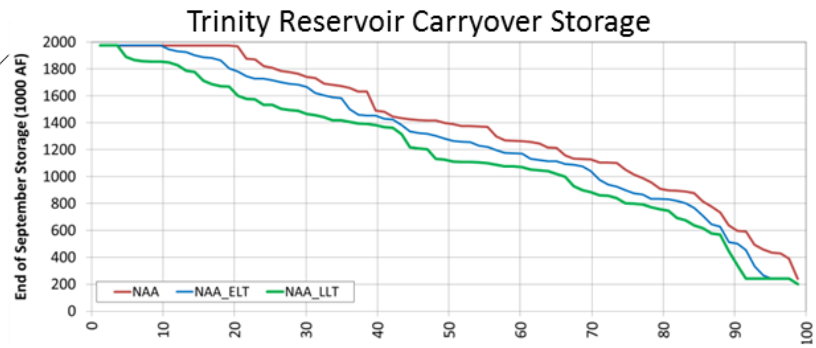
Carryover Storage in the Sacramento River Basin

For upstream CVP and SWP reservoirs the assumed shift of inflows due to climate change (Figure 1) along with a continuing need to satisfy exports demands significantly affects carryover storage. The CVP and SWP simply cannot satisfy water demands and regulatory criteria imposed on them in the NAA-ELT and NAA-LLT modeling scenarios.

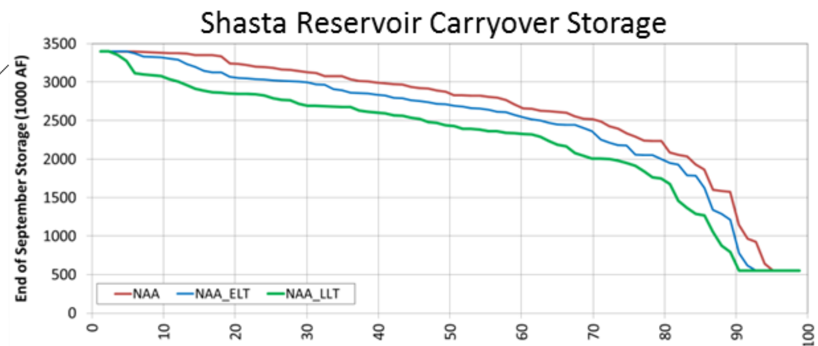
Figure 2 illustrates the typical change in carryover storage as shown for Trinity, Shasta, Oroville, and Folsom Reservoirs. The relatively high frequency (approximately 10% of time) of minimum storage occurring at CVP reservoirs illustrates our questioning of credible operations in the studies.

Figure 2. Projected Shasta Reservoir Carryover Storage, NAA, NAA-ELT and NAA-LLT

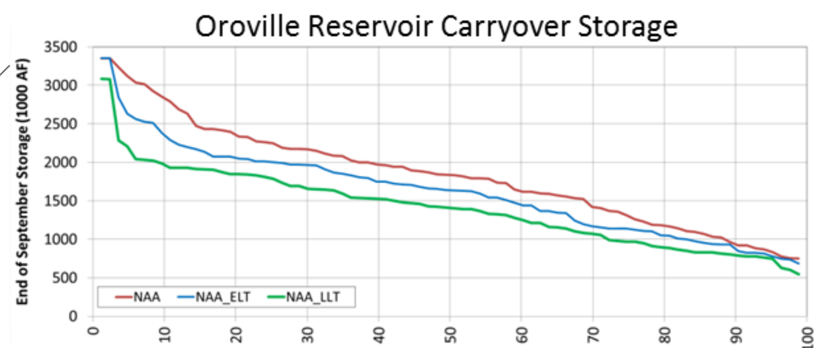
	Year Type	NAA_ELT minus NAA	NAA_LLT minus NAA
Trinity	W	-62	-187
	AN	-79	-198
	BN	-102	-170
	D	-138	-271
	C	-126	-216
	All	-97	-209



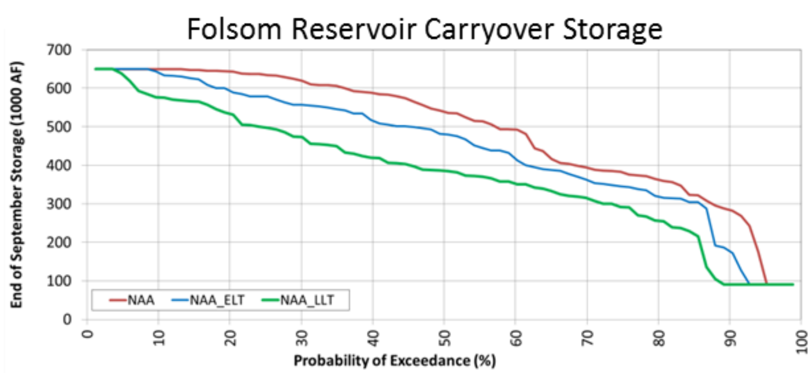
	Year Type	NAA_ELT minus NAA	NAA_LLT minus NAA
Shasta	W	-117	-331
	AN	-199	-452
	BN	-152	-340
	D	-154	-463
	C	-192	-377
	All	-154	-386



	Year Type	NAA_ELT minus NAA	NAA_LLT minus NAA
Oroville	W	-296	-588
	AN	-225	-460
	BN	-229	-513
	D	-180	-296
	C	-54	-159
	All	-213	-430



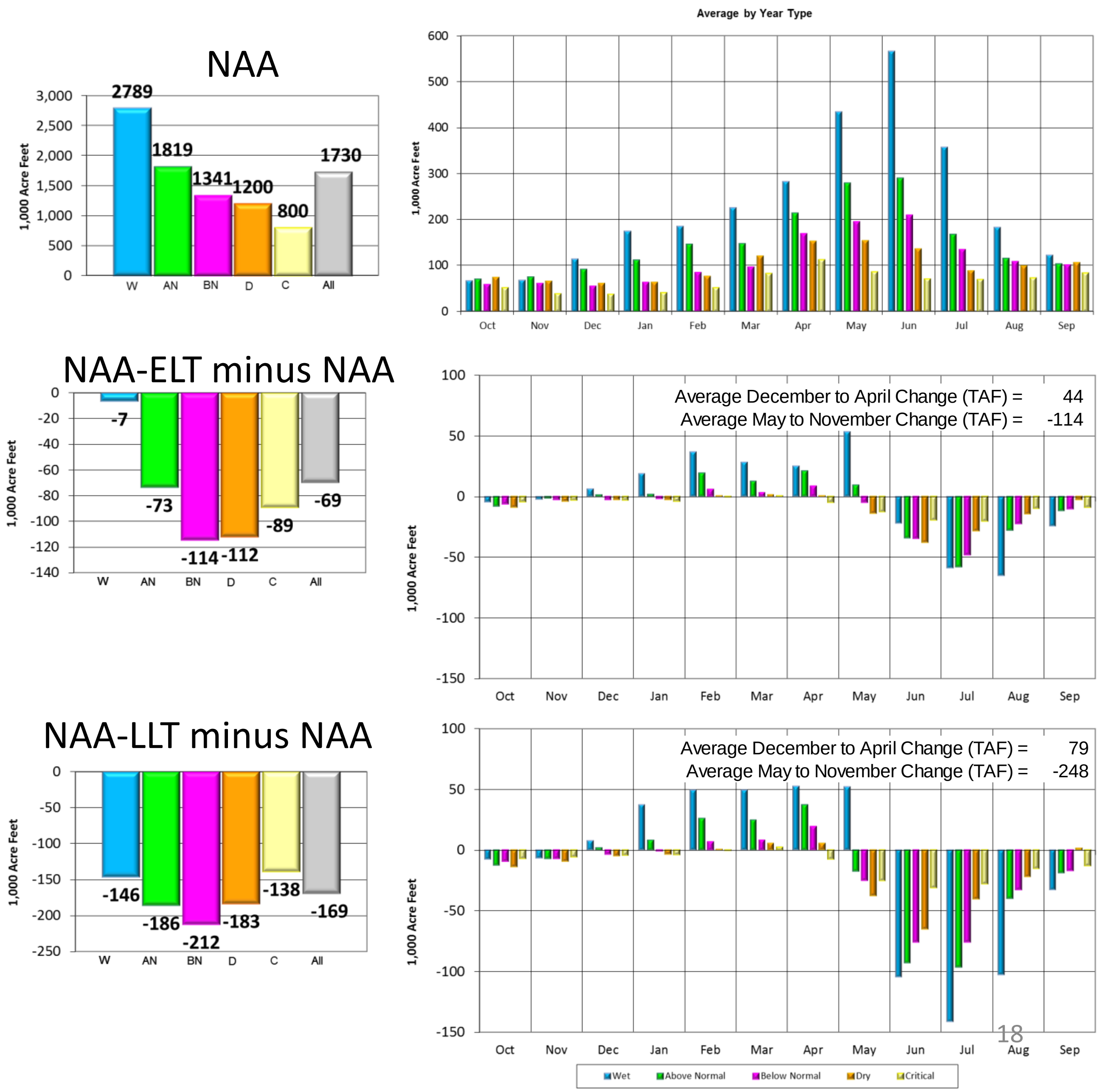
	Year Type	NAA_ELT minus NAA	NAA_LLT minus NAA
Folsom	W	-42	-115
	AN	-54	-128
	BN	-58	-136
	D	-43	-112
	C	-43	-68
	All	-47	-113



Inflow and Carryover Storage in the San Joaquin River Basin

San Joaquin Valley reservoirs are depicted with an overall decrease in annual runoff with some shifting of runoff from spring to winter, but mostly just decreases in spring runoff due to a decline in snowmelt runoff during late spring[5]. Figure 3 illustrates the assumed effects of climate change upon inflow to Millerton Lake.

Figure 3. Projected Inflow to Millerton Lake –NAA, NAA-ELT and NAA-LLT



The hydrology differences imposed in the NAA Scenarios of the Friant Division are described above, and its appropriateness may be subject to additional debate and Alternative assumptions. However, our review found that implementation of Millerton Reservoir inflow as affected by climate change was improperly performed.

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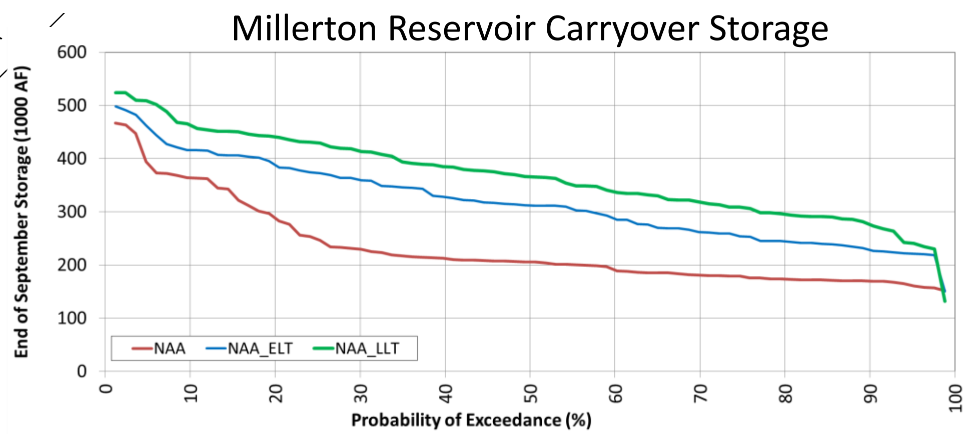
[5] BDCP Appendix 5A.2

Inflow to Millerton Reservoir in this version of CalSim is input in three separate time series for purposes of depicting the hydrology of potential upper basin reservoirs. Climate change hydrology was inconsistently incorporated at Millerton Reservoir and misapplied to the water supply and flood control operations. The result is an unrealistic operation for river releases and canal diversions. Figure 3 illustrates the projected ELT and LLT changes in Millerton Reservoir inflow incorporated in these studies. On face value of the input data, regardless of Friant Dam river release assumptions the effect of climate change at Millerton Lake will affect water deliveries.

Evidence of the inconsistent inflow problem is shown in the result for the comparison of carryover storage of Millerton Reservoir under the NAA, NAA-ELT, and NAA-LLT Scenarios (Figure 4). Carryover storage is higher in the ELT and LLT Scenarios due to climate change effects to inflow incorporated in reservoir operations but not in the computation of water supply deliveries. Thus, water deliveries are suppressed and the reservoir ends the year with greater storage.

Figure 4. Millerton Reservoir Carryover Storage, NAA, NAA-ELT and NAA-LLT Scenarios

	Year Type	NAA_ELT minus NAA	NAA_LLT minus NAA
Millerton	W	56	103
	AN	82	137
	BN	99	161
	D	87	131
	C	131	166
	All	87	136



CVP Water Service Contractor's water allocations are based on available CVP supplies, Figure 5 contains exceedance probability plots of deliveries and allocation percentages to these contractors. Table 2 contains average annual allocation to these CVP Water Service Contractors. Water supplies to these contractors decrease in the ELT and LLT relative to NAA Conditions.

Table 2. CVP Water Service Contractor Allocation Summary

	NAA	NAA-ELT	NAA-LLT
North of Delta Agricultural Service Contractors	61%	53%	46%
South of Delta Agricultural Service Contractors	48%	44%	39%
North of Delta M&I Contractors	85%	81%	77%
South of Delta M&I Contractors	79%	77%	74%

CVP Sacramento River Settlement, San Joaquin River Exchange, and Refuge deliveries are based on Shasta Criteria and are 100% in most years and 75% in "Shasta critical" years[6]. Figure 6 contains exceedance probability charts for annual water deliveries to CVP contractors whose allocations are based on Shasta Criteria. In the NAA-ELT and NAA-LLT modeling scenarios, the Sacramento River Settlement and Refuge deliveries are reduced due to water shortages that occur more often under the climate change assumptions.

SWP Water Supply

Corresponding with the CVP operation is the projected operation of the SWP under No Action Conditions. These illustrations are shown to provide a comparison to SWP storage and exports, particularly during drought. A comparison of SWP exports to CVP SOD deliveries shows that each project exports about the same amount of water during drought.

Average annual SWP Table A water supply allocations are 62% for NAA, 61% for NAA-ELT, and 57% for NAA-LLT. Figure 7 contains an exceedance probability plot summary of SWP deliveries. SWP North of Delta deliveries to the Feather River Service Area in both the ELT and LLT are less than NAA during about 10% of the time.

[6] A "Shasta critical" year is determined when the forecasted full natural inflow into Shasta Lake is equal to or less than 3.2 million acre-feet.

Figure 5. CVP Water Service Contractor Delivery Summary

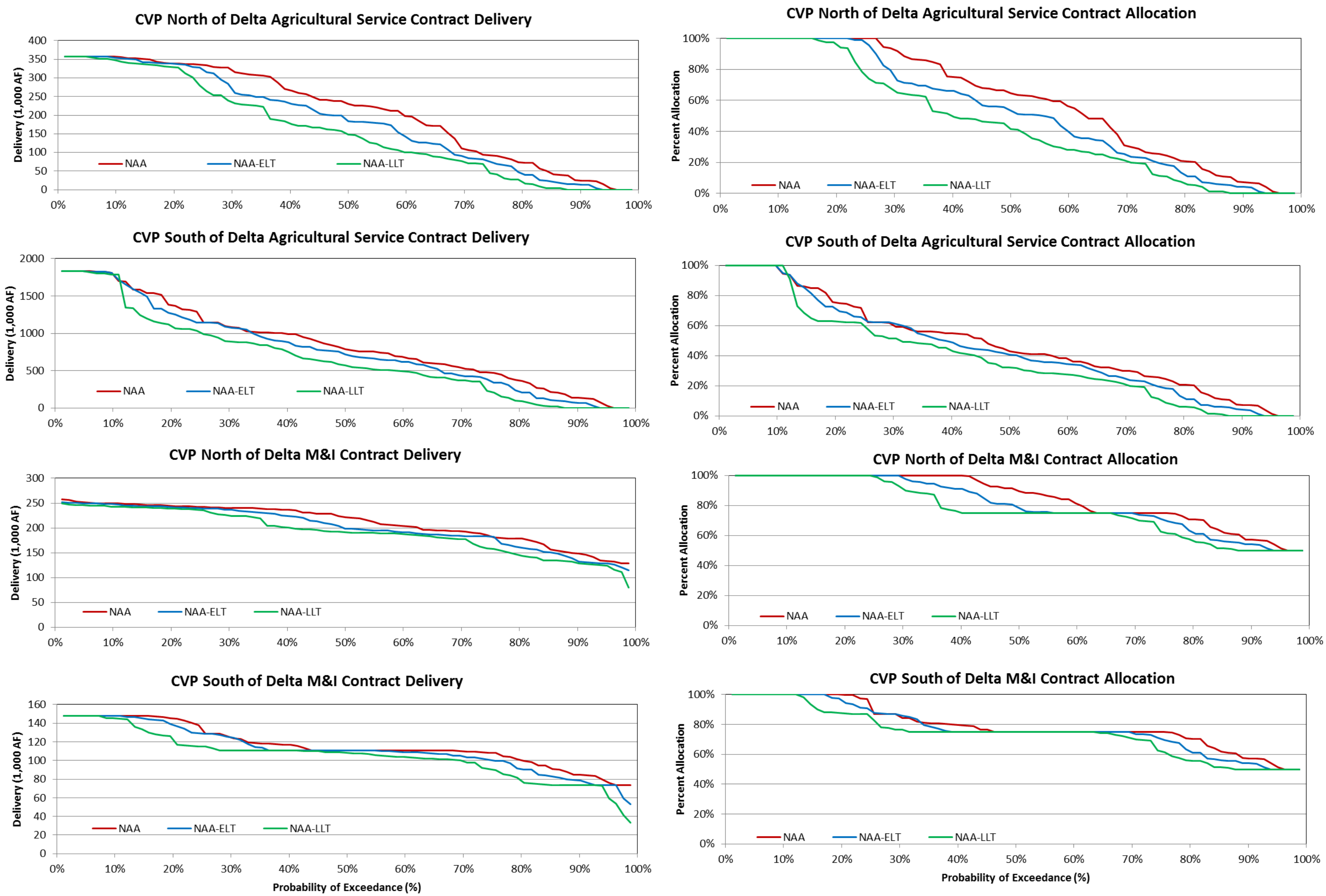


Figure 6. CVP Contractor Delivery Summary for Contractors with Shasta Criteria Allocations

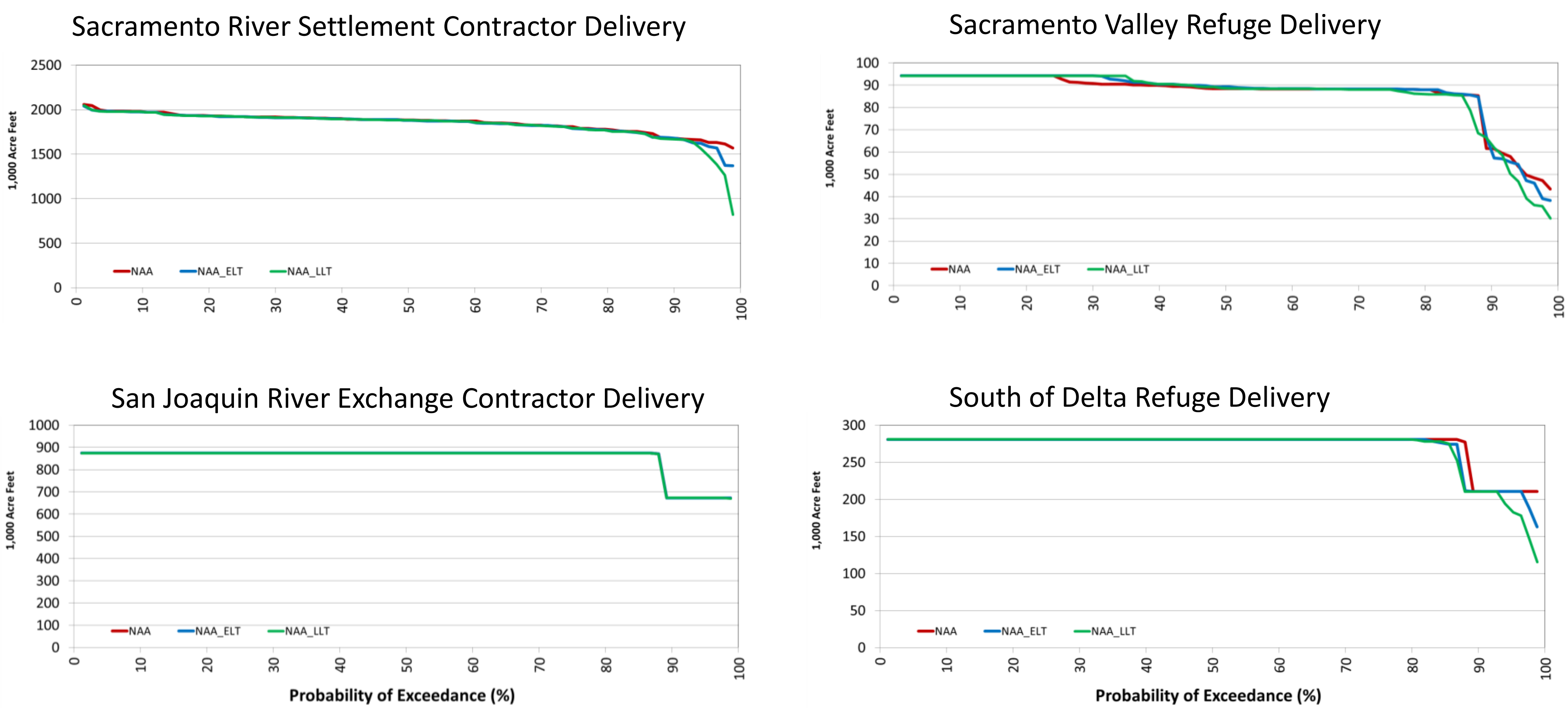
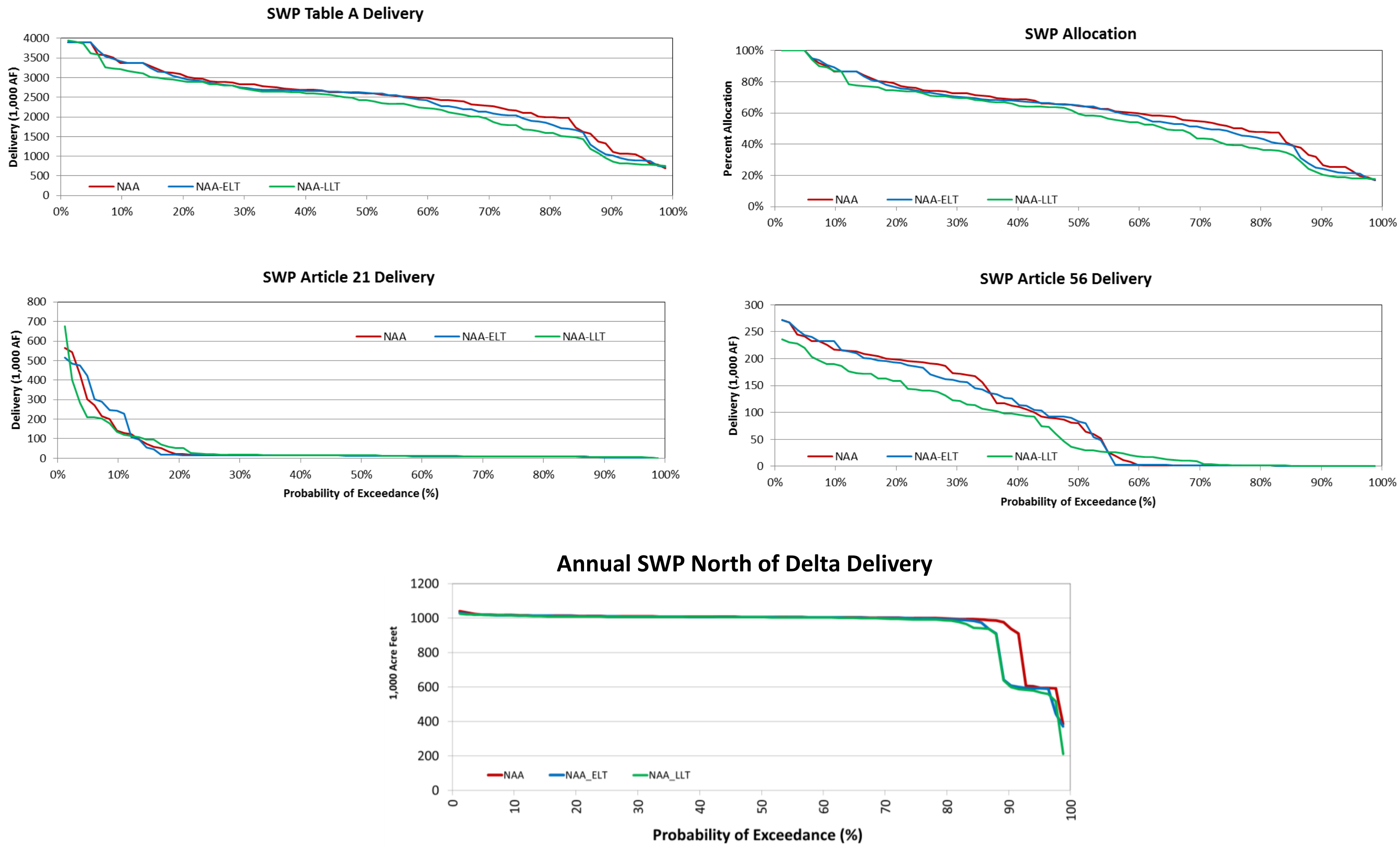


Figure 7. SWP Delta Delivery Summary



CVP/SWP Exports

Exports of the CVP and SWP have been projected to change due to a combination of climate change effects on water availability (primary effect), flow requirements for salinity control (sea level rise), additional in-basin water demands, and to a small extent greater export potential (DMC-CA intertie). Figure 8 illustrates the simulation of CVP exports and combined CVP/SWP exports under NAA, NAA-ELT, and NAA-LLT Scenarios. Under NAA average annual CVP exports are about 2.24 MAF (2.18 at Jones PP) and are about 100 TAF less in the NAA-ELT Scenario and 230 TAF less in the NAA-LLT. Annual average SWP exports are about 2.61 MAF in the NAA and are 68 TAF less in the NAA-ELT and 212 TAF less in the NAA-LLT. Annual average combined CVP/SWP exports are about 4.9 MAF in the NAA modeling (Figure 9) and about 170 TAF and 460 TAF less in the NAA-ELT and NAA-LLT respectively.

Figure 8. CVP Exports at Jones PP, NAA, NAA-ELT and NAA-LLT

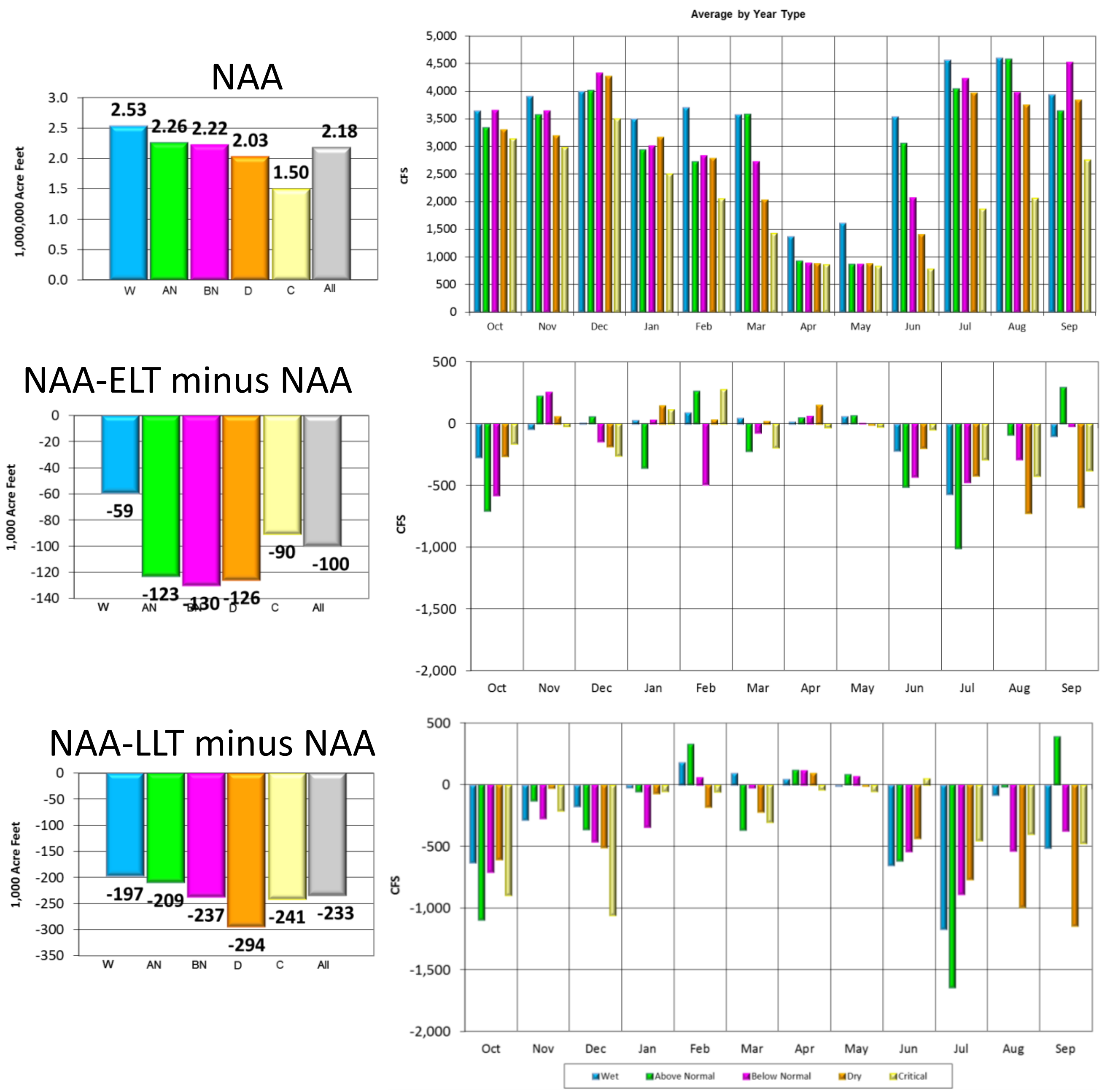
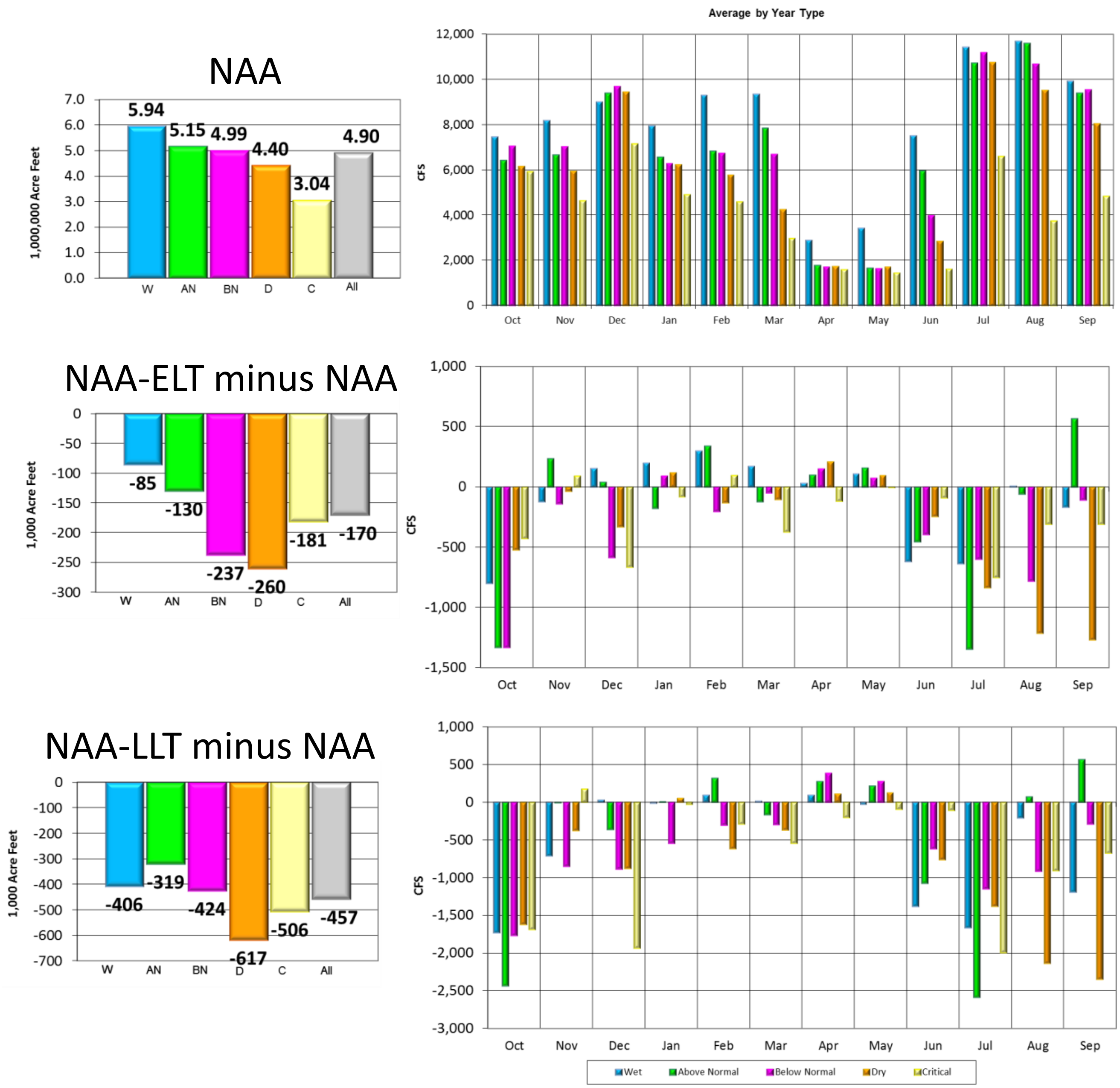


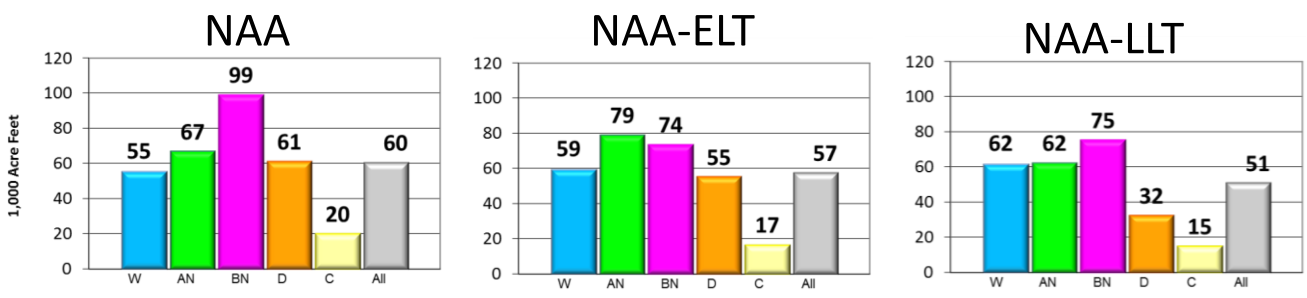
Figure 9. Total CVP/SWP Exports, NAA, NAA-ELT and NAA-LLT



Joint Point of Diversion

The NAA Alternatives do not make use of Joint Point of Diversion (JPOD), however CVP water is pumped at Banks to satisfy the Cross Valley Canal (CVC) contracts. **Figure** 10 shows annual Banks wheeling for CVC for the NAA, NAA-ELT and NAA-LLT.

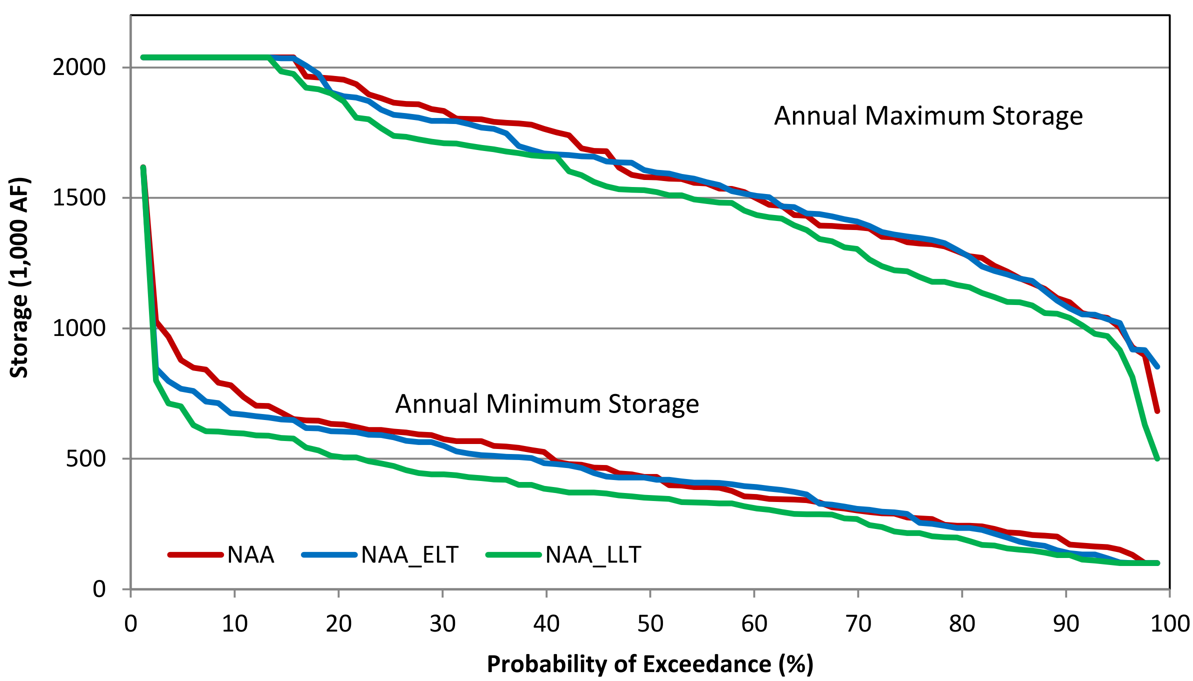
Figure 10. Cross Valley Canal Wheeling at Banks



San Luis Reservoir Operations

Modeling protocols will use San Luis Reservoir to store water when available and provide supply as exports are constrained by hydrology or regulatory constraints. Figure 11 illustrates the projected operation of San Luis Reservoir under the NAA, NAA-ELT, and NAA-LLT Scenarios. The annual maximum storage shows that the ability to fill San Luis Reservoir is somewhat similar for NAA and NAA-ELT but with less ability to fill in the NAA-LLT. The frequency of a low annual low point of San Luis Reservoir is exacerbated in the NAA-LLT Scenario. In all the Scenarios, San Luis Reservoir is heavily exercised. As currently projected, San Luis Reservoir will only fill as the result of very favorable hydrologic conditions including the availability of spill water from Friant or the Kings River system that offsets DMC water demands at the Mendota Pool.

Figure 11. San Luis Reservoir Storage – NAA, NAA-ELT and NAA-LLT



Sacramento River Temperature

CalSim II results, along with meteorological data, are used in temperature models that simulate reservoir temperature and river temperature. The BDCP modeling provided by DWR for review included the Sacramento

River temperature model and results for the No Action and Alternatives. Each BDCP Alternative used temperature target criteria for the upper Sacramento River as is used for the Existing Conditions modeling scenario. Equilibrium temperatures, a calculated model input that approximately depicts the effective air temperature for interaction with water temperature in the model, between Shasta and Gerber are increased by an annual average of 1.6°F for the ELT Scenarios and by 3.3°F for LLT Scenarios. Figure 12 contains monthly exceedance probability charts of temperature at Bend Bridge in the Sacramento River for April through October for the Existing Conditions and NAA-ELT Scenarios. There is about a 1 degree increase in average monthly temperature for the April through October period. Figure 13 contains similar information as Figure 12, but compares modeling results for the NAA-LLT and Existing Conditions Scenarios, there is often a 2°F increase in the NAA-LLT relative to Existing Conditions.

The increase in equilibrium temperatures combined with decreases in storage would lead to water temperature conditions that would likely not achieve the assumed objectives. Figure 12 and Figure 13 illustrate an increase in the probability that a water temperature target of 56°F would be exceeded at Bend Bridge under both the NAA-ELT and NAA-LLT Scenarios. The probability of exceedance increases approximately 5% to 20% depending on the month for the NAA-ELT Scenario and approximately 10% to 40% for the NAA-LLT Scenario.

Figure 12. Temperature Exceedance Sacramento River at Bend Bridge Existing, No Action Alternative, ELT

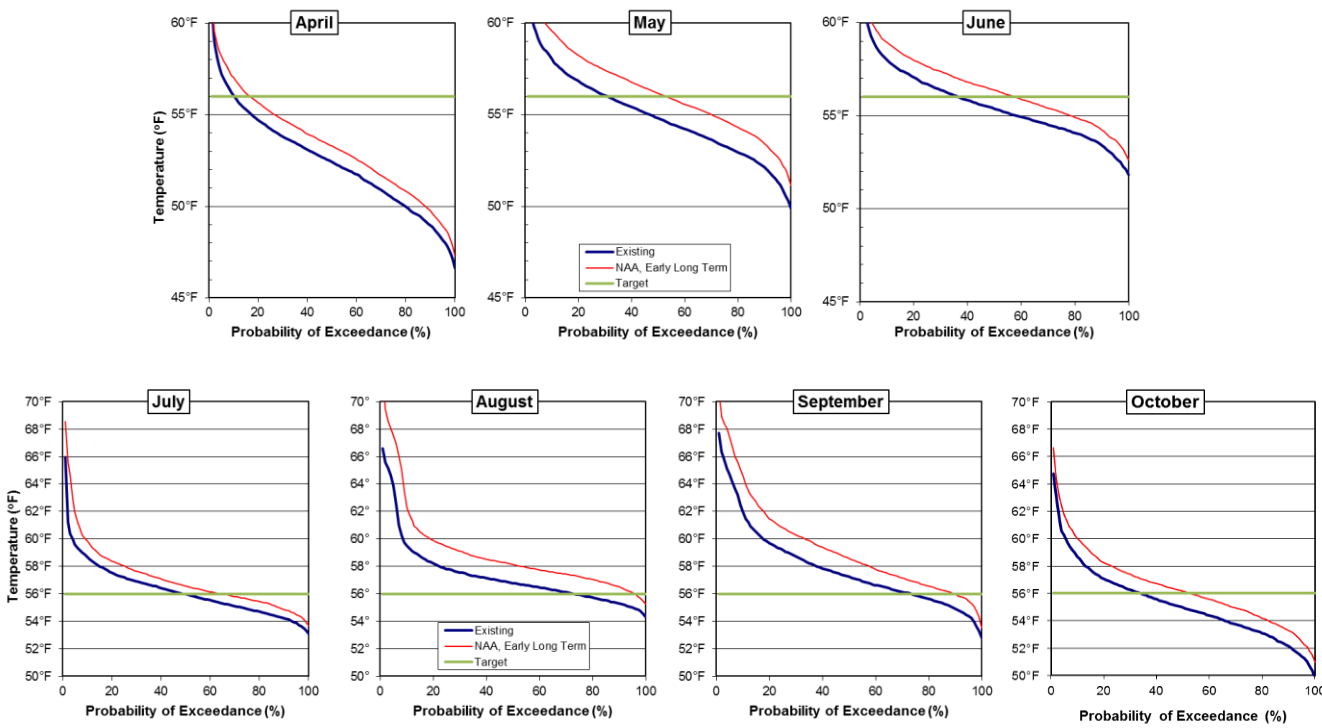
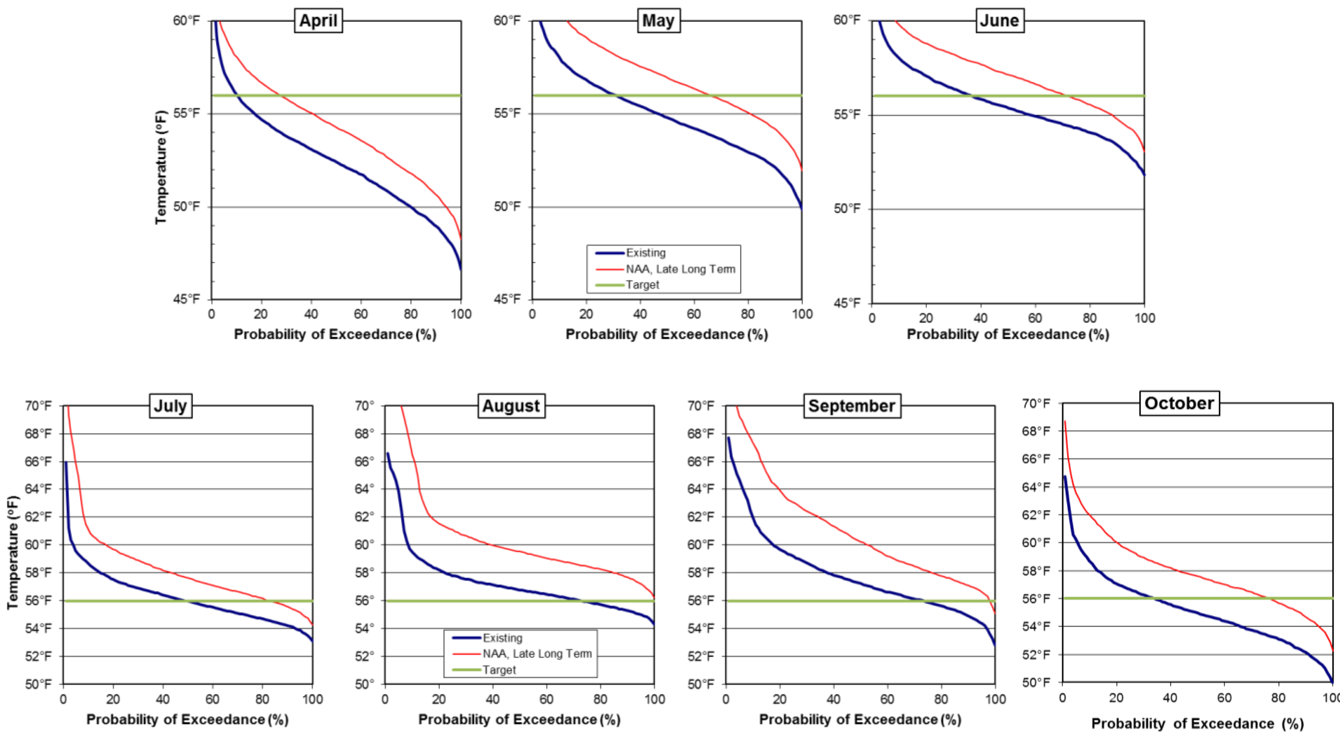


Figure 13. Temperature Exceedance Sacramento River at Bend Bridge Existing, No Action Alternative, LLT



Conclusions regarding Climate Change Assumptions and Implementation

In examining the possible effects of climate change, it is not appropriate to assume that current project operations will remain static and not respond to climate change. The BDCP's simplistic approach of assuming a linear operation of the CVP and SWP produces results that are not useful for dealing with the complex problem of climate change because it does not reflect the way in which the CVP and the SWP would actually operate whether or not the BDCP is implemented. Reviewers recommend a sensitivity analysis be conducted to develop a better understanding of the range of possible responses to climate change by the CVP and SWP, and the regulatory structures that dictate certain project operations.

Including climate change, without adaptation measures, results in insufficient water needed to meet all regulatory objectives and user demands. For example, the BDCP Model results that include climate change indicate that during droughts, water in reservoirs is reduced to the minimum capacity possible. Reservoirs have not been operated like this in the past during extreme droughts and the current drought also provides evidence that adaptation measures are called for long in advanced to avoid draining the reservoirs. In this aspect, the BDCP Model simply does not reflect a real future condition. Foreseeable adaptations that the CVP and SWP could make in response to climate change include: (1) updating operational rules regarding water releases for flood protection; (2) during severe droughts, emergency drought declarations could call for mandatory conservation; and (3) if droughts become more frequent, the CVP and SWP would likely revisit the rules by which they allocate water during shortages and operate more conservatively in wetter years. The modifications to CVP and SWP operations made during the winter and spring of 2014 in response to the drought supports the likelihood of future adaptations. The BDCP Model is, however, useful in that it reveals that difficult decisions must be made in response to climate change. But, in the absence of making those decisions, the BDCP Model results themselves are not informative, particularly during drought conditions. With future conditions projected to be so dire without the BDCP, the effects of the BDCP appear positive simply because it appears that conditions cannot get any worse (i.e., storage cannot be reduced below its minimum level). However, in reality, the future condition will not be as depicted in the BDCP Model. The Reviewers recommend that Reclamation and DWR develop more realistic operating rules for the hydrologic conditions expected over the next half-century and incorporate those operating rules into the any CalSim II Model that includes climate change.

2.2 BDCP Operation

The next step of our analysis centered on reviewing BDCP modeling of the with project scenarios as described in the December 2013 Draft BDCP and described as Alternative 4 in the Draft EISR.

Description of the BDCP Project
At the time of review, this Alternative was coined Alt 4 and represented a dual conveyance facility. The two DWR analyses reviewed were identified as:

- Alt 4 (dual conveyance) – ELT
    The same system demands and facilities as described in the NAA-ELT with the following primary changes: three proposed North Delta Diversion (NDD) intakes of 3,000 cfs each; NDD bypass flow requirements; additional positive OMR flow requirements and elimination of the San Joaquin River I/E ratio and the export restrictions during VAMP; modification to the Freemont Weir to allow additional seasonal inundation and fish passage; modified Delta outflow requirements in the spring and/or fall (defined in the Decision Tree discussed below); movement of the Emmaton salinity standard; redefinition of the EI ratio; and removal of current permit limitations for the south Delta export facilities. Set within the ELT environment.
- Alt 4 (dual conveyance) – LLT
    The same as the previous Scenario except established in the LLT environment.

The BDCP contemplates a dual conveyance system that would move water through the Delta's interior or around the Delta through an isolated conveyance facility. The BDCP CalSim II files contained a set of studies evaluating the projected operation of a specific version of such a facility. The Alternative was imposed on two baselines: the NAA-ELT scenario and the NAA-LLT scenario.

The changes (benefits or impacts) of the operation due to Alt 4 are highly dependent upon the assumed operation of not only the BDCP facilities and the changed regulatory requirements associated with those facilities, but also by the assumed integrated operation of the CVP and SWP facilities. The modeling of the NAA Scenarios introduced a significant change in operating protocols suggested primarily for reaction to climate change. We consider the extent of the reaction not necessarily representing a likely outcome, and thus have little confidence that the NAA baselines are a "best" (or even valid) representation of a baseline from which to compare an action Alternative. However, a comparison review of the Alternative to the NAA baselines illuminates operational issues in the BDCP modeling and provides insight as to where benefits or impacts may occur as additional studies are provided.

Since the effects of climate changes are more severe in the LLT than in the ELT, this review focuses on the ELT modeling because the results are less skewed by the climate change assumptions and problems.

BDCP's Alternative 4 has four possible sets of operational criteria, termed the Decision Tree, that differ based on the "X2" standards[7] that they contemplate:

- Low Outflow Scenario (LOS), otherwise known as operational scenario H1, assumes existing spring X2 standard and the removal of the existing fall X2 standard;

[7] X2 is a salinity standard that requires outflows sufficient to attain a certain level of salinity at designated locations in the Delta at certain times of year.

- High Outflow Scenario (HOS), otherwise known as H4, contemplates the existing fall X2 standard and providing additional outflow during the spring;
- Evaluated Starting Operations (ESO), otherwise known as H3, assumes continuation of the existing X2 spring and fall standards;
- Enhanced spring outflow only (not evaluated in the December 2013 Draft BDCP), scenario H2, assumes additional spring outflow and no fall X2 standards.

While it is not entirely clear how the Decision Tree would work in practice, the general concept is that the prior to operation of the new facility, implementing authorities would select the appropriate Scenario (from amongst the four choices) based on their evaluation of targeted research and studies to be conducted during planning and construction of the facility.

For our analysis, we reviewed the HOS (or H4) scenario because the BDCP[8] indicates that the initial permit will include HOS operations that may be later modified at the conclusion of the targeted research studies. The HOS includes the existing fall X2 requirements but adds additional outflow requirements in the spring. We reviewed the model code and discussed the operations with DWR and Reclamation, who acknowledged that although the SWP was bearing the majority of the responsibility for meeting the additional spring outflow in the modeling, the responsibility would need to be shared with the CVP[9]. In subsequent discussions, DWR and Reclamation have suggested that the additional water may be purchased from other water users. However, the actual source of water for the additional outflow has not been defined. Since the BDCP modeling assumes that SWP bears the majority of the responsibility for meeting the additional outflow, yet this is not how the project will be operated in reality, our review of the BDCP modeling results for HOS is limited to the evaluation of how the SWP reservoir releases on the Feather River translate into changes in Delta outflow and exports.

Our remaining analysis examines the ESO (or H3) scenario (labeled Alt 4-ELT or Alt 4-LLT in this section) because it employs the same X2 standards as are implemented in the No Action Alternatives NAA-ELT and NAA-LLT. This allows us to focus our analysis on the effects of the BDCP operations independent of the possible change in the X2 standard.

High Outflow Scenario (HOS or H4) Results

In Alt 4-ELT H4 Feather River flows during wetter years are increased more than 3,000 cfs in April and May and then decreased in most year types during July and August, while September flow is only decreased in wetter years. Figure 14 shows average monthly change in Feather River flow by water year type. Accompanying the changes in Feather River flow are changes in Oroville Reservoir storage levels, Figure 15 contains average monthly changes in Oroville storage. Alt4-ELT H4 end of June storage in Oroville during wetter years is about 480 TAF lower than the NAA-ELT while critical year storage is about 400 TAF higher. Counter to the reduction in Oroville storage, CVP average upstream carryover storage increases about 80 TAF and critical year increases by 380 TAF. Figure 16 contains average monthly changes in Delta outflow, increases in Feather River spring time flows are generally not used to increase Delta outflow, but are allowed to support increases in Delta exports.

Figure 17 displays changes in average monthly Delta exports, there are increases when diverting higher upstream spring releases in wetter years, while there are decreases during summer months in most years. Figure 18

[8] Draft BDCP, Chapter 3, Section 3.4.1.4.4
[9] August 7, 2013 meeting with DWR, Reclamation, and CH2M HILL

contains an average annual summary of project deliveries, total CVP deliveries increase by about 70 TAF while SWP deliveries decrease by about 100 TAF. Dryer year SWP deliveries decrease by 250 to 400 TAF, while wet year deliveries increase by 200 TAF. Total CVP deliveries increase in wetter years by exporting increased releases from Oroville.

The overall effect of the HOS appears to be increases in Oroville releases that support both CVP and SWP exports in wetter years, with modest increases in Delta outflow. There is also a decrease in SWP reliability through large delivery reductions in dryer years accompanied by Oroville storage increases. In addition to increases in dry and critical year storage in Oroville, total CVP dry and critical year carryover increases by 100 TAF and 380 TAF respectively with negligible reductions in wetter years types.

CVP and SWP obligation for providing flow to satisfy Delta outflow requirements is described in the Coordinated Operations Agreement (COA). Because the CVP and SWP share responsibility for meeting required Delta outflow based on specific sharing agreement, it doesn't seem reasonable that CVP water supplies would increase while SWP water supplies decrease under this Alternative. The manner in which this alternative is modeled is inconsistent with existing agreements and operating criteria.   If the increases in outflow were met based on COA, there would likely be reductions in Shasta and Folsom storage that may cause adverse environmental impacts.

Figure 14. Changes in Feather River Flow, Alt 4 H4 ELT minus NAA-ELT

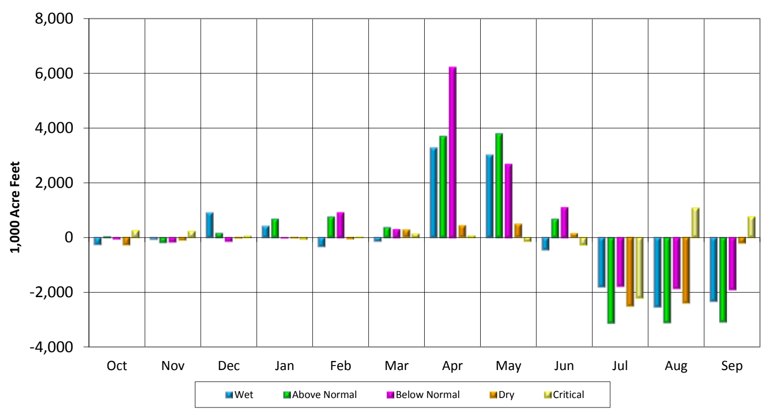


Figure 15. Changes in Oroville Storage, Alt 4 H4 ELT minus NAA-ELT

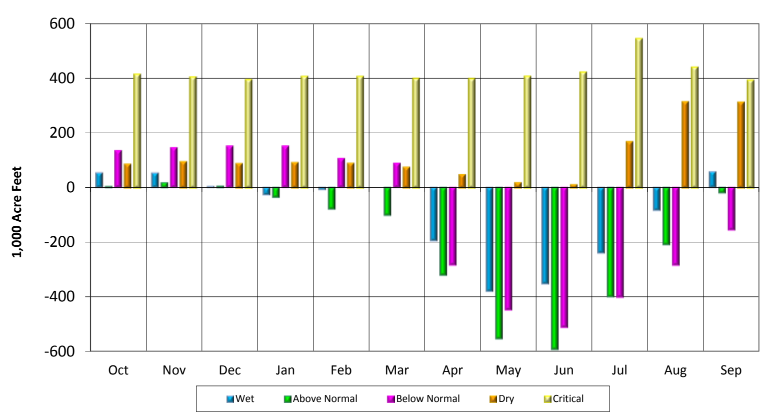


Figure 16. Changes in Delta Outflow, Alt 4 H4 ELT minus NAA-ELT

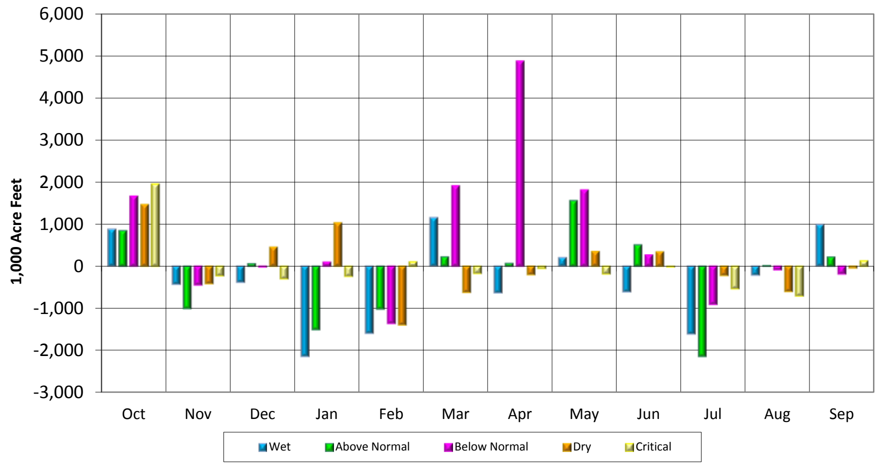


Figure 17. Changes in Delta Export, Alt 4 H4 ELT minus NAA-ELT

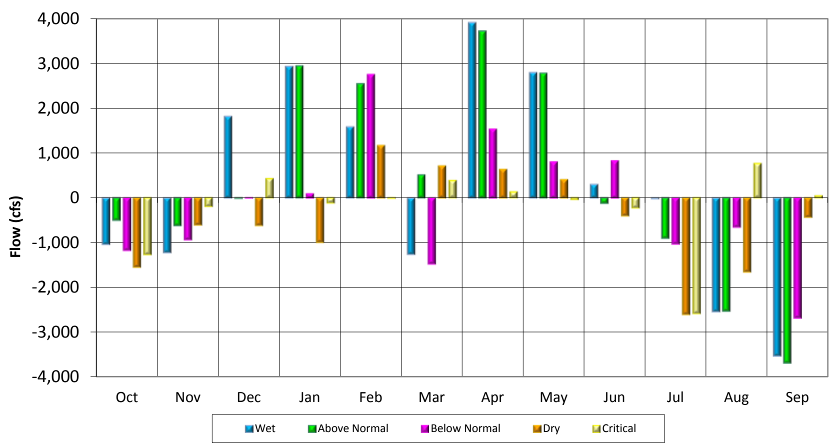
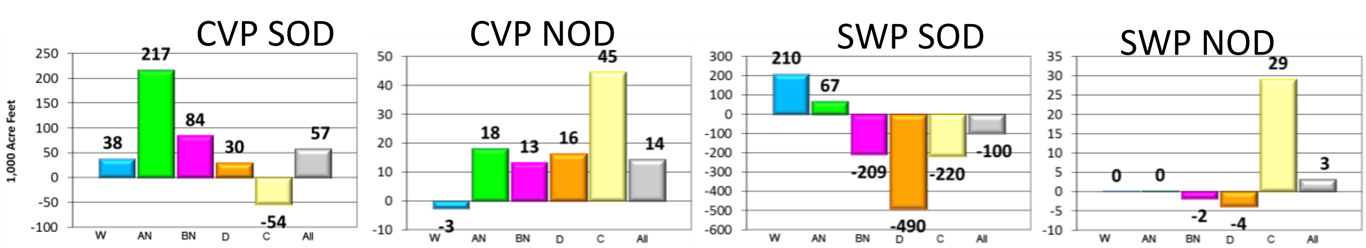


Figure 18. Changes in CVP and SWP Deliveries, Alt 4 H4 ELT minus NAA-ELT

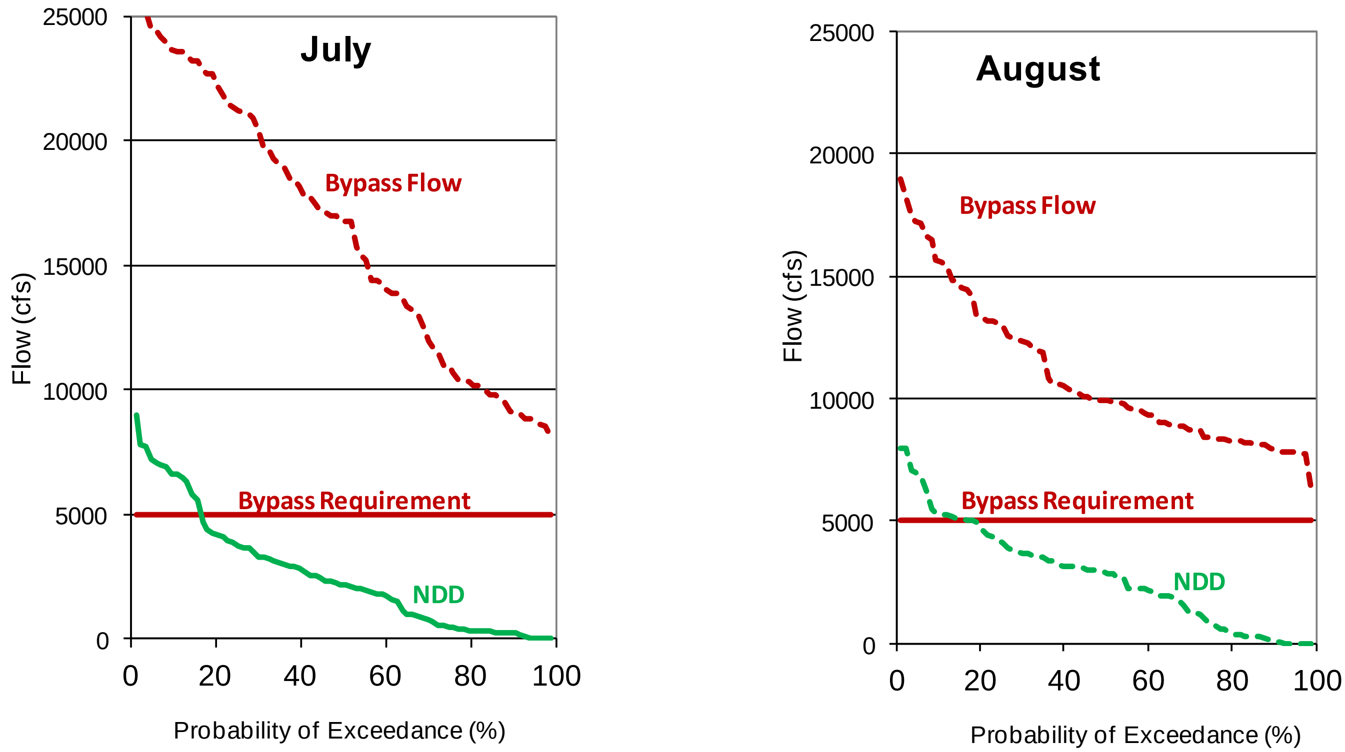


Evaluated Starting Operations (ESO or H3) Results

North Delta Diversion Intakes

Sacramento River flow below the North Delta Diversion (NDD) must be maintained above the specified bypass flow requirement, therefore the NDD rates are limited to the Sacramento River flow above the bypass requirement. Due to an error in CalSim II that specifies an unintended additional bypass requirement, modeling performed for the BDCP EIRS often bypasses more Sacramento River flow than is specified in the BDCP project description. This error has been fixed in the most recent public releases of CalSim II, but BDCP modeling has not been updated to reflect these fixes. Figure 19 contains exceedance probability plots showing the Sacramento River required bypass, Sacramento River bypass flow, NDD, and excess Sacramento River flow to the Delta as modeling for BDCP. As can be seen in Figure 19, the bypass flow is always above the bypass requirement in July and August. The BDCP version of CalSim sets a requirement for Sacramento River inflow to the Delta needed to satisfy all Delta flow, quality, and export requirements, this requirement should be removed when modeling the NDD.

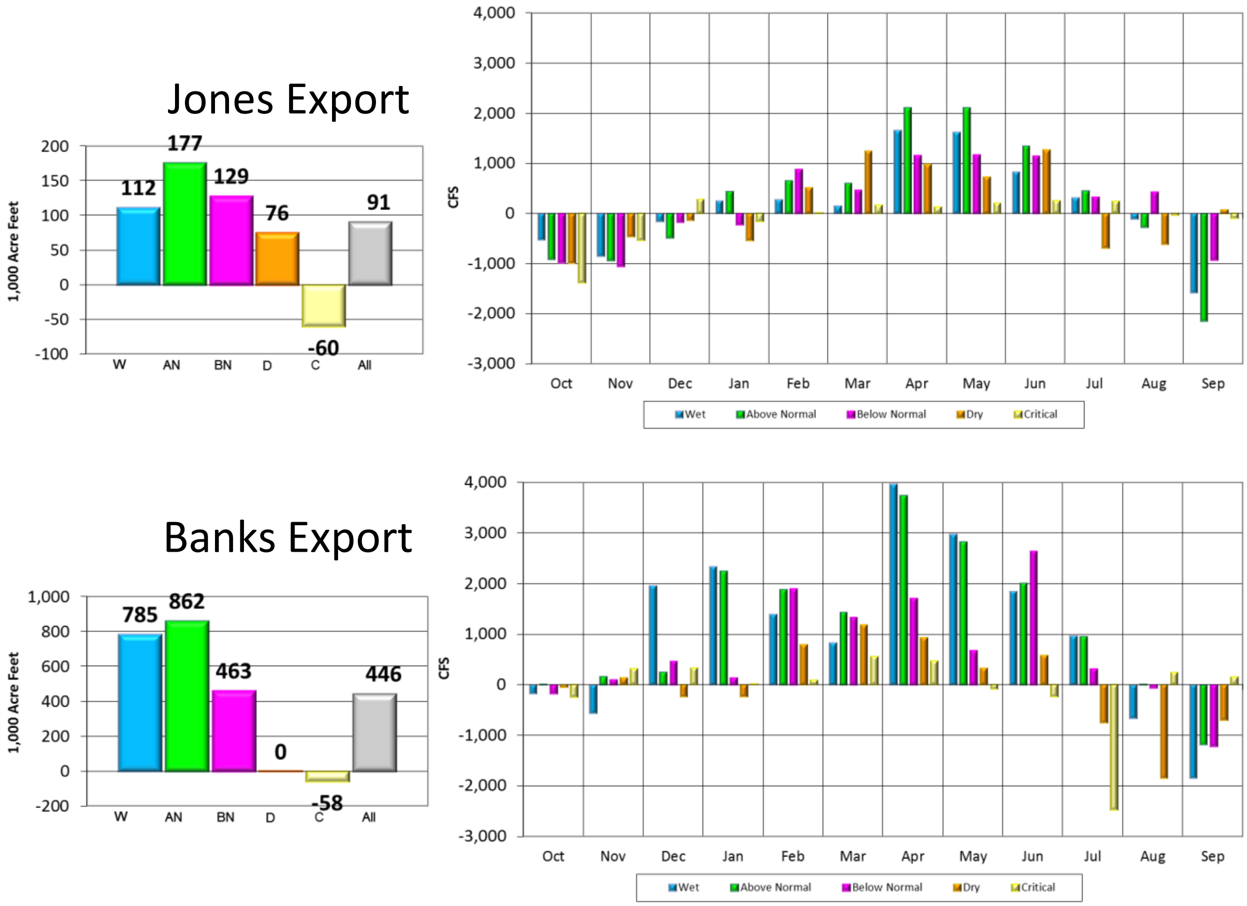
Figure 19. NDD, Bypass Requirement, Bypass Flow, and Excess Sacramento R. flow for Alt 4-ELT



CVP/SWP Exports

Overall the Alt 4 will increase exports compared to the NAA-ELT, with the majority of the increased exports realized by the SWP. Figure 20 illustrates a comparison between the NAA-ELT and Alt 4-ELT of CVP and SWP exports. On average, total combined exports under Alt 4–ELT are projected to increase by 537 TAF from 4.73 MAF to 5.26 MAF compared to the NAA-ELT.

Figure 20. Change in CVP (Jones) and SWP (Banks) Exports (Alt 4-ELT minus NAA-ELT)



With the addition of the North Delta Diversion facility, the water exported dramatically shifts from South Delta diversions to North Delta diversions. Figure 21 illustrates the change in routing of South of Delta exports under Alt 4 compared to the NAA-ELT. On average, export through the South Delta facility are projected to decrease by 2.1 MAF and the North Delta diversions will export 2.6 MAF which includes the 2.1 MAF shifted from the South Delta facility plus the additional 537 TAF of increased exports.

Figure 21. Change in Conveyance Source of Exports (Alt 4-ELT minus NAA-ELT)

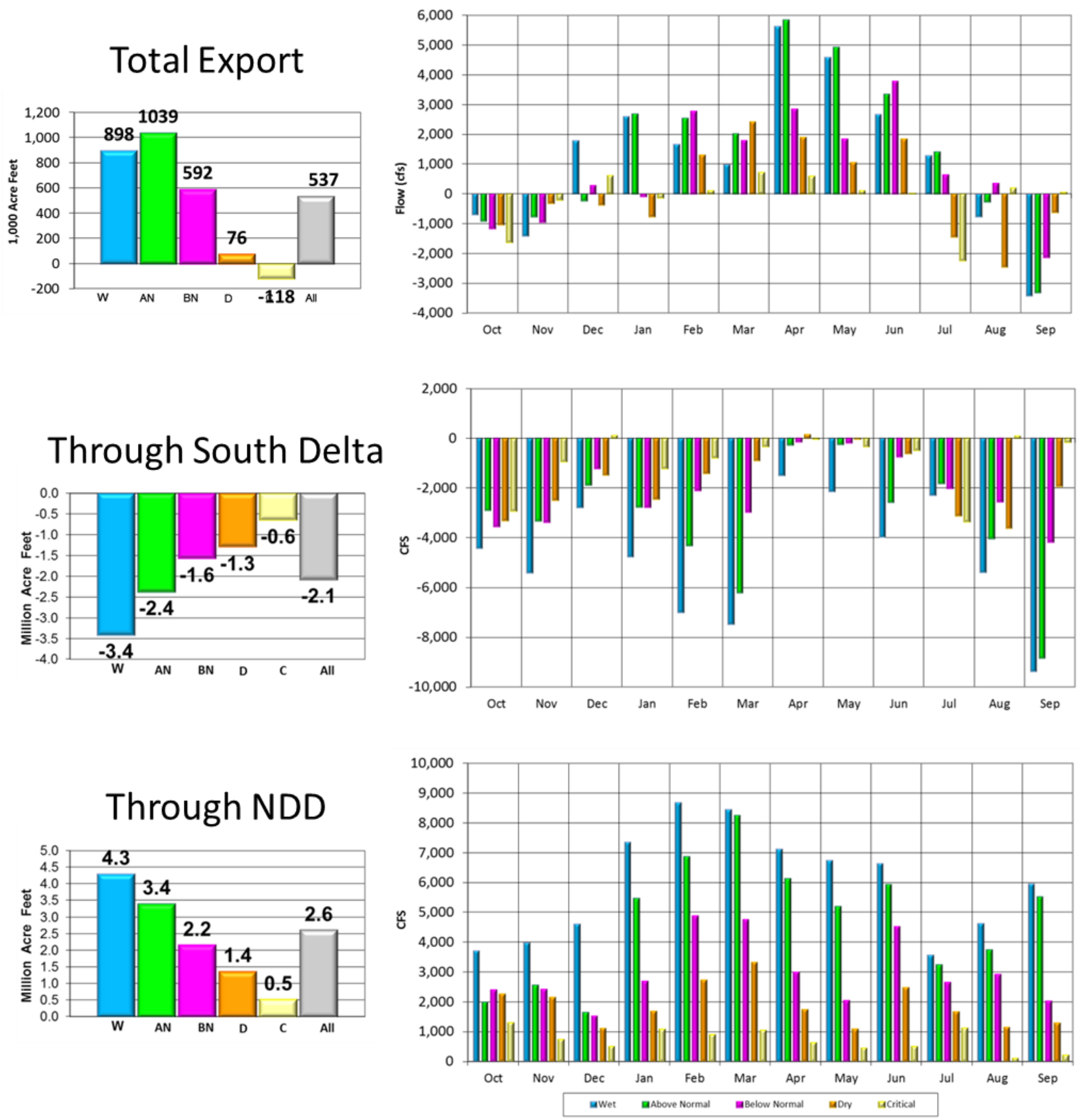
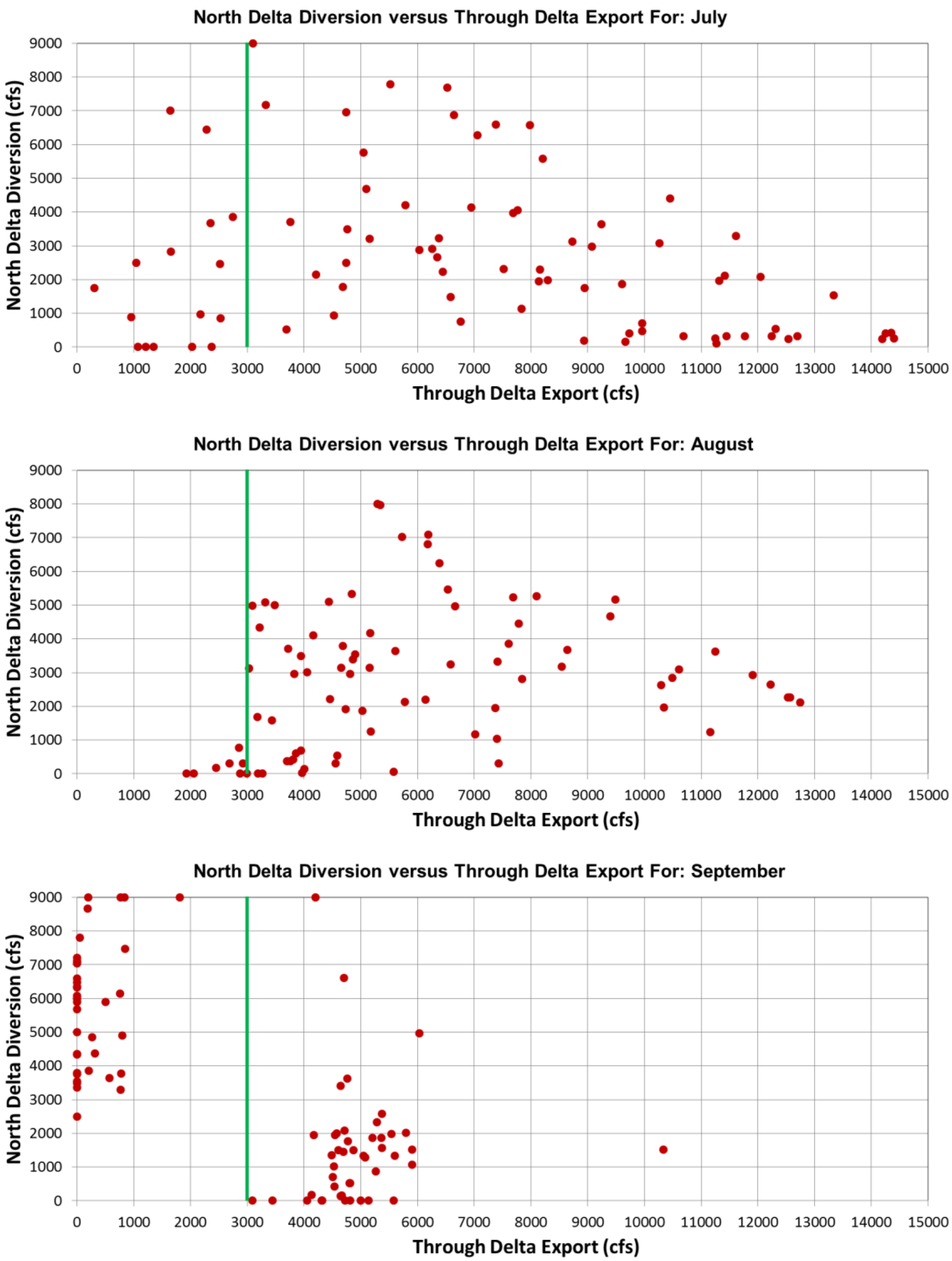


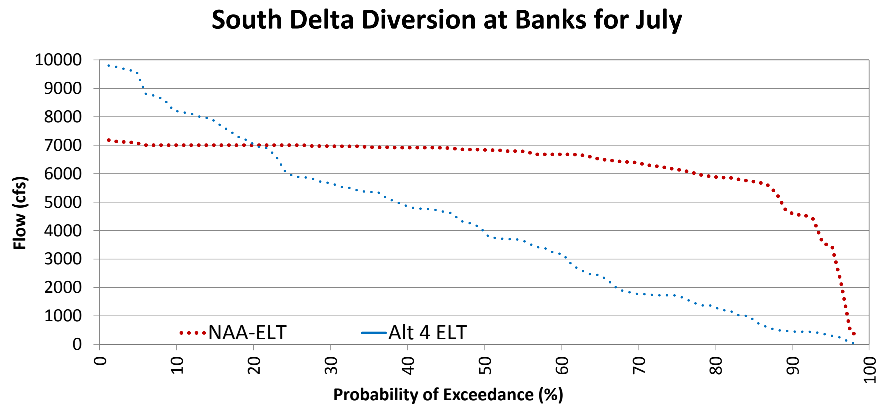
Figure 22 contains figures for July, August, and September for Alt 4-ELT that plot NDD against SDD. In the months of July to September SDD are occasionally very high, exceeding 14,000 cfs in July, with minimal NDD. This occurs due to outdated model code that imposes an instream flow requirement in Sacramento River flow below Hood in excess of the bypass criteria prescribed in the BDCP. There are numerous occurrences when bypass flows prescribed in the BDCP are exceeded and SDD are higher than expected. On the other hand, there are also many times when NDD are above minimum pumping levels and SDD are below the BDCP prescribed 3,000 cfs threshold indicated by the green line in Figure 22. For unknown reasons, the model code requiring SDD to be greater than 3,000 cfs before NDDs occur from July through September is deactivated in the BDCP modeling of this Alternative.

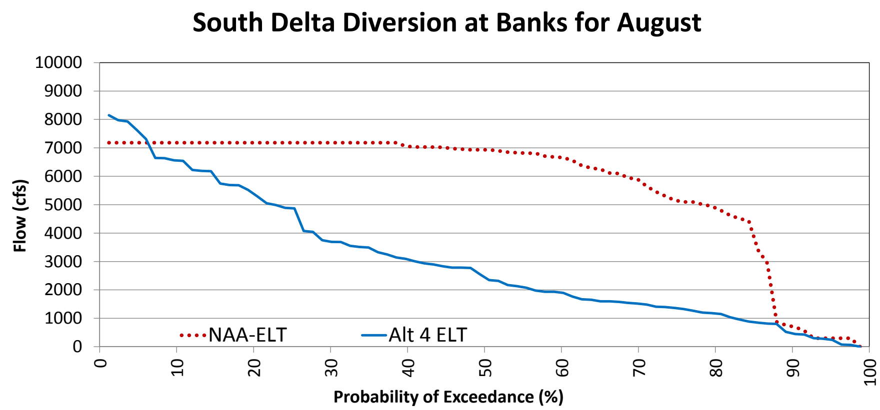
Figure 22. Alt 4-ELT North Delta Diversion Versus South Delta Diversion for July, August, and September

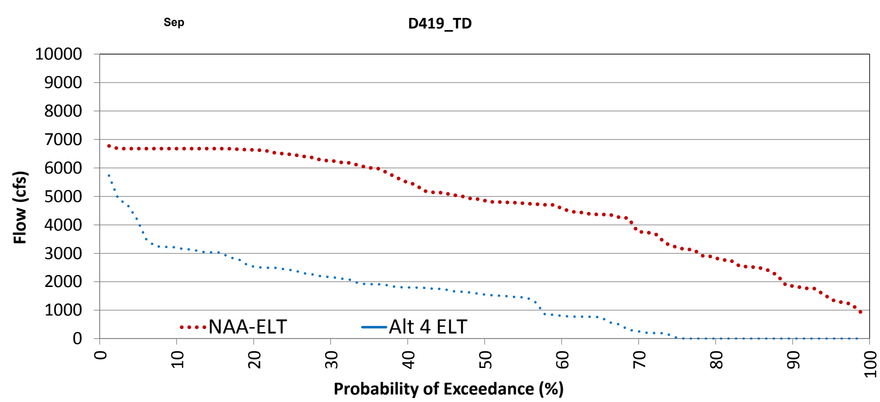


South Delta Diversion at Banks is not limited to existing permit capacity of 6,680 cfs and pumping may reach full capacity of 10,300 cfs in July, August, and September. Figure 23 contains exceedance probability charts of South Delta Diversion at Banks for July, August, and September. The chart for July shows SDD at Banks exceeding existing permit capacity 20% of years, in August this occurs in about 7% of years. There are South Delta diversions at Banks 25% of the time in September while diversions from the Sacramento River may range from 2,500 cfs to 7,500 cfs.

Figure 23. South Delta Diversion at Banks





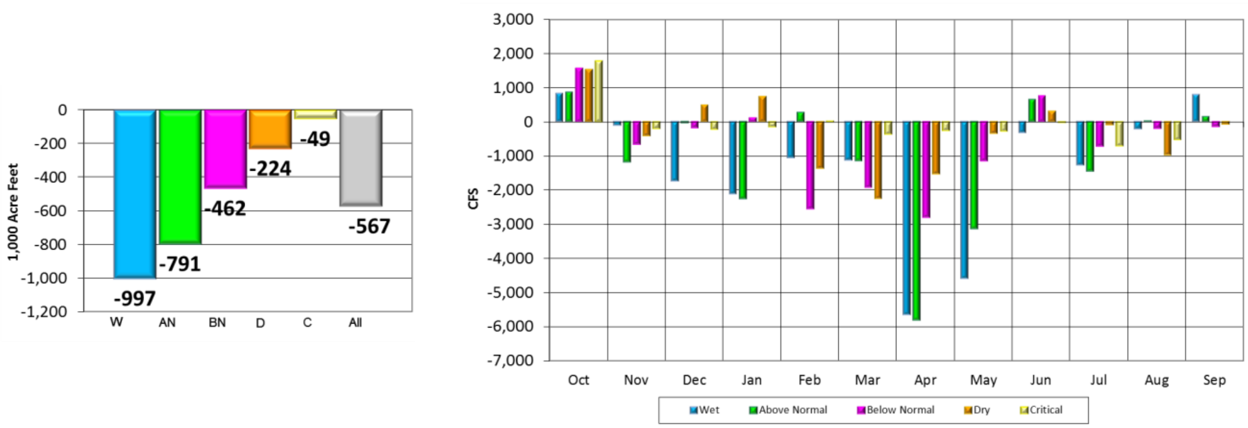


Generally exports increase during winter and spring months due to the ability to avoid fishery concerns by diverting at the North Delta rather than South Delta.

Delta Outflow

Figure 24 illustrates a comparison of Delta outflow between the NAA-ELT and Alt 4-ELT. Decreases in Delta outflow are the result of the CVP and SWP ability to increase Delta exports in Alt 4-ELT. The apparent increase in Delta outflow in October is partially due to additional export restrictions though Old and Middle River flow requirements. However, the increase in October Delta outflow is also due to an unrealistic operation of the Delta Cross Channel. The additional export restrictions cause the flow standards imposed at Rio Vista to be the controlling point in CVP and SWP operations; the water quality standards are all being met and do not require flows above the amount needed to satisfy the Rio Vista standard. Meeting the Rio Vista flow standards without closing the Delta Cross Channel gate results in releasing more water from upstream reservoirs than would otherwise be necessary. This occurs because a certain amount of the water released to meet the Rio Vista flow standards would flow into the Central Delta at location of the Delta Cross Channel gate. This water would not make it to Rio Vista and therefore would not be counted towards meeting the Rio Vista flow standards. However, due to the BDCP model's assumed restrictions on exports at this time, this water could not be pumped from the South Delta facilities and thus ends up as "extra" Delta outflow. By closing the Delta Cross Channel gate, the operators would assure that all of the water released to meet the Rio Vista flow standards would be counted towards those standards. The BDCP model's assumptions that the Delta Cross Channel gate would not be closed are not practical or a sensible operation as the operators confirmed they would close the gate during these conditions to avoid the unnecessary loss of water supplies (as was done in October and November 2013). The assumption in the BDCP model to maintain the gate in the open position causes it to overstate the amount of Delta outflow.

Figure 24. Delta Outflow Change (Alt 4-ELT minus NAA-ELT)



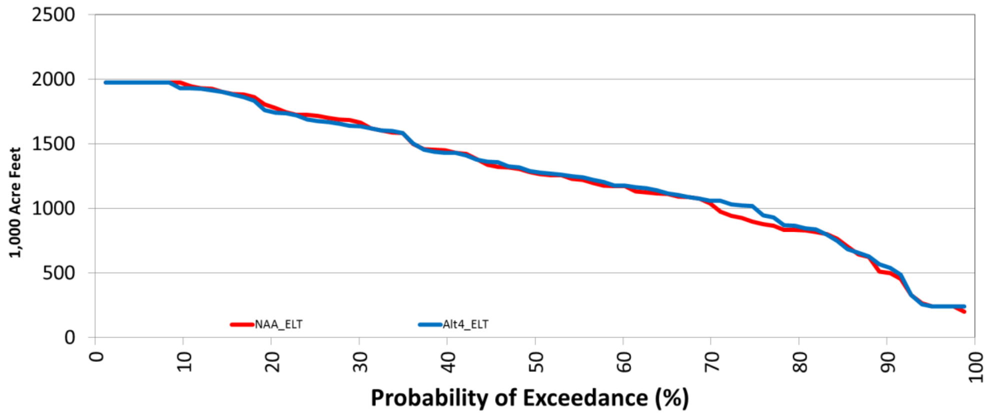
CVP/SWP Reservoir Carryover Storage

CVP/SWP reservoir operating criteria in the Alt4-ELT scenario differs from the NAA-ELT scenario. This difference is primarily driven by changes in both CVP and SWP San Luis Reservoir target storage. CalSim II balances upstream Sacramento Basin CVP and SWP reservoirs with storage in San Luis Reservoir by setting target storage levels in San Luis Reservoir. CalSim II will release water from upstream reservoirs to meet target levels in San Luis Reservoir and the target storage will be met as long as there is capacity to convey water and water is available in upstream reservoirs. In Alt 4 the San Luis Reservoir target storage is set very high in the spring and early summer months, and then reduced in August and set to San Luis Reservoir dead pool from September through December. This change in San Luis target storage relative to the NAA causes upstream reservoirs to be drawn down from June through August and then recuperate storage relative to the NAA by cutting releases in September; Alt 4 upstream storage then remains close to the NAA during fall months. These operational criteria cause changes in upstream cold water pool management and affect several resource areas. Figure 25, Figure 26, Figure 27, and Figure 28 contain exceedance charts for carryover storage and average monthly changes in storage by Sacramento Valley Water Year Type for North of Delta CVP and SWP reservoirs.

San Luis Reservoir Operations

In addition to changes in upstream storage conditions, changes in San Luis Reservoir target storage cause San Luis Reservoir storage to reach dead pool in many years with subsequent SOD delivery shortages. Although some delivery shortages are due to California Aqueduct capacity constraints, the largest annual delivery shortages are a result of inappropriately low target storage levels. Average annual Table A shortages due to artificially low San Luis reservoir storage levels increased from 3 TAF in the NAA-ELT scenario to 35 TAF in the Alt4-ELT scenario. (Shortages due only to a lack of South of Delta conveyance capacity were not included in these averages.) Such shortages occurred in 2% of simulated years in the NAA-ELT scenario and 23% of years in the Alt4-ELT scenario. In addition to the inability to satisfy Table A allocations, low storage levels cause loss of SWP contractors' Article 56 water stored in San Luis Reservoir. Average annual Article 56 shortages were 43 TAF in the Alt4-ELT scenario because of low San Luis storage and 5 TAF in the NAA-ELT scenario. Low San Luis storage causes Article 56 shortages in 27% of simulated years in the Alt4-ELT scenario as compared to 5% of simulated years in the NAA-ELT. Another consequence of low storage levels in San Luis Reservoir is a shift in water supply benefits from Article 21 to Table A. As seen in Figure 29 and Figure 30 San Luis Reservoir storage fills more regularly in the Alt 4-ELT scenario, but is exercised to a lower point more often.

Figure 25. Trinity Reservoir Carryover Storage and Average Monthly Changes (Alt 4-ELT minus NAA-ELT) in Storage by Water Year Type



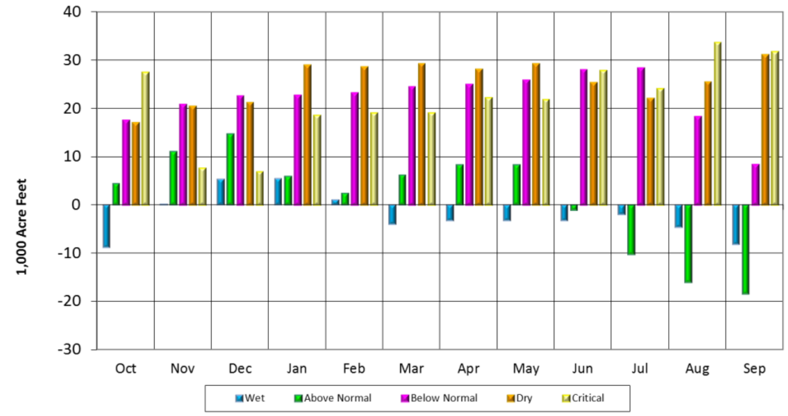
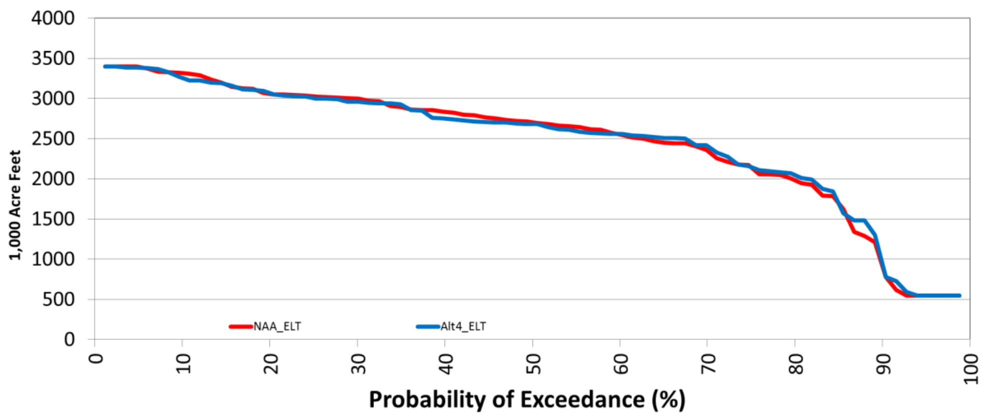


Figure 26. Shasta Reservoir Carryover Storage and Average Monthly Changes (Alt 4-ELT minus NAA-ELT) in Storage by Water Year Type



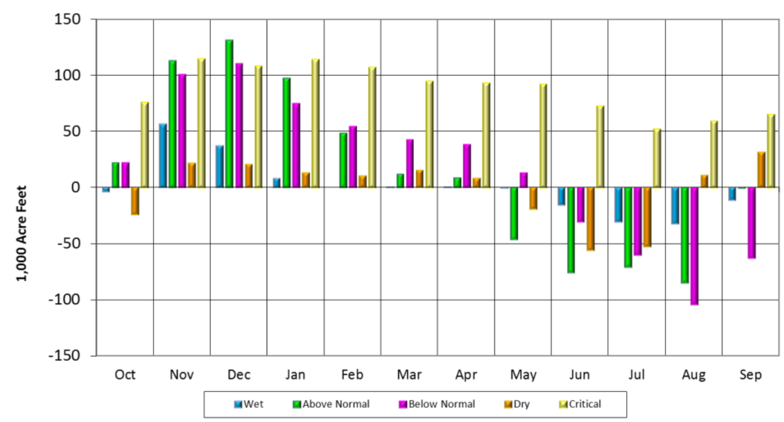


Figure 27. Oroville Reservoir Carryover Storage and Average Monthly Changes (Alt 4-ELT minus NAA-ELT) in Storage by Water Year Type

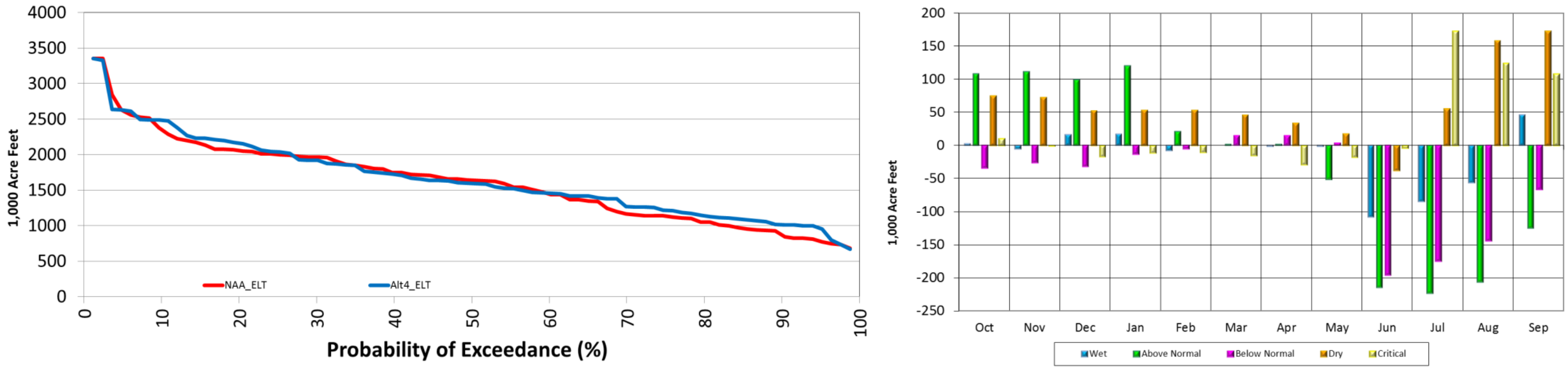


Figure 28. Folsom Reservoir Carryover Storage and Average Monthly Changes (Alt 4-ELT minus NAA-ELT) in Storage by Water Year Type

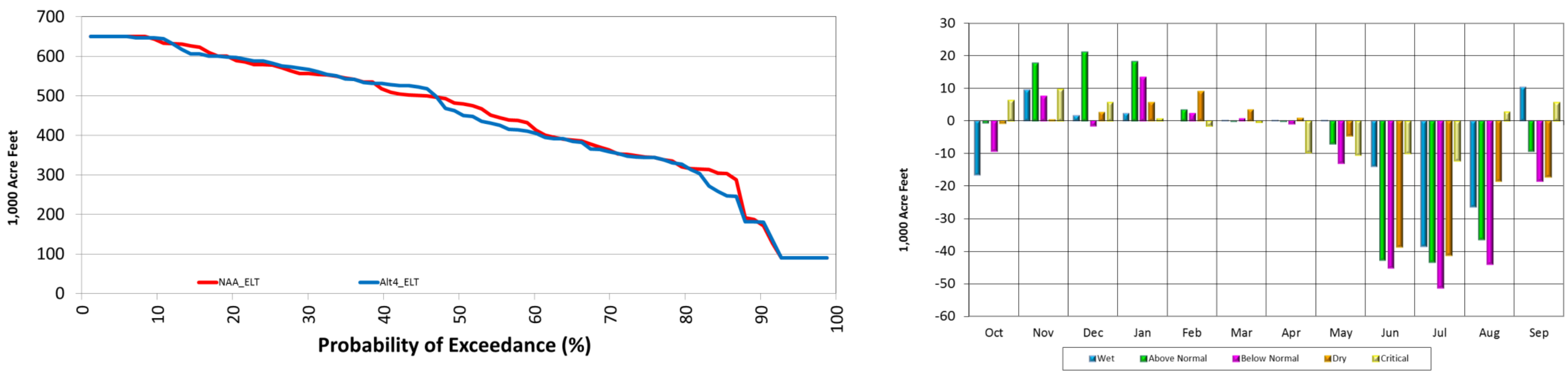


Figure 29. Federal Share of San Luis Reservoir (Alt 4-ELT and NAA-ELT)

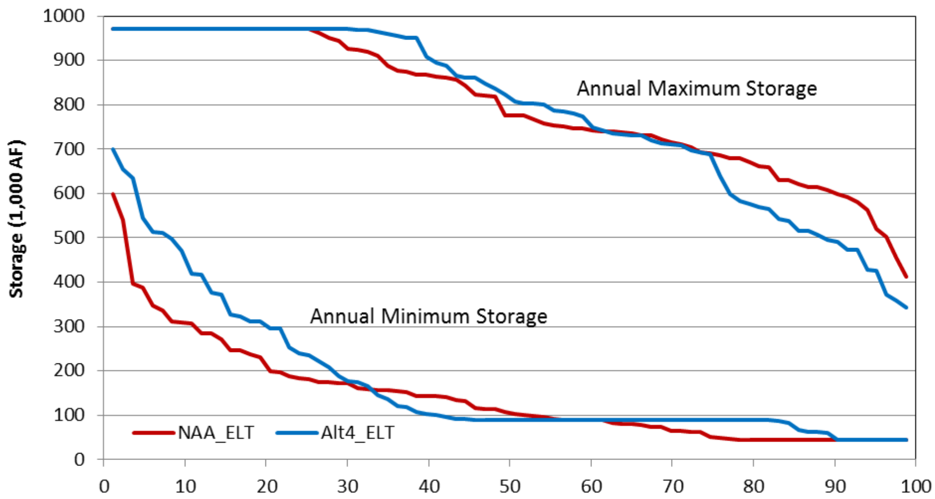
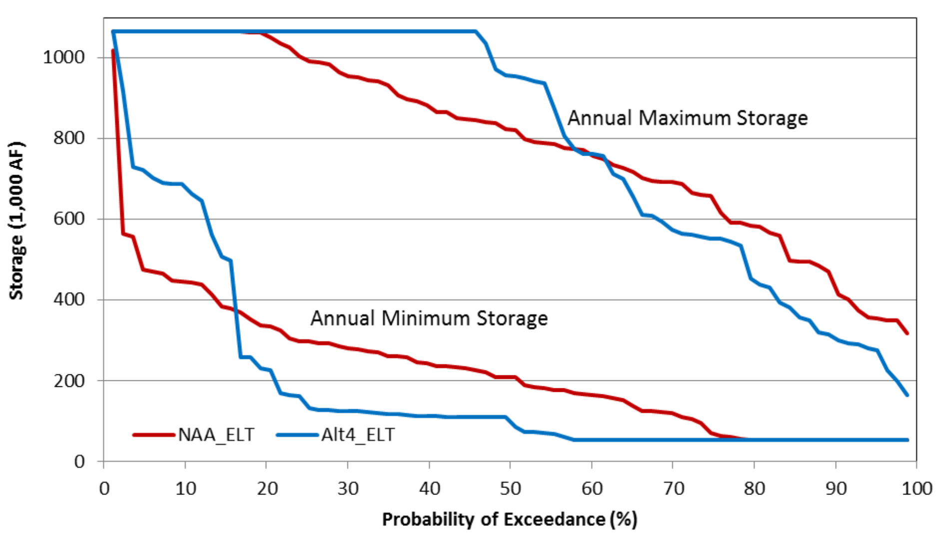


Figure 30. State Share of San Luis Reservoir (Alt 4-ELT and NAA-ELT)



CVP Water Supply

The changes in water supply to CVP customers, based on customer type and water year type is shown in Table 3. Alt 4-ELT shows an average increase of approximately 109,000 AF of delivery accruing to CVP customers with CVP SOD agricultural contractors receiving most of the benefit. Changes in Sacramento River Settlement contract deliveries are not an anticipated benefit of the BDCP, increases in these deliveries in Alt 4-ELT relative to the NAA-ELT are due to the shortages in the NAA-ELT from climate change that are reduced in Alt 4-ELT. Although the BDCP modeling demonstrates minor benefits to NOD CVP service contractors, this increase is not an anticipated benefit of the BDCP.

Consistent with modeling for the NAA-ELT Scenario, San Joaquin River Exchange Contractors receive full deliveries in accordance with contract provisions. Figure 31 compares CVP Service Contract delivery of Alt 4-ELT to the NAA-ELT Scenario. Increases in delivery generally occur in below and above normal years.

Table 3. CVP Delivery Summary (Alt 4-ELT and NAA-ELT)

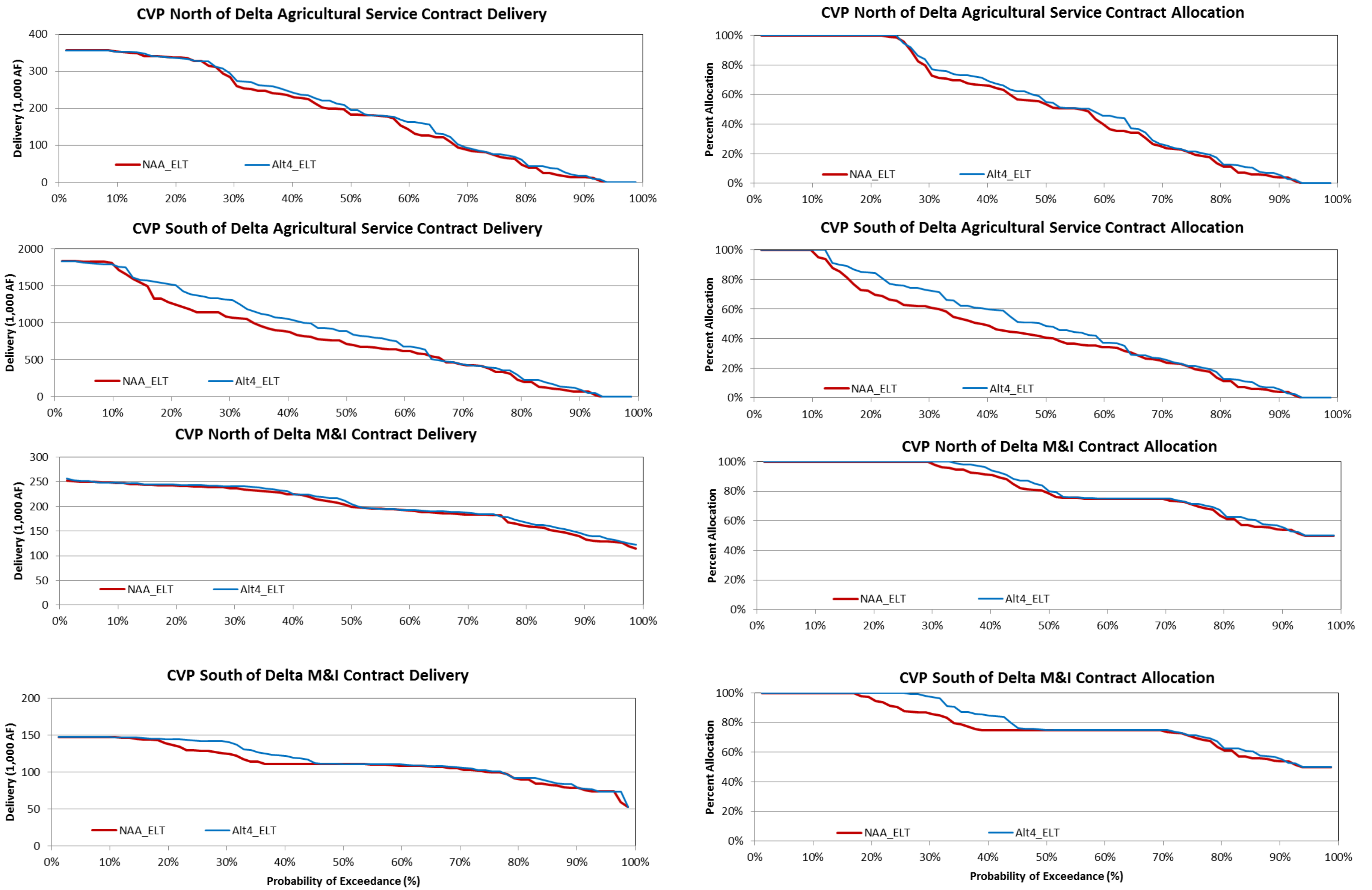
NAA-ELT (1,000 AF)

	AG NOD	AG SOD	Exchange	M&I NOD	M&I SOD	Refuge NOD	Refuge SOD	Sac. Setlmnt	CVP NOD Total	CVP SOD Total
All Years	**187**	**796**	**852**	**201**	**112**	**86**	**271**	**1846**	**2321**	**2215**
W	309	1364	875	236	134	90	281	1856	2491	2837
AN	246	908	802	214	110	83	257	1716	2258	2246
BN	146	596	875	198	108	92	281	1899	2335	2044
D	95	440	864	175	100	90	277	1890	2250	1864
C	29	152	741	140	79	64	223	1674	1908	1376

Difference: Alt4-ELT minus NAA-ELT (1,000 AF)

	AG NOD	AG SOD	Exchange	M&I NOD	M&I SOD	Refuge NOD	Refuge SOD	Sac. Setlmnt	CVP NOD Total	CVP SOD Total
All Years	8	90	0	4	4	1	0	3	15	94
W	1	68	0	1	3	2	1	-2	1	72
AN	14	199	0	3	12	1	0	-1	17	211
BN	17	153	0	5	4	0	0	0	22	158
D	10	48	0	5	2	1	-1	-1	15	49
C	3	6	0	5	2	-1	2	26	33	12

Figure 31. CVP Service Contract Deliveries (Alt 4-ELT and NAA-ELT)



SWP Water Supply

Similar in nature, but larger in magnitude are changes in SWP deliveries. Figure 32 and Table 4 illustrate the benefits of Alt 4-ELT in comparison to the NAA-ELT Scenario. These studies show an increase in average annual SWP SOD deliveries of approximately 408,000 AF, but a reduction in critical year deliveries of approximately 177,000 AF. There is an overall reduction in Article 56 deliveries. Typically in modeling and in actual SWP operations, increases in Table A correspond with increases in Article 56. The reason that Article 56 deliveries decrease overall is that insufficient quantities of water are carried over in San Luis and Article 56 contractors are subsequently shorted. SWP delivery increase is slightly less than increases in Banks export because there is increased wheeling for the Cross Valley Canal contractors with BDCP.

Table 4. SWP Delivery Summary (Alt 4-ELT and NAA-ELT)

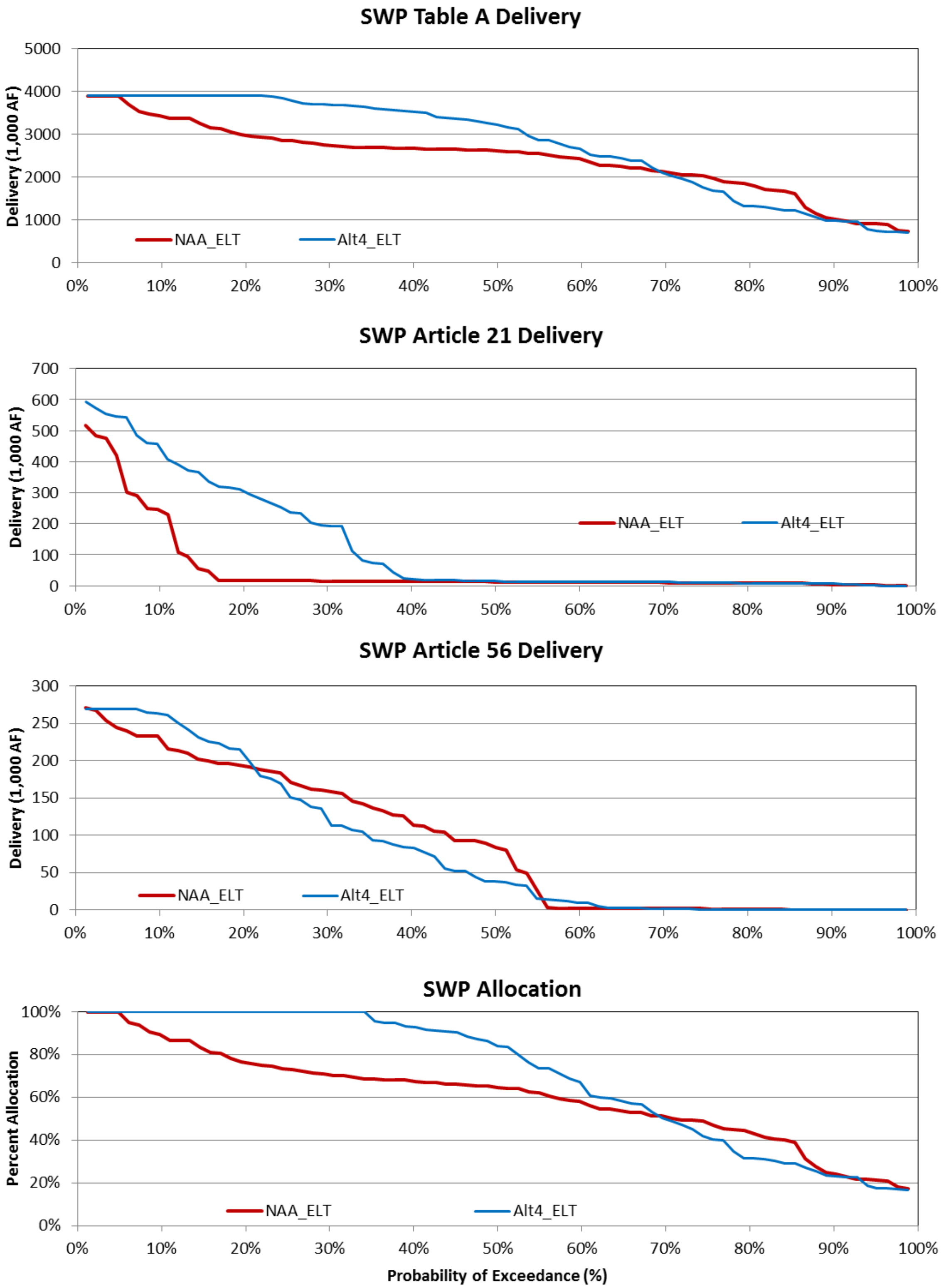
NAA-ELT (1,000 AF)

	Table A	Art. 21	Art. 56	Total
All Years	**2425**	**52**	**90**	**2567**
W	3112	79	112	3303
AN	2467	34	57	2559
BN	2515	48	109	2673
D	2033	43	88	2165
C	1172	28	47	1246

Difference: Alt4-ELT minus NAA ELT (1,000 AF)

	Table A	Art. 21	Art. 56	Total
All Years	339	75	-6	408
W	587	159	5	751
AN	728	99	-24	803
BN	525	44	2	571
D	-120	19	-10	-111
C	-146	-19	-12	-177

Figure 32. SWP Contract Deliveries (Alt 4-ELT and NAA-ELT)



Freemont Weir Modifications and Yolo Bypass Inundation

A component of the BDCP Alternative 4 is a modification to the Freemont Weir to allow water to flow into the Yolo Bypass when the Sacramento River is at lower flow than is currently needed. Currently, the Sacramento River does not flow over the Freemont Weir until flow reaches about 56,000 cfs. With the proposed modification Sacramento River flow may enter the Yolo Bypass at much lower flow levels. Figure 33 and Figure 34 contains charts that compare Freemont Weir flow into the Yolo Bypass to Sacramento River flow at the weir, Figure 33 show this relationship for the NAA-ELT and Figure 34 shows this same relationship for Alt 4-ELT.

Although CalSim II is a monthly time-step model, it contains an algorithm that estimates daily flow. Therefore, average monthly flows displayed in Figure 33 shows Sacramento River entering the Yolo Bypass at flow levels less than 56,000 cfs, when this occurs water is flowing over the Freemont Weir for a portion of the month. There is a 100 cfs minimum flow diversion from the Sacramento River diversion to the Yolo Bypass from September through June in Alt 4-ELT.

Figure 35 and Figure 36 contains average monthly flow from the Sacramento River over the Freemont Weir to the Yolo Bypass for the NAA-ELT (Figure 35), average monthly difference between Alt 4-ELT and NAA-ELT (Figure 36), and the annual average difference between Alt 4-ELT and NAA-ELT (Figure 37). In the NAA-ELT scenario flow over the Freemont Weir generally occurs in wet years, this flow is extended to all year types and all months except July and August in Alt 4-ELT. The average annual increase in flow is about 430 TAF.

Figure 33. Fremont Weir vs. Sacramento River NAA-ELT

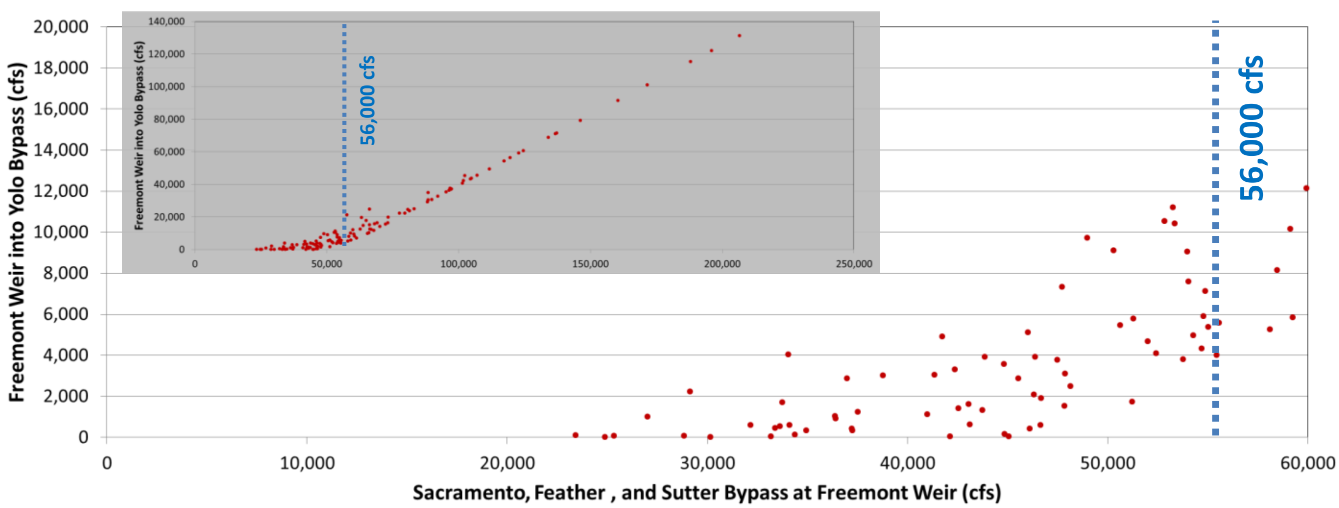


Figure 34. Fremont Weir vs. Sacramento River Alt 4-ELT

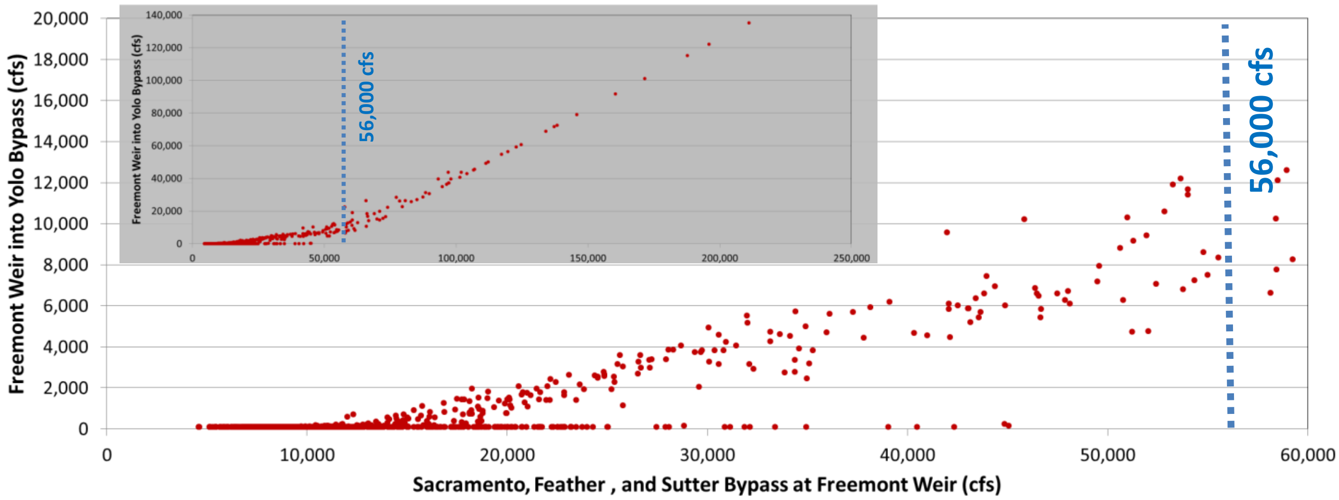


Figure 35. Average Fremont Weir Flow to Bypass by Water Year Type NAA-ELT

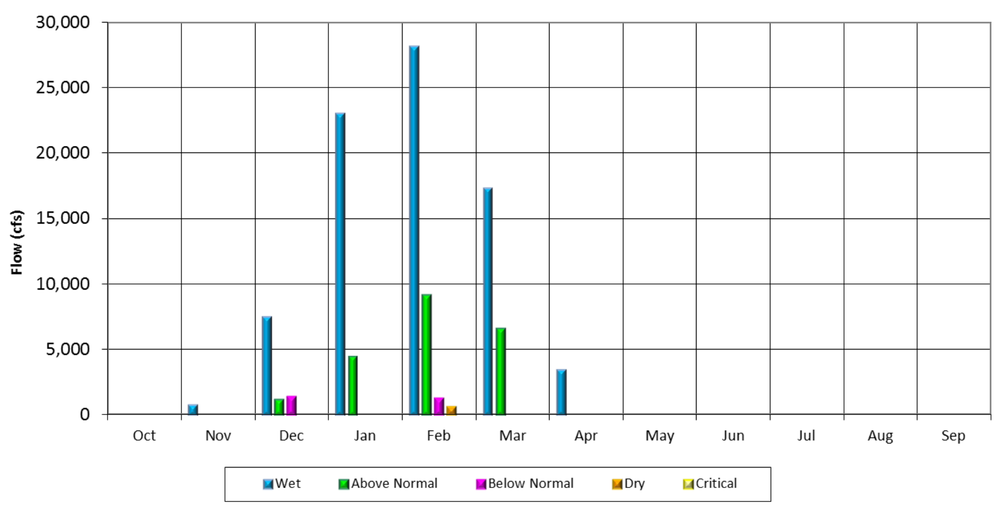


Figure 36. Average Fremont Weir Flow to Bypass by Water Year Alt 4 ELT minus NAA-ELT

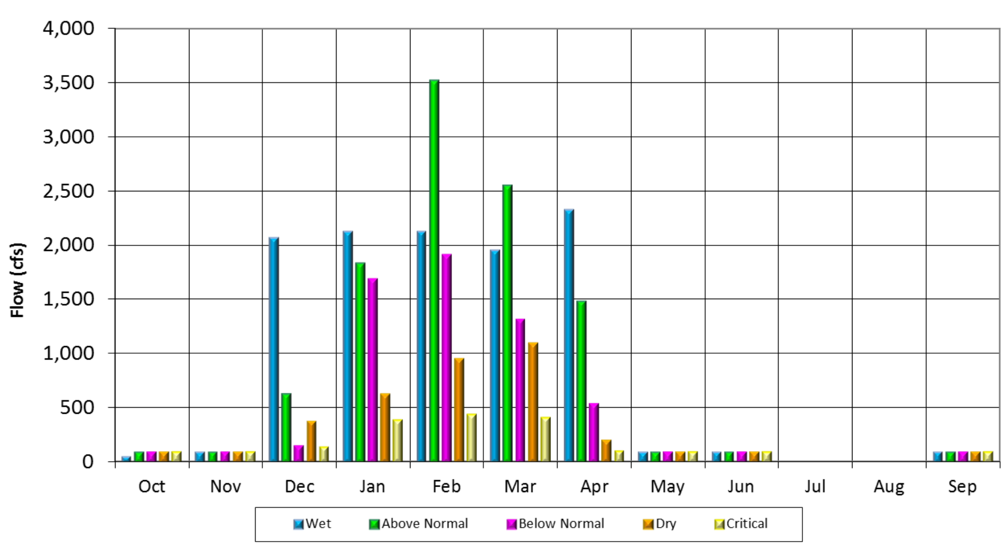
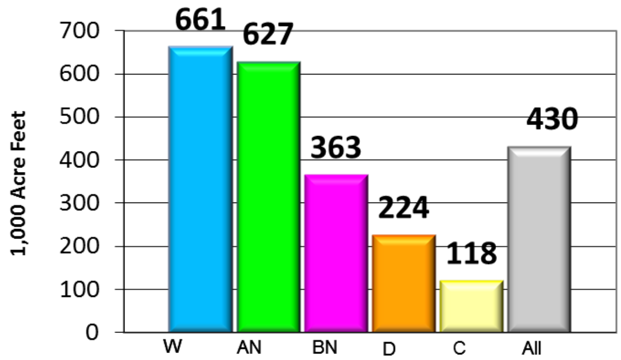


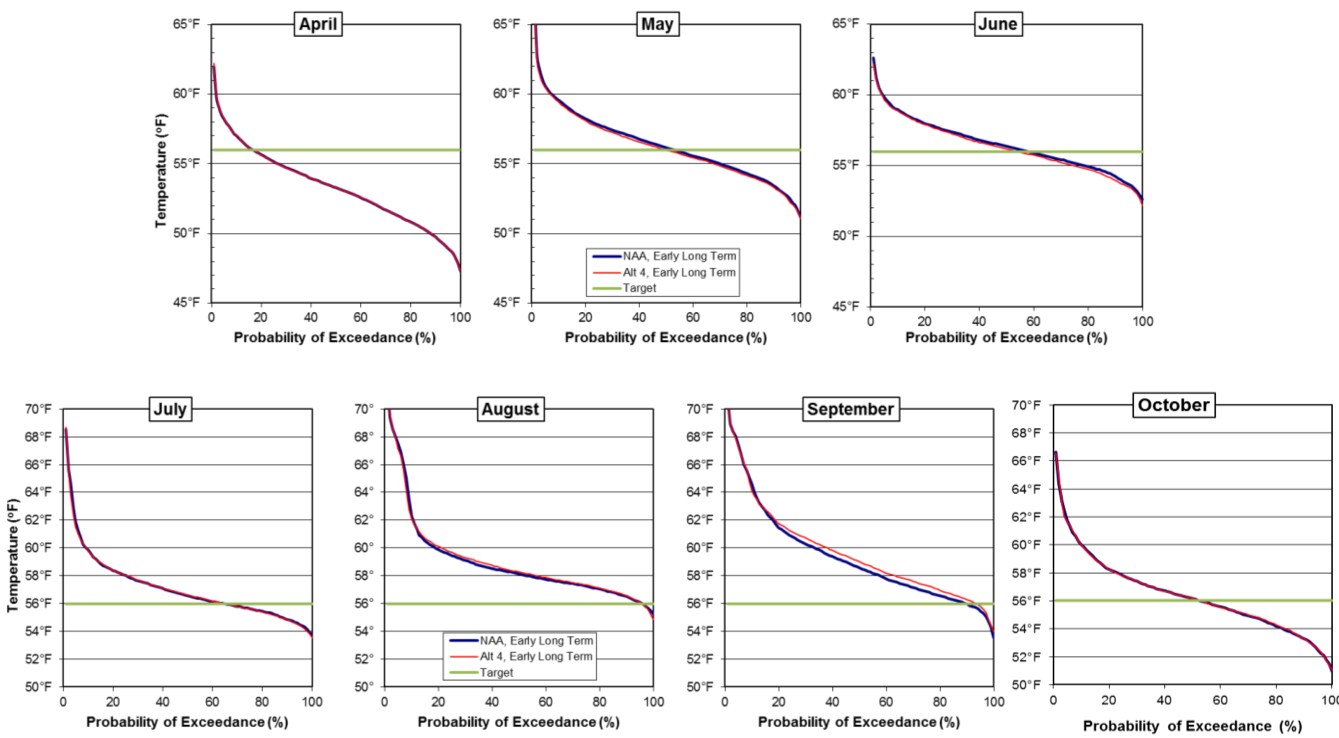
Figure 37. Annual Change in Fremont Weir Flow to Bypass Alt 4-ELT minus NAA-ELT



Sacramento River Temperature

Figure 38 contains exceedance probability plots of Sacramento River temperature at Bend Bridge for the NAA-ELT and Alt 4-ELT. For the months of April through July modeling shows few changes in upper Sacramento River water temperature. The Alt 4-ELT scenario shows temperature increases in August relative to the NAA-ELT. In about 75% of years modeling shows about 0.5°F increase in Alt 4-ELT relative to the NAA-ELT. The temperature models will meet inputted target temperatures until Shasta Lake cold water is depleted, this typically occurs in September. This is the likely reason temperature increases in modeling tend to occur in September.

Figure 38. Sacramento River Temperature at Bend Bridge NAA-ELT and Alt 4-ELT



Conclusions regarding CalSim II modeling of BDCP Alternative 4

BDCP's "High Outflow Scenario" is not sufficiently defined for analysis.

The High Outflow Scenario (HOS) requires additional water (Delta outflow) during certain periods in the spring. The BDCP Model places most of the responsibility for meeting this new additional outflow requirement on the SWP. However, the SWP may not actually be responsible for meeting this new additional outflow requirement. This is because the COA, as it is currently being implemented, would require a water allocation adjustment that would keep the SWP whole. Where one project (CVP or SWP) releases water to meet a regulatory requirement, the COA requires a water balancing to ensure the burden does not fall inappropriately among the projects. The BDCP Model is misleading because it fails to adjust project operations, as required by the COA, to "pay back" the water "debt" to the SWP due to these additional Delta outflow requirements. Unless there is a significant revision to COA, the BDCP Model overstates the impacts of increased Delta outflow on the SWP and understates the effects on the CVP.

Furthermore, after consulting with DWR and Reclamation project operators and managers, the Reviewers conclude that there is no apparent source of CVP or SWP water to satisfy both the increased Delta outflow requirements and pay back the COA "debt" to the SWP without substantially depleting upstream water storage. It appears, through recent public discussions regarding the HOS, that BDCP anticipates additional water to satisfy the increased Delta outflow requirement and to prevent the depletion of cold water pools will be acquired through water transfers from upstream water users. However, this approach is unrealistic because during most of the spring, when BDCP proposes that Delta outflow be increased, agricultural water users are not typically irrigating. This means that there is not sufficient transfer water available to meet the increased Delta outflow requirements without releasing stored water from the reservoirs. Releasing stored water to meet the increased Delta outflow requirements could potentially impact salmonids on the Sacramento and American River systems

Simulated operation of BDCP's dual conveyance, coordinating proposed North Delta diversion facilities with existing south Delta diversion facilities, is inconsistent with the project description.

The Draft BDCP and associated Draft EIR/EIS specify criteria for how much flow can be diverted by the new North Delta Diversion (NDD) facilities and specify when to preferentially use either the NDD facilities or the existing South Delta Diversion (SDD) facilities. However, the BDCP Model contains an artificial constraint that prevents the NDD facilities from taking water as described in the BDCP project description. In addition to affecting diversions from the NDD, this artificial constraint contains errors that affect the NAA operation. This error has been fixed by DWR and Reclamation in more recent versions of the model; however, the error remains in the BDCP Model. Additionally, the BDCP Model does not reflect the Summer operations of the SDD that are described in the Draft EIR/EIS as a feature of the BDCP project intended to prevent water quality degradation in the south Delta. The net effect of these two errors is that the BDCP Model significantly underestimates the amount of water diverted from the NDD facilities and overestimates the amount of water diverted from the SDD.

BDCP modeling contains numerous coding and data issues that skew the analysis and conflict with actual real-time operational objectives and constraints

logic is coded into the CalSim II model to simulate how DWR and Reclamation would operate the system under circumstances for which there are no regulatory or other definitive rules. This attempt to specify (i.e., code) the logic sequence and relative weighting so that a computer can simulate "expert judgment" of the human operators is a critical element to the CalSim II model. In the BDCP Model, some of the operational criteria for water supply allocations and existing facilities such as the Delta Cross Channel and San Luis Reservoir are inconsistent with real-world conditions.

3 INDEPENDENT MODELING

The Independent Modeling effort originally stemmed from reviews of BDCP Model during which the Reviewers discovered that the BDCP Model did not provide adequate information to determine the effects of the BDCP. There are three basic reasons why the Reviewers cannot assess how the BDCP will affect water operations: 1) NAAs do not depict reasonable operations under the described climate change assumptions, 2) operating criteria used in the BDCP Alternative 4 result in unrealistic operations, and 3) updates to CalSim II since the BDCP modeling was performed almost 4 years ago will likely alter model results to a sufficient degree that conclusions based on the BDCP modeling will likely be different than those disclosed in the Draft EIR/EIS. Given that it is not possible to determine how BDCP may affect CVP and SWP operations or water system flows and conditions with the BDCP model, Independent Modeling was performed to assess potential effects due to the BDCP.

To revise the models, the Reviewers consulted with operators at DWR and Reclamation to improve the representation of operational assumptions. Additionally, the Reviewers consulted with modelers at DWR and Reclamation to share findings, to strategize on the proper way to incorporate the guidance received from the operators, and to present revised models to DWR and Reclamation for their review. This collaborative and iterative process differed considerably from a standard consulting contract where the work product is not shared beyond the client-consultant until a final version is complete. To the contrary, consultations with agency experts were conducted early and repeatedly to ensure the revisions would reflect reasonable operations and to provide an independent review.

The first phase of this Independent Modeling effort was development of an updated without project baseline (similar to the NAA but with current, improved assumptions). The Independent Modeling does not incorporate climate change because the climate change hydrological assumptions developed by BDCP cause unrealistic operation of the system absent commensurate changes to operating criteria.

After the baseline was complete and reviewed, the second phase of this effort incorporated the facilities and operations for the BDCP described as Alternative 4 H3 in the Draft EIR/EIS, and otherwise known as the Evaluated Starting Operations (ESO) scenarios in the BDCP. During this phase, the issues that were identified during the Reviewers' initial review were corrected along with corrections made to resolve additional issues that were revealed as improvements were incorporated. Finally, results of the Independent Modeling and potential effects of the BDCP on water supply and instream flows are discussed.

3.1 Changes to CalSim II Assumptions

Revisions approved by DWR and Reclamation for the 2013 baseline

DWR and Reclamation provided CalSim II models used for the 2013 SWP Delivery Reliability Report (DRR) for use in this independent modeling effort. Changes to these models were made for this effort and provided to DWR and Reclamation, many of these changes have since been incorporated into DWR and Reclamation's model and others are under review.

The CalSim II model used for the 2013 SWP DRR is located on DWR's web site at: http://baydeltaoffice.water.ca.gov/modeling/hydrology/CalSim/Downloads/CalSimDownloads/CalSim-IIStudies/SWPReliability2013/index.cfm. Documentation for this model is described in the report titled: "*Draft Technical Addendum to the State Water Project Delivery Reliability Report 2013*", also located on DWR's web site at: http://baydeltaoffice.water.ca.gov/swpreliability/. Key modeling assumptions used for this effort are consistent with the 2013 SWP DRR and are listed in Table 4 of the Technical Addendum.

CalSim II is continuously being worked on and improved to better represent CVP and SWP operations and fix known problems. The Technical Addendum to the 2013 SWP DRR contains a description of updates and fixes that have occurred since modeling was performed for the BDCP Draft EIRS. Among these changes and fixes are key items that directly affect operation of facilities proposed in BDCP Alternative 4, these items are described on page 4 of 2013 SWP DRR Technical Addendum. Key among these fixes is the correction of the Sacramento River flow requirement for Delta inflow that causes NDD bypass to exceed requirements.

A key component of this independent modeling effort is the development of an acceptable CalSim II Future No-Action (FNA) model scenario. The purpose for developing the FNA Scenario is to produce an operational scenario that is realistic enough to understand how changes proposed in the BDCP will affect operations. The process of developing the FNA involved research and development of CalSim II model updates and several meetings with Reclamation and DWR modeling and operations staff. In addition to changes in the FNA Scenario, CalSim II was updated to better reflect operation of the NDD, CVP and SWP reservoir balancing, DCC gate operations, and CVP/SWP water supply allocations.

Additional Revisions to CalSim II Assumptions

The following changes were made to the 2013 SWP DRR version of CalSim II for this effort:

- San Joaquin River Basin
    - Turned off San Joaquin River Restoration Program (SJRRP) The SJRRP will cause a change to San Joaquin River inflow to the Delta not associated with the BDCP. To avoid adding complications to the identification of BDCP export benefits the SJRRP was not incorporated into the analysis.
    - Tuolumne: updated time-series, lookup tables, and wresl code
    - Turned off SJRA (VAMP) releases
- Updated Folsom flood diagram
- Rice decomposition demand diversions from Feather River
- Dynamic EBMUD diversion at Freeport
- SEP1933 correction to daily disaggregated minimum flow requirements at Wilkins Slough and Red Bluff
- CVP M&I demands are updated to reflect assumptions used by Reclamation
- Yuba Accord Transfer
- Los Vaqueros Reservoir capacity

San Joaquin River Basin

BDCP modeling depicted San Joaquin River Basin operations generally consistent with the actions, programs and protocols in place at the time of NOI/NOP issuance. Some of those conditions are now not representative of current development or operations. With the exception of the assumption for the SJRRP, the independent modeling has revised San Joaquin River Basin operations to reflect more contemporary LOD assumptions. In future level analyses the independent modeling similarly assumes no SJRRP, but only for analysis simplicity concerning BDCP export benefits. Additional analyses may be useful in understanding effects of collectively implementing the BDCP and SJRRP.

The San Joaquin River Basin (SJR) is depicted for current conditions, primarily affected by the operations of the Stanislaus, Tuolumne, Merced, and upper San Joaquin River tributaries. The upper San Joaquin River is currently modeled in a “pre-“ SJRRP condition, consistent with the 2005 CalSim version. The FNA Scenario also models the upper San Joaquin River without the SJRRP. The SJR depicts near-term operations including SWRCB D-1641 flow and water quality requirements at Vernalis met when hydrologically possible with New Melones operations. The Vernalis flow objective is set by SWRCB D-1641 February-June base flow requirements. There are no pulse flow requirements during April and May, and there is no acquired flow such as VAMP or Merced water. D1641 Vernalis water quality requirements are set at 950/650 EC to provide an operational buffer for the requirement. New

Melones is operated to provide RPA Appendix 2E flows as fishery releases and maintains the DO objective in the Stanislaus River through a flow surrogate. Stanislaus River water right holders (OID/SSJID) are provided deliveries up to land use requirements as occasionally limited due to operation agreement (formula). CVP Stanislaus River contractors are provided allocations up to 155 TAF per year in accordance with proposed 3-level plan based on the New Melones Index (NMI). For modeling purposes during the worst drought sequence periods, CVP Stanislaus River contractors and OID/SSJID diversions are additionally cut to maintain New Melones Reservoir storage no lower than 80 TAF. Merced River is operated for Federal Energy Regulatory Commission (FERC) and Davis-Grunsky requirements, and provides October flows as a condition of Merced ID's water rights. The Tuolumne River is operated to its current FERC requirements and current water use needs and has been updated to recent conditions.

Folsom Lake Flood Control Diagram

During wetter years, inflow to Folsom Lake is sufficient to keep the reservoir full while satisfying all demands downstream. When this condition occurs in actual operations, operators increase releases during summer months to maintain higher instream flows and prevent large releases in the fall to evacuate Folsom to satisfy flood control storage requirements. To prevent the model from keeping the reservoir full going into the fall months and then making large releases to comply with flood control storage requirements, the maximum allowable storage during summer months is ramped from full storage in June to flood control levels in the fall. Although this is a common modeling tool, Folsom storage level for the end of September was set too low in the SWP DRR model causing unnecessary releases and resulting in Folsom storage being lower than desired. An adjustment was made to achieve a more realistic summer drawdown for Folsom.

Feather River Rice Decomposition Demand

Demand for rice straw decomposition (decomp) water from Thermalito Afterbay was added to the model and updated to reflect historical diversion from Thermalito in the October through January period. There are approximately 110,000 acres of rice in the Feather River Service Area irrigated primarily with water diverted from Thermalito Afterbay. Although decomp water demand for the Sacramento River has been included in CalSim II since about 2006, this demand has been absent for the Feather River. Inclusion of decomp demand in the version of CalSim II used for this effort results in an increase in Feather River diversion in fall months of about 160,000 AF.

Dynamic EBMUD Diversion at Freeport

Previously the EBMUD operation was pre-determined and input to CalSim II as a time-series. The below criteria was implemented in CalSim II model code to achieve a dynamic representation of EBMUD diversion from the Sacramento River at Freeport.

The EBMUD water service contract is unique. EBMUD's total system storage must be forecast to be below 500 TAF on October 1 for CVP water to be available under the EBMUD contract. In years when this occurs, we assume EBMUD will take the minimum of 65 TAF of CVP water or their CVP allocation (133 TAF * CVP M&I allocations) in the first and second years of any multi-year period when CVP water is available under their contract. In the third year, EBMUD would be limited to 35 TAF of CVP water (assuming diversion of 65 TAF in years one and two) because their contract limits cumulative CVP water over three consecutive years to 165 TAF. The 65, 65, 35 TAF annual diversion pattern then repeats if water is available for four or more consecutive years under the EBMUD contract.

Wilkins Slough Minimum Flow Requirement

Wilkins Slough minimum flow requirements, C129_MIF, includes an adjustment for daily operations based on work with the Sacramento River Daily Operations Model (SRDOM). The flow adjustment for daily flows for September 1933 in the state variable input file appeared unreasonable in the previous model. The flow adjustment in this month was approximately 1,860 cfs and was requiring release of approximately 100 TAF out of Shasta. Review of the entire time-series of daily adjustments showed the adjustment in this month was an order of magnitude greater than in any other September in the simulation period. The year 1933 is a critically dry year, and the third of four consecutive Shasta Critical years. Historical precipitation records from the consumptive use models for the Sacramento Valley, which serves as the basis of much of the CalSim hydrology, were reviewed to ensure there was no unusual precipitation in this month that may create variations in daily flows. It was determined that this daily adjustment is in error. The daily adjustment for this time-step was set to 10 cfs, the value for August 1933.

CVP M&I Demands

Reclamation M&I contractor demands upstream from the Delta have not been adequately represented in CalSim II until Reclamation updated the model in 2012. A more accurate representation of CVP M&I demands, developed in 2012, was incorporated into the model for this effort.

Yuba Accord Water Transfer

In CalSim, Yuba Accord Water Transfers are limited to releases from New Bullards Bar Reservoir. The release is picked up at Banks Pumping Plant or stored in Oroville and Shasta for later release. The additional release from New Bullards Bar is represented in CalSim through an inflow arc. The subsequent refill of New Bullards Bar is represented in CalSim through a diversion arc. In CalSim II, refill is assumed to always occur in the winter following the transfer. However, in the SWP DRR model, there were a few years in which no transfers took place but refill still occurred in the following winter. This was fixed in the updated baseline by capping refill to the previous summer's total transfer.

Los Vaqueros Reservoir

Expansion of Los Vaqueros Reservoir was completed in 2012. Storage capacity was increased from 103 TAF to 160 TAF. In DWR's BDCP studies, Los Vaqueros capacity was set to 103 TAF. The independent modeling increases Los Vaqueros capacity to 160 TAF.

3.2 Changes to BDCP Operations

San Luis Reservoir Rule-Curve Logic Change

In the independent modeling, San Luis rule-curve logic was refined for both SWP and CVP operations. San Luis rule-curve is used to maintain an appropriate balance between San Luis Reservoir storage and North of Delta reservoirs. The key considerations in formulating rule-curve are as follows:

- Ensure that sufficient water is available in San Luis Reservoir to meet contract allocations when exports alone are insufficient due to various operational constraints.
- Minimize San Luis Reservoir carryover storage to low point criteria (both CVP and SWP) and Article 56 carryover (only SWP). The basic premise is to maintain Reservoir San Luis storage no higher than necessary to satisfy south of Delta obligations to avoid excessive drawdown of upstream storage.

In DWR's BDCP studies, there were significant shortages in Table A and Article 56 deliveries because of an improper balance between upstream and San Luis Reservoir storage. The updated SWP rule-curve logic reduces these shortages but does not eliminate them. Also, the updated CVP rule-curve logic allows for higher CVP allocations without increasing risk of shorting SOD contractors.

Upstream Storage Release to Fill San Luis Reservoir Above Needed Supply

In the BDCP NAA and the independent modeling FNA, the model has a priority to release excess stored water that will likely be released for flood control purposes from Shasta and Folsom storage for export at Jones Pumping Plant to storage in San Luis Reservoir in the late summer and early fall months. The purpose was to get a head start on filling San Luis Reservoir for the coming water year if there is a high likelihood of Shasta or Folsom spilling. This was an assumed CVP/SWP adaptation to the export reductions in the winter and spring months due to the salmon and smelt biological opinions. However, with the NDD facility in Alt 4, winter and spring export restrictions impact CVP exports much less and there is no longer a reason to impose this risk on upstream storage. As such, the weights, or prioritizations, of storage in Shasta and Folsom were raised so that excess water would not be released specifically to increase CVP San Luis storage Reservoir above rule-curve. This was changed in Alt 4 and not the FNA to better reflect how the system may operate under these different conditions.

Delivery allocation adjustment for CVP SOD Ag service and M&I contractors

CVP SOD Ag service and M&I allocations are limited by both systemwide water supply (storage plus inflow forecasts) and Delta export constraints; whereas similar CVP NOD allocations are dependent solely on water supply. This frequently results in SOD water service contractors receiving a lower contract year allocation than NOD water service contractors, especially under the Biological Opinion export restrictions. However, with the NDD facility operations as proposed under Alt 4 H3, the CVP can largely bypass these Delta export restrictions, and the export capacity constraint on CVP SOD allocations was determine to be overly conservative. Therefore, the export capacity component of CVP SOD allocations was removed in the BDCP Alternative and both SOD and NOD CVP allocations are equal and based only on water supply.

Folsom/Shasta Balance

CVP operations were refined in the BDCP Alternative to provide maximum water supply benefits to CVP contractors while protecting Trinity, Shasta, and Folsom carryover storage in the drier years. As a whole, this was accomplished with refinements to allocation logic and San Luis rule-curve. However, in initial study runs, an imbalance between Folsom and Shasta was created; while there was a total positive impact to upstream storage in dry years, there was a negative impact to Folsom storage. This was resolved by inserting Folsom protections in the Shasta-Folsom balancing logic. With these protections, the positive carryover impacts were distributed to Trinity, Shasta, and Folsom.

North Delta Diversion Bypass Criteria

The daily disaggregation method for implementing NDD bypass criteria as implemented in DWR's BDCP model was left mostly intact for the updated BDCP studies. However, there were modifications to properly fit the bypass criteria implementation within the latest CalSim operations formulation. Modifications are as follows:

1. No NDD operations occur in cycles 6 through 9 so that Delta operations and constraints can be fully assessed without NDD interference.
2. Cycles 10 and 11 (Daily 1 and Daily 2 respectively) were added to determine NDD operations given various operational constraints including the NDD bypass criteria.
3. From July to October, bypass criteria are based on monthly average operations (no daily disaggregation). Given the controlled reservoir releases at this time and the constant bypass criteria (5,000 cfs from July to September and 7,000 cfs in October), this was determined to be a reasonable assumption. This also simplified coordination of DCC gate operations with NDD in October which will be discussed later.
4. When warranted by conditions in cycle Daily 1 (cycle 10), the bypass criteria in May and June were allowed to be modeled on a monthly average basis in cycle Daily 2 (cycle 11). This allowed a reduction in the number of cycles necessary to determine the fully allowed diversion under the bypass criteria when

the Delta was in balance and additional upstream releases were made to support diversions from the North Delta.

Delta Cross Channel Gate Reoperation in October

The BDCP Alt 4 results in significantly more October surplus Delta outflow as compared to the baseline. The cause of this Delta surplus at a time when the Delta is frequently in balance is a combination of proposed through-Delta export constraints (OMR flow criteria and no through-Delta exports during the San Joaquin River October pulse period), Rio Vista flow requirements, and DCC gate operations. In DWR's BDCP studies, it was assumed that the DCC gates would be open for the entire month of October thereby requiring much higher Sacramento River flows at Hood in order to meet the Rio Vista flow requirement than if the DCC gates were closed. Whereas in the independent BDCP modeling it was assumed that the DCC gates were closed for a number of days during the month such that the 7,000 cfs NDD bypass criteria would be sufficient to meet the weekly average Rio Vista flow requirements. The intent was to minimize surplus Delta outflow while meeting Delta salinity standards and maintaining enough bypass flow to use the NDD facility for SOD exports. This is an approximation of what is likely to occur in real-time operations under similar circumstances. Further gate closures may be possible as salinity standards allow if operators decide to preserve upstream storage at the expense of NDD diversions. This type of operation would require additional model refinements.

Wilkins Slough minimum flow requirement

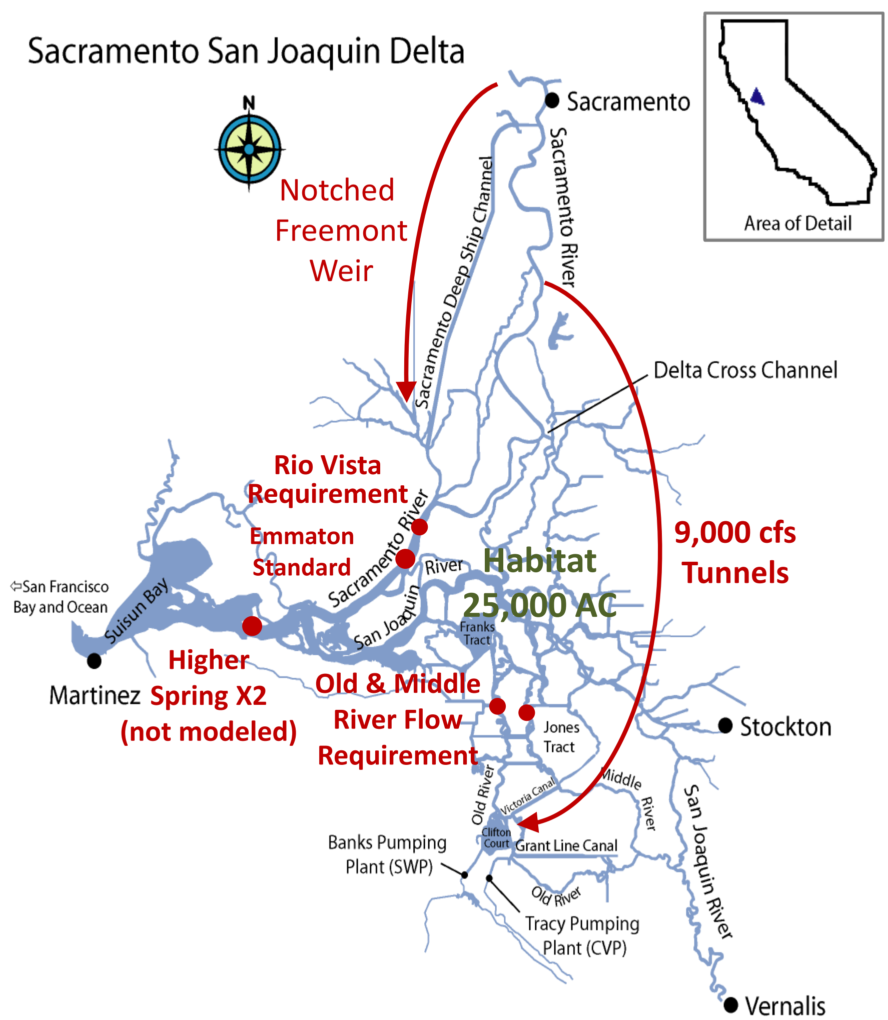
Currently in CalSim II, relaxation of the Wilkins Slough minimum flow requirement is tied to CVP NOD Ag Service Contractor allocations. This does not reflect actual operations criteria where relaxation of the flow requirement is dependent solely on storage conditions at Shasta. From the comparative analysis perspective of our CalSim planning studies, this introduces a potential problem: changes in CVP NOD Ag Service allocations can result in unrealistic changes in required flow at Wilkins Slough, and such changes in Wilkins Slough required flow can result in unrealistic impacts to Shasta storage. To bypass this problem, we assumed that the required flow at Wilkins Slough in the alternative was equal to the baseline.

3.3 Alternative 4 Modeling results

Analysis for this effort was focused on BDCP Alt 4 with existing spring and fall X2 requirements, which corresponds to “Alternative 4 H3” in the Decisions Tree. This modeling is performed without climate change, and includes refined operating criteria for the NDD, CVP and SWP reservoirs, DCC gate closures, and water supply allocations. This modeling includes all Project features that are included in Alt 4 in the BDCP modeling. The Project features are displayed in Figure 39 and summarized as:

- NDD capacity of 9,000 cfs
- Bypass flow requirements for operation of the NDD
- Additional positive OMR flow requirements
- No San Joaquin River I/E ratio
- Changed location for Emmaton water quality standard in SWRCB D-1641
- Additional Sacramento River flow requirement at Rio Vista
- 25,000 acres of additional tidal habitat
- Notched Fremont Weir

Figure 39. Alt 4 Features

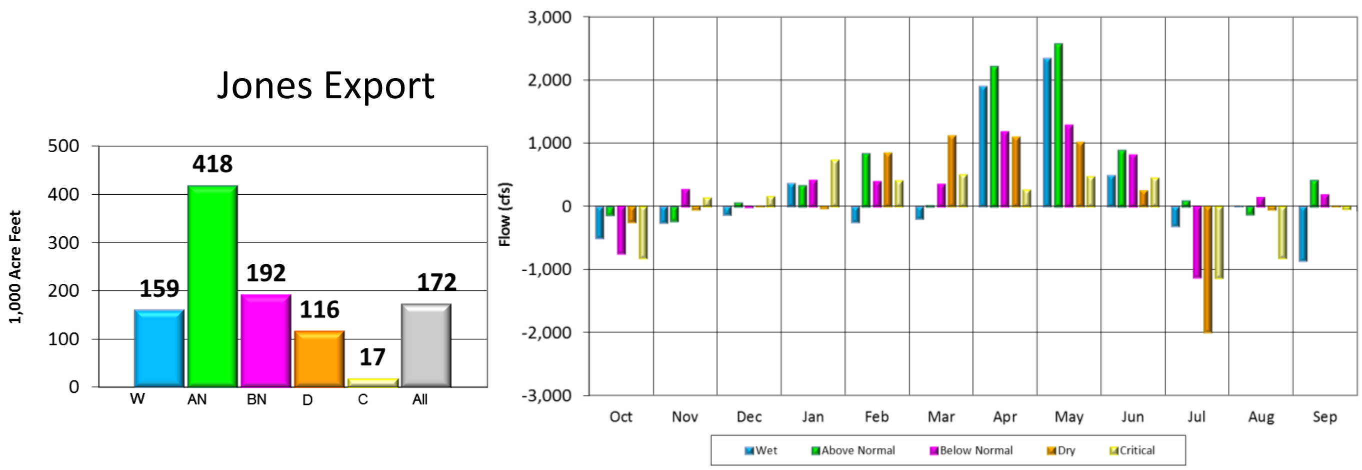


For the purpose of describing results of the independent modeling, the revised Future No Action model scenario is labeled "FNA" and the revised BDCP Alt 4 scenario is labeled "Alt 4".

CVP/SWP Delta Exports

Average annual exports at Jones pumping plant are about 170 TAF higher in the Alt 4 Scenario compared to the FNA scenario, as seen in Figure 40. Increases generally occur from January through June when Old & Middle River (OMR) criteria limit use of Jones PP in the FNA Scenario. Decreases occur in July in drier year types because the increased ability to convey water in spring months reduces the need to convey water stored in upstream reservoirs in July. Reductions in Jones export in October are partially a function of increases in OMR flow requirements.

Figure 40. Change in Delta Exports at Jones Alt 4 minus FNA



Similar to export at Jones, Banks exports are generally higher from January through June because use of NDD allows pumping that is not possible in the FNA Scenario, as seen in Figure 41. Banks exports are increased during summer months of wetter year types. This is due to earlier wheeling for CVP Cross Valley Canal contractors (without NDD Banks capacity isn't typically available until Fall in wet years) and wheeling of CVP water through Joint Point of Diversion (JPOD). CVP export at Banks is displayed in **Figure 42**. In wetter years, upstream CVP reservoirs hold more water than can be exported at Jones pumping plant, this water is typically spilled in the FNA scenario. CVP water stored in upstream reservoirs can be released in July, August, and September to support south of Delta beneficial use of water through use of JPOD in Alt 4.

Figure 41. Change in Delta Exports at Banks Alt 4 minus FNA

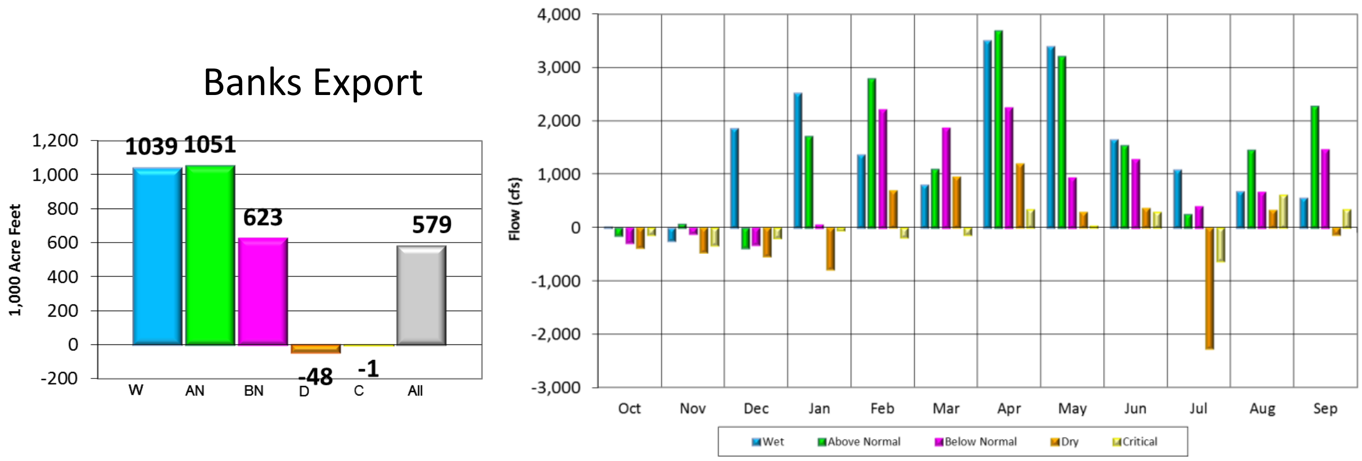
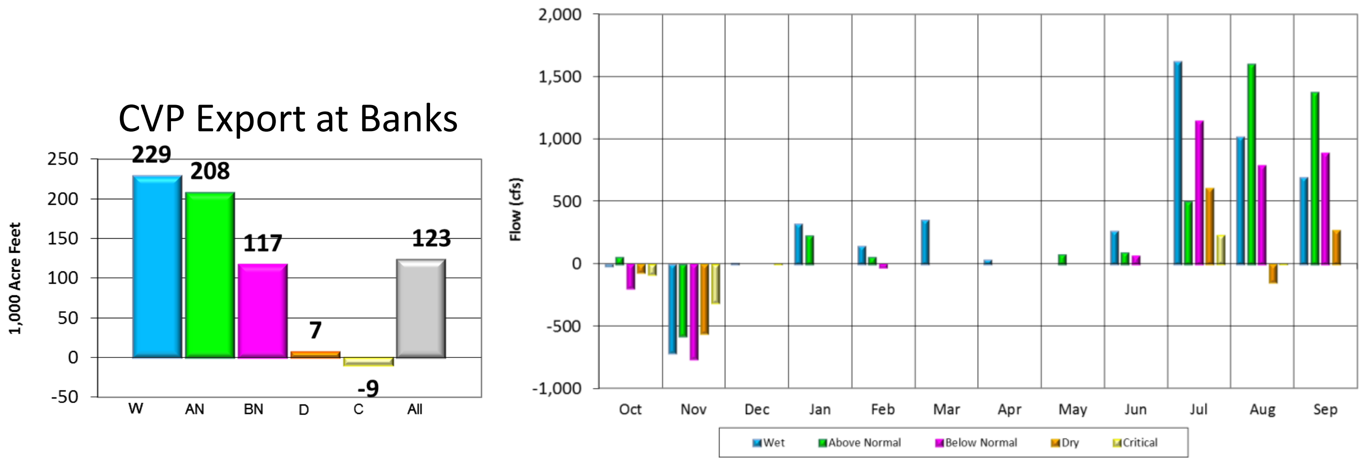


Figure 42. Change in CVP Delta Exports at Banks Alt 4 minus FNA

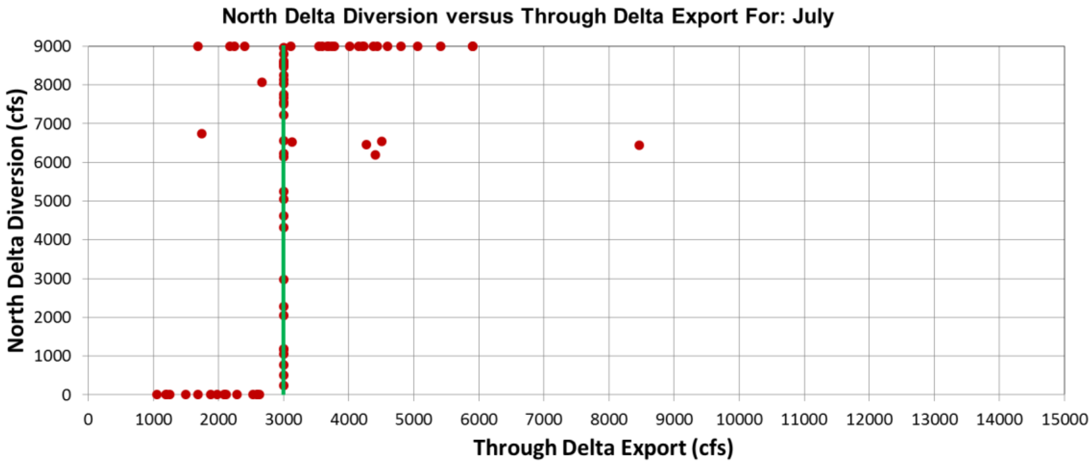


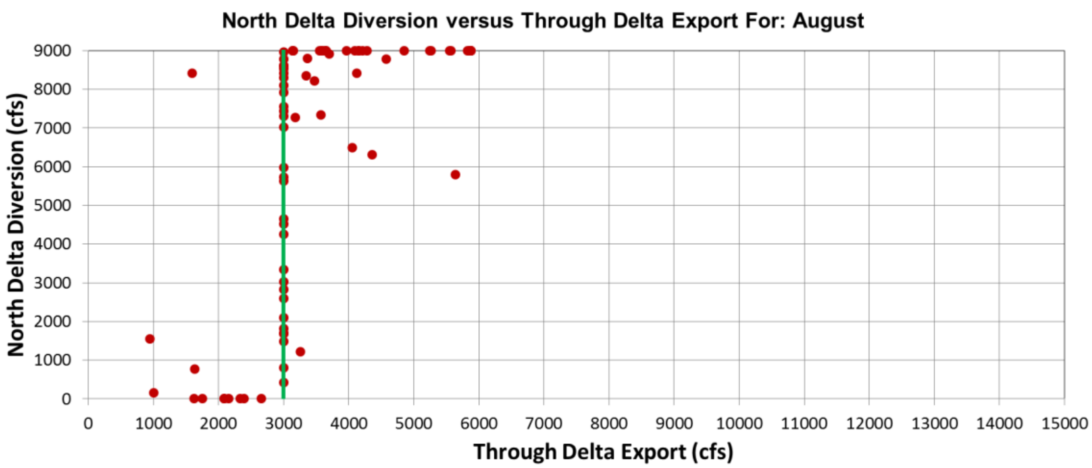
Changes in total, South Delta, and North Delta exports are displayed in Figure 43. Average annual increase in total Delta exports is about 750 TAF, the increases primarily occur in wetter year types with lesser increases in dryer years. South Delta export decreases about 2.53 MAF in Alt 4 relative to the FNA. Export through the NDD is 3.28 MAF in Alt 4, about 58% of total exports are diverted from the North Delta.

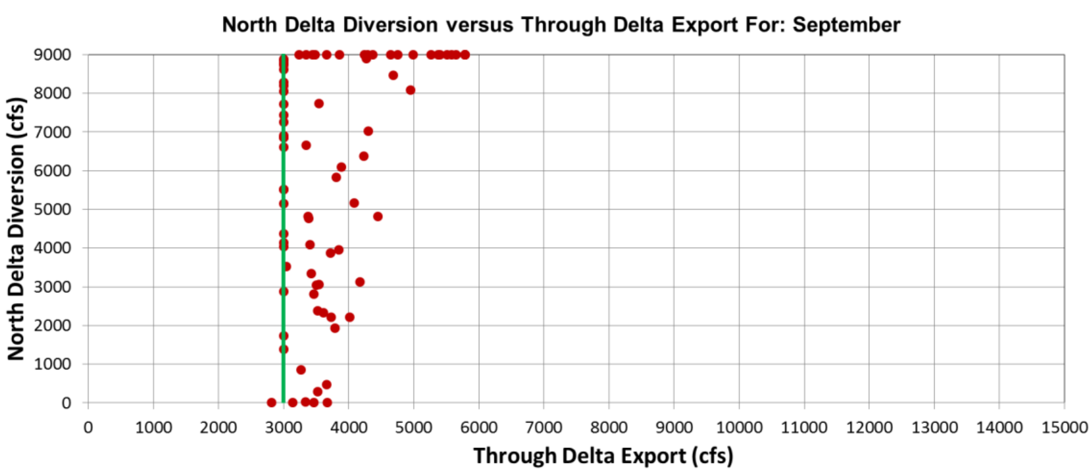
Figure 43. Change in Conveyance Source of Exports (Alt 4 minus FNA)

Figure 44 contains modeling results from Alt 4 for July, August, and September that plot NDD against SDD (Through Delta Export). There are many occasions when SDD are 3,000 cfs, which is due to criteria specifying that SDD during this time period need to be at least 3,000 cfs prior to diverting at the NDD facility. Although there are about six occurrences in July and three in August where the model did not satisfy this criterion, this issue has not yet been addressed for this modeling effort.

Figure 44. Alt 4 North Delta Diversion Versus South Delta Diversion for July, August, and September



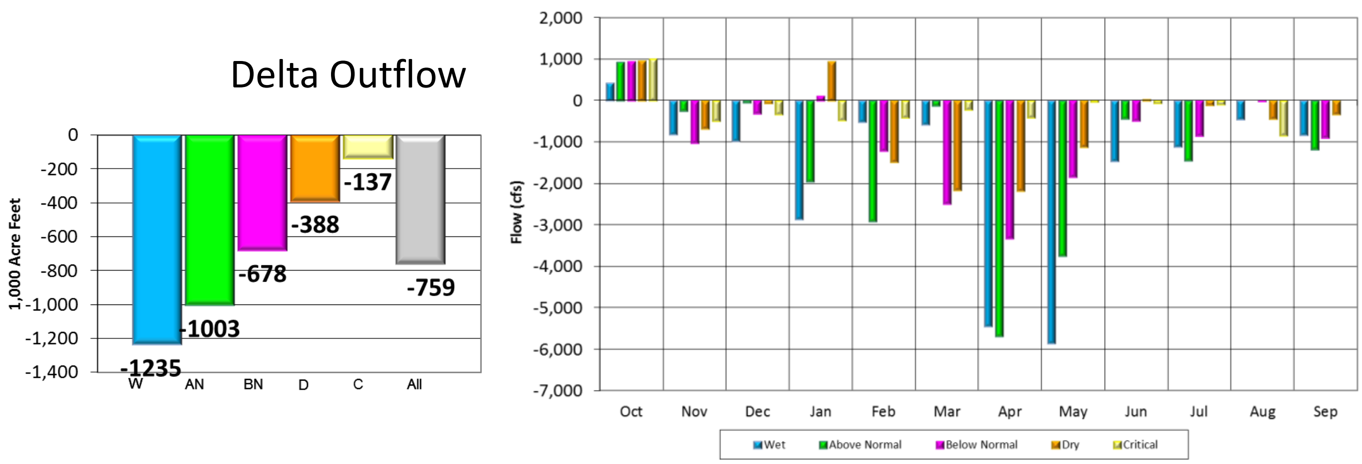




Delta Outflow

Figure 45 contains annual and monthly average changes in Delta outflow by water year type, average annual Delta outflow decreases about 760 TAF in the Alt 4 Scenario relative to the FNA Scenario. The decrease is primarily due to increases in Delta exports, which are about 750 TAF on average. Larger decreases generally occur in January through May when exports are constrained in the FNA Scenario and in the Alt 4 Scenario the NDD can be used to export water. Delta outflow increases in October due to the combination of additional OMR flow requirements that restrict exports and Sacramento River flow requirements at Rio Vista. The additional surplus Delta outflow in Alt 4 was minimized through coordination of the Delta Cross Channel Gate operations with the Rio Vista flow requirements and North Delta Diversion bypass requirements.

Figure 45. Changes in Delta Outflow (Alt 4 minus FNA)



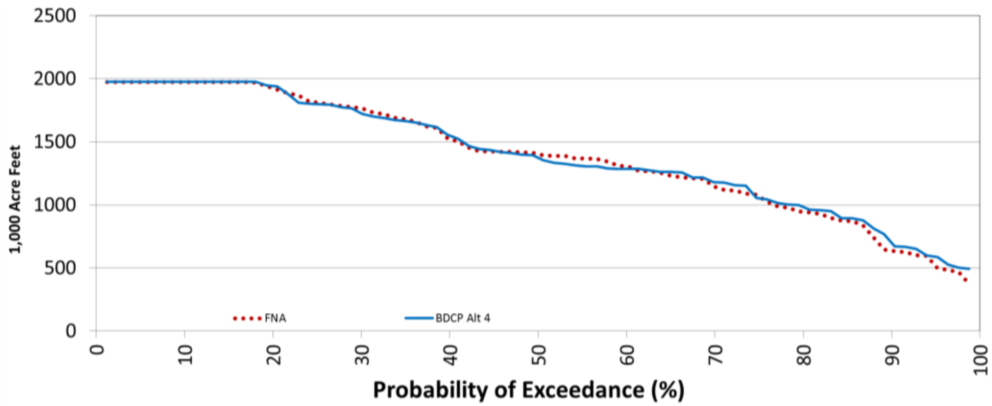
Carryover Storage

Figure 46, Figure 47, Figure 48, and Figure 49 contain exceedance charts for carryover storage and average monthly changes in storage by Sacramento Valley Water Year Type for CVP and SWP upstream reservoirs. CVP/SWP reservoirs tend to be higher in the Alt 4 Scenario relative to the FNA on an average basis. Generally, CVP/SWP reservoirs are higher in storage in dryer year types and can be lower in wetter year types.

Ability to convey stored water from upstream CVP/SWP reservoirs to south of Delta water users is increased in Alt 4 relative to the FNA. Therefore, when upstream reservoirs are at higher storage levels more water is released to satisfy south of Delta water demands. This is the primary reason Shasta, Oroville, and Folsom tend to be lower during summer months of wetter years.

Currently, and in the FNA Scenario, the CVP and SWP ability to export natural flow, or unstored water, is constrained due to SWRCB D-1641 and requirements in the salmon and smelt biological opinions. With the greater ability to export unstored water during winter and spring months in the Alt 4 Scenario, compared to FNA, there is generally a reduced reliance on stored water to satisfy south of Delta demands. The increased ability to export unstored water allows the CVP and SWP to maintain higher storage levels in upstream reservoirs during dryer year types while still maintaining south of Delta deliveries. Carryover storage in the Alt 4 Scenario tends to be higher than the FNA Scenario at lower storage levels, and Alt 4 storage is lower in wetter years when storage levels are higher. In the wettest of years there is enough water in the system that both scenarios have similar carryover storage conditions.

Figure 46. Trinity Reservoir Carryover Storage and Average Monthly Changes in Storage by Water Year Type



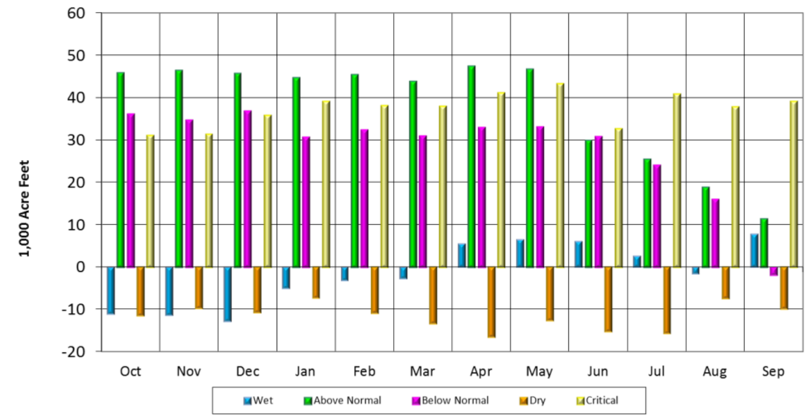
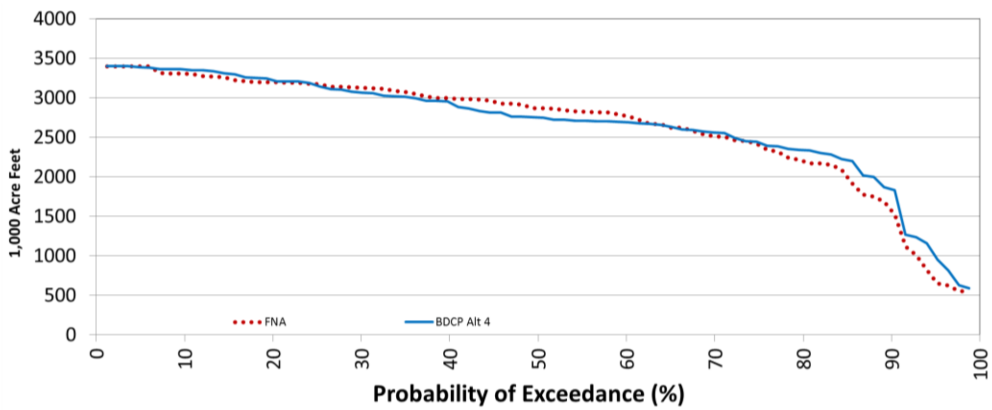


Figure 47. Shasta Reservoir Carryover Storage and Average Monthly Changes in Storage by Water Year Type



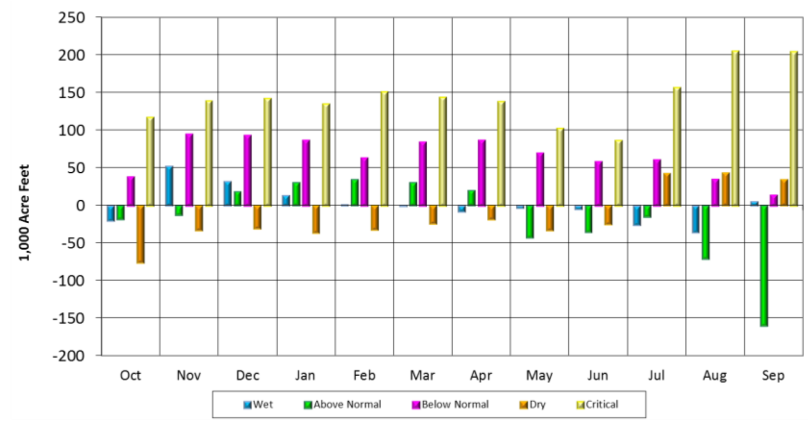
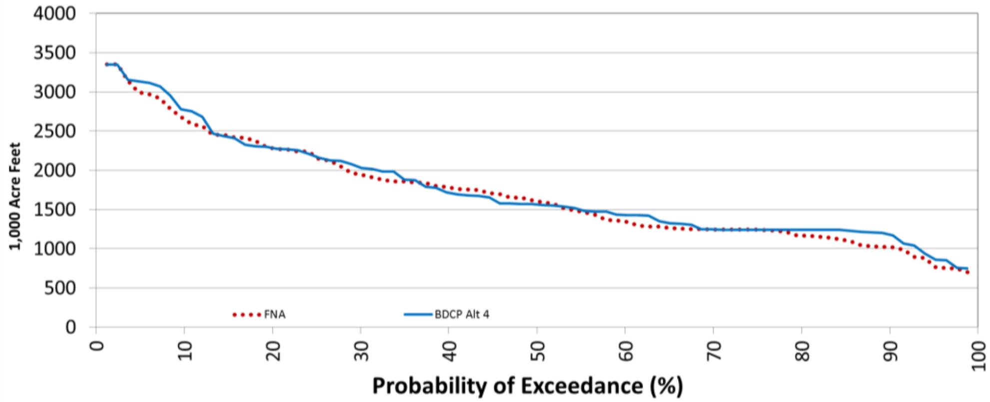


Figure 48. Oroville Reservoir Carryover Storage and Average Monthly Changes in Storage by Water Year Type



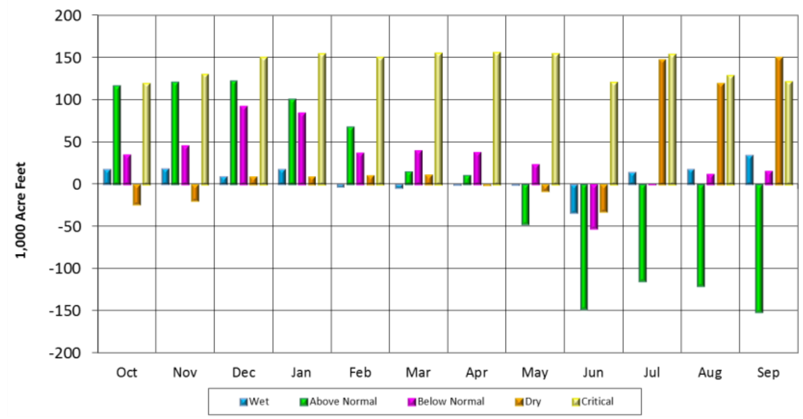
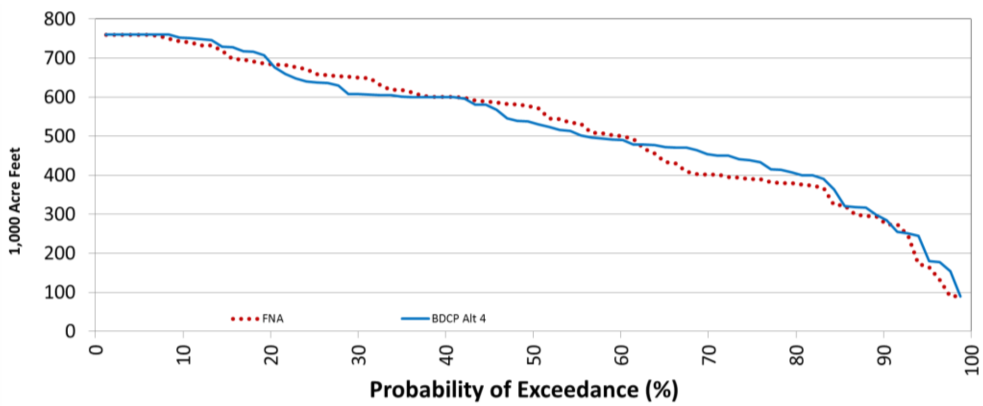
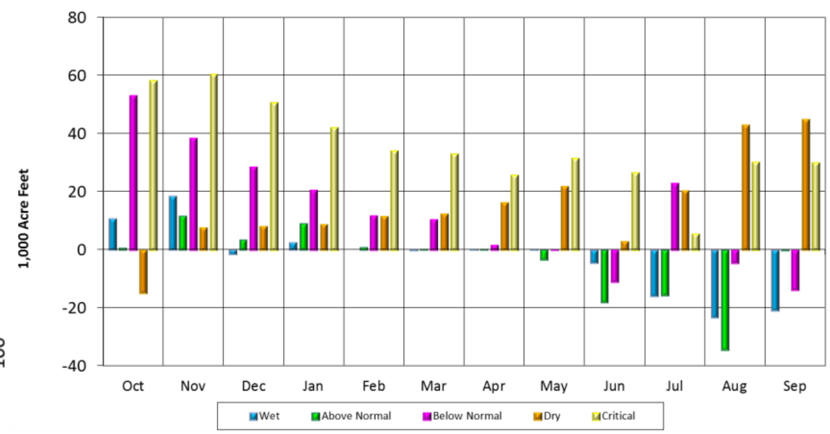


Figure 49. Folsom Reservoir Carryover Storage and Average Monthly Changes in Storage by Water Year Type





San Luis Reservoir Operations

As seen in Figure 50 and Figure 51 below, both CVP and SWP portions of San Luis Reservoir storage fills more regularly in the Alt 4 Scenario. As described earlier in this document, low point in both CVP and SWP San Luis Reservoir is managed to satisfy water supply obligations the model makes during the spring of each year. This is a complex balance involving available upstream storage, available conveyance capacity, delivery allocations, and south of Delta demand patterns. Considering this myriad of variables, there are times when low point in San Luis Reservoir is higher in the Alt 4 Scenario than the FNA Scenario and times when the opposite is true.

Figure 50. SWP San Luis

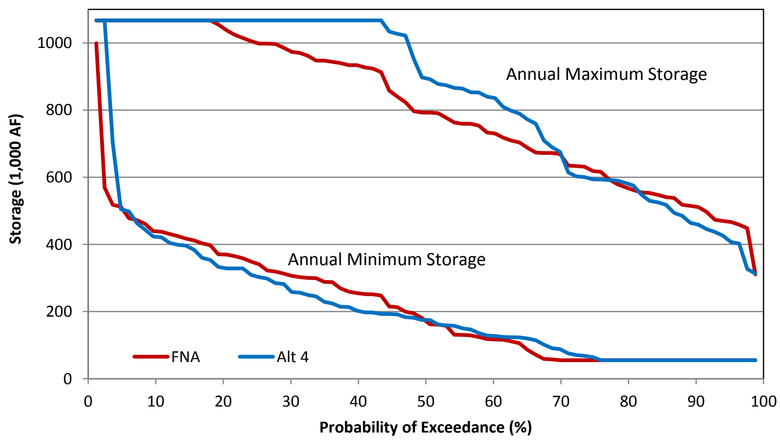
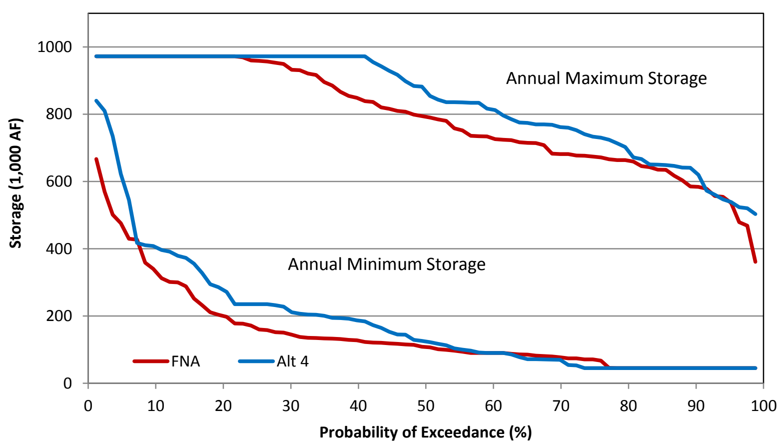


Figure 51. CVP San Luis



CVP Water Supply

As can be seen in Table 5, the independent modeling analysis shows an average increase of approximately 262 TAF of delivery accruing to CVP customers in the Alt 4 Scenario relative to the FNA Scenario, mostly occurring to CVP SOD agricultural customers. Delivery increases are greater in wetter year types with lower increases in dryer years. Figure 52 contains exceedance probability plots for CVP water service contractor deliveries and allocations. Changes in Sacramento River Settlement and San Joaquin River Exchange Contractor deliveries do not occur in the modeling analysis and are not an anticipated benefit of the BDCP. Although modeling demonstrates minor changes to NOD CVP service contractors, this increase is not an anticipated benefit of the BDCP.

Table 5. CVP Delivery Summary

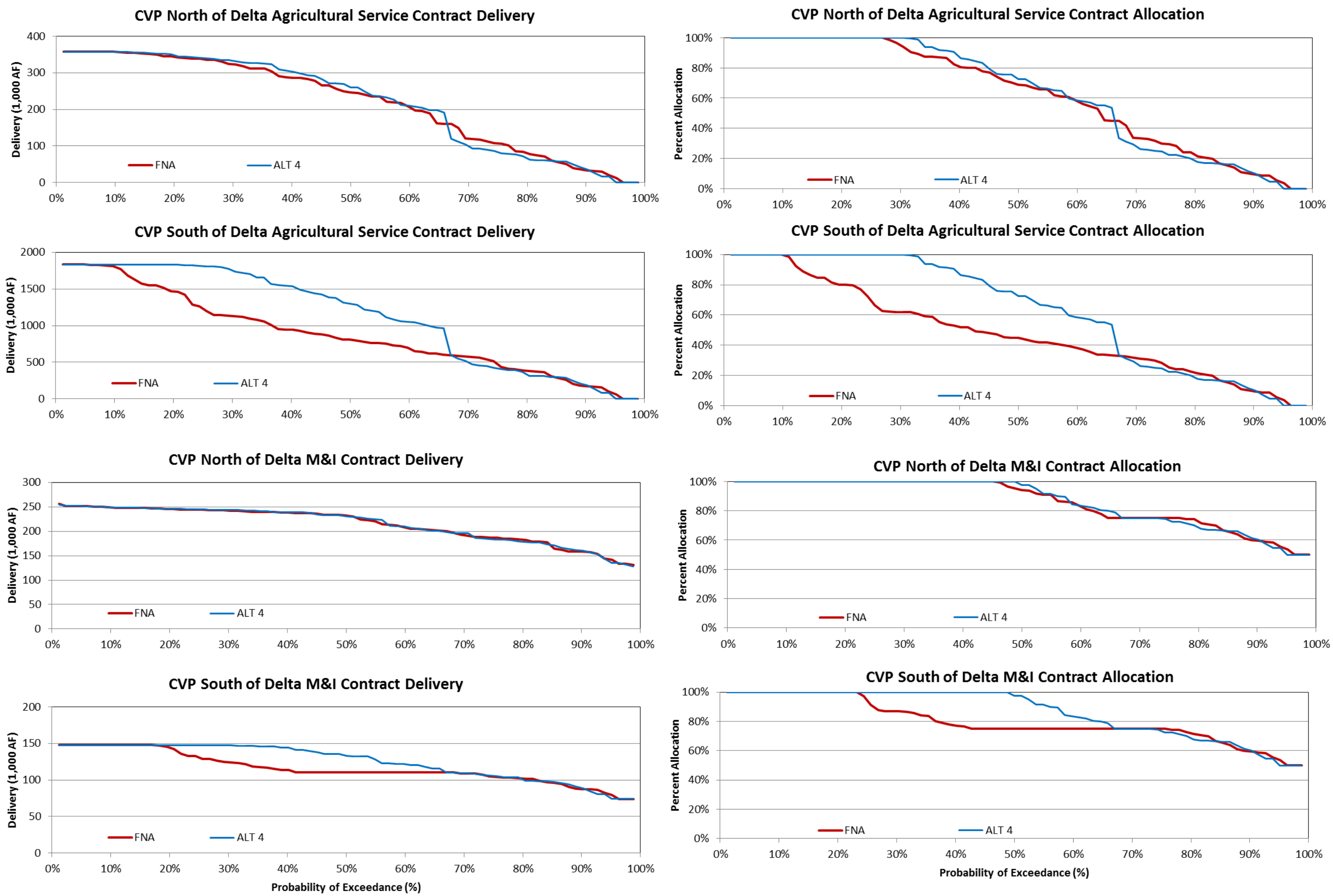
Average Annual CVP deliveries by Water Year Type FNA (1,000 AF)

	AG NOD	AG SOD	Exchange	M&I NOD	M&I SOD	Refuge NOD	Refuge SOD	Sac. Setlmnt	CVP NOD Total	CVP SOD Total
All Years	**220**	**882**	**852**	**214**	**116**	**87**	**273**	**1860**	**2380**	**2306**
W	327	1408	875	241	135	90	280	1856	2515	2881
AN	284	999	802	221	113	83	258	1716	2304	2341
BN	206	725	875	217	111	90	281	1900	2413	2176
D	138	569	864	195	106	88	277	1896	2317	2000
C	43	202	741	157	87	71	234	1754	2025	1447

Difference: Alt 4 minus FNA (1,000 AF)

	AG NOD	AG SOD	Exchange	M&I NOD	M&I SOD	Refuge NOD	Refuge SOD	Sac. Setlmnt	CVP NOD Total	CVP SOD Total
All Years	2	251	0	0	9	0	0	0	2	260
W	0	305	0	0	10	0	1	0	0	316
AN	10	492	0	1	14	1	0	-2	10	504
BN	12	354	0	5	16	0	-2	1	19	366
D	-10	67	0	-4	4	1	0	-1	-15	72
C	2	27	0	2	2	1	0	-1	4	29

Figure 52. CVP Water Supply Delivery and Allocation



SWP Water Supply

The independent analysis shows an increase in average annual SWP SOD deliveries of approximately 450 TAF, but a reduction in critical year deliveries of approximately 116 TAF. Annual average Article 21 deliveries increase by about 100 TAF and Article 56 increases by about 18 TAF. Figure 53 contains exceedance probability plots for SWP SOD deliveries for the FNA and Alt 4 Scenarios, each of these plots show increases in higher delivery years. Although Table A deliveries increase in 65% of years, there are decreases in 35% of the dryer years (see Table 6).

Table 6. SWP Delivery Summary

FNA

	Table A	Art. 21	Art. 56	Total
All Years	**2426**	**64**	**90**	**2580**
W	3221	98	121	3440
AN	2628	86	81	2794
BN	2527	82	95	2703
D	1809	14	70	1893
C	1105	17	48	1170

Difference Alt4 minus FNA

	Table A	Art. 21	Art. 56	Total
All Years	328	102	18	448
W	525	220	14	759
AN	636	98	-1	733
BN	565	50	31	647
D	-63	41	27	6
C	-124	-8	16	-116

Figure 53. SWP Delivery for Alt 4 and FNA

4 COMPARING INDEPENDENT MODELING AND BDCP MODELING

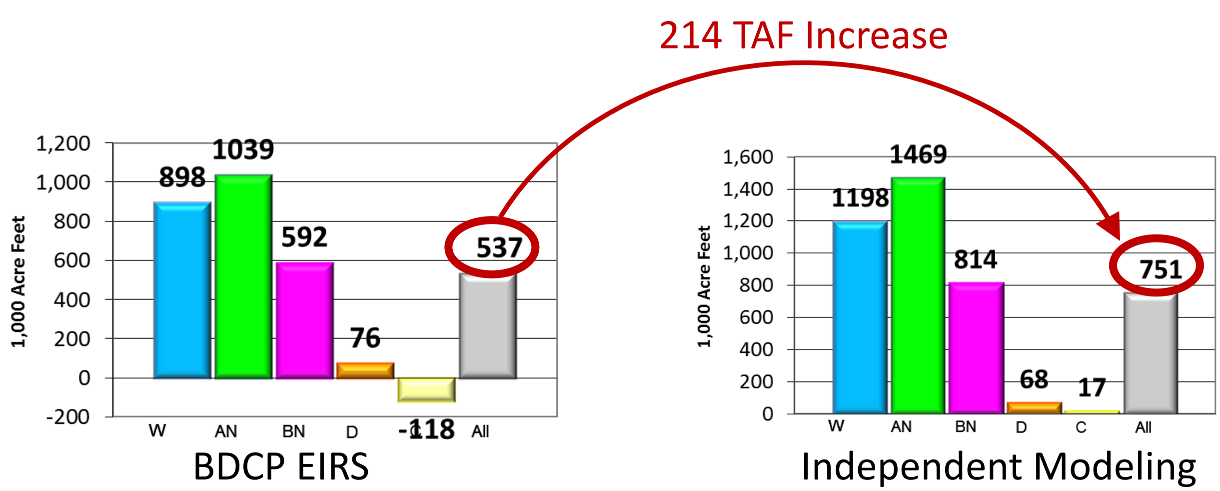
The independent modeling effort originally stemmed from reviews of DWR's BDCP modeling where we found that BDCP modeling does not provide adequate information to determine how BDCP may affect the system. Based on the premise that the independent modeling portrays a more accurate characterization of how the CVP/SWP system may operate under Alt 4, this comparison is meant to demonstrate the differences between results of a more accurate analysis and BDCP modeling. Differences in results between these modeling efforts are believed to provide insight regarding how effects that BDCP will have on the actual CVP/SWP system differ from modeling used to support the Draft EIRS.

Although thorough comparisons of modeling were performed, only key differences are illustrated for the purpose of this comparison.

Delta Exports

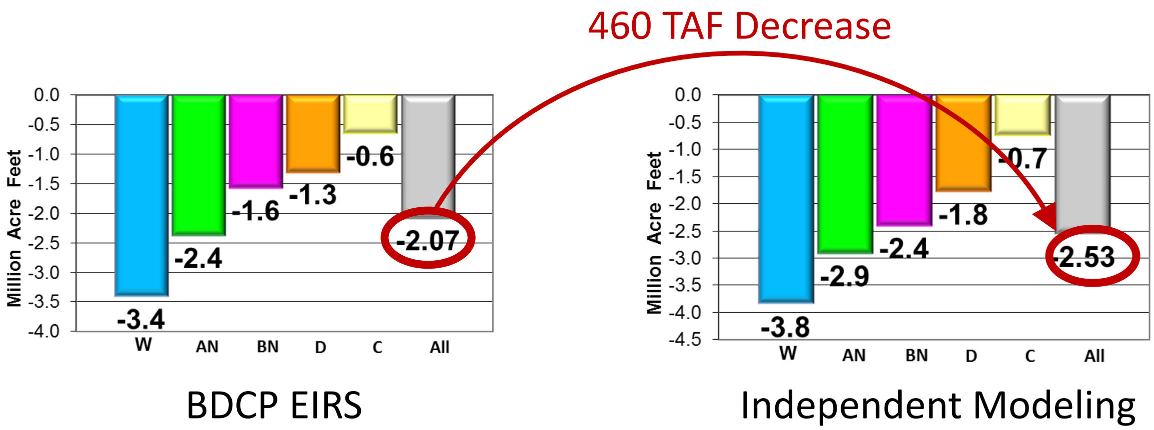
Figure 54 displays changes in the Delta exports for the BDCP modeling (Alt 4-ELT minus NAA-ELT) and for the independent modeling (Alt 4 minus FNA). Independent modeling analysis shows about 200 TAF greater increases in exports than the BDCP modeling. A large component of this difference is due to fixes of known modeling issues, as described in the 2013 SWP DRR. This difference is also attributable to more realistic reservoir operations, more efficient DCC gate operations, changes in water supply allocation logic, and more efficient operation of the NDD.

Figure 54. Result Difference: Delta Exports



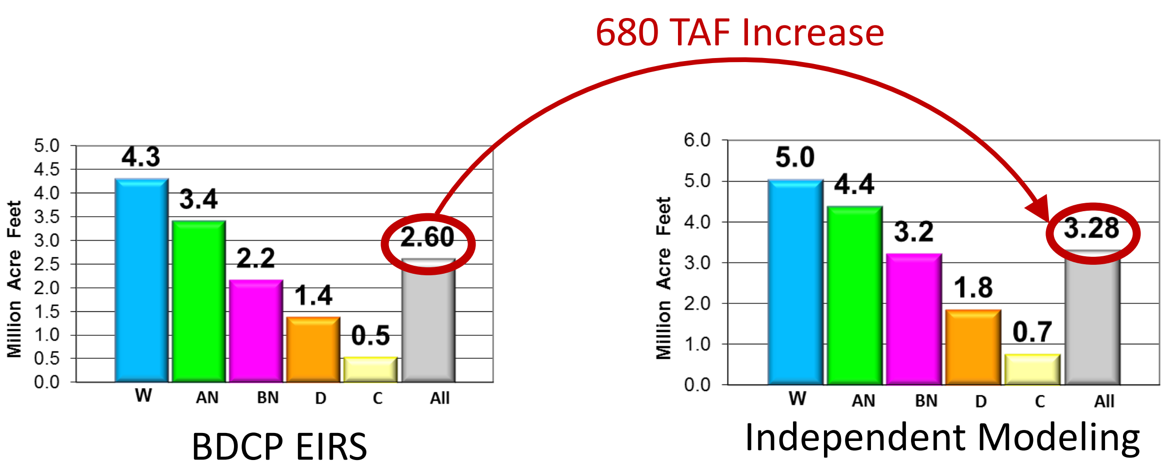
Average annual SDD are decreased by about 460 TAF in the independent analysis compared to the BDCP modeling. A large component of this difference is due to fixes of known modeling issues, as described in the 2013 SWP DRR. These fixes prevent "artificial" bypass criteria from limiting use of the NDD beyond what is intended in the BDCP project description. This difference is also attributable to more efficient DCC gate operations and more efficient operation of the NDD. Figure 55 demonstrates the difference between the BDCP and independent analysis, where SDD decrease by 2.07 MAF in the BDCP analysis and by 2.53 MAF in the independent analysis.

Figure 55. Result Difference: South Delta Diversion



Use of the NDD is 680 TAF greater in the independent analysis relative to the BDCP analysis. A large component of this difference is due to fixes of known modeling issues, as described in the 2013 SWP DRR. These fixes prevent "artificial" bypass criteria from limiting use of the NDD beyond what is described in the BDCP project description. Figure 56 compares average annual NDD in the BDCP to the independent analysis.

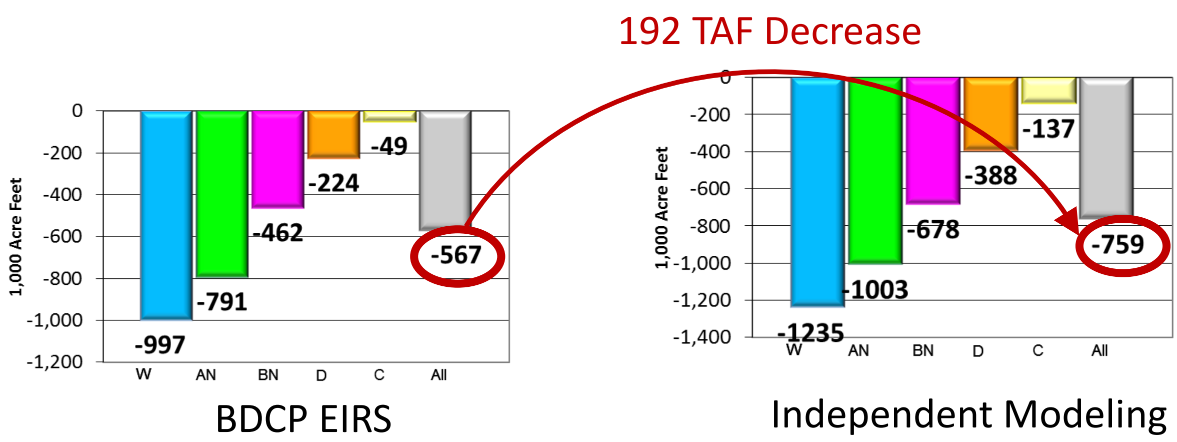
Figure 56. Result Difference: North Delta Diversion



Delta Outflow

Total Delta exports in the independent analysis are about 200 TAF greater than the BDCP modeling analysis with a corresponding decrease in Delta outflow in the independent analysis of about 200 TAF. Figure 57 compares average annual changes in Delta outflow between the independent analysis and BDCP modeling, BDCP modeling shows a decrease of about 567 TAF and the independent analysis shows a decrease of about 759 TAF.

Figure 57. Result Difference: Net Delta Outflow



Reservoir Storage

Reservoir operating rules for Alt4 in the BDCP EIRS modeling are changed relative to the NAA. In the BDCP EIRS modeling of Alt 4 rules are set to releases more water from upstream reservoirs to San Luis Reservoir from late winter through July, reduce releases in August, and then minimize releases to drive San Luis Reservoir to dead pool from September through December. This operation is inconsistent with actual operations and causes reductions in upstream storage from May through August. Figure 58 and Figure 59 contain exceedance probability plots of carryover storage and average monthly changes in storage by water year type for Shasta and Folsom for the BDCP and independent modeling. Although carryover storage for Alt 4 and the NAA is similar in the BDCP EIRS modeling, there is drawdown from June through August that may cause impacts to cold water pool management. In the independent modeling upstream reservoirs are drawn down more in years when storage is available while dryer year storage is maintained at higher levels, this is illustrated in the carryover plots for Shasta and Folsom in Figure 58 and Figure 59.

Figure 58. Result Difference: Shasta Storage

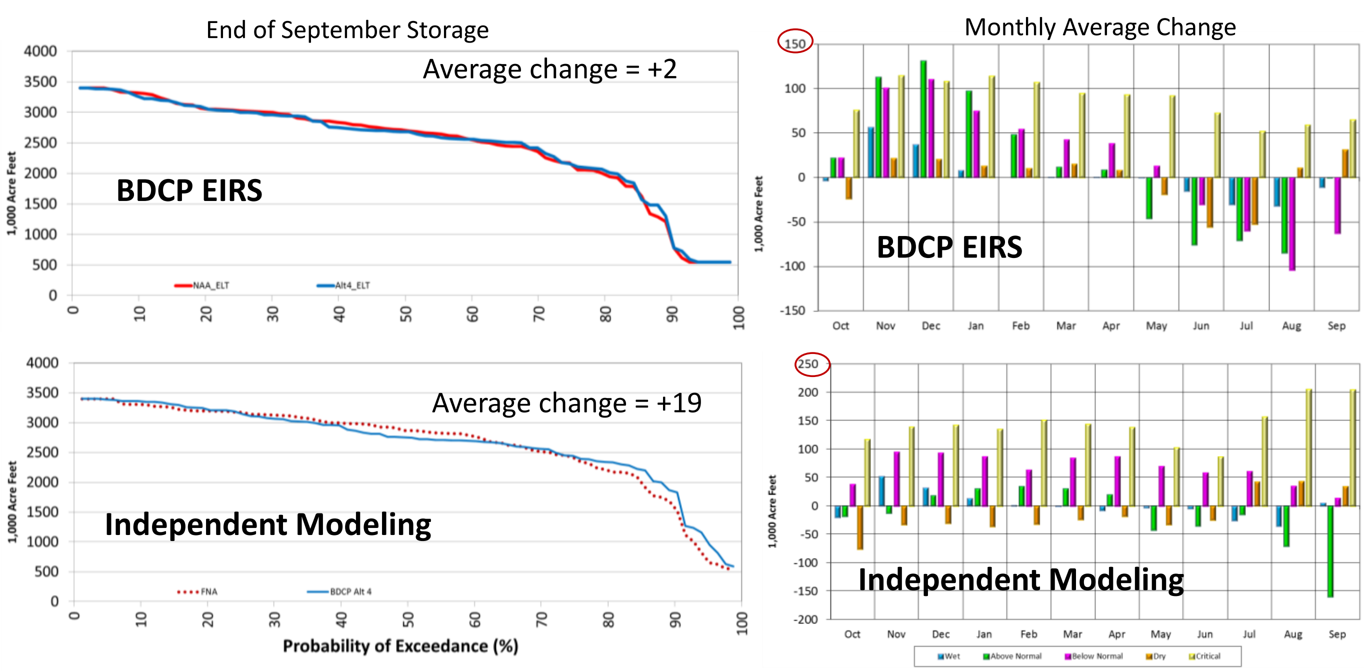
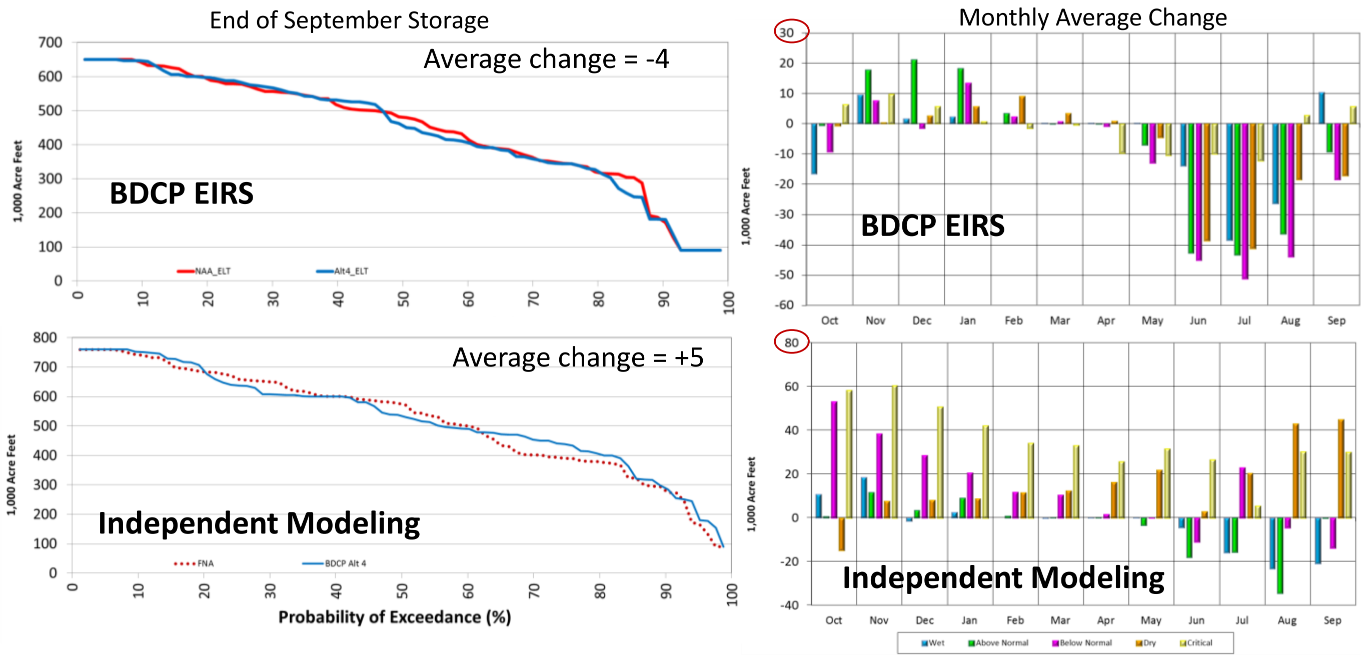


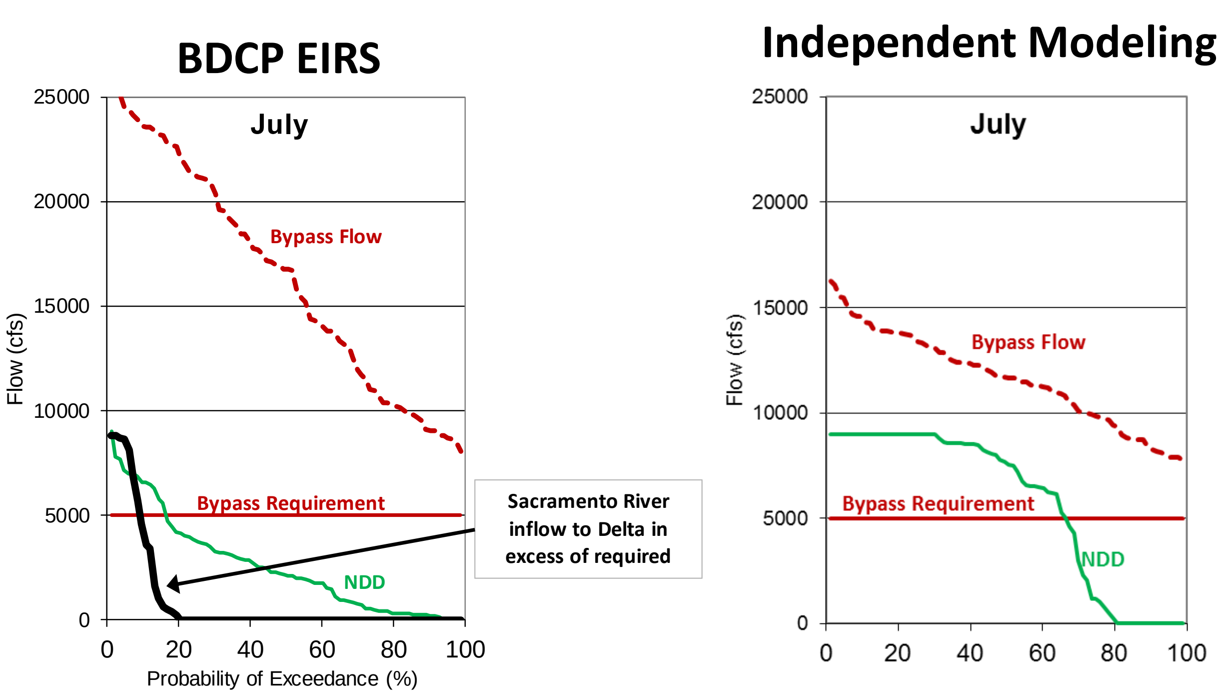
Figure 59. Result Difference: Folsom Storage



North Delta Diversions

Independent modeling shows greater NDD during July and other months because the BDCP EIRS modeling includes artificially high Sacramento River bypass flow requirements. Figure 60 contains exceedance probability plots of Sacramento River required bypass, Sacramento River bypass flow, NDD, and excess Sacramento River flow to the Delta. As can be seen in Figure 60, bypass flow is always above the bypass requirement. The BDCP version of CalSim sets a requirement for Sacramento River inflow to the Delta that the independent modeling does not need in order to satisfy Delta requirements, therefore the NDD is higher in the independent modeling.

Figure 60. NDD, and Sacramento River Flow



Delta flows below the NDD facility

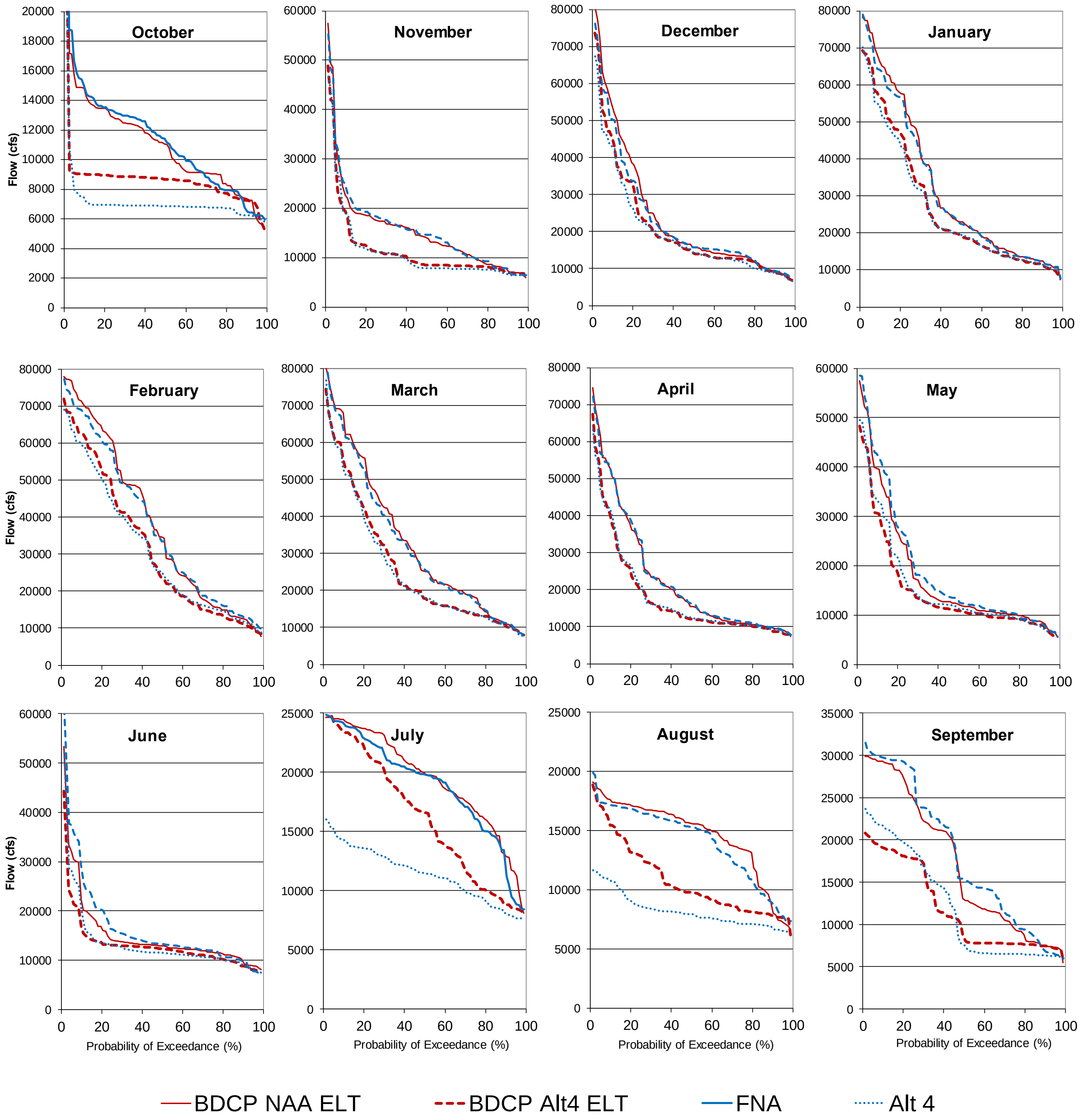
Figure 61 contains monthly exceedance probability plots for Sacramento River below the NDD for the following scenarios: 1) BDCP NAA-ELT, 2) BDCP Alt 4-ELT, 3) independent modeling FNA, and 4) independent modeling Alt 4. The most significant differences in flow changes occur in October, July, August, and September. Changes in Sacramento River flow entering the Delta are a key indicator of changes in interior Delta flows, water levels, and water quality.

For the month of October the independent modeling shows flow below the NDD to be about 2,000 cfs lower than the BDCP modeling. The difference in this month is largely due to reoperation (closure) of the cross channel gate to lessen the amount of Sacramento River flow at Hood necessary to maintain Rio Vista flow requirements downstream of the cross channel gates.

The most substantial difference between the BDCP and independent modeling occurs in July and August. The differences in these two months are primarily attributable to model fixes that have occurred since the BDCP modeling was performed. In the independent modeling, July flows are reduced on average about 7,500 cfs while BDCP shows a reduction of about 3,300 cfs. In the independent modeling August flows are reduced on average about 5,900 cfs while BDCP shows a reduction of about 3,900 cfs.

In the independent modeling September flows are reduced by about 6,100 cfs while BDCP modeling shows a reduction of about 5,300 cfs. The independent modeling shows Sacramento River flow entering the Delta to be about 7,000 cfs 50% of the time, BDCP modeling show Sacramento River flow is about 8,000 cfs 50% of the time.

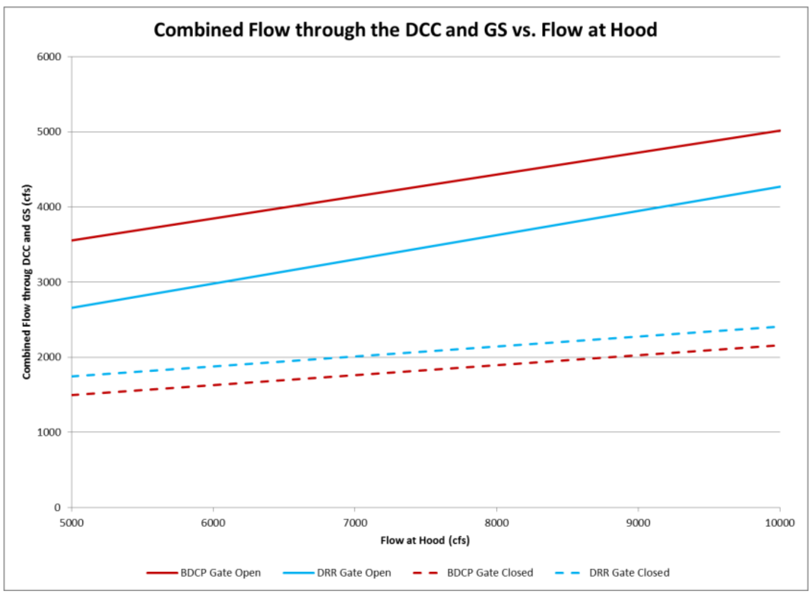
Figure 61. Sacramento River below Hood



Sacramento River water entering the Central Delta

In CalSim, flow through the DCC gate and Georgianna Slough from the Sacramento River into the Central Delta is assumed to be linearly dependent on flow at Hood. There are two linear relationships; one is used when the DCC gates are closed, and the other is used when the DCC gates are open. The 2013 SWP Delivery Reliability Report CalSim II modeling, and therefore our independent modeling, used different linear flow relationships than BDCP. The BDCP and 2013 DRR (and independent) flow relationships for both the open and closed gate conditions are compared in Figure 62. When Sacramento River flow at Hood is in the range from 5,000 cfs to 10,000 cfs the balance between Hood flow, required flow at Rio Vista, and DCC gate operation can affect upstream reservoir operations, SOD exports, and Delta outflow. As shown in Figure 62, given the same flow at Hood and DCC gates closed, the independent analysis will show slightly higher flow into the Central Delta (12% to 17% difference for the Hood flows in the 5,000 cfs to 10,000 cfs range). With DCC gates open the same flow at Hood, the independent analysis will show lower flow into the Central Delta (-15% to -25% difference for the Hood 5,000 cfs to 10,000 cfs range). Figure 63 and Figure 64 show the differences through the DCC and combined flow through the DCC and Georgiana Slough.

Figure 62. Flow through Delta Cross Channel and Georgiana Slough versus Sacramento River Flow at Hood



In addition to the differences in flow equations for portion of Sacramento River entering the interior Delta through the DCC and Georgiana Slough, the DCC gate operations were modified for the month of October. In the independent modeling, the DCC gate is operated to balance the amount of Sacramento River flow needed to meet flow standards at Rio Vista on the Sacramento River and flow needed to meet western Delta water quality. This changed operation often results in DCC gate closures for about 15 days during the month of October. The reduction in flow through the DCC during October can be seen in Figure 64.

Figure 63. Cross Channel Flow

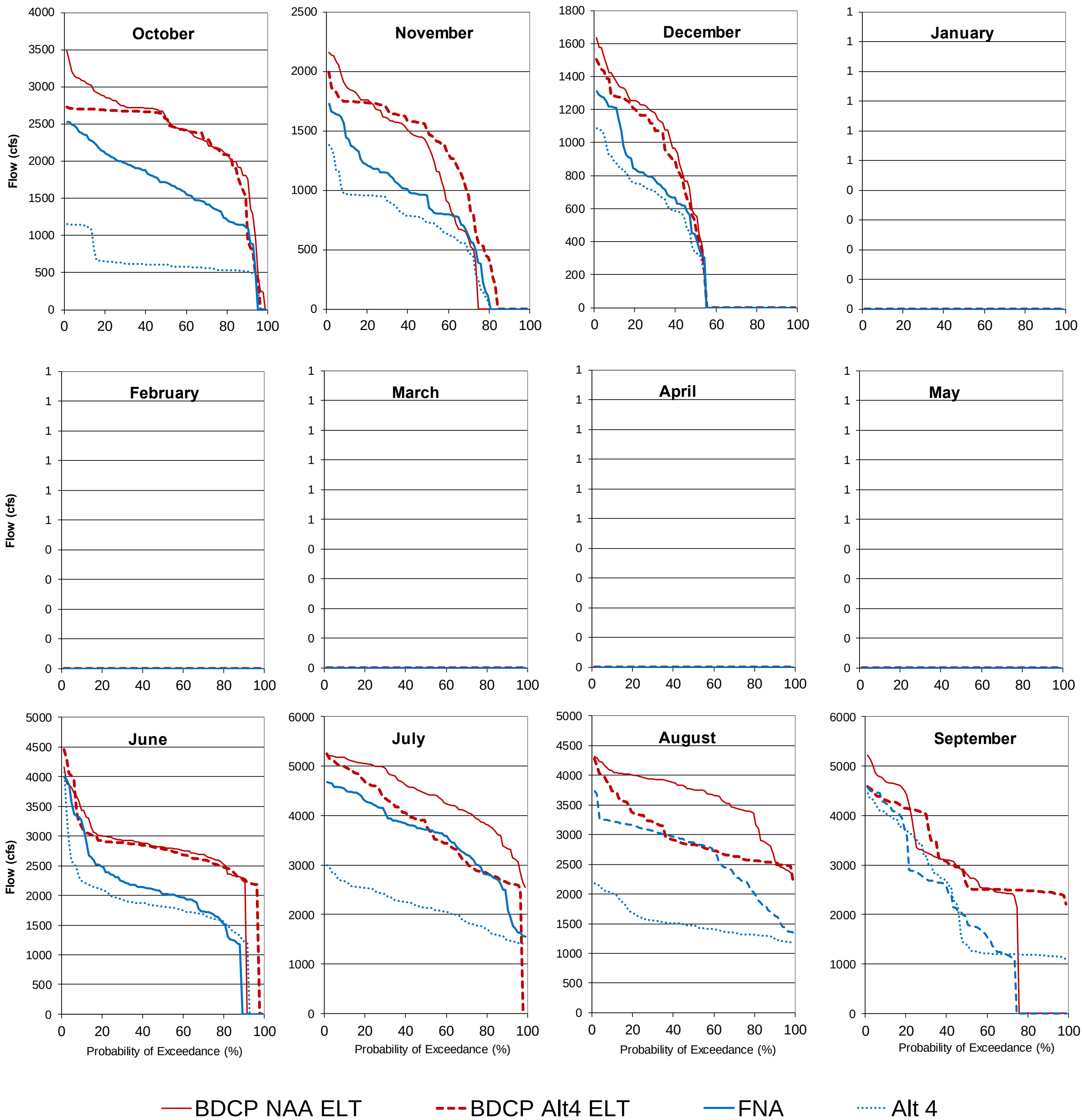
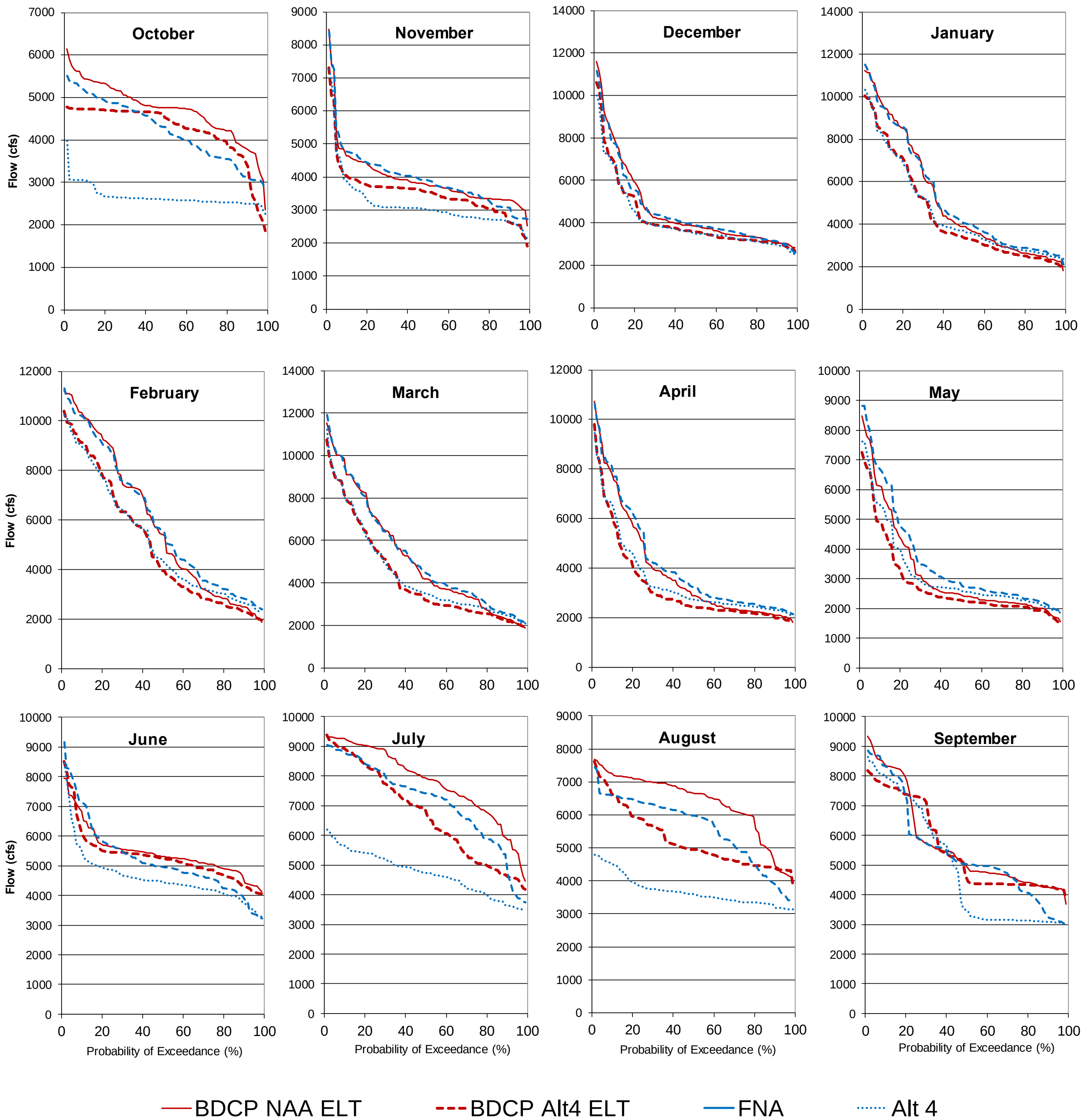


Figure 64. Flow through Delta Cross Channel and Georgiana Slough



Conclusions regarding BDCP effects

Based on the Independent Modeling, the amount of water exported (diverted from the Delta) may be approximately 200 thousand acre-feet (TAF) per year higher than the amount disclosed in the Draft EIR/S. This total represents

- approximately 40 TAF/yr more water diverted and delivered to the SWP south of Delta contractors, and
- approximately 160 TAF/yr more water diverted and delivered to the CVP south of Delta contractors.

The BDCP Model estimates that, under the NAA ELT (without the BDCP), total average annual exports for CVP and SWP combined are estimated to be 4.73 million acre feet (MAF) and in the Independent Modeling FNA combined exports are 5.61 MAF. The BDCP Model indicates an increase in exports of approximately 540 TAF and the Independent Modeling shows an increase of approximately 750 TAF in Alt 4.

The Independent Modeling suggests that Delta outflow would decrease by approximately 200 TAF/yr compared to the amount indicated in the Draft EIR/S.

- This lesser amount of Delta outflow has the potential to cause greater water quality and supply impacts for in-Delta beneficial uses and additional adverse effects on species. To determine the potential effects of the reduced amount of outflow, additional modeling is needed using tools such as DSM2.

The BDCP Model does not accurately reflect the location of the diversions that the SWP and CVP will make from the Delta.

- When the errors in the model are corrected, it reveals that the North Delta intakes could divert approximately 680 TAF/yr more than what was disclosed in the BDCP Draft EIR/S, and
- the amount of water diverted at the existing South Delta facilities would be approximately 460 TAF/yr less than what is projected in the BDCP Draft EIR/S.

Hydrologic modeling of BDCP alternatives using CalSim II has not been refined enough to understand how BDCP may affect CVP and SWP operations and changes in Delta flow dynamics. Better defined operating criteria for project alternatives is needed along with adequate modeling rules to analyze how BDCP may affect water operations. Without a clear understanding of how BDCP may change operations, affects analysis based on this modeling may not produce reliable results and should be revised as improved modeling is developed.